Environmental Footprints of Mass Bathing on Water Quality of River Ganga during Kumbh Mela

CENTRAL POLLUTION CONTROL BOARD
(Ministry of Environment, Forest, and Climate Change)

ACKNOWLEDGEMENTS

This report "Environmental Footprints of Mass Bathing on Water Quality of River Ganga during Kumbh Mela" is the outcome of the study on the environmental footprint of the world's largest religious congregation on river Ganga and its tributaries. The report provides a detailed record of the water quality of river Ganga and its tributaries with special emphasis on the impact of mass bathing on river health, pollution load of different drains discharging into the Ganges, efficiency of the sewage treatment plants and solid waste management (municipal and biomedical) in Prayagraj during the entire duration of the Kumbh Mela. It envisages to create a model roadmap for developing strategies for pollution minimization and mitigation in River Ganga for upcoming Kumbh Melas.

CPCB gratefully acknowledge the support and guidance of all experts received towards completion of this report. This report has been conceptualized and prepared under the guidance of Dr. Prashant Gargava, Member Secretary, CPCB and Dr. Ajit Kumar Vidyarthi, Director, CPCB. The data presented in this report has been analyzed and compiled by Dr. D.K. Soni, Additional Director, under the supervision of Sh. S.K. Gupta, Regional Director-Lucknow, CPCB. The contribution of Ms. Garima Dublish, Research Associate-III and Dr. Vivek Rana, Research Associate-I in finalization of report is also acknowledged. This work was supported by National Mission for Clean Ganga (NMCG) under Pollution Inventorization, Assessment and Surveillance on River Ganga (PIAS) project and World Bank Funded Strengthening of Environmental Regulators (SER) project. We would like to thank Dr. (Prof.) C. B. Majumder, IIT Roorkee for sparing his valuable time to review this report technically for better presentation and understanding.

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CONTENTS

1. Salient Features of River Ganga

The Ganga is a trans-boundary river, flowing through India and Bangladesh. The 2525 km (1,569 mi) long river rises from the western Himalayas in Uttarakhand and flows through the Gangetic plain of north India in Uttar Pradesh, Bihar, Jharkhand and West Bengal and finally joins the Bay of Bengal. Average annual discharge of river Ganga is about 493400 million cusecs. Main tributaries of river Ganga are Yamuna, Ramganga, Gomti, Ghaghara, Gandak, Damodar, Kosi & Kali-East and main sub tributaries are Chambal, Sindh, Betwa, Ken, Tons (beyond Five States), Sone & Kasia-Haldi. Major Cities located on the bank are Srinagar, Rishikesh, Haridwar, Roorkee (in Uttarakhand), Bijnor, Narora, Kannauj, Kanpur, Prayagraj, Varanasi, Mirzapur (in Uttar Pradesh), Patna, Bhagalpur (in Bihar) and Bahrampur, Serampore, Howrah and Kolkata (in West Bengal).

2. Kumbh Mela

The Kumbh Mela is the biggest religious congregation in the world. UNESCO has recognized Kumbh Mela as a "Cultural heritage of humanity" and held up as the world's largest peaceful gathering of pilgrims at Sangam (confluence of the holy rivers Ganga, Yamuna and Saraswati) in Prayagraj district of Uttar Pradesh (**Figure 1**). Uttar Pradesh Government has made special arrangements to ensure cleanliness in and around the Mela area of about 3200 acres. To provide clean surroundings of Mela, total area of Kumbh Mela was divided into 20 (twenty) sectors. Prayagraj hosted around 13.02 Crore people this year. According to media reports, around 20 lakh people were residing at the site. It was very challenging for the Government organizations to keep the Mela area clean & swachha, especially on mass bathing occasions.

Figure 1 (a) Mass bathing at Kumbh Mela 2019; **(b)** Panoramic view of tent city inhabited by pilgrims at Kumbh Mela; **(c)** Seagull birds – Annual visitors of Sangam; and **(d)** Operation of small ships during Kumbh Mela

3. Objective of the Study

CPCB Regional Directorate (North) Lucknow along with officials of CPCB Head Office Delhi carried out monitoring during Kumbh Mela 2019 to assess the water quality of river Ganga and its tributaries, i.e., Kali, Ramganga and Yamuna at various locations starting from Farrukhabad to D/s of Prayagraj including Triveni Sangam at Prayagraj (U.P). The details of auspicious bathing dates of Kumbh Mela 2019, along with number of pilgrims and water discharge in river Ganga at Prayagraj is mentioned in **Table 1**.

Table 1 Details of bathing occasions, number of pilgrims and water discharge in river Ganga at Prayagraj

Name of the Festival	Date	No. of pilgrims (in crores) (approx.)*	Flow of R. Ganga at Prayagraj (m^3/sec)**
Makar Sakranti	15.01.2019	3	404.04
Paush Poornima	21.01.2019	1.07	387.61
Mauni Amawasya	04.02.2019	5	426.00
Basant Panchami	10.02.2019	1.7	458.00
Maghi Poornima	19.02.2019	1.25	344.00
Mahashivratri	04.03.2019	1	455.33

**Data provided by Kumbh Mela Administration, Prayagraj*
***Data provided by CWC, Lucknow*

4. Water Quality of River Ganga

Monitoring of river Ganga and its tributaries was carried out during different auspicious mass bathing occasions for assessment of water quality for various parameters. The details of monitoring locations and sampling frequency are given in **Figure 2** and **Table 2**.

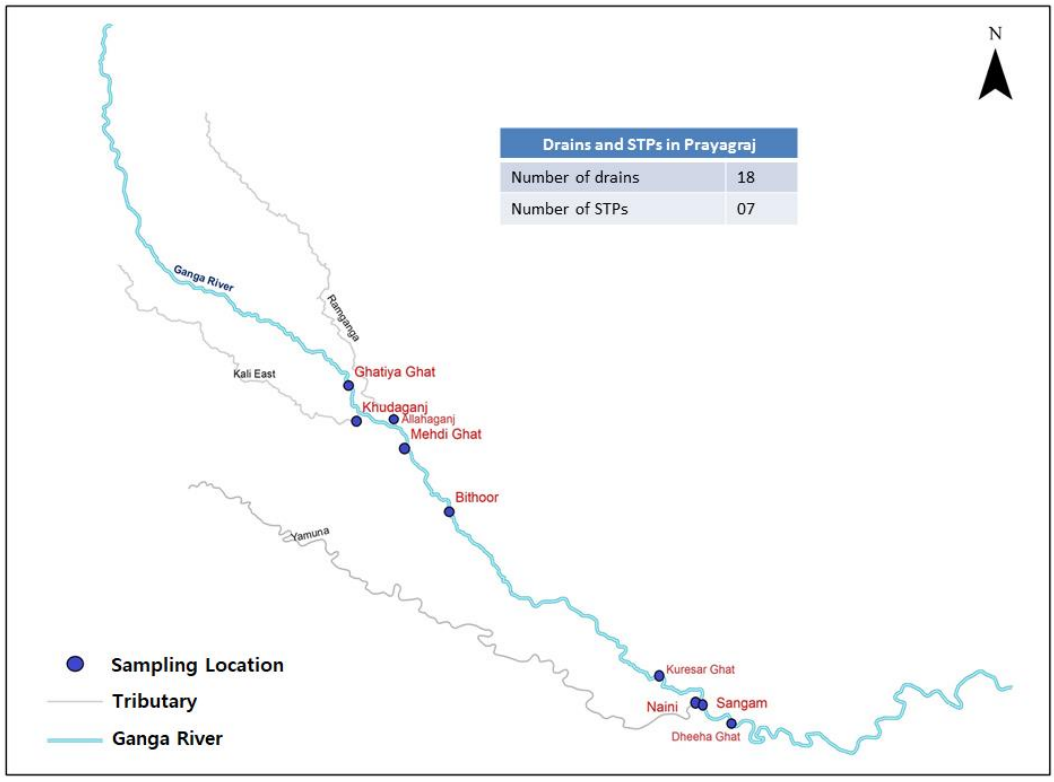

Figure 2 Water quality-monitoring locations on River Ganga and its tributaries namely Yamuna, Ramganga and Kali (East)

Table 2 Details of monitoring locations and sampling frequency

Location	Frequency
River Ramganga at Allahganj, Farrukhabad River Ganga at Ghatiya Ghat, Farrukhabad River Kali at Khudaganj Kannauj River Ganga a/c with River Kali at Mehdi Ghat, Kannauj	Once a day 4-5 days before auspicious bathing
River Ganga at Bithoor, Kanpur	Once a day 3-4 days before auspicious bathing
River Ganga D/s of Kanpur at Dyodhi Ghat, Kanpur	Once a day on daily basis
River Yamuna (B/c to river Ganga) near Naini Bridge, Prayagraj	Twice a day during auspicious bathing
River Ganga U/s of Prayagraj at Kuresar Ghat, Prayagraj	Once a day during auspicious bathing
Sangam	Twice a day on daily basis
River Ganga D/s of Prayagraj at Deeha Ghat, Prayagraj	Once a day during auspicious bathing

Water quality of river Ganga w.r.t. pH, temperature, colour, conductivity, chloride, NH_3-N, DO, BOD, COD, TC and FC was evaluated at U/s of Sangam near Kuresar Ghat, at Sangam (during morning and evening) and Deeha Ghat on different bathing occasions. The results are shown in Figure 3-13. Results of water quality at different locations during mass bathing occasions are attached at Annexure-I.

Primary water quality criteria for outdoor bathing: As per Environment (Protection) Amendment Rules, 2000, standard for river water quality used for organized outdoor bathing are as follows;

Table 3 Primary water quality criteria for outdoor bathing

Parameter	Standard
pH	6.5 - 8.5
Dissolved Oxygen	5 mg/l or more
Biochemical Oxygen demand 3 day,27°C:	3 mg/1 or less
Fecal Coliform	2500 MPN/100 ml

4.1 River Ganga U/s of Sangam near Kuresar Ghat, Prayagraj

The samples from river Ganga were collected at Kuresar Ghat and analyzed for various relevant parameters. The pH value of samples collected from Kuresar Ghat varies from 8.13 to 8.64 against 6.5-8.5 criteria for outdoor bathing as Designated Best Use (DBU). River Ganga water exceed pH for outdoor bathing only during Makar Sakranti; whereas on other occasions it lies within limit of designated best use water quality criteria for organized outdoor bathing. DO

varies from 8.2 to 13 mg/L against 5 mg/L and BOD varies from 2.5 to 8.6 mg/L against limit of 3 mg/L of outdoor bathing water quality criteria. Except pre-Makar Sakranti and Basant Panchami BOD value exceeds outdoor bathing water quality criteria on all occasions whereas FC exceeds outdoor bathing water quality criteria on Pre-Makar Sakranti, Pre Basant-Panchami and Basant Panchami.

4.2 River Ganga at Sangam (confluence of Ganga, Yamuna and Saraswati rivers)

Sangam is the place where the maximum number of pilgrims takes a bath. Water quality was monitored at this location in the morning and evening. The analysis result shows a higher concentration of BOD, COD, Cl^{-}, Fecal Coliform, etc., which is an indication of the addition of organic pollutants into the river.

In the morning, pH varies from 8.09 to 8.83 mg/L against 6.5 to 8.5 mg/L of outdoor bathing water quality criteria. pH exceeds outdoor bathing norms on pre-Makar Sakranti, post-Makar Sakranti, post-Mauni Amawasya and from pre to post Basant Panchami. DO vary from 8.5 to 12 mg/L against 5 mg/L thus lies within outdoor bathing water quality norms of limit and BOD varies from 2.1 to 7.7 mg/L against 3 mg/L of outdoor bathing water quality criteria. BOD was found higher than outdoor bathing norms at almost all occasions except pre-Makar Sakranti, pre Basant Panchami and Basant Panchami. FC varies from <1.8 to 13000 MPN/100 ml which lies within outdoor bathing water quality norms except on Makar Sakranti, post-Mauni Amawasya, Maghi Poornima, pre-Maha Shivratri to post-Maha Shivratri.

In the evening, pH varies from 8.09 to 8.72 mg/L against 6.5 to 8.5 mg/L of outdoor bathing norms. pH value was found higher than norms at six occasions, i.e., Makar Sakranti, post-Makar Sakranti, pre-Paush Poornima, Mauni Amawasya, post-Mauni Amawasya and Basant Panchami. DO vary from 8.4 to 13 mg/L against the limit of 5 mg/L thus lies within norms of outdoor bathing water quality on all occasions. BOD varies from 2.6 to 7.5 mg/l; thus, BOD value exceeds outdoor bathing norms on all occasions except Basant Panchami. Impact of bathing on BOD level can be seen by morning and evening value of BOD at Sangam as on various auspicious occasions BOD value was found higher than outdoor bathing norms in the morning than evening. FC value varies from <1.8 to 23000 MPN/100ml and exceeds outdoor bathing norms at six locations. FC was found exceeding outdoor bathing norms on the occasion of Maha Shivratri and post-Maha Shivratri in the morning as well as evening.

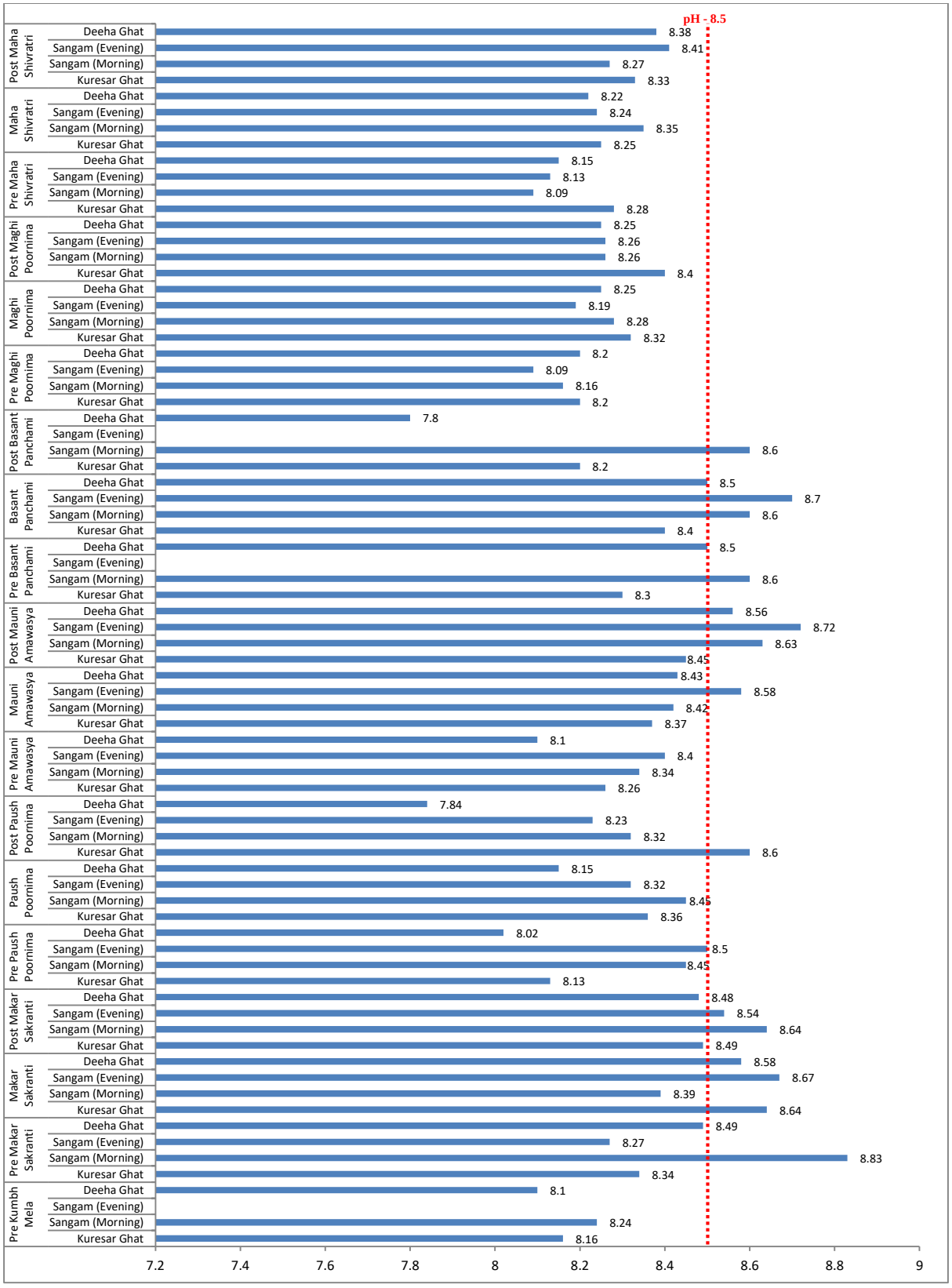

Figure 3 Variation of pH at Kuresar Ghat, Sangam (morning and evening) and Deeha Ghat on different bathing occasions (Primary bathing water quality criteria for pH: 6.5-8.5)

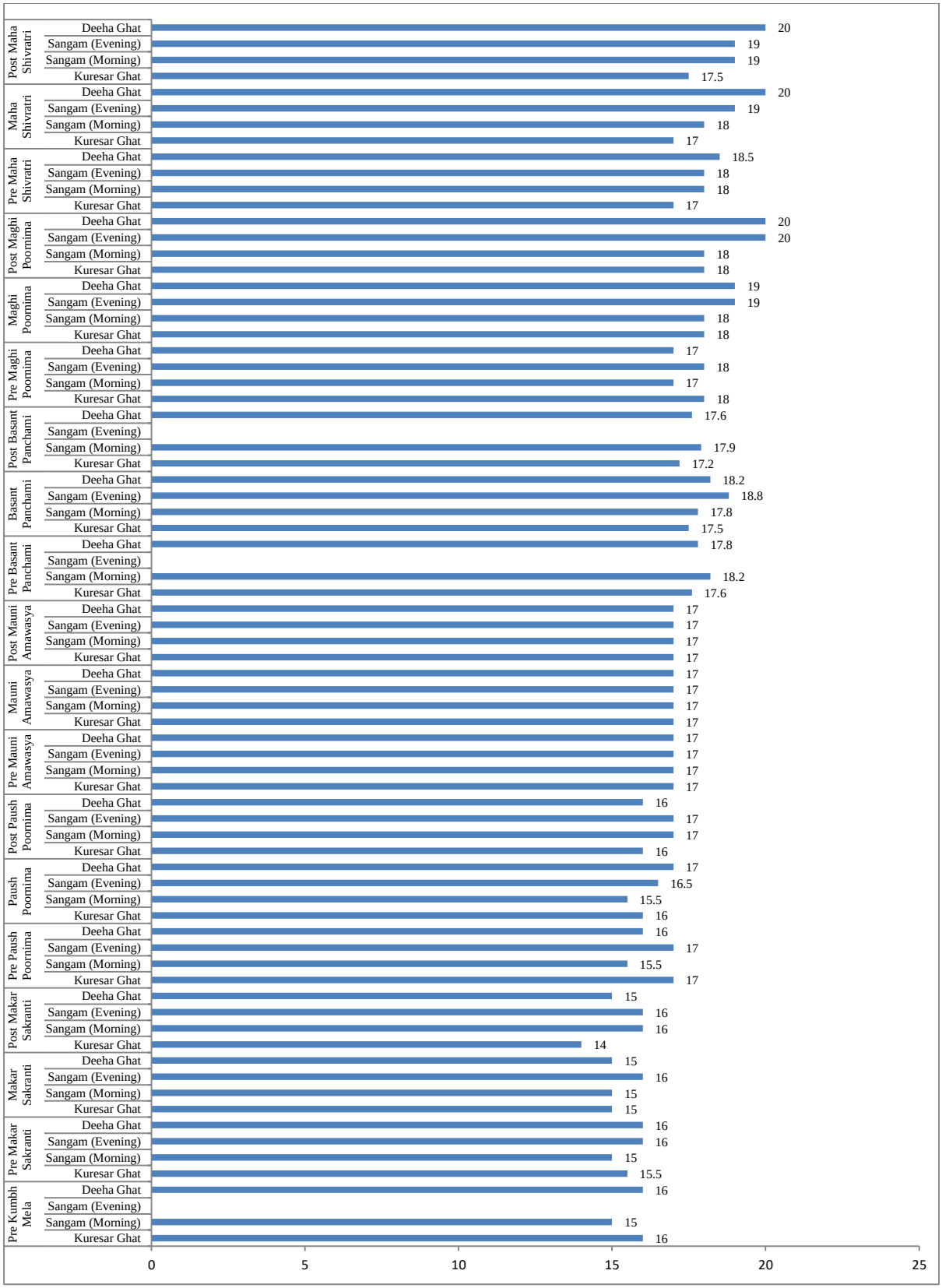

Figure 4 Variation of temperature (°C) at Kuresar Ghat, Sangam (morning and evening) and Deeha Ghat on different bathing occasions

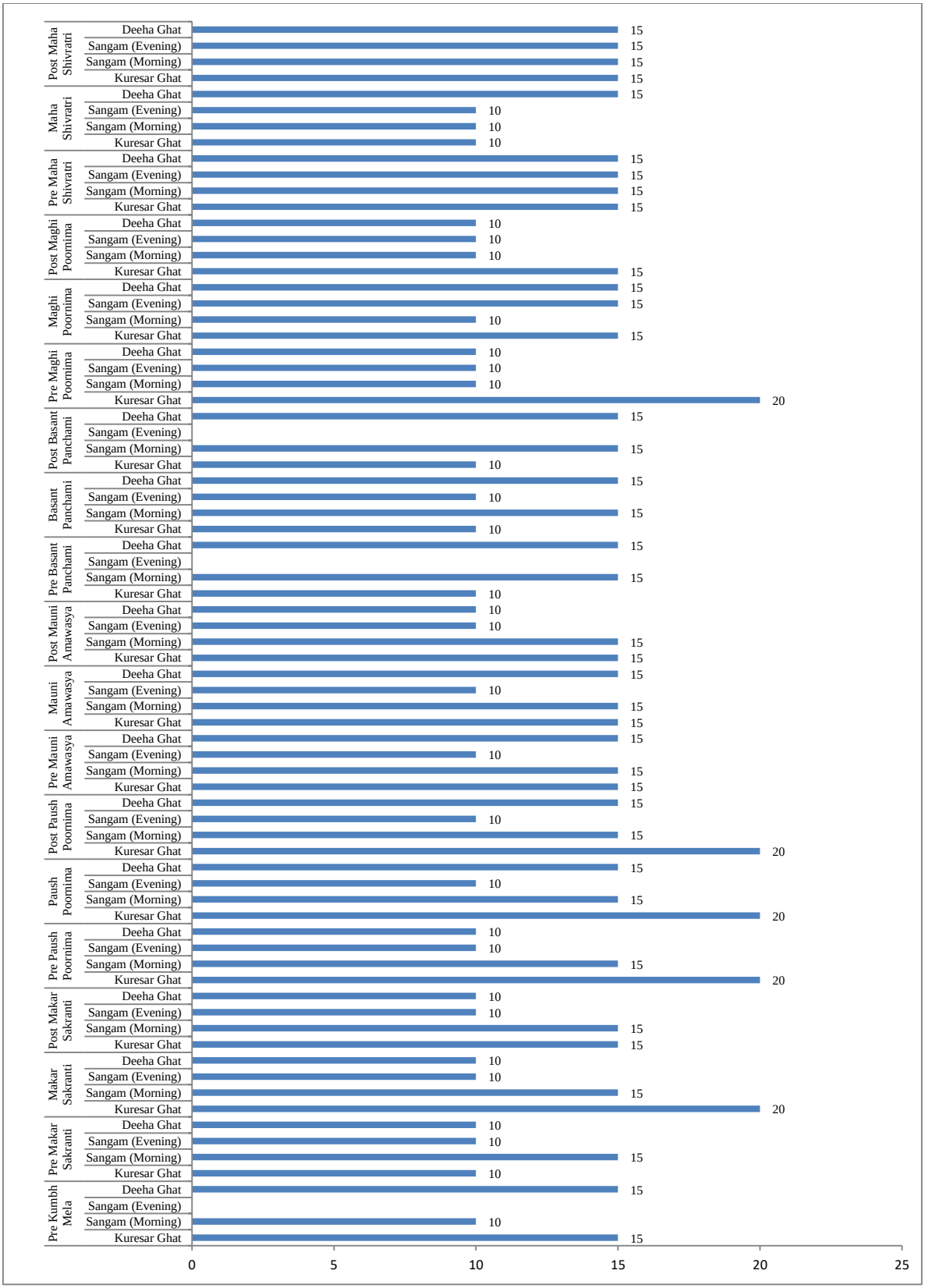

Figure 5 Variation of colour (Hazen) at Kuresar Ghat, Sangam (morning and evening) and Deeha Ghat on different bathing occasions

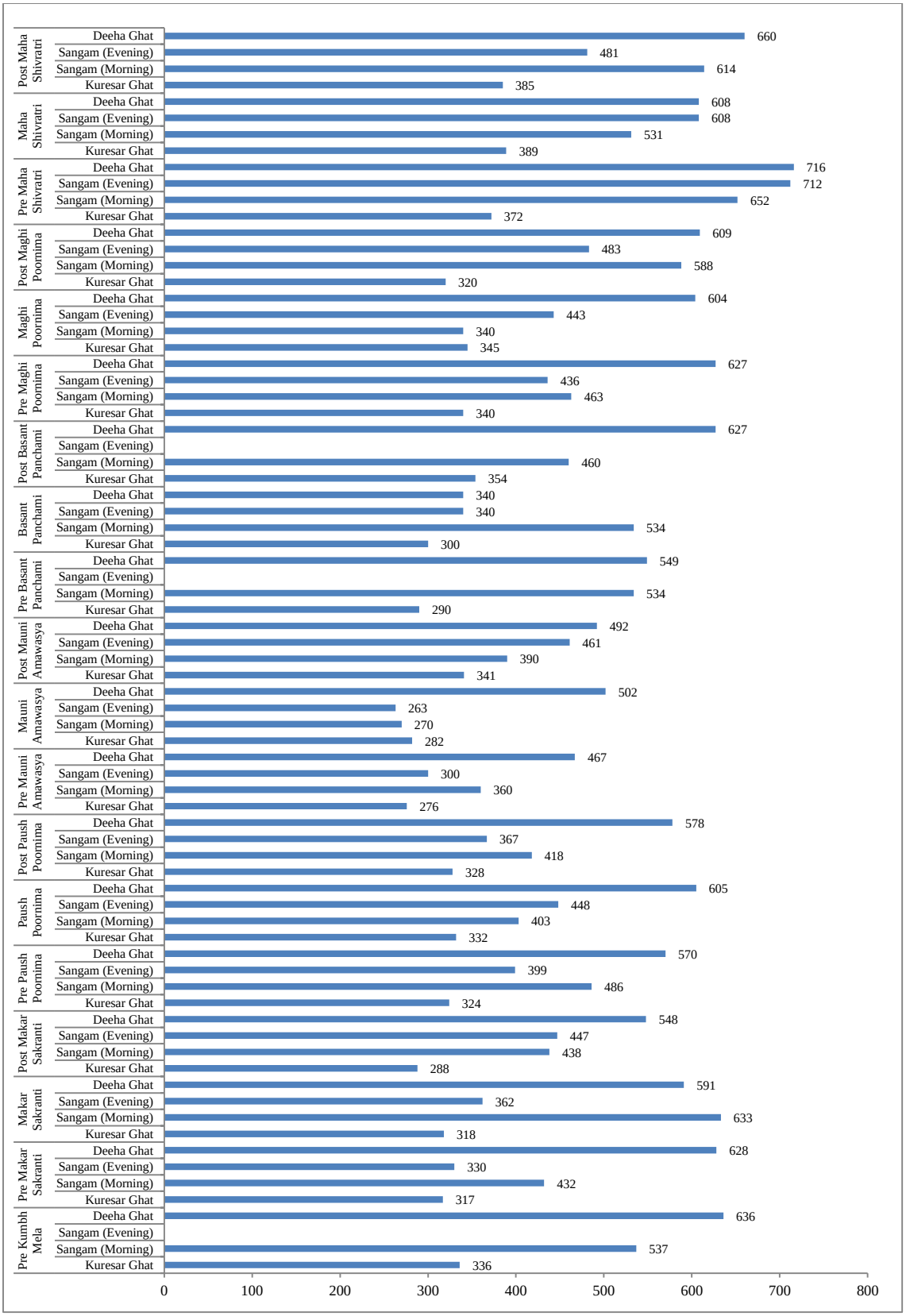

Figure 6 Variation of conductivity (µS/cm) at Kuresar Ghat, Sangam (morning and evening) and Deeha Ghat on different bathing occasions

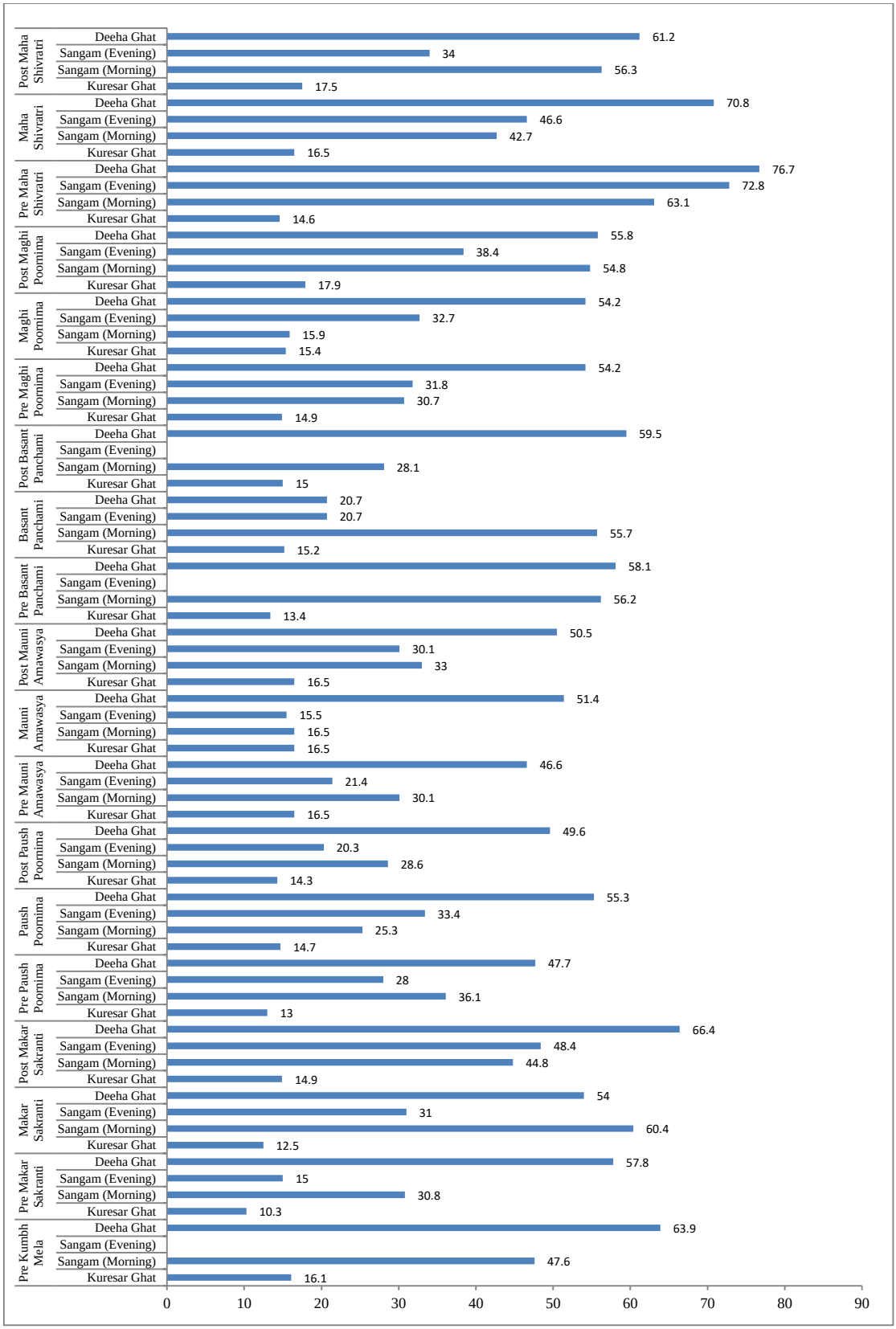

Figure 7 Variation of chloride (mg/l) at Kuresar Ghat, Sangam (morning and evening) and Deeha Ghat on different bathing occasions

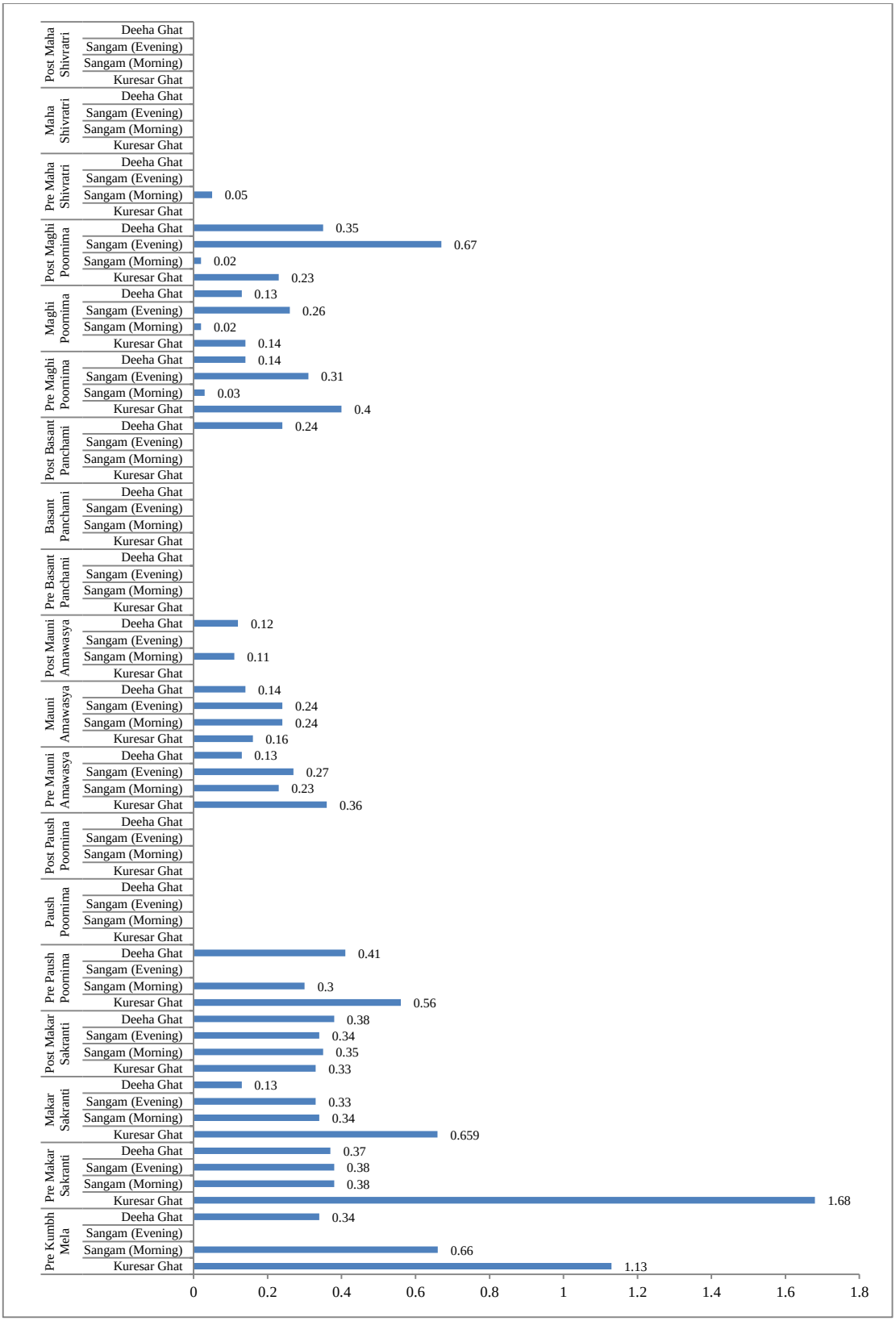

Figure 8 Variation of NH_3-N (mg/l) at Kuresar Ghat, Sangam (morning and evening) and Deeha Ghat on different bathing occasions

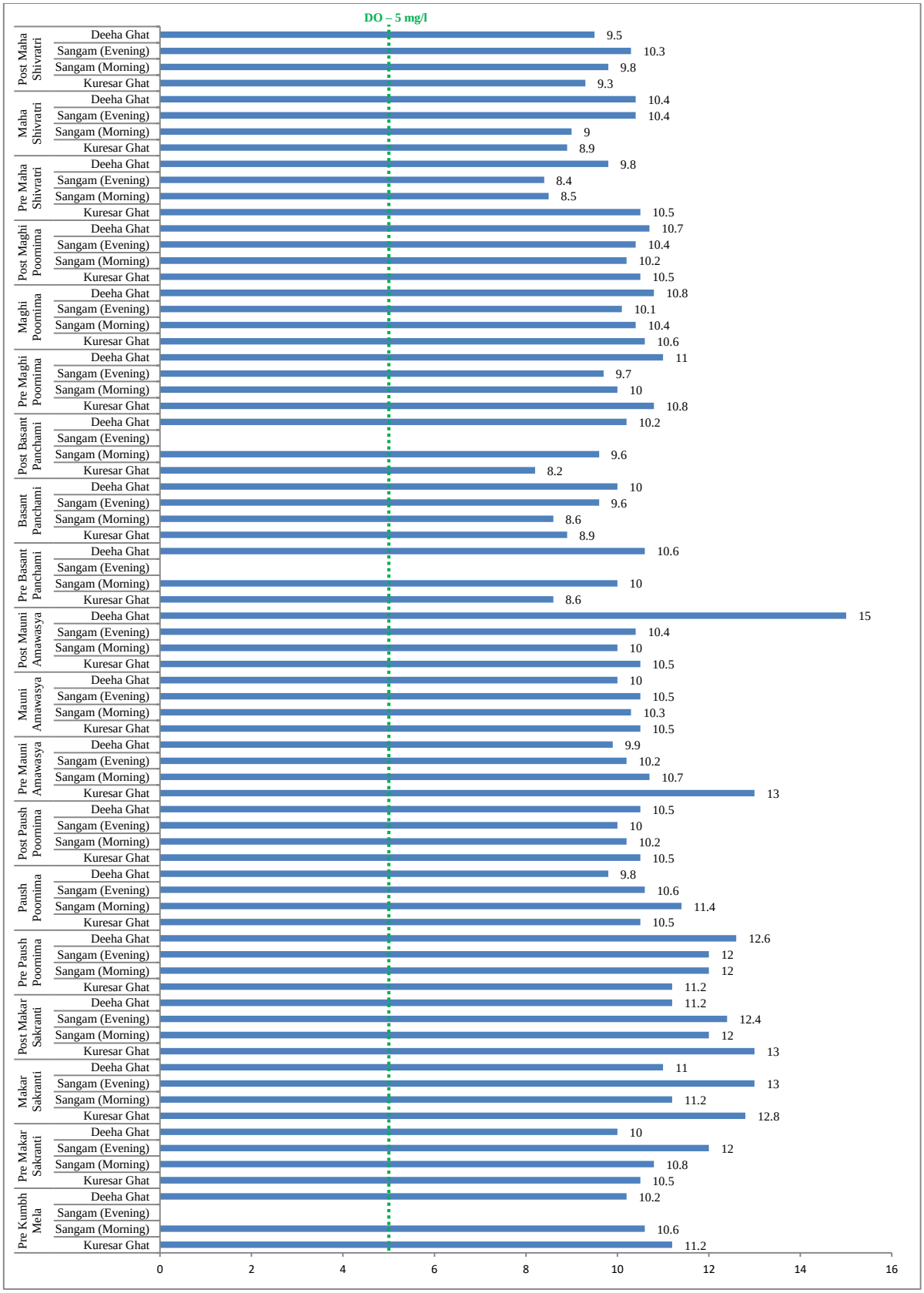

Figure 9 Variation of DO (mg/l) at Kuresar Ghat, Sangam (morning and evening) and Deeha Ghat on different bathing occasions (Primary bathing water quality criteria for DO: ≥ 5 mg/l)

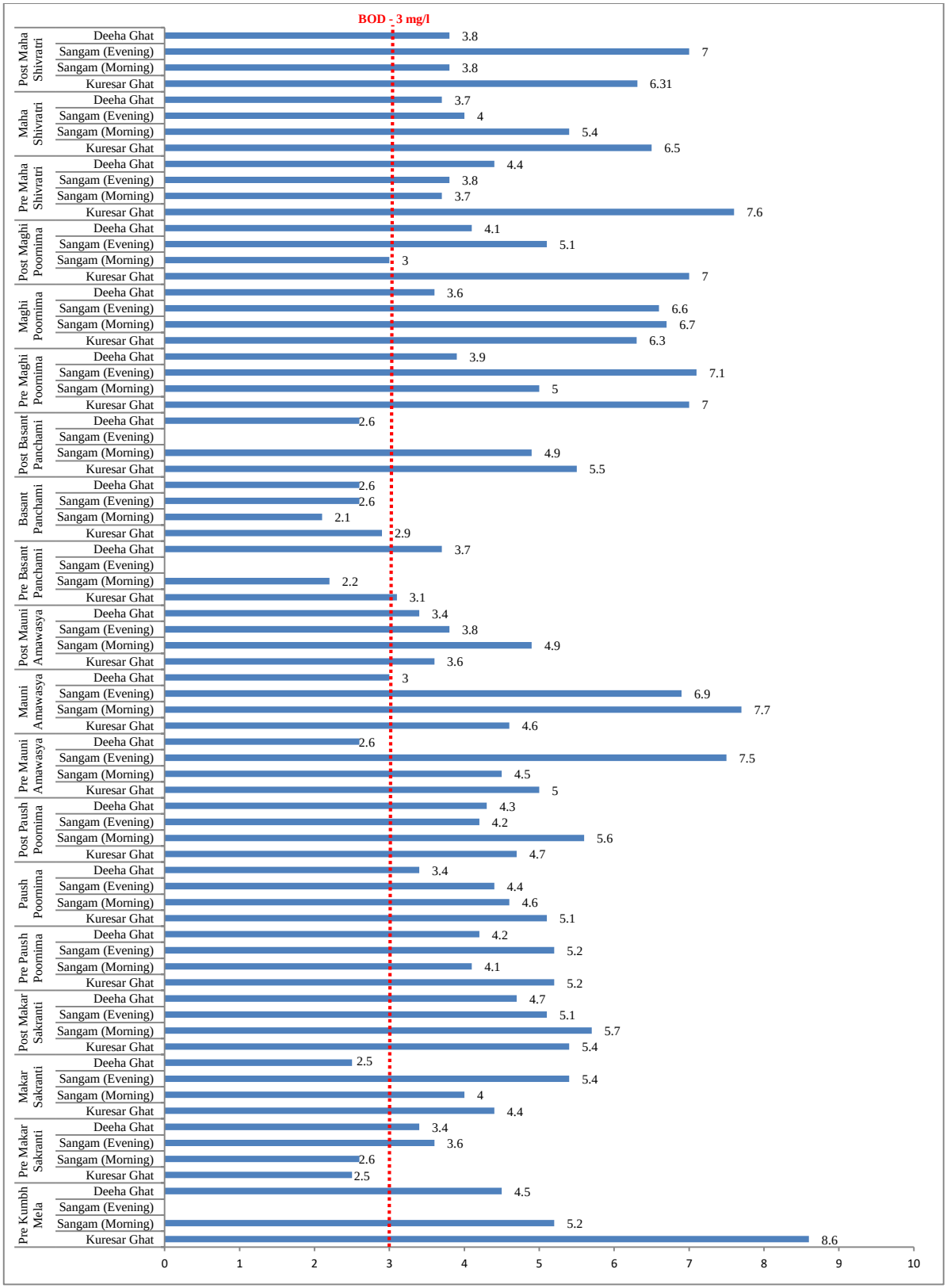

Figure 10 Variation of BOD (mg/l) at Kuresar Ghat, Sangam (morning and evening) and Deeha Ghat on different bathing occasions (Primary bathing water quality criteria for BOD: ≤ 3 mg/l)

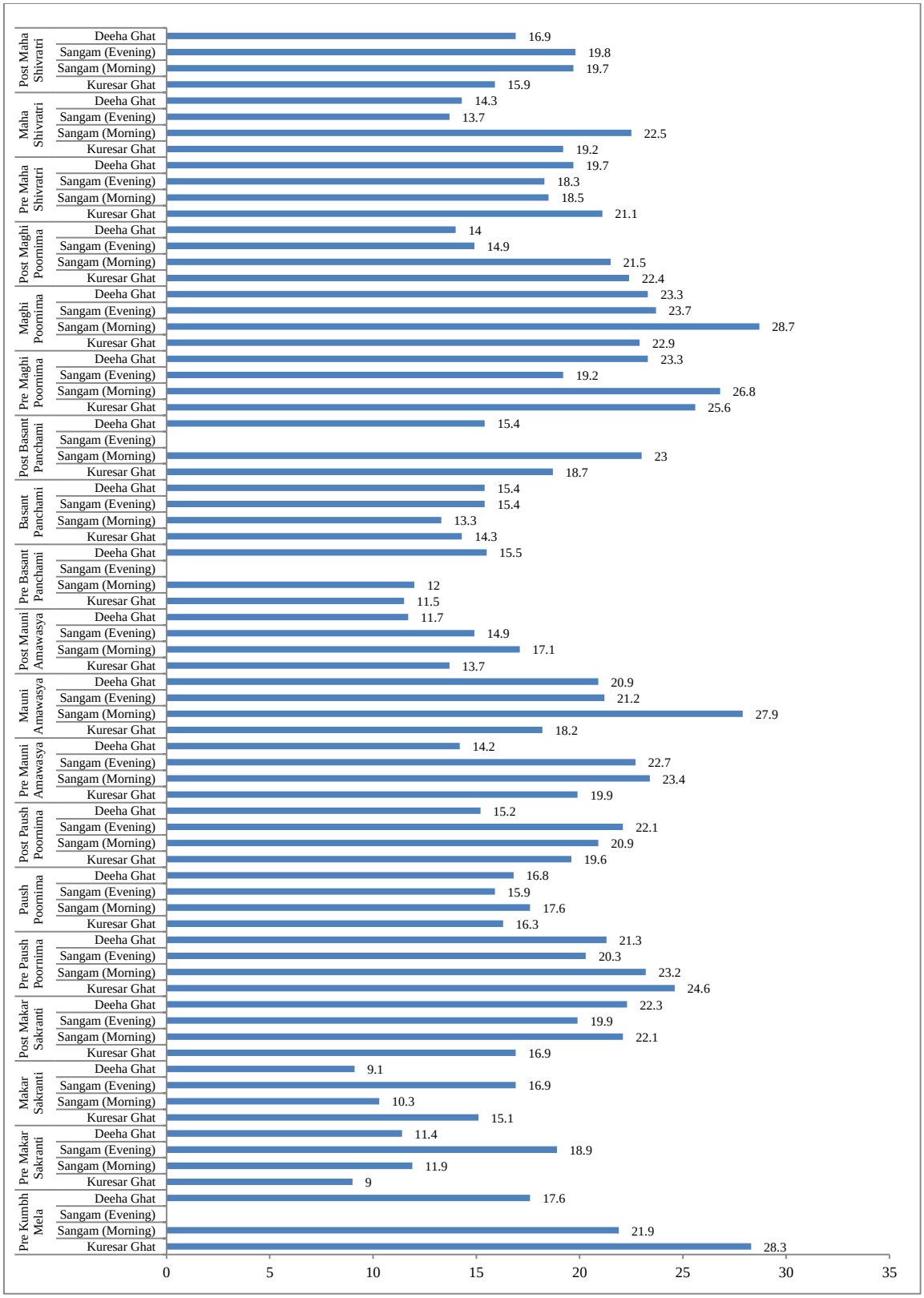

Figure 11 Variation of COD (mg/l) at Kuresar Ghat, Sangam (morning and evening) and Deeha Ghat on different bathing occasions

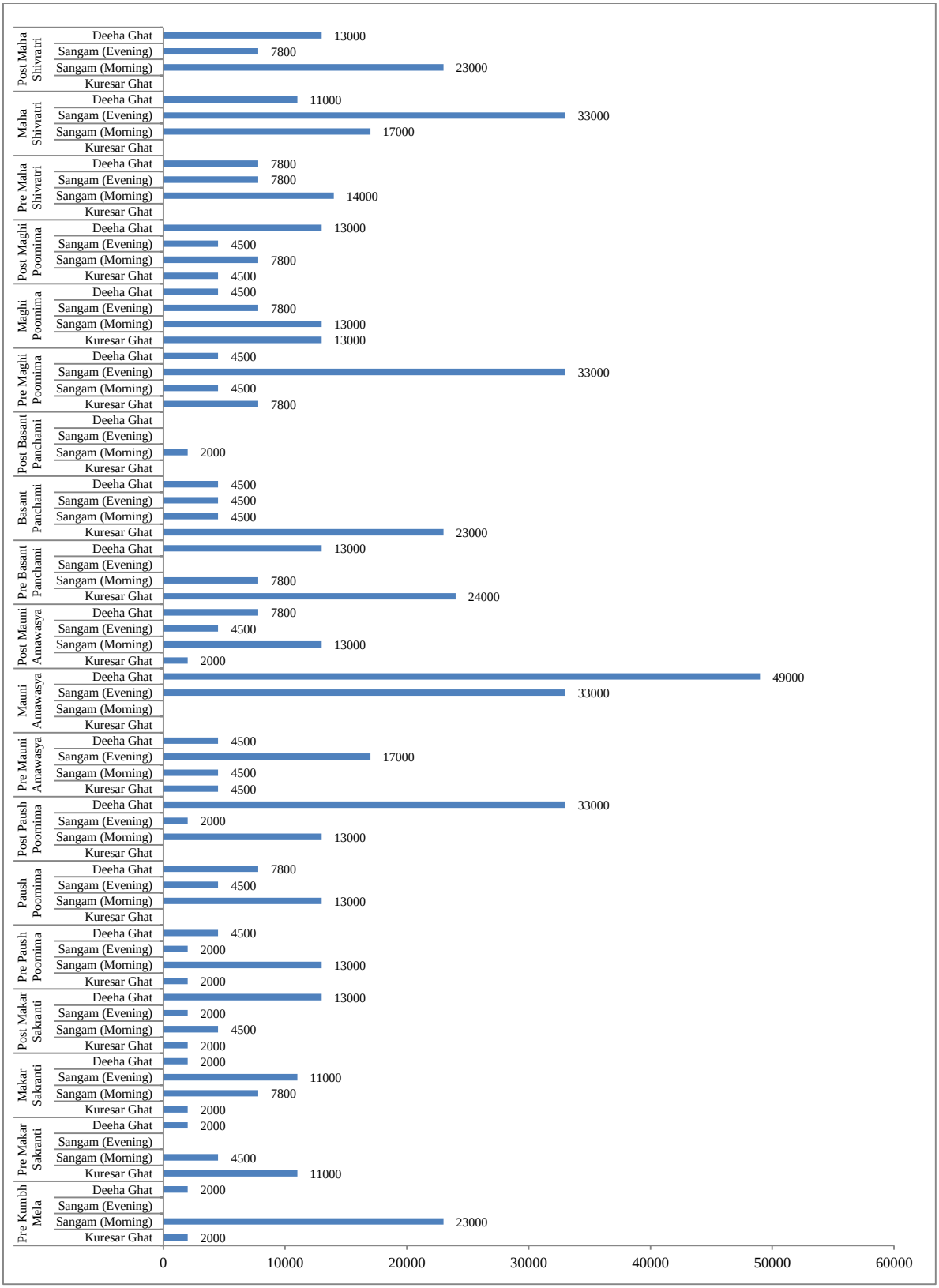

Figure 12 Variation of total coliform (MPN/100 ml) at Kuresar Ghat, Sangam (morning and evening) and Deeha Ghat on different bathing occasions

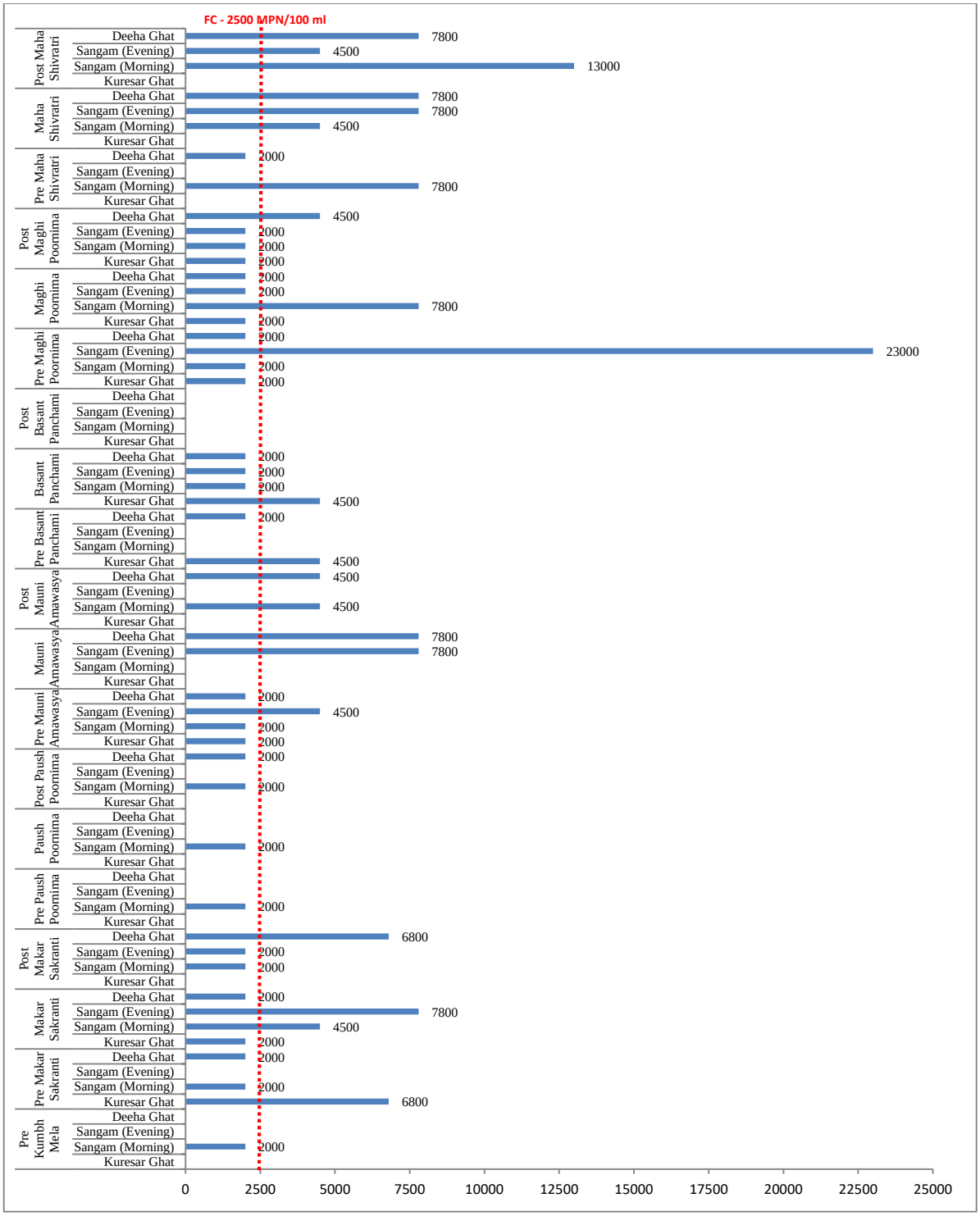

Figure 13 Variation of fecal coliform (MPN/100 ml) at Kuresar Ghat, Sangam (morning and evening) and Deeha Ghat on different bathing occasions (Primary bathing water quality criteria for fecal coliform: < 2500 MPN/ 100 ml)

Daily data for pH, Color, DO and temperature at Sangam is tabulated in **Table 6**. Dissolved oxygen was found in the range of 8.2-12.6 mg/l. Colour was found in the range of 10-15 Hazen.

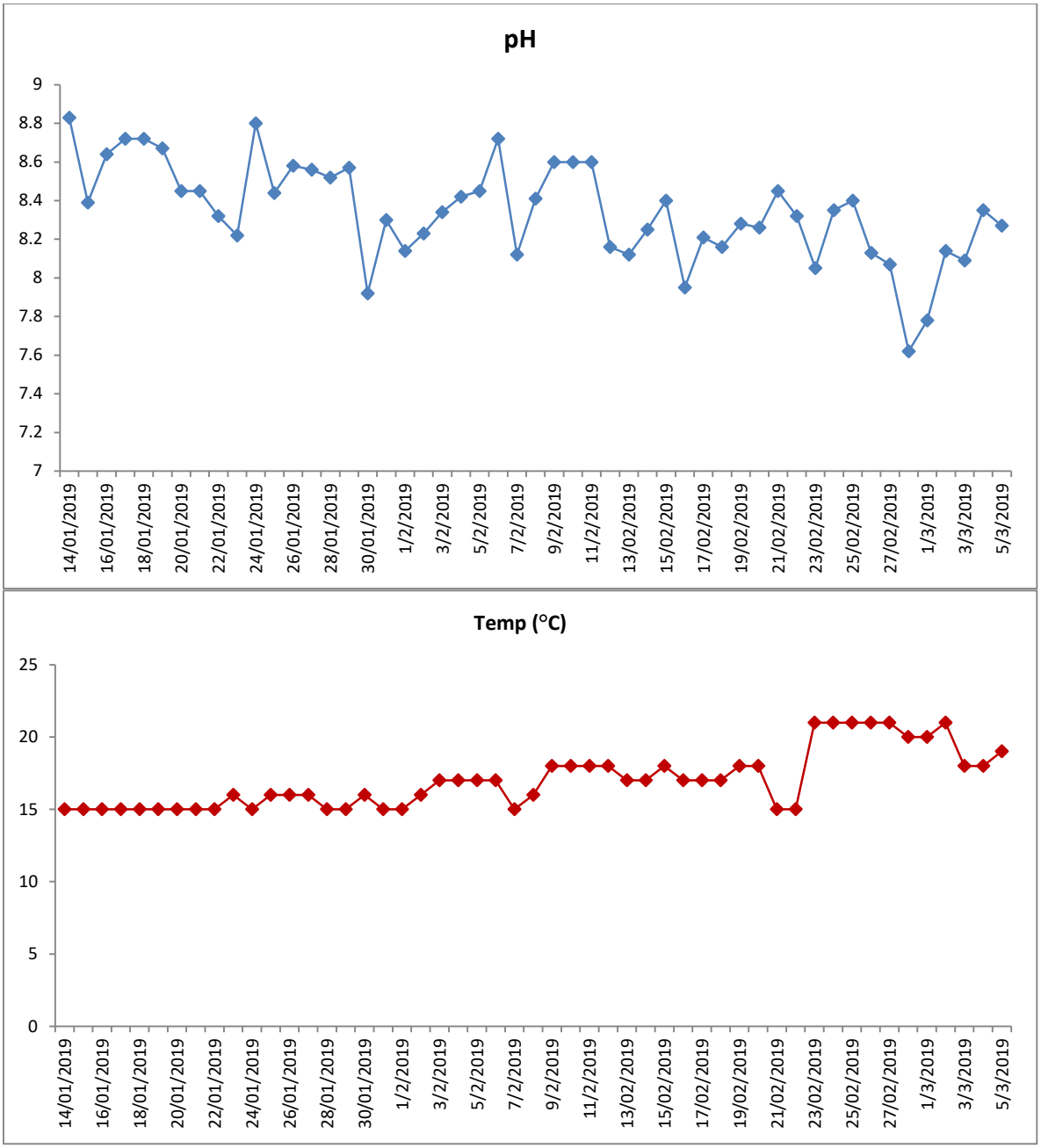

Figure 14 Variation of pH and temperature (°C) during morning at Sangam (from 14.01.2019 to 05.03.2019), Prayagraj during Kumbh Mela 2019

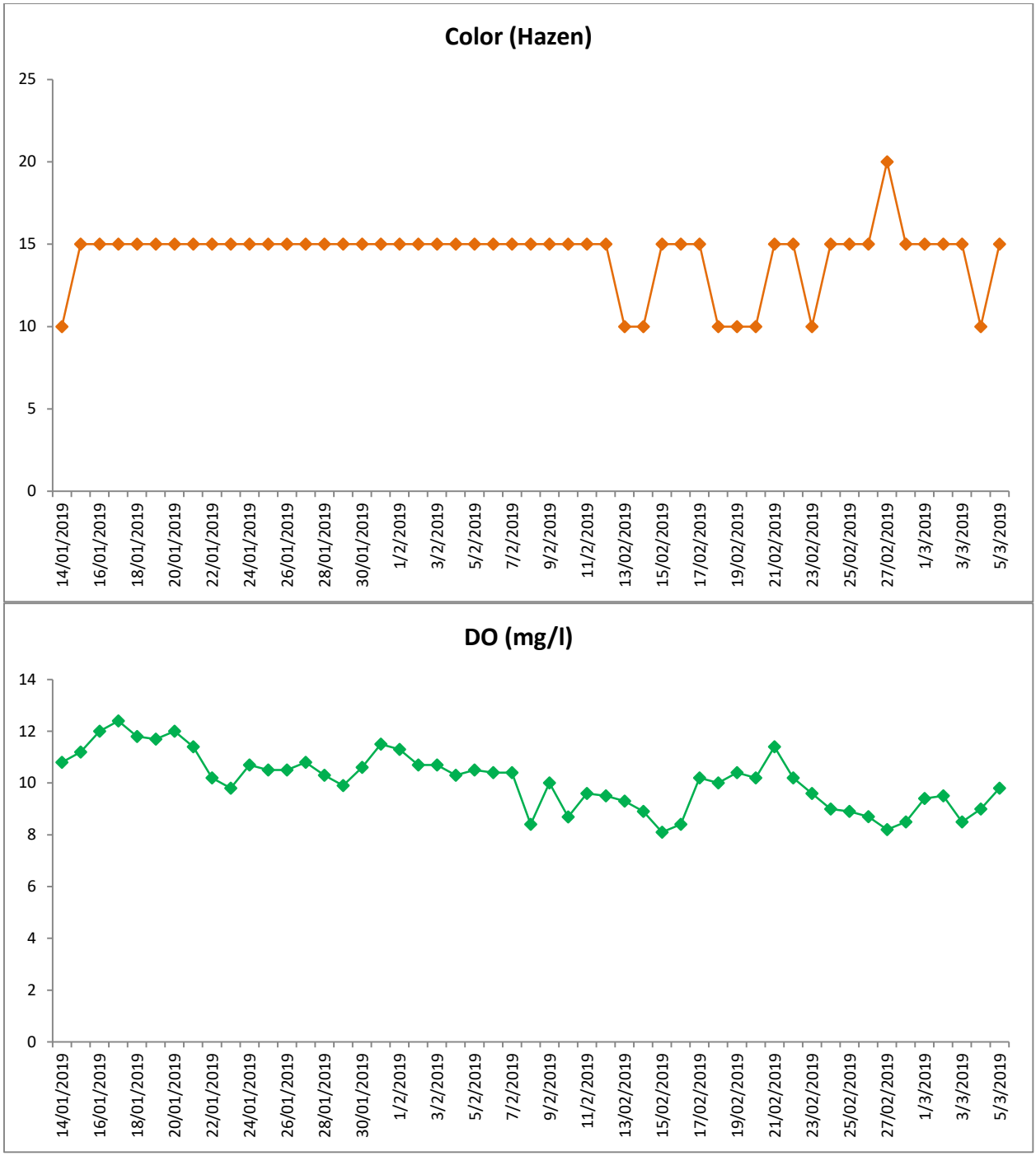

Figure 15 Variation of colour (Hazen) and DO (mg/l) during morning at Sangam (from 14.01.2019 to 05.03.2019), Prayagraj during Kumbh Mela 2019

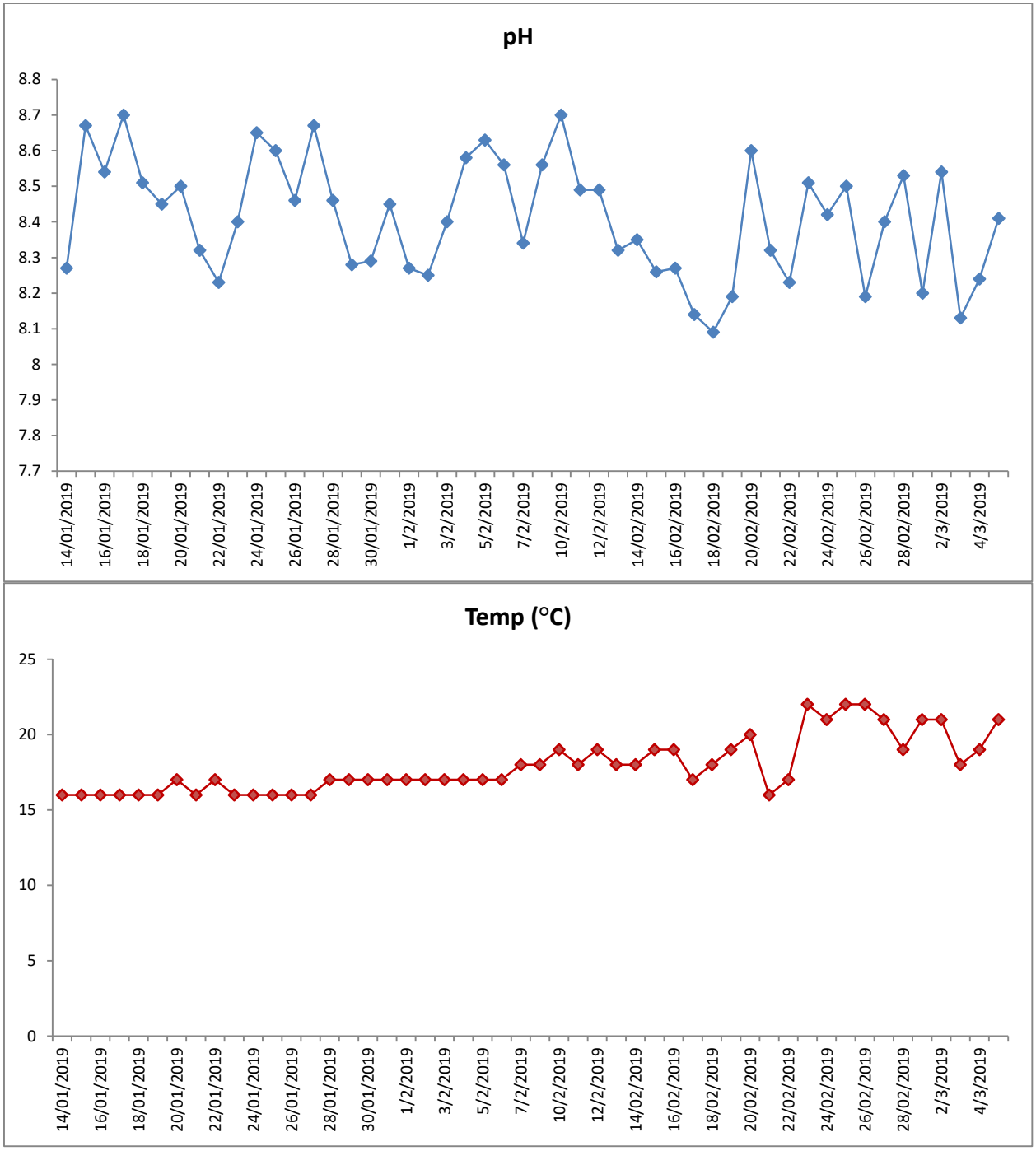

Figure 16 Variation of pH and temperature (°C) during evening at Sangam (from 14.01.2019 to 05.03.2019), Prayagraj during Kumbh Mela 2019

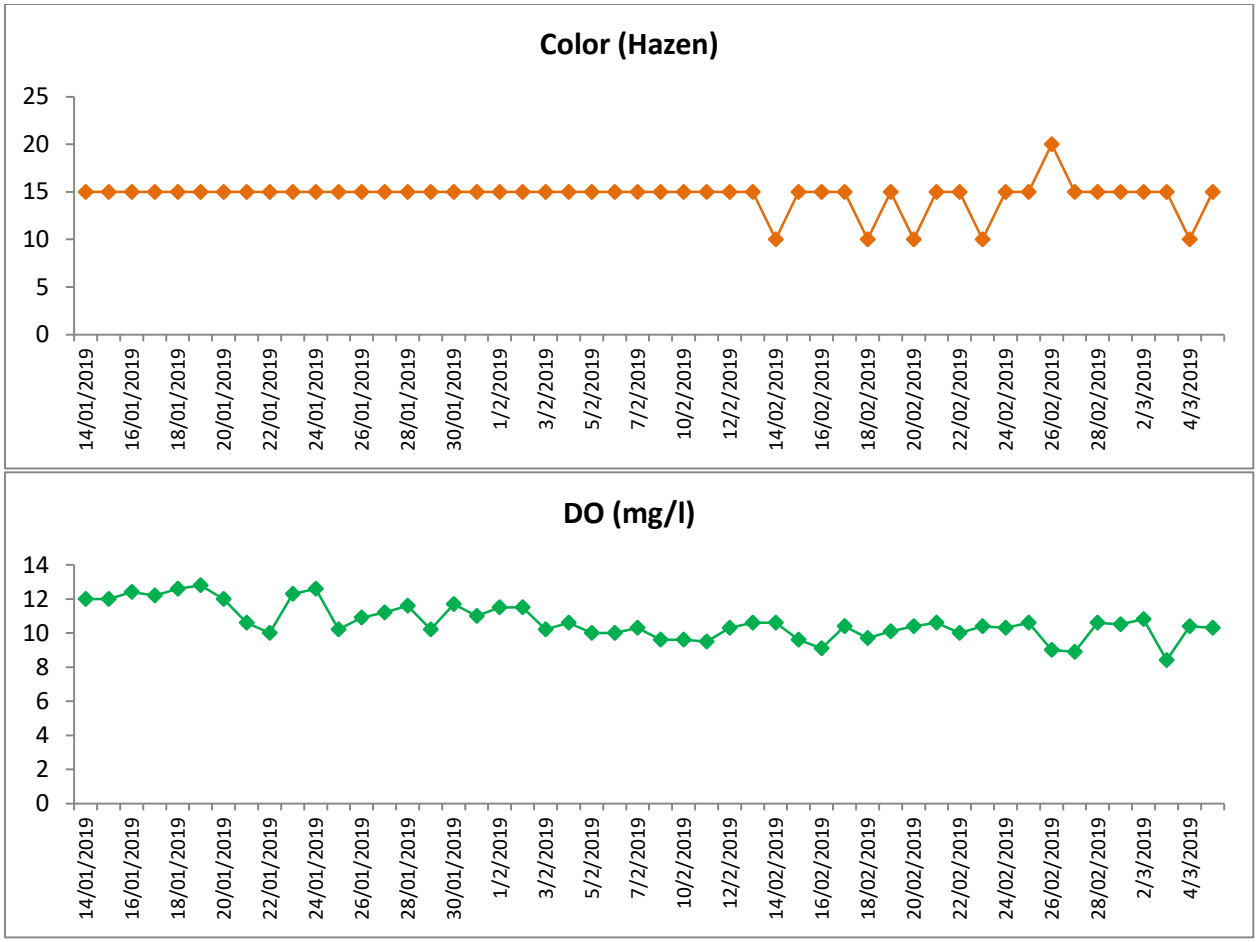

Figure 17 Variation of colour (Hazen) and DO (mg/l) during evening at Sangam (from 14.01.2019 to 05.03.2019), Prayagraj during Kumbh Mela 2019

4.3 River Ganga at Deeha Ghat downstream of Prayagraj

Deeha Ghat is located 18-20 Km downstream of Sangam. Samples were collected once a day (before, after and during each auspicious bathing occasion) and analyzed for relevant parameters. pH varies from 7.8 to 8.58 against 6.5 to 8.5 of outdoor bathing norms; thus, it exceeds norms only on Makar Sakranti. DO value found higher than 5 mg/l on all occasions, whereas, BOD varies from 2.5 to 4.7 mg/l against 3mg/l of outdoor bathing criteria and exceeds outdoor bathing norms on Makar Sakranti, pre-Mauni Amawasya, Basant Panchami and post-Basant Panchami. FC value varies from <1.8 to 7800 MPN/100ml; its value was found exceeding outdoor bathing water quality norms on post-Makar Sakranti, Mauni Amawasya, post-Mauni Amawasya, post-Maghi Poornima, Maha Shivratri and post-Maha Shivratri.

5 Water Quality of tributaries of River Ganga i.e. Yamuna, Kali and Ramganga

5.1 Water Quality of River Yamuna at Naini (B/c to river Ganga), Prayagraj

Water quality of river Yamuna B/c to river Ganga w.r.t. different pollution sensitive parameters is mentioned in **Table 4 and 5**. As per outdoor bathing water quality criteria, the water quality at this location lie within norms w.r.t. BOD except during Makar Sakranti, pre to post-Basant Panchami and post-Maha Shivratri. pH and DO meet outdoor bathing water quality criteria on all occasions whereas FC meets outdoor bathing water quality criteria on six occasions during morning and seven occasions during evening.

Table 4 Water quality of river Yamuna (Morning) near Naini (B/c of river Ganga)

Bathing occasion	pH	Temp (^{0}C)	Colour (Hz)	Conductivity (µS/cm)	Chloride (mg/l)	NH_3-N (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TC (MPN/100 ml)	FC (MPN/100 ml)
Pre Kumbh Mela	8.06	18	10	742	76.8	0.91	9.4	1.7	13.9	13000	4500
Pre Makar Sakranti	8.53	16	10	746	77.4	0.91	9.5	1.7	13.7	6800	4000
Makar Sakranti	8.28	15	10	765	80.9	0.28	10.4	3.4	12.6	17000	11000
Post Makar Sakranti	8.48	16	15	675	85.2	0.41	11	1.98	25.1	21000	17000
Pre Paush Poornima	8.34	17	10	775	83.1	BDL	9.5	1.7	10.7	490000	2000
Paush Poornima	8.23	15.5	10	769	79	0.21	10	1.7	13.2	23000	4500
Post Paush Poornima	8.07	15	10	751	76.8	BDL	9.6	1.2	13.2	33000	2000
Pre Mauni Amawasya	8.1	16.5	10	596	67.9	BDL	9.9	1.75	20.2	7800	4500
Mauni Amawasya	8.23	16	10	592	67	BDL	9.8	1.66	14.4	7800	4500
Post Mauni Amawasya	8.1	17	10	587	71.8	BDL	9.6	1.37	9.79	7800	4500
Pre Basant Panchami	8.4	18.1	15	615	69.5	BDL	11	3.7	17.2	33000	13000
Basant Panchami	8.30	17.2	15	616	69.2	BDL	10	4.0	17.4	130000	4500
Post Basant Panchami	7.8	18	15	735	76.2	1.26	10.2	4.8	25.3	<1.8	<1.8
Pre Maghi Poornima	8.21	17	10	754	79.5	0.10	9.2	1.43	19.8	13000	7800
Maghi Poornima	8.09	18	10	732	75.9	0.15	9.4	1.44	17.5	23000	2000
Post Maghi Poornima	7.97	18	10	761	79.1	0.10	9.8	2.15	19.4	4000	2000
Pre Maha Shivratri	8.04	18	15	815	93.2	BDL	7.8	2.96	18.1	4500	<1.8
Maha Shivratri	7.80	19	15	790	85.4	BDL	8.3	2.38	18	33000	23000
Post Maha Shivratri	8.16	19	15	775	83.5	BDL	8.8	3.64	20.7	49000	17000

Table 5 Water quality of river Yamuna (Evening) near Naini (B/c of river Ganga)

Bathing occasion	pH	Temp (^{0}C)	Colour (Hz)	Conductivity (µS/cm)	Chloride (mg/l)	NH_3-N (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TC (MPN/100 ml)	FC (MPN/100 ml)
Pre Makar Sakranti	8.18	16	10	747	77.2	0.28	10.2	1.9	12.1	9300	6800
Makar Sakranti	8.42	16	10	661	80.3	0.53	11	1.39	15.7	4500	<1.8
Post Makar Sakranti	8.41	16	15	677	87.9	0.42	11.4	2.02	12.4	2000	<1.8
Paush Poornima	8.18	16.5	10	753	78.3	BDL	10.1	1.1	9.8	7800	2000
Post Paush Poornima	8.1	16	10	738	73.1	BDL	9.8	1.8	11.4	49000	4500
Pre Mauni Amawasya	8.28	17	10	589	69.9	BDL	9.6	2.63	20.6	2000	<1.8
Mauni Amawasya	8.31	17	10	593	67.9	BDL	9.5	1.84	10.4	33000	7800
Post Mauni Amawasya	8.18	17	10	706	66	BDL	9.6	3.20	11.7	NA	NA
Basant Panchami	8.60	18.8	15	613	68.8	BDL	10	1.8	11.3	13000	4500
Pre Maghi Poornima	8.18	18	10	741	80.9	BDL	9.0	2.17	23.9	4500	2000
Maghi Poornima	8.14	19	10	724	77.2	BDL	9.1	1.80	19.9	4000	2000
Pre Maha Shivratri	7.85	18	15	808	90.3	BDL	8.5	2.65	19.3	33000	23000
Maha Shivratri	7.86	20	15	792	87.3	BDL	9.0	2.76	15.8	79000	23000
Post Maha Shivratri	8.11	21	15	767	84.4	BDL	9.0	2.95	21.2	33000	23000

5.2. Water Quality of River Ganga, Kali, Ramganga from Farrukhabad to Kanpur D/s

Water samples of River Kali at Khudaganj Bridge (Kannauj), River Ramganga at Allahaganj Bridge (Farrukhabad), River Ganga at Ghatiya Ghat (Farukhabad), Mehendi Ghat (Kannauj), Bithoor and Dyodhi Ghat (Kanpur) were collected. Samples were collected before each auspicious bathing occasion from locations as mentioned above for 4-5 days, and 3-4 days at Bithoor (U/s of Kanpur city). The daily sample was collected from downstream of Kanpur, i.e. at Dyodhi Ghat to check the impact of discharge of untreated/partially treated industrial effluent in Kanpur city, particularly Jajmau area. The concentration of Dissolved Oxygen (DO) was found meeting bathing standards at all locations of R. Kali, R. Ramganga and R. Ganga. Colour was found in the range of 5-30 Hazen whereas BOD value shows as high value as 19.4 mg/l in R. Kali at Khudaganj. Water quality of the river Ganga at Ghatiya Ghat w.r.t. BOD meets outdoor bathing criteria. The lowest BOD is found in R. Ganga at Ghatiya Ghat and Dyodhi Ghat whereas highest BOD is found in R. Kali at Khudaganj. Most of the time, the faecal coliform count was found higher than outdoor bathing criteria standards. In general, the river Kali was found most polluted in comparison to other tributaries of river Ganga. Water Quality of River Ramganga, Kali and Ganga are presented in **Figure 18-21**.

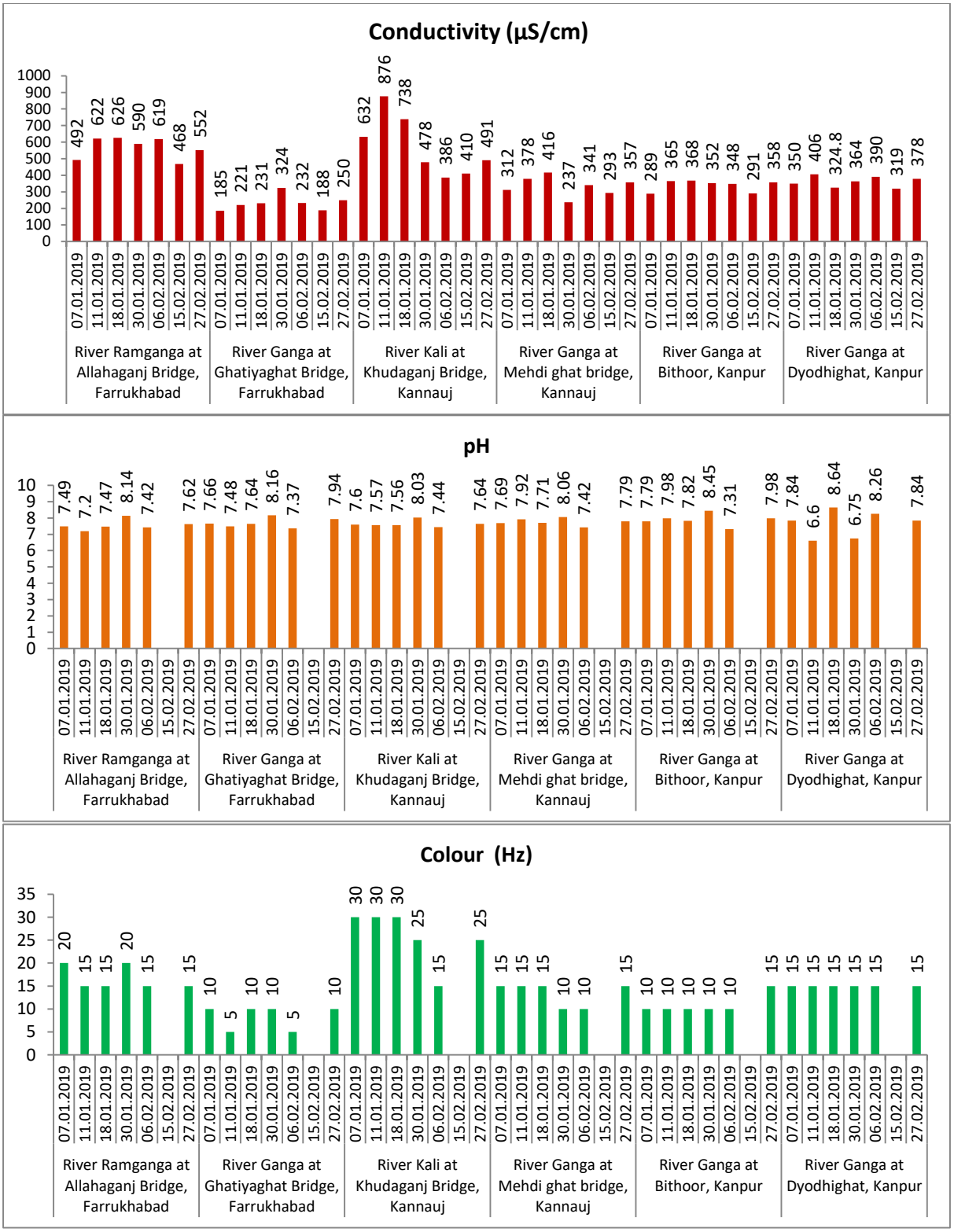

Figure 18 Water quality of river Ramganga, Kali and Ganga w.r.t. pH, colour and conductivity

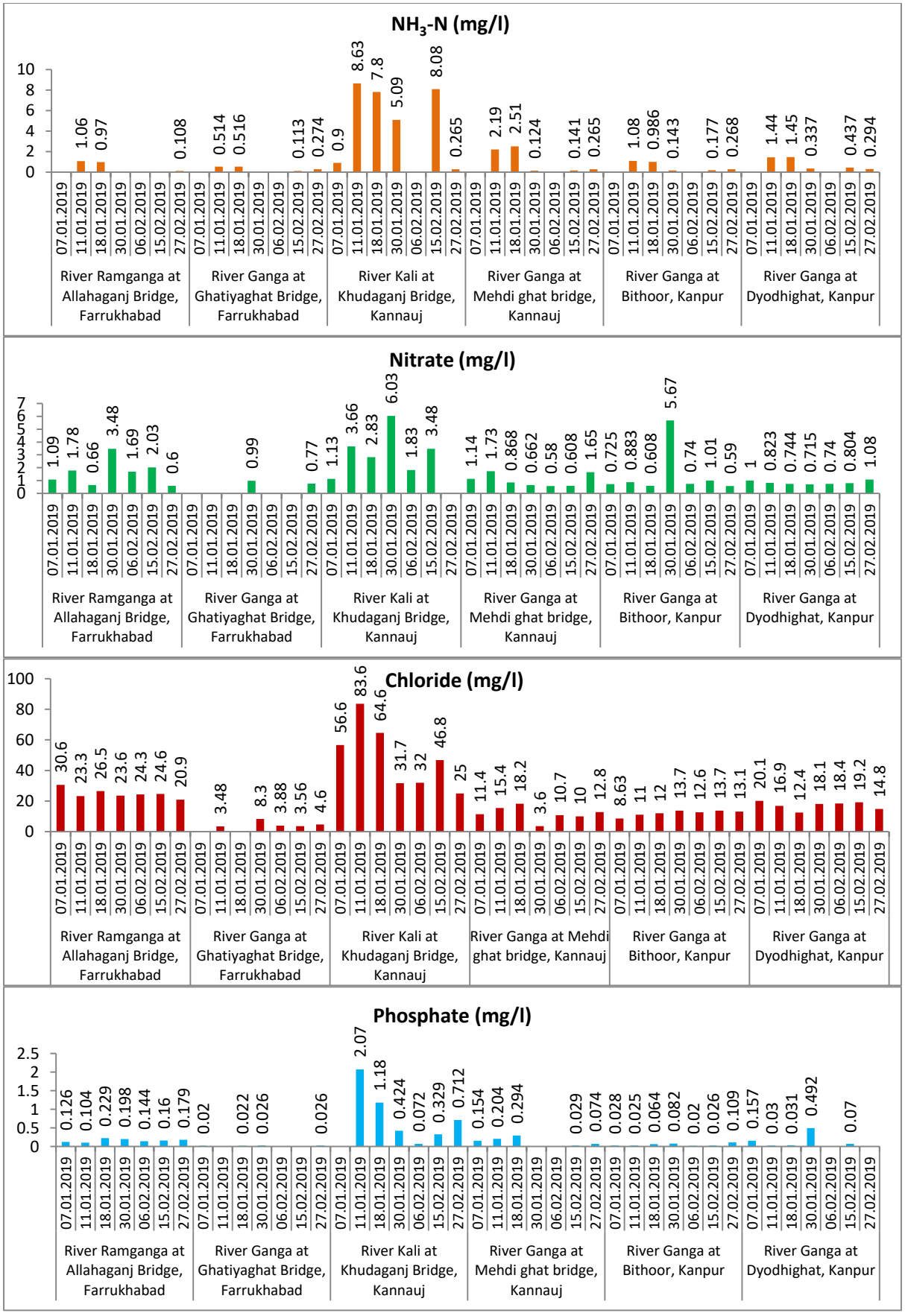

Figure 19 Water quality of river Ramganga, Kali and Ganga w.r.t. NH_3-N, nitrate, chloride and phosphate

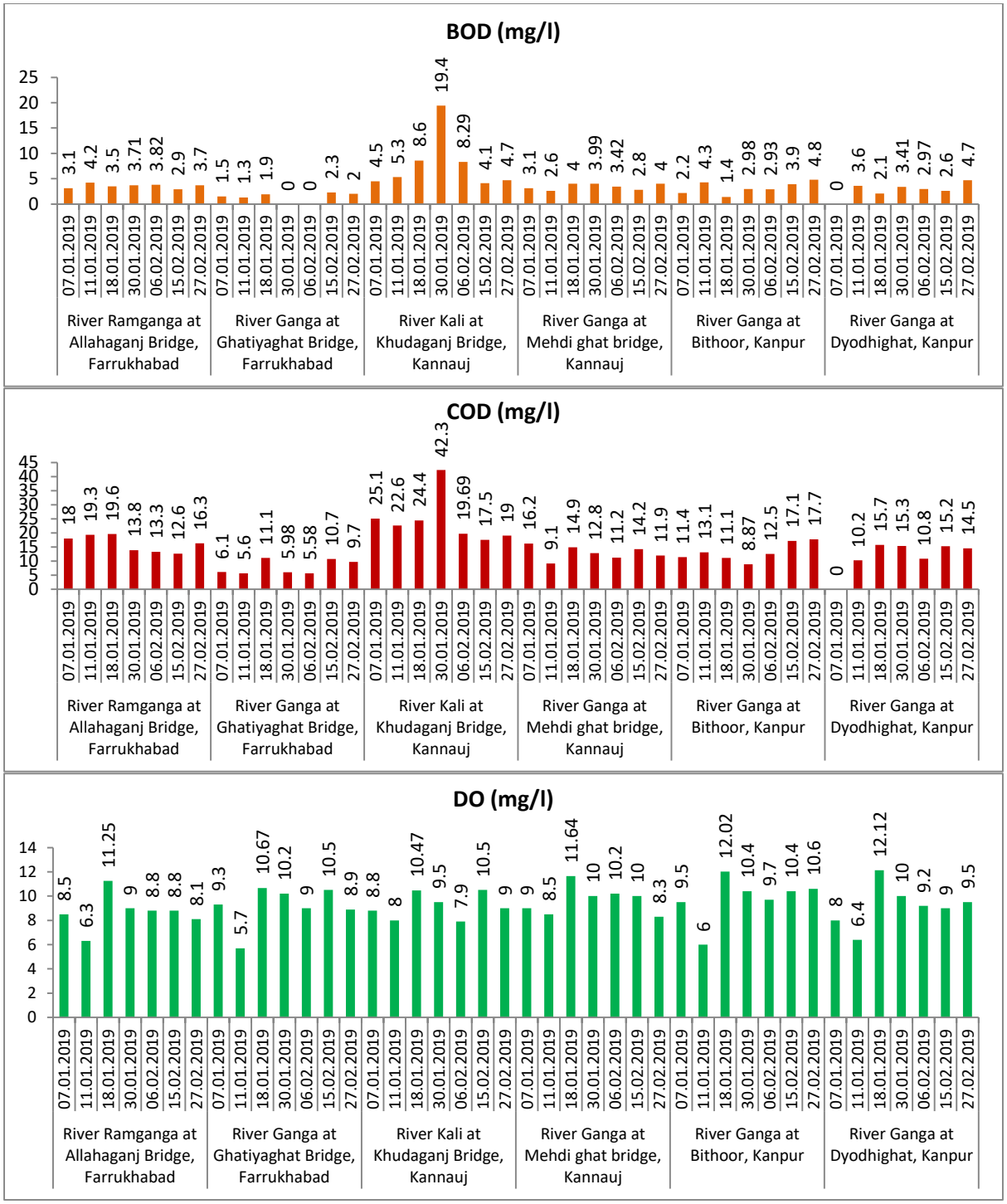

Figure 20 Water quality of river Ramganga, Kali and Ganga w.r.t. BOD, COD and DO

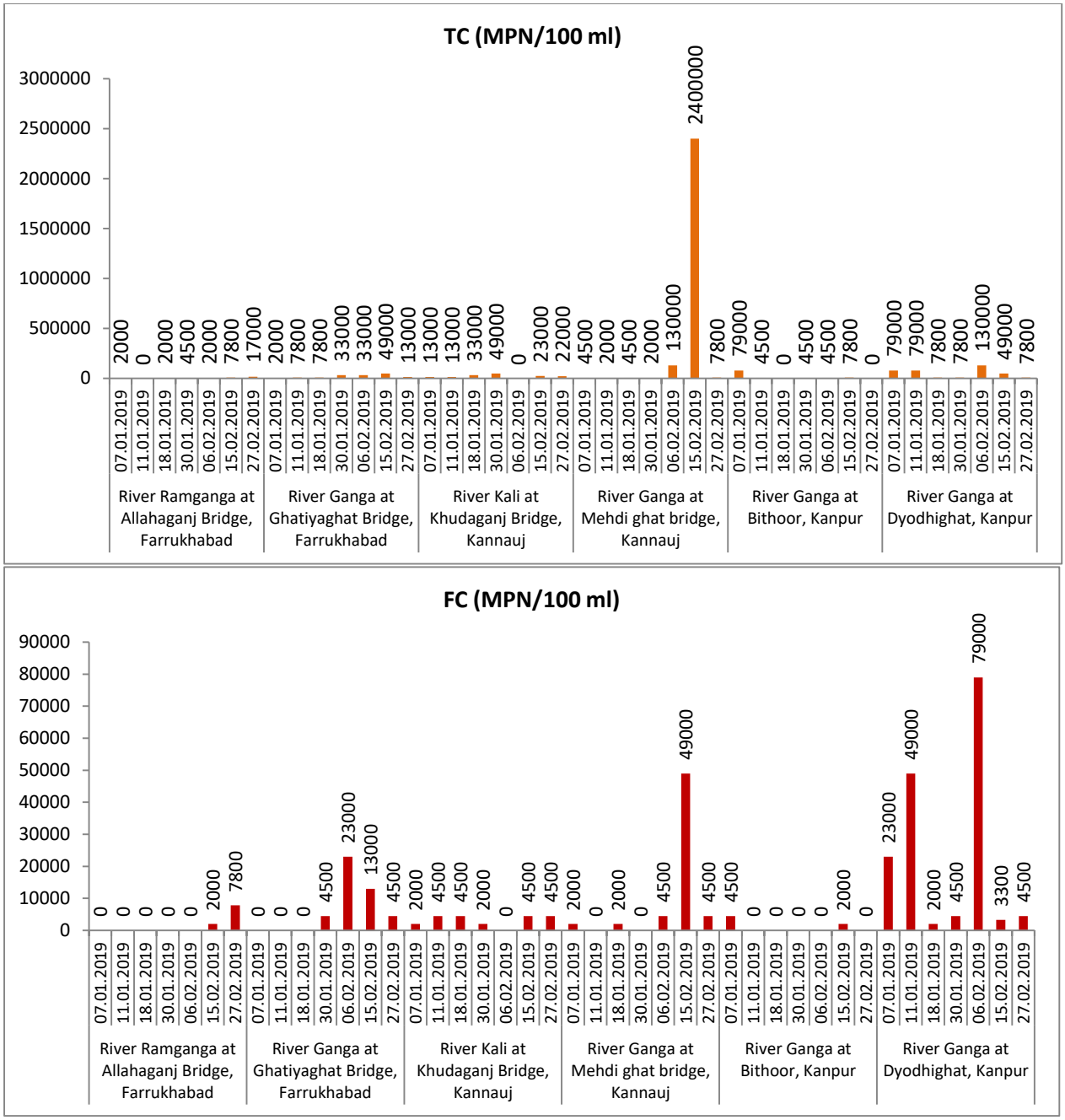

Figure 21 Water quality of river Ramganga, Kali and Ganga w.r.t. total and fecal coliform

Table 6 Characteristics of river Ganga at Dyodhi Ghat, downstream of Kanpur (U.P.)

Date of Monitoring	pH	Temp (^{0}C)	DO (mg/l)	Color (Hazen)	EC (µS/cm)	BOD (mg/l)	COD (mg/l)	Nitrate-N (mg/l)	NH_3-N (mg/l)	Chloride (mg/l)	Cr (mg/l)	TC (MPN/100 ml)	FC (MPN/100 ml)
17/01/2019	8.4	15	11.6	15	327.8	2.95	14.1	0.67	0.34	21.3	NA	NA	NA
18/01/2019	7.5	15	8.2	10	328.0	3.01	10.9	0.58	0.41	14.1	NA	NA	NA
19/01/2019	8.64	14	12.12	10	324.8	2.1	15.7	0.744	1.45	12.4	NA	NA	NA
20/01/2019	8.39	17	9.2	15	369	1.1	8.81	0.710	1.54	11.6	NA	NA	NA
21/01/2019	7.37	16.5	9.0	10	378	1.9	12.4	0.955	1.09	12.7	NA	NA	NA
22/01/2019	8.36	15	10.3	15	386	3.1	15.3	0.640	BDL	14.0	NA	NA	NA
23/01/2019	8.4	16	10.4	15	379	2.39	11.5	0.57	0.292	13.2	NA	NA	NA
24/01/2019	7.79	17	10.4	10	359	1.58	8.68	0.607	1.26	12.7	NA	NA	NA
25/01/2019	7.68	16	10.4	10	348	3.51	17.7	0.591	BDL	10.3	NA	NA	NA
26/01/2019	7.78	15	9.9	15	362	2.67	12.6	0.87	0.102	12.3	NA	NA	NA
27/01/2019	7.12	15	9.4	10	363	1.36	10.9	0.96	0.242	11.9	NA	NA	NA
28/01/2019	6.33	15	10.2	15	354	2.93	10.4	0.94	0.196	11.3	NA	NA	NA
29/01/2019	7.09	15	10.5	15	324.7	2.82	14.3	0.680	0.715	12.0	NA	NA	NA
30/01/2019	7.92	16	10.6	15	NA	NA	NA	NA	NA	NA	NA	NA	NA
31/01/2019	6.75	17	10	15	364	3.41	15.3	0.715	0.337	18.1	BDL	7800	4500
01/02/2019	7.16	16	10.2	10	362	1.97	14.1	0.95	0.34	15.2			
02/02/2019	7.14	16	10.2	15	323	2.90	14.8	1.32	0.603	15.9	BDL	7800	2000
03/02/2019	7.208	16	10.4	15	365.9	2.54	15.7	0.98	0.39	15.2			
04/02/2019	7.106	17	10.2	15	314	2.02	9.76	4.50	0.388	15.1	BDL	33000	7800
05/02/2019	7.08	17	10.1	10	303	3.05	16.7	0.920	0.112	14.6			
06/02/2019	7.8	17	10	15	364	2.51	8.5	0.96	0.119	13.6	BDL	17000	<1.8
07/02/2019	8.26	16	9.2	15	390	2.97	10.8	0.86	BDL	18.4		130000	79000
08/02/2019	7.19	17	10	15	316	3.2	12.8	1.08	BDL	11.7	BDL	13000	4500
09/02/2019	7.27	16	9.6	15	359.1	1.3	10.7	1.03	BDL	9.41	BDL		
10/02/2019	8.32	17	9.5	15	292	1.9	9.3	0.934	BDL	10.1	BDL	7800	<1.8
11/02/2019	7.75	18	9.5	10	300	1.70	5.42	0.712	BDL	9.69			
12/02/2019	7.53	18	10.5	15	NA	4.1	11.6	0.737	BDL	10.3	BDL	7800	2000
13/02/2019	7.62	16	10.6	10	363	4.0	22.6	0.86	BDL	11.2			
14/02/2019	8.01	17	10.8	15	355	4.5	17.4	4.64	0.14	18.8	BDL	33000	11000
15/02/2019	8.42	19	9.0	15	339	3.4	14.7	1.08	BDL	11.2			
16/02/2019	NA	NA	NA	NA	319	2.6	15.2	0.804	0.439	19.2	BDL	49000	33000
17/02/2019	7.85	19	9.2	15	387	3	17.1	0.80	0.206	14.2			
18/02/2019	8.16	19	9.8	10	373	2.5	BDL	0.768	BDL	12.6	BDL	4500	<1.8
19/02/2019	7.231	19	9.9	15	380	2.6	13.9	0.818	0.140	13.6			
20/02/2019	7.21	20	8.9	15	383	5.44	28.3	0.526	0.972	16	BDL	6800	2000
21/02/2019	7.20	21	8.9	15	371	3.96	16.8	0.404	0.28	14.4			
22/02/2019	8.45	21	10	10	349	2.05	11.2	3.23	0.311	15.7	BDL	13000	<1.8
23/02/2019	7.63	20	8.3	10	369	3.3	16.9	3.72	0.319	13.8			
24/02/2019	7.43	20	8.9	15	367.4	3.5	14.9	4.36	0.325	14.1	BDL	7800	2000
25/02/2019	7.47	20	9.7	10	-	4.2	20.7	0.76	0.110				
26/02/2019	8.16	18.5	9.6	10	389	3.5	20.3	0.303	0.474	18.6	BDL	33000	13000
27/02/2019	7.66	17	9.8	15	377	3.1	16	0.260	1.99	17.4			
28/02/2019	7.84	17	9.5	15	378	4.7	14.5	1.08	0.294	14.8	BDL	7800	4500
01/03/2019	8.18	18.5	9.6	10	NA	NA	NA	NA	NA	NA	NA	NA	NA
02/03/2019	7.37	19	9.3	15	371	1.84	14.4	4.0	0.171	12.6	BDL	4500	<1.8
03/03/2019	7.34	20	9.1	15	358	3.67	18.6	0.79	0.144	12.6	BDL	2000	<1.8
04/03/2019	7.46	19	2.41	15	368	2.41	17.7	0.76	0.195	10.7	NA	NA	NA

NA: Not Available; BDL: Below Detection Limit

6. Comparison of River Water Quality during Magh Mela 2018 and Kumbh Mela 2019

A similar study was also carried out by the Regional Directorate (N) Lucknow during Magh Mela 2018. Despite exponentially higher pilgrims (1-5 crore) during Kumbh 2019 in comparison to Magh Mela 2018 (0.13-2.25 crore), the water quality remained within standards for most of the parameters and no public complaint raised regarding water quality during the entire period of Kumbh Mela at Prayagraj.

The adequate environmental flow in river Ganga (344-458 m^3/sec) was retained throughout the Kumbh Mela (2019) to maintain its water quality even after mass bathing. During Magh Mela 2018 water discharge in river Ganga varied from 233 to 319 m^3/sec. Dissolve oxygen was also significantly improved as compared to last year due to the availability of adequate volume of water released from different dams located in the upstream of R. Ganga.

7. Monitoring of Sewage Treatment Plants (STPs)

Prayagraj city have 7 STPs to treat the wastewater generated from different urban settlements (**Figure 22**). The performances of these STPs were regularly monitored during Kumbh Mela 2019 to ensure that no untreated sewage mixes with the river Ganga. The details of STPs are delineated in **Table 7.**

Table 7 Details of sewage treatment plants located at Prayagraj (U.P.)

Location of STP	Technology/Process	Designed capacity (MLD)
Pon Ghat	Improved Bio-tower	10
Kodra	Improved Bio-tower	25
Rajapur	UASB	60
Salori	FAB	29
Salori	SBR	14
Numayadahi	Improved Bio-tower	50
Naini	ASP	80
Total designed treatment capacity (MLD)		**268**

Figure 22 Operational STPs in Prayagraj during Kumbh 2019

Total treatment capacity of 7 STPs is 268 MLD however the actual treatment capacity during December 19-21, 2018 was 275.21 MLD. All STPs were operational during Kumbh 2019 and most of them were operating over capacity due to increased floating population, except STPs at Pon Ghat (10 MLD), Kodra (25 MLD) and Salori (14 MLD). The treated wastewater of each STP was monitored regularly and found complying with the prescribed standards except for STP at Salori (FAB). Details of the monitoring data are depicted through **Figure 23-31.**

During Dec 19-21 (2018), highest treatment capacity (MLD) was observed at Numayadahi STP, i.e. 67 MLD whereas lowest was observed at Pon Ghat STP, i.e. 7.55 MLD. Analysis result shows that COD and BOD were found compliant w.r.t. inland surface water discharge norms at outlet of all STP pre-Kumbh Mela whereas FC was found compliant only at Salori (FAB & SBR) and Numayadahi.

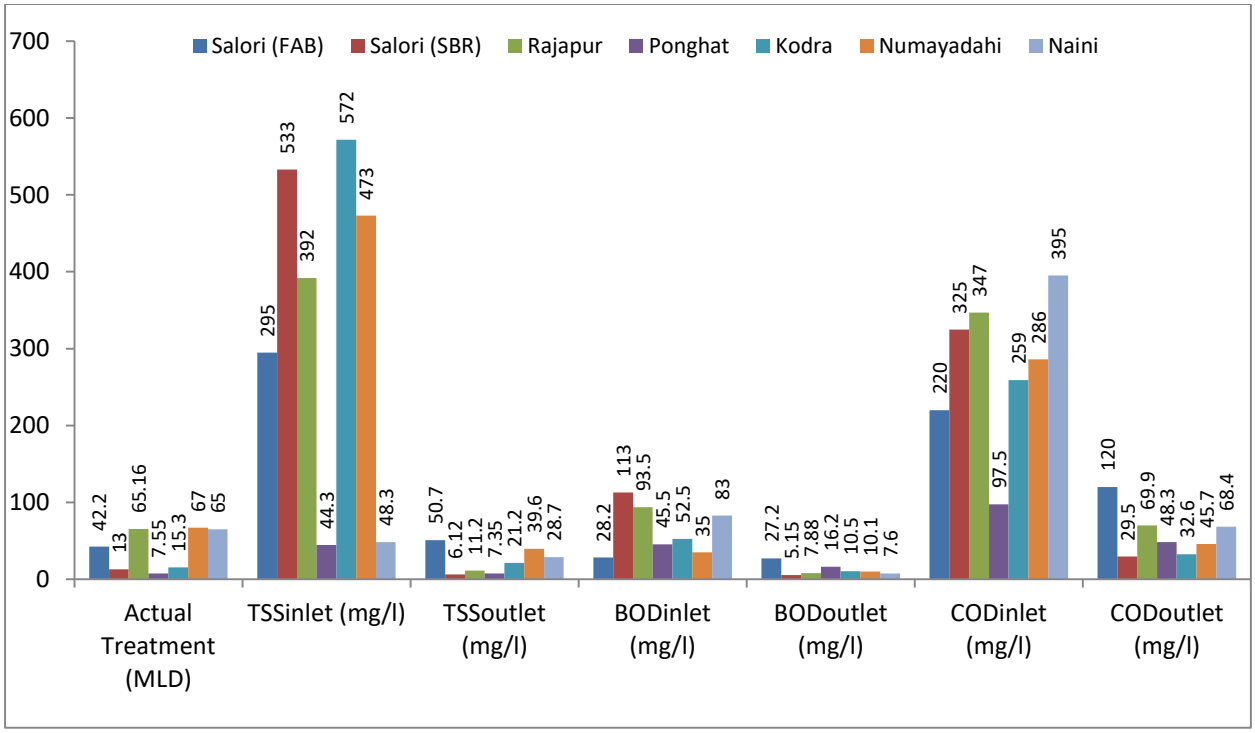

Figure 23 Performance evaluation of sewage treatment plants in Prayagraj (December 19-21, 2018) during Pre Kumbh Mela-2019

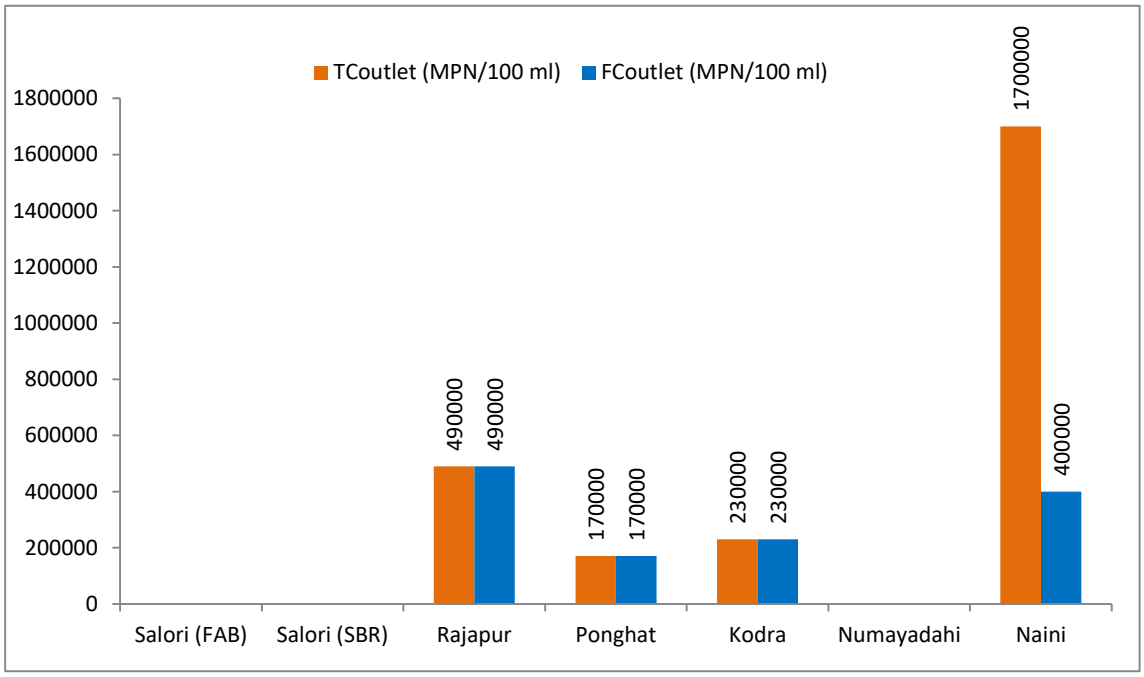

Figure 24 Total and fecal coliform at outlet of sewage treatment plants in Prayagraj (December 19-21, 2018) during Pre Kumbh Mela-2019

During Jan 28-30 (2019), only Salori (FAB) was found non-compliant in terms of BOD having value of 56.5 mg/l at its outlet whereas in terms of TSS, and COD all STPs outlet were complying

w.r.t. inland surface water discharge norms. FC was found compliant only at Salori (SBR), Numayadahi and Naini (**Figure 25-26**).

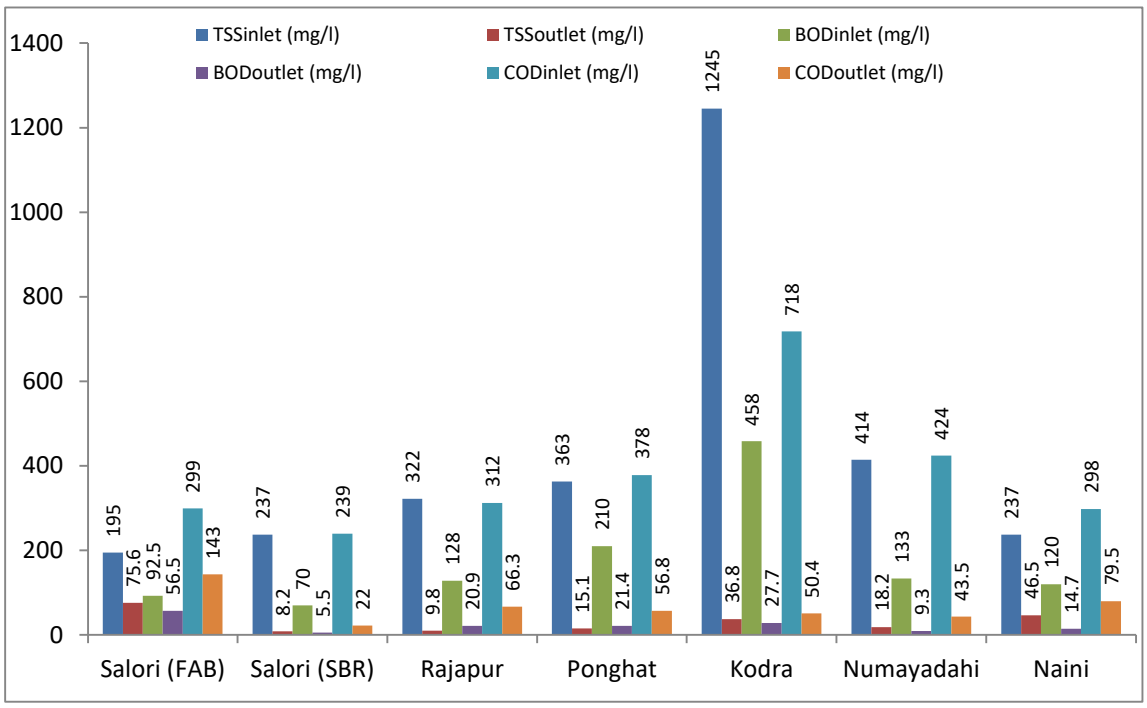

Figure 25 Performance evaluation of sewage treatment plants in Prayagraj (January 28-30, 2019) during Kumbh Mela-2019

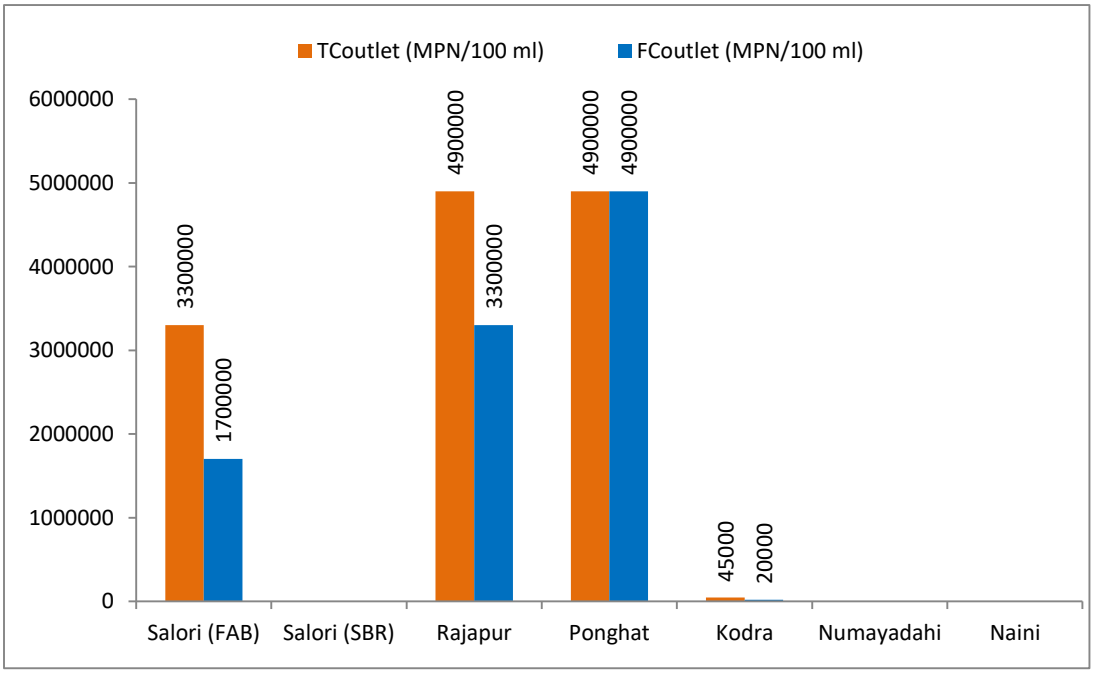

Figure 26 Total and fecal coliform at outlet of sewage treatment plants in Prayagraj (January 28-30, 2019) during Kumbh Mela-2019

During Feb 26-27 (2019), TSS and COD were found complying w.r.t inland surface water discharge norms whereas BOD shows non-compliance at Salori (FAB) and FC shows Non-compliance at Salori (FAB), Rajapur and Kodra STP (**Figure 27 - 28**).

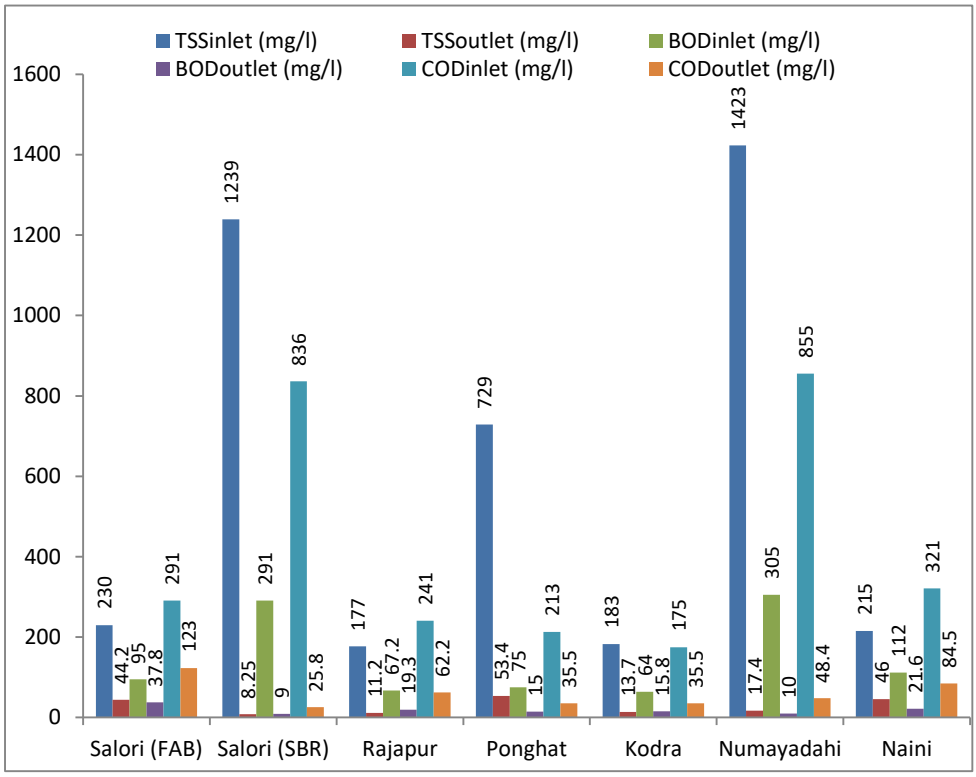

Figure 27 Performance evaluation of sewage treatment plants in Prayagraj (February 26-27, 2019) during Kumbh Mela-2019

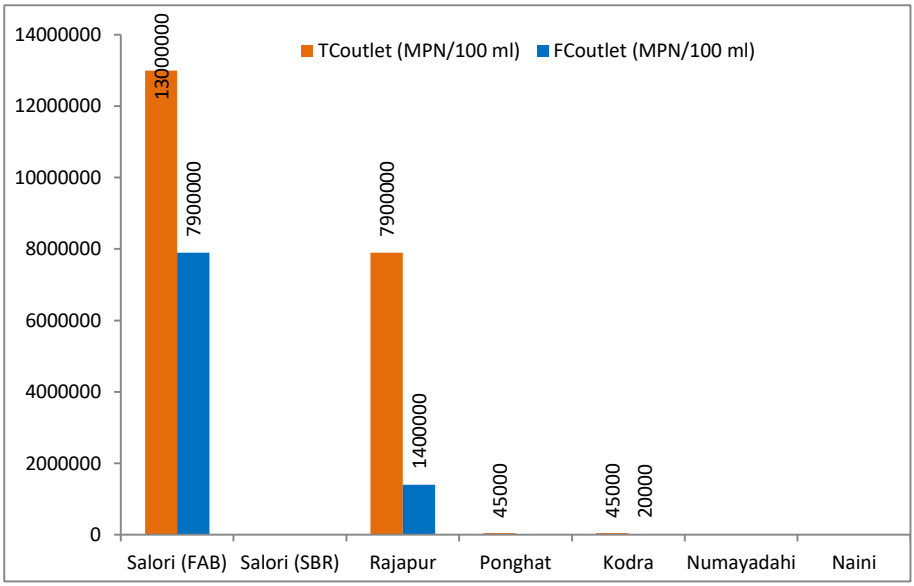

Figure 28 Total and fecal coliform at outlet of sewage treatment plants in Prayagraj (February 26-27, 2019) during Kumbh Mela-2019

During March 11-14 (2019), the total actual treatment in STPs increased from 275.2 to 305.82 MLD. STPs was found in compliance with inland surface discharge norms in terms of TSS and

COD whereas it does not meet the norms for BOD at Salori (FAB) and FC at Salori (FAB), Rajapur and Numayadahi STPs. (**Figure 29 - 30**). The BOD and COD reduction from inlet of wastewater to outlet of STP at Salori (FAB) STP were not satisfactory.

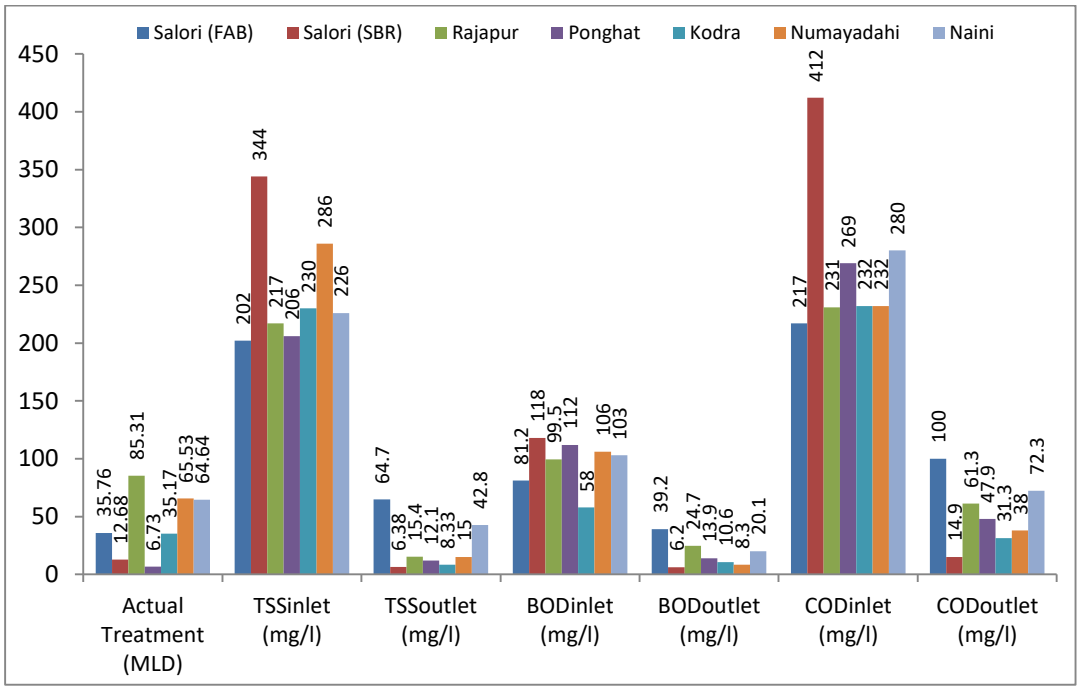

Figure 29 Performance evaluation of sewage treatment plants at Prayagraj (March 11- 14, 2019) during post Kumbh Mela-2019

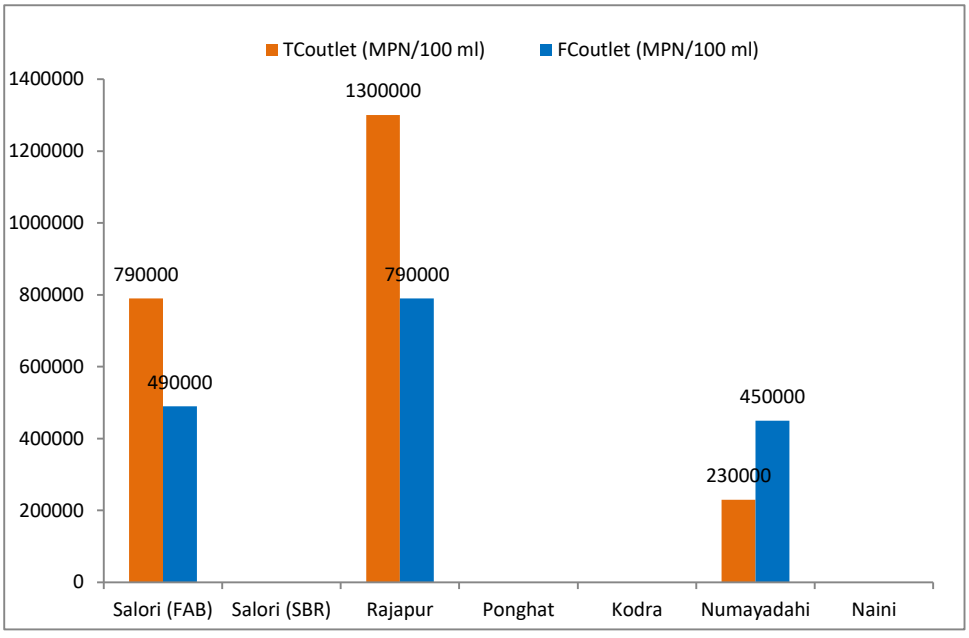

Figure 30 Total and fecal coliform at outlet of sewage treatment plants in Prayagraj (March 11- 14, 2019) during post Kumbh Mela-2019

The pollutant removal efficiencies of STPs before and after Kumbh Mela are shown in **Figure 31**. BOD and COD reduction efficiencies at Salori (FAB) before Kumbh Mela were 3.6 and 45.5%, respectively. Even after Kumbh Mela, the BOD and COD reduction efficiencies increased to 51.7

and 53.9%, respectively which further indicated low efficiency of Salori (FAB) STP. At other STPs, removal efficiencies were satisfactory except COD removal efficiency (50.5%) at Pon Ghat STP during pre-Kumbh Mela period.

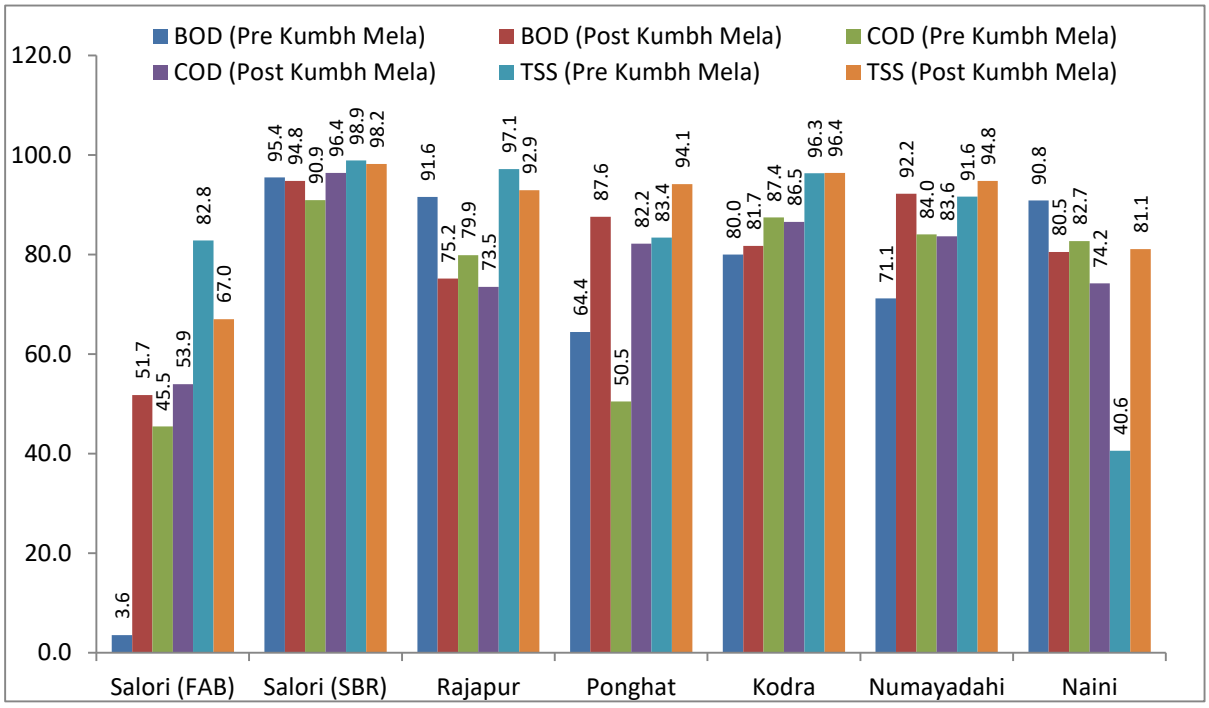

Figure 31 Pollutant removal efficiency (%) of sewage treatment plants in Prayagraj

8. Monitoring of Drains

There are total 18 major drains flowing in Prayagraj and meeting to river Ganga / Yamuna. CPCB Regional Directorate (North) Lucknow regularly monitors these drains to assess the pollution load contributed by them in to these rivers. Monitoring of these drains was carried out during pre and post-Kumbh Mela period to assess the pollution load exerted by them on rivers Ganga and Yamuna. The details of these drains are given in **Table 8**.

Table 8 Major Drains in Prayagraj

S. No.	Name of Drain	S. No.	Name of Drain
1	Pon Ghat	10	Jhunsi
2	Kodra	11	Chatnag
3	Nehru	12	Arail
4	Rasulabad-1	13	Chhuhara Mandir-1
5	Rasulabad-2	14	Chhuhara Mandir-2
6	Rasulabad-3	15	Sadanand Ashram
7	Rasulabad-4	16	Mehdeori
8	Salori	17	Manaiya (Mughlaha)
9	Sasurkhaderi River	18	Mavaiya

Wastewater samples were collected from identified locations of drains for physico-chemical characterization and measurement of discharge. Characteristics of the wastewater and their pollution load on the rivers are given in **Table 9 and 10**. The analyses results indicated that

these drains carry mostly sewage of diluted nature. It is observed that most of the water public posts in the city were found unregulated, which may be one of the reasons for the dilution of sewage. Due to migratory population for different rituals associated with Kumbh, the quantum of wastewater generation fluctuates significantly. The BOD concentration of these drains varied from 13.1 to 121 mg/l, whereas total pollution load in terms of BOD varied from 0.03 to 4.83 TPD. During Pre Kumbh-2019 monitoring, it was noticed that the discharge of these drains has reduced significantly (~15%) in comparison to Pre Magh Mela 2018.

Table 9 Characteristics of wastewater and pollution load of different drains in Prayagraj during pre Kumbh Mela, 2019

Name of Drain	Flow (MLD)	pH	Colour (Hazen)	Chloride (mg/l)	Ammoniacal N(mg/l)	BOD (mg/l)	BOD Load (TPD)	COD (mg/l)	COD Load (TPD)	TSS (mg/l)	TSS Load (TPD)	TC (MPN/100 ml)	FC (MPN/100 ml)
Pon Ghat	Tapped												
Kodra	Tapped												
Nehru	2.85	7.32	30	56.5	11.5	13.1	0.03	39.5	0.11	45.1	0.12	23×10^5	45×10^5
Rasulabad 4	52.05	7.04	50	45.1	20.8	30.1	1.56	84.7	4.40	66.9	3.48	17×10^6	4×10^6
Mehdauri	Tapped												
Rasulabad 3	5.49	7.23	30	56.5	11.5	48.2	0.26	122	0.66	154	0.84	16×10^8	35×10^7
Rasulabad 2	Tapped												
Rasulabad 1	Tapped												
Chuahara mandir 1	Tapped												
Chuahara mandir 2	7.64	7.08	35	57	13.9	58.4	0.44	181	1.38	235	1.79	54×10^7	22×10^7
Sadanand ashram	Tapped												
Salori	93.06	7.03	50	86.8	23.7	52	4.83	159	14.7	533	49.6	13×10^7	79×10^6
Jhunsi	1.84	7.27	50	124	14.5	59.2	0.10	230	0.42	560	1.03	79×10^6	17×10^5
Chatnag	26.6	7.05	60	112	22.6	121	3.21	373	9.92	521	13.8	54×10^7	24×10^7
Arail	2.59	7.09	35	91.2	7.06	33	0.08	112	0.29	378	0.97	92×10^7	12×10^7
Mavaiya	58.87	7.12	30	66.5	14.4	45	2.64	140	8.24	125	7.35	35×10^7	24×10^7
Manaiya	Dry												
Sasurkhaderi	Tapped												

During pre-Kumbh Mela period, 8 out of 18 drains were tapped and 1 drain was dry. Total organic load of drains flowing into river Ganga was 13.15 TPD. However, during post-Kumbh Mela period, 13 drains were tapped and the total organic load of drains was 1.5 TPD. A reduction of 88.5% in organic load of drains was observed during post-Kumbh Mela period in comparison to pre-Kumbh Mela period.

Table 10 Characteristics of wastewater and pollution load of different drains in Prayagraj during post Kumbh Mela, 2019

Name of Drain	Flow (MLD)	pH	Colour (Hazen)	Chloride (mg/l)	Ammoniacal N(mg/l)	BOD (mg/l)	BOD Load (TPD)	COD (mg/l)	COD Load (TPD)	TSS (mg/l)	TSS Load (TPD)	TC (MPN/100ml)	FC (MPN/100ml)
Pon Ghat	Tapped												
Kodra	Tapped												
Nehru	7.53	7.89	-	68.7	3.69	16.4	0.12	58.9	0.44	133	1.00	13×10^5	17×10^5
Rasulabad 4	Tapped												
Mehdauri	Tapped												
Rasulabad 3	10.39	7.25	-	60.7	10.5	68.7	0.71	208	2.16	131	1.36	54×10^6	35×10^7
Rasulabad 2	Tapped												
Rasulabad 1	Tapped												
Chuahara mandir 1	Tapped												
Chuahara mandir 2	Tapped												
Sadanand ashram	Tapped												
Salori	Tapped												
Jhunsi	-	7.45	-	136	10.1	41.2	-	150	-	263	-	13×10^6	79×10^5
Chatnag	Tapped												
Arail	Tapped												
Mavaiya	60.8	7.38	-	66.3	9.54	10.6	0.64	41.8	2.54	72.7	4.42	49×10^4	33×10^4
Manaiya	3.9	7.81	-	64	1.08	7.9	0.03	42.2	0.16	38	0.15	45×10^3	2×10^4
Sasurkhaderi	Tapped												

Figure 32 & 33 indicates wastewater discharge and pollution load pattern of different drains meeting river Ganga during Pre Kumbh Mela and Post Kumbh Mela. Pollution potential of these drains was found reduced in terms of discharge and pollution load, due to efficient interception and diversion of drains to STPs and/or their in-situ treatment.

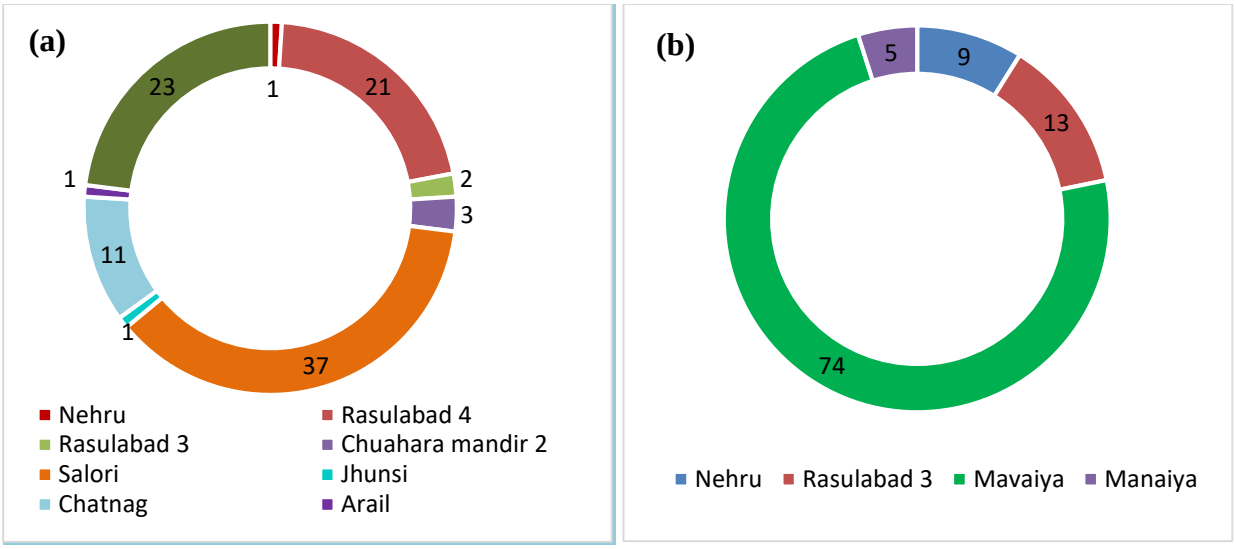

Figure 32 Percent discharge by different drains during **(a)** pre; and **(b)** post Kumbh Mela (2019)

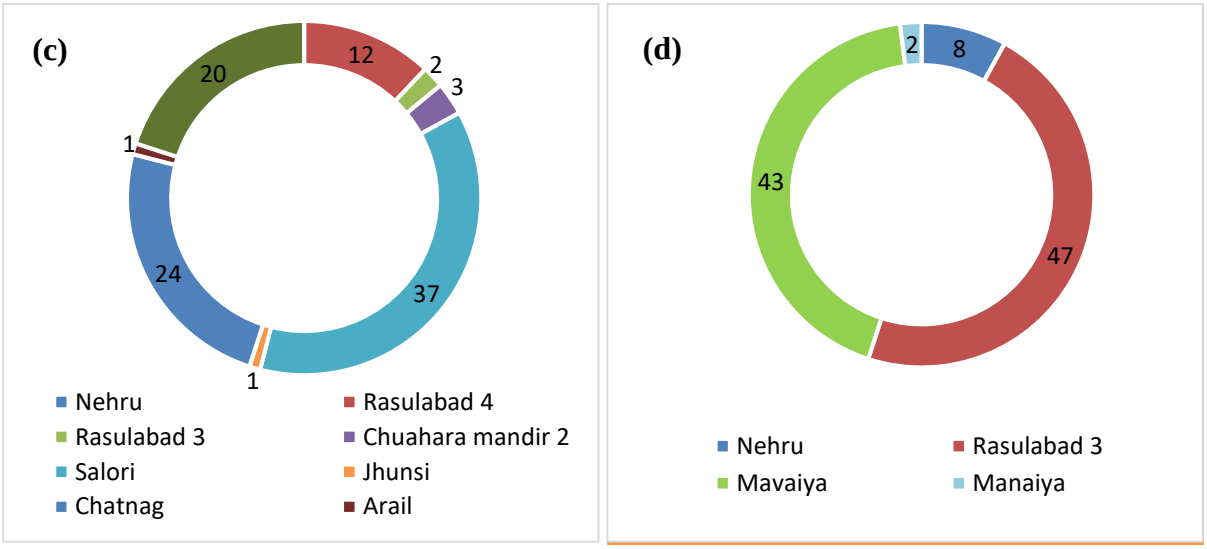

Figure 33 BOD load (in percentage) of different drains during **(a)** pre; and **(b)** post Kumbh Mela (2019)

Before meeting R. Ganga, wastewater of 8 drains was being treated through technologies like bioremediation or geo-bag modular STP. Bioremediation is a process of using living organisms such as microbes and bacteria to remove contaminants, pollutants, and toxins from water. Geo-bag or Nonwoven Geotextile bag, on the other hand, is made out of porous synthetic fabric that is stitched from three sides and is open from one side. It is designed to be filled with soil and is installed at the beaches. It helps in protecting rivers and other water bodies from erosion by developing an embankment and by filtering sludge from the wastewater. This project was started by Uttar Pradesh Government about a month before the commencement of the Kumbh and continued till June 2019 (**Figure 34**).

Figure 34 (a & b) Deployment of Geo tubes for treatment of drains directly going towards river; **(c)** Deployment of phytoremediation for treatment of drains directly going towards river; and **(d)** Deployment of bioremediation for treatment of drains directly going towards river

The State Mission for Clean Ganga - Uttar Pradesh (SMCG-UP) and Prayagraj Jal Board continuously monitored these drains to ensure a cleaner Ganga by controlling the amount of sludge entering the river. CPCB, RD (N) monitored drains in Prayagraj during Kumbh to vigil the status of drains and to ensure that none of the drains discharge BOD wastewater into river Ganga. The characteristics of drain and observations regarding treatment technologies adopted for treatment of drains are tabulated in **Table 11 and 12**, respectively.

Table 11 Characteristics of wastewater flowing in to river through drain during Kumbh Mela, 2019

Name of Drain	Flow (MLD)	pH	TSS (mg/l)	PO_4-P (mg/l)	NH_3-N (mg/l)	BOD (mg/l)	COD (mg/l)	TC (MPN/100 ml)	FC (MPN/100 ml)
Pon Ghat	Tapped								
Kodra	Tapped								
Nehru	5.51	7.94	13.7	1.90	0.888	18.7	61	79×10^4	17×10^4
Rasulabad-1	Tapped								
Rasulabad-2	Tapped								
Rasulabad-3	1.05	7.41	110	4.43	4.57	88.7	165	16×10^7	54×10^6
Rasulabad-4 geo-tube outlet	24.2	7.40	45.9	0.606	5.34	23.9	75.4	11×10^6	7×10^5
Mehdeori	Tapped								
Sadanand Ashram	Tapped								
Chhuhara Mandir-1	Tapped								
Chhuhara Mandir-2	5.86	7.18	122	3.72	14.4	91.7	189	54×10^6	22×10^6
Salori geo-tube outlet	9	7.66	10.9	1.40	16.4	5.2	22.7	78×10^3	45×10^3
Sasurkhaderi	Tapped								
Jhunsi	2.42	7.65	29.5	1.40	13.6	33.1	70.4	17×10^6	14×10^6
Chatnag geo-tube outlet	13.37	7.01	10.6	BDL	19.9	40.1	72	-	-
Arail	1.05								
Mavaiya	26	7.18	104	BDL	15.9	32	85.2	11×10^6	7×10^6
Manaiya	15.84	7.80	260	BDL	BDL	6.9	24.6	<1.8	<1.8

BDL: Below Detection Limit

Table 12 Observations of Drain and STPs monitoring at Prayagraj during 28-31 January, 2019

Drain	Observations
Kodra	Tapped and diverted to 25 MLD Kodra STP
Pon Ghat	Tapped and diverted to 10 MLD Pon Ghat STP
Nehru	➢ The drain was neither tapped nor treated by any other method. ➢ The measured flow was 5.51 MLD (@ 0.8 factor)
Rasoolabad-1	Tapped and diverted to STP.
Rasoolabad-2	Tapped and diverted to STP.
Rasoolabad-3	➢ The drain was directly meeting to R. Ganga. During its run, it was getting in-situ treatment using Biozyme, by M/s National Project Construction Corporation Ltd. ➢ 90° triangular V-notch was installed at the drain. At the time of monitoring, the flow calculated by V-notch was 1.054 MLD.
Rasoolabad-4	➢ The drain was meeting to R. Ganga after treatment through geo-tube technology.

	➢ For this purpose, the flow of the drain was tapped and the sewage was pumped to the geo-tube for treatment. ➢ As per the geo-tube facility representative, they are treating approximately 20-22 MLD sewage per day. Although they have the contract with U.P. Jal Nigam for treatment of 18 MLD sewage per day. ➢ As per the geo-tube facility representative, nearly 10% sewage is still getting bypassed, which is meeting to R. Ganga without any treatment. ➢ Hence, the approximate flow of the drain during monitoring was 24.2 MLD (22 + 2.2).
Chuhara Mandir-1	Tapped and diverted to STP.
Chuhara Mandir-2	➢ The drain was directly meeting to R. Ganga. During its run, it was getting in-situ treatment using Biozyme, by M/s National Project Construction Corporation Ltd. ➢ 90° triangular V-notch was installed at the drain. At the time of monitoring, the flow calculated by V-notch was 5.86 MLD.
Sadanand Ashram	➢ The drain was found tapped at the time of monitoring. But due to improper tapping and diversion, some sewage was overflowing and meeting to R. Ganga directly. ➢ As the overflow of sewage was very lean, flow measurement and sampling could not be done.
Mehdauri	➢ Tapped and diverted STP.
Jhusi	➢ The drain was meeting to R. Mansaita, which further meets to R. Ganga. During its run, it was getting in-situ treatment by phytoremediation. ➢ The flow of the drain was monitored as 2.42 MLD (@ 0.8 factor).
Arail	➢ The drain was directly meeting to R. Yamuna. During its run, it was getting in-situ bioremediation using Bokashi balls and microbial liquid culture, by M/s Greenway Technologies. ➢ 90° triangular V-notch was installed at the drain. At the time of monitoring, the flow calculated by V-notch was 1.054 MLD.
Salori	➢ The drain was meeting to R. Ganga after treatment through geo-tube technology. ➢ For this purpose, the flow of the drain was tapped and the sewage was pumped to the geo-tube for treatment. ➢ As per the geo-tube facility representative, they are treating approximately 8-9 MLD sewage per day. Although they have the contract with U.P. Jal Nigam for treatment of 10 MLD sewage per day.
Chatnag	➢ The drain was meeting to R. Ganga after treatment through geo-tube technology. ➢ For this purpose, the flow of the drain was tapped and the sewage was pumped to the geo-tube for treatment. ➢ As per the geo-tube facility representative, they are treating approximately 10 MLD sewage per day. Although they have the contract with U.P. Jal Nigam for treatment of 4.45 MLD sewage per day. ➢ Except, the treated sewage, some of the sewage was getting bypassed due to overflow, which is meeting to R. Ganga without any treatment. ➢ The measured flow of the bypass was 3.77 MLD. ➢ Hence, the approximate flow of the drain during monitoring was 13.77 MLD (10 + 3.77).
Manaiya	➢ The drain was neither tapped nor treated by any other method. ➢ The measured flow was 15.84 MLD (@ 0.8 factor).

Mavaiya	➢ The drain was meeting to R. Ganga after treatment through geo-tube technology. ➢ For this purpose, the flow of the drain was tapped and the sewage was pumped to the geo-tube for treatment. ➢ As per the geo-tube facility representative, they are treating approximately 26 MLD sewage per day. ➢ Except, the treated sewage, some of the sewage was getting bypassed due to overflow, which is meeting to R. Ganga without any treatment. ➢ As per the geo-tube facility representative, the approximate flow of the bypass is 1-2 MLD. ➢ The BOD after treatment was 23 mg/l and COD was 47.3 mg/l. ➢ Hence, the approximate flow of the drain during monitoring was 28 MLD (26 + 2).
Sasur Khaderi	➢ Tapped to Sasur Khaderi sewage pumping station.

9. Comparison of Pollution load: Pre Kumbh Mela- 2019 and Pre Magh Mela - 2018

The discharge from total 18 drains during pre Kumbh Mela 2019 was 250 MLD whereas during pre Magh Mela, 2018 it was 295.35 MLD (**Figure 35**). The city has total 07 STPs of 268 MLD capacity. Contribution of the organic load (BOD) from the different drains during December 2018 in river was 13.15 TPD which is higher than discharge during Magh Mela, 2018 whereas COD load was less than last year.

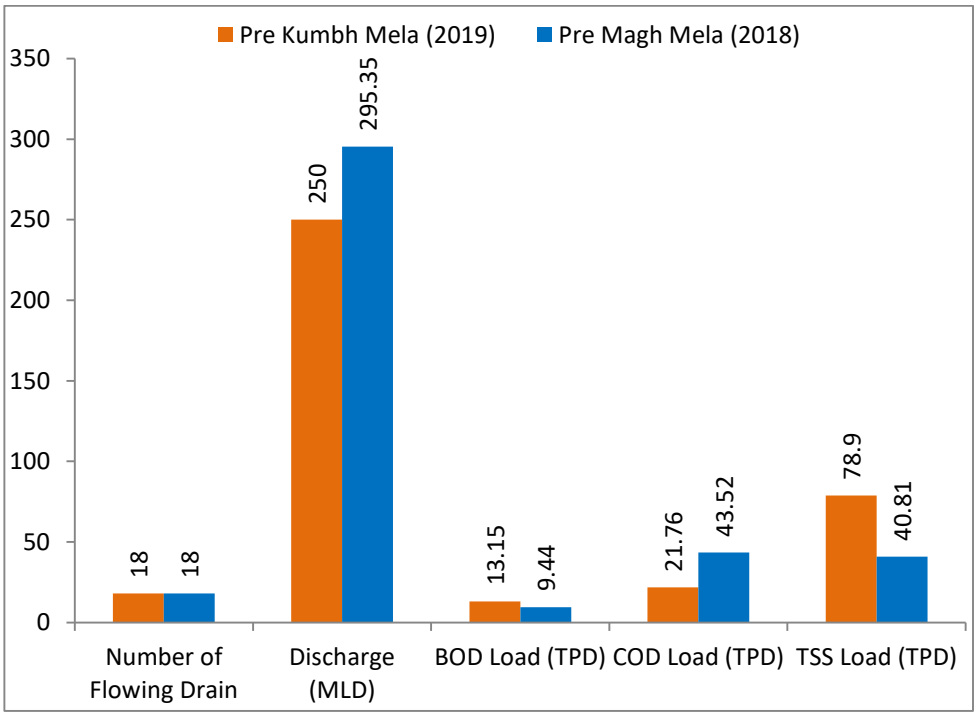

Figure 35 Status of drains monitored during pre Kumbh Mela 2019 and Pre Magh Mela 2018

10. Solid Waste Generation & its Management during Kumbh Mela-2019

To keep the Mela area clean, metal dustbins were placed in adequate numbers in each sector of the Mela area for garbage collection. The quantity of solid waste generated in the Mela area is

shown in **Table 13**. These dustbins were of single type and were used by the pilgrims for disposal of all types (mixed) of solid waste generated within the Mela area without segregation at source. Compactor vehicles were engaged to collect the garbage from dustbins. Collected garbage was compressed to reduce the volume and transported to the Common Solid Waste Management site near Baswar village, Prayagraj. The representative of Prayagraj Municipal Corporation reported that 40 compactors were engaged in Kumbh Mela-2019 for collection & disposal of solid waste to the Baswar Waste Processing Unit (**Figure 36**).

Figure 36 (a) Compactor vehicles engaged in Mela area for collection & transportation of solid waste; **(b)** Waste Processing Units at Baswar; **(c)** Un-segregated Solid waste dumped at Baswar Waste Processing Unit; and **(d)** Wind-rose of mixed Solid Waste at Baswar village (Prayagraj)

Presently, the unit is operated & managed by M/s Hari Bhari Allahabad Waste Management Pvt. Ltd. The quantity of un-segregated solid waste generated from the city & Kumbh Mela is recorded separately for every day by Municipal Corporation. The un-segregated solid waste collection system was in practice in Kumbh Mela-2019. As per record, the average quantity of un-segregated solid waste generated in Kumbh Mela and Prayagraj city is given in **Table 13**. The solid waste collected from different parts of the city and Mela area is not getting disposed as per the SWM rules, 2016.

Table 13 Quantity of solid waste generated in the Mela Area

Location	Avg. Generation (MT per day)	Remarks
Kumbh Mela Area	150 MT	On auspicious bathing dates generation of solid waste was increased, ranging from 300 - 500 MT.
Other than Kumbh Mela Area	600 MT	One day before & after auspicious bathing dates generation of solid waste was more, i.e. up to 700 MT

11. Wastewater Generation & its Management during Kumbh Mela-2019

In order to ensure clean surroundings, hygiene and sanitation, the government has made arrangements for portable toilets, taps for drinking water, sweeping of roads, etc. It is reported that the average freshwater consumption during Kumbh Mela is 95 MLD. This requirement was fulfilled by 67 number of tube wells. It was also reported that about 1.22 lakh portable toilets were installed, 500 sanitation workers and 1,500 Swachha grahis (volunteers) were deployed at the site to keep the venue clean (**Figure 37**).

Figure 37 (a) Portable toilets in Kumbh Mela area-2019; **(b)** Plastic tanks buried in soil connected to portable toilets; **(c)** Portable urinals in Kumbh Mela area-2019; and **(d)** Temporary ponds constructed for storage of waste water

Following observations were made:

- Out of 20 Sectors, toilets in 18 sectors were connected to plastic tanks buried in soil for the collection of sewage. Toilets in rest two sectors namely Sector-1 & Sector-2 are connected to

drain carrying sewage of nearby area which is further pumped to Rajapur STP via Alopibagh PS.

- As per the Health Department representative, once the plastic tanks filled completely the tanks were emptied by tankers having pressure suction system, transported and discharged into drains connected to sewage treatment plants in Prayagraj city.
- Wastewater other than sewage (grey water) was stored in temporary lined ponds of a total of 2,00,000 m^3 capacity within low lying Mela area.

12. Bio Medical Waste Generation & its Management

To provide medical facilities to pilgrims, Health Department made 11 temporary hospitals in Kumbh Mela-2019. Details of these hospitals are shown in **Table 14.**

Table 14 Details of Hospitals in the Kumbh Mela Area, 2019

Hospital Name	Sector
Central Hospital (100 Beds)	Sector-2
Sector Circle Hospitals (20 Beds)	Sector-1
	Sector-4
	Sector-6
	Sector-7
	Sector-10
	Sector-12
	Sector-16
	Sector-19
Infectious Disease Hospitals (20 Beds)	Sector-14
	Sector-20

In order to record the biomedical waste generation & its disposal in the above hospitals, CPCB officials inspected the Central Hospital in Sector-2 and three Circle Hospitals in Sector-12, 14 & 16. Following observations were made:

- Dustbins having assigned colour coding namely Red, Yellow and Blue were found kept for collection of biomedical waste at source. Besides this, Black colored dustbins were also kept in each hospital for the collection of general solid waste (**Figure 38**).

Figure 38 (a) Colour coded dustbins in central hospital of Kumbh Mela; **(b)** Central hospital in sector-2 of Mela; **(c)** Container for general waste in hospitals; **(d)** Central hospital in sector-14 of Mela; **(e)** Unsegregated BMW in sector hospital; and **(f)** Mixed BMW in a yellow dustbin

- It is noticed that hospitals in Kumbh Mela were not following the colour code for the collection & segregation of biomedical waste at source, except at Central hospital.
- As per record available hospitals and CBWTF, the average quantity of biomedical waste generation is presented in **Table 15.**

Table 15 Biomedical waste generation in the Kumbh Mela area

Hospital	BMW generation (Kg per day)	Remarks
Central Hospital	8 to 10 Kg	On auspicious bathing dates generation of BMW increased by 100%
Circle Hospitals	8 Kg	

- A Common Bio-Medical Waste Treatment Facility (CBWTF) namely M/s Ferro Build Hards (I) Pvt. Ltd, having 2000 Kg/day capacity, was engaged in the collection, transportation and processing of BMW from different hospitals in Kumbh Mela-2019. This CBWTF has a waste processing site at Mahewa Purab Patti, Naini, Prayagraj.

13. Efforts made by Government for maintaining the river water quality

Considering the sensitivity and importance of the occasion of Kumbh Mela, a meeting was convened which was headed by the Chairperson of UPPCB and participated by all stakeholders, i.e., RD (N) CPCB, UPPCB and UEPPCB, to take the precautionary measures for maintaining the water quality of river Ganga during the Kumbh Mela. The following precautionary measures were suggested:

a. Action taken by Central Pollution Control Board (CPCB) to maintain the river water quality during Kumbh, 2019

1. *Directions under section 18(1) (b) of the Water (Prevention and Control of Pollution) Act, 1974 has been issued to UPPCB and UEPPCB vide office letter dated 16-11-2018 to maintain the river water quality. The condition levied in the direction are as under:*

- There will be no discharge of effluent in river Ganga & its tributaries from Grossly Polluting Units (Distillery, Sugar, Pulp & Paper, Textile, etc.) during the Kumbh Mela.
- UPPCB shall monitor the water quality of river Ganga on a daily basis and UEPPCB shall monitor the river water quality of river Dhela, Kosi, Bhela, Kitcha on daily basis and upload the data on the web.
- UPPCB shall ensure the monitoring of discharge from drains twice in a week/weekly basis and UEPPCB shall ensure the monitoring of drains on weekly basis and upload the data on the web.
- UPPCB and UEPPCB shall ensure the monitoring of discharge from STPs on a weekly basis and upload the data on the web.
- UPPCB shall ensure the monitoring of CETPs at Jajmau, Rooma, Banthar and Unnao on a weekly basis and upload the data on the web.
- UPPCB and UEPPCB shall inspect Grossly Polluting Industries on a weekly basis for a compliance check.

- UPPCB and UEPPCB shall enforce regulatory measures for control of pollution so that bathing water quality is maintained during Kumbh Mela.

b. CPCB has scheduled extensive monitoring of water quality of river Ganga and its tributaries (Ramganga, Kali East and Yamuna), drains, STPs starting from January 08, 2019 to March 14, 2019.

- Pre & Post Kumbh Mela period: Monitoring of 7 STPs & 18 drains in Prayagraj.
- Monitoring of R. Ganga, Kali and Ramganga at Farrukhabad, Kannauj and Kanpur 3-5 days before each auspicious bathing day.
- Monitoring of R. Ganga and Yamuna at Prayagraj during Pre Snan day, on Snan day and Post Snan day.
- Daily monitoring of R. Ganga at Sangam (twice a day) from 14.01.19 to 05.03.19.
- Daily monitoring of R. Ganga at Kanpur downstream (at Dyodhi Ghat) from 17.01.19 to 04.03.19.

c. Proposed discharge of water to river Ganga during Kumbh

The proposed discharge of water to river Ganga during Kumbh is shown in **Table 15**.

Table 16 Discharge of water in to river Ganga

Duration for discharge of water during Kumbh	Discharge (Cusec)	Major auspicious bathing dates and occasions
13.01.2019-16.01.2019	7000	Makar Sakranti 15.01.2019
19.01.2019 to 26.01.2019	7000	Paush Poornima 21.01.2019
01.02.2019 to 06.02.2019	8000	Mauni Amawasya 04.02.2019
08.02.2019 to 11.02.2019	7000	Basant Panchmi 10.02.2019
17.02.2019 to 20.02.2019	7000	Maghi Poornima 19.02.2019
02.03.2019 to 05.03.2019	7000	Mahashivratri 04.03.2019

14. Mass Awareness

- Mela Administration displayed banners and cut-outs to encourage people to keep the Mela area and city clean. Mass awareness activities such as announcement, audio & video display, poster presentation also organized by Mela administration, to appeal the pilgrims to refrain from dumping of flowers, idols, coconut barks & polythene in the river.
- The CPCB displayed the model in the exhibition on 20 MLD Zero Liquid Discharge based CETP for the tannery cluster of Jajmau, Kanpur (**Figure 39**).

- CPCB made an audio-visual presentation to aware the public on plastic pollution, reuse of wastewater, water quality of river Ganga & its tributaries, significance of rivers & aquatic animals and their ecological importance.

Figure 39 (a) Exhibition organized by CPCB at Kumbh 2019 for mass awareness; and **(b)** Display of model of 20 MLD ZLD based CETP for Jajmau tannery cluster

15. Conclusion

The Kumbh Mela the biggest religious congregation in the world hosted 13.02 Crore people in 2019. To provide clean surroundings for Kumbh Mela was one of the most challenging jobs done by CPCB Head Office Delhi along with CPCB Regional Directorate (North) Lucknow. The monitoring was carried out during Kumbh Mela on River Ganga and its tributaries. River water quality monitoring and its comparative study with previous year Kumbh Mela has been presented in this report. From the analysis report it can be concluded that;

1. Water quality of river Ganga was evaluated at Kuresar Ghat, Sangam and Dyodhi Ghat w.r.t outdoor bathing water quality criteria shows that;
   - At Kuresar Ghat, pH and DO were found complying w.r.t. outdoor bathing water quality criteria whereas BOD and FC exceed outdoor bathing norms on Pre-Makar Sakranti, Pre-Basant Panchami & Basant Panchami and Pre-Makar Sakranti, Pre-Basant Panchami & Basant Panchami respectively for BOD and FC.
   - At Sangam, the water quality of the river Ganga was monitored twice a day i.e. during morning and evening. The analysis result shows that;
     a. During the morning, the water quality of the river Ganga was found compliant w.r.t. DO for outdoor bathing water quality criteria on all occasions whereas pH (on 06 occasions), BOD (on 16 occasions) and FC (on 06 occasions) were found non-compliant w.r.t. outdoor bathing criteria.

b. During the evening, DO was found complying w.r.t. outdoor bathing water quality criteria on all occasions whereas pH (on 06 occasions), BOD (on 15 occasions) and FC (on 06 occasions) were found non-compliant.
c. During most of the auspicious bathing occasions, BOD value at Sangam significantly increased in the evening as compared to the morning.
d. FC was found exceeding outdoor bathing norms on the occasion of Maha Shivratri and post-Maha Shivratri in the morning as well as evening.

- At Deeha Ghat, also the water quality of river Ganga was found compliant w.r.t. DO for outdoor bathing water quality criteria on all occasions whereas pH (on 04 occasions), BOD (on 15 occasions) and FC (on 06 occasions) were found non-compliant.
- At all three locations DO was found complying on all occasions w.r.t. outdoor bathing water quality criteria whereas BOD was found non-compliant at most of the occasions amongst all parameters analyzed.

2. Water quality of tributaries Yamuna, Kali and Ramganga was evaluated and the following conclusions were made:

- In river Yamuna, DO meet outdoor bathing water quality criteria on all occasions whereas pH (on 01 occasion), BOD (on 05 occasions) and FC (on 13 occasions) were found non-compliant. However, during evening pH (on 01 occasion), BOD (on 01 occasions) and FC (on 07 occasions) were found non-compliant.
- The DO in river water was meeting outdoor bathing standards at all locations of river Kali and river Ramganga.
- Water quality of river Ganga at Ghatiya Ghat w.r.t. BOD meets outdoor bathing criteria. The lowest BOD was found in river Ganga at Ghatiya Ghat and Dyodhi Ghat whereas the highest BOD was found in river Kali at Khudaganj.
- Among tributaries of river Ganga, river Kali was found most polluted in comparison to other tributaries of river Ganga.

3. The adequate environmental flow in river Ganga (344-458 m^3/sec) was retained throughout the Kumbh Mela (2019) to maintain its water quality after mass bathing.

4. A reduction of 88.5% in the organic load of drains was observed during the post-Kumbh Mela period in comparison to the pre-Kumbh Mela period. During Kumbh Mela 8 out of 18 drains were tapped and 1 was dry. Monitoring of drains during Kumbh shows that;

- During Jan 28-30, 2019, only Salori (FAB) was found non-compliant in terms of BOD whereas in terms of TSS, and COD all STPs outlets were complying w.r.t. inland surface water discharge norms. FC was found compliant only at Salori (SBR), Numayadahi and Naini.
- During Feb 26-27 (2019), TSS and COD were found complying w.r.t. inland surface water discharge norms whereas BOD shows non-compliance at Salori (FAB) and FC shows Non-compliance at Salori (FAB), Rajapur and Kodra STP.

5. To ensure clean surroundings, hygiene and sanitation, the Government has made arrangements for portable toilets, taps for drinking water, sweeping of roads, etc.
6. Mela Administration has taken effective measures for maintaining the water quality of river Ganga at Sangam. Floating skimmers were deployed under the Namami Gange programme for collecting floating particles like leaves, flowers, coconut barks, polythene, etc. at Sangam. Around 1.22 lakh portable toilets were installed, 500 sanitation workers and 1,500 Swachha grahis (volunteers) were deployed at the site to keep the surroundings clean.

Table 1 Water Quality of river Ganga near Kuresar Ghat U/s of Prayagraj

	pH	**Temp (^{0}C)**	**Colour (Hz)**	**Conductivity (µS/cm)**	**Chloride (mg/l)**	**NH_3-N (mg/l)**	**DO (mg/l)**	**BOD (mg/l)**	**COD (mg/l)**	**TC (MPN/100 ml)**	**FC (MPN/100 ml)**
Pre Kumbh Mela	8.16	16	15	336	16.1	1.13	11.2	8.6	28.3	2000	<1.8
Pre Makar Sakranti	8.34	15.5	10	317	10.3	1.68	10.5	2.5	9.0	11000	6800
Makar Sakranti	8.64	15	20	318	12.5	0.659	12.8	4.4	15.1	2000	2000
Post Makar Sakranti	8.49	14	15	288	14.9	0.33	13	5.4	16.9	2000	<1.8
Pre Paush Poornima	8.13	17	20	324	13	0.56	11.2	5.2	24.6	2000	<1.8
Paush Poornima	8.36	16	20	332	14.7	BDL	10.5	5.1	16.3	<1.8	<1.8
Post Paush Poornima	8.6	16	20	328	14.3	BDL	10.5	4.7	19.6	<1.8	<1.8
Pre Mauni Amawasya	8.26	17	15	276	16.5	0.36	13	5.0	19.9	4500	2000
Mauni Amawasya	8.37	17	15	282	16.5	0.16	10.5	4.6	18.2	<1.8	<1.8
Post Mauni Amawasya	8.45	17	15	341	16.5	BDL	10.5	3.6	13.7	2000	<1.8
Pre Basant Panchami	8.30	17.6	10	290	13.4	BDL	8.6	3.1	11.5	24000	4500
Basant Panchami	8.40	17.5	10	300	15.2	BDL	8.9	2.9	14.3	23000	4500
Post Basant Panchami	8.20	17.2	10	354	15	BDL	8.2	5.5	18.7	<1.8	<1.8
Pre Maghi Poornima	8.20	18	20	340	14.9	0.40	10.8	7.0	25.6	7800	2000
Maghi Poornima	8.32	18	15	345	15.4	0.14	10.6	6.3	22.9	13000	2000
Post Maghi Poornima	8.40	18	15	320	17.9	0.23	10.5	7.0	22.4	4500	2000
Pre Maha Shivratri	8.28	17	15	372	14.6	BDL	10.5	7.6	21.1	<1.8	<1.8
Maha Shivratri	8.25	17	10	389	16.5	BDL	8.9	6.5	19.2	<1.8	<1.8
Post Maha Shivratri	8.33	17.5	15	385	17.5	BDL	9.3	6.31	15.9	<1.8	<1.8

BDL: Below Detection Limit

Table 2 Water Quality at Sangam (Morning), Prayagraj

	pH	Temp (^{0}C)	Colour (Hz)	Conductivity (µS/cm)	Chloride (mg/l)	NH_3-N (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TC (MPN/100 ml)	FC (MPN/100 ml)
Pre Kumbh Mela	8.24	15	10	537	47.6	0.66	10.6	5.2	21.9	23000	2000
Pre Makar Sakranti	8.83	15	15	432	30.8	0.38	10.8	2.6	11.9	4500	2000
Makar Sakranti	8.39	15	15	633	60.4	0.34	11.2	4.0	10.3	7800	4500
Post Makar Sakranti	8.64	16	15	438	44.8	0.35	12	5.7	22.1	4500	2000
Pre Paush Poornima	8.45	15.5	15	486	36.1	0.30	12	4.1	23.2	13000	2000
Paush Poornima	8.45	15.5	15	403	25.3	BDL	11.4	4.6	17.6	13000	2000
Post Paush Poornima	8.32	17	15	418	28.6	BDL	10.2	5.6	20.9	13000	2000
Pre Mauni Amawasya	8.34	17	15	360	30.1	0.23	10.7	4.5	23.4	4500	2000
Mauni Amawasya	8.42	17	15	270	16.5	0.24	10.3	7.7	27.9	<1.8	<1.8
Post Mauni Amawasya	8.63	17	15	390	33	0.11	10	4.9	17.1	13000	4500
Pre Basant Panchami	8.60	18.2	15	534	56.2	BDL	10	2.2	12	7800	<1.8
Basant Panchami	8.60	17.8	15	534	55.7	BDL	8.6	2.1	13.3	4500	2000
Post Basant Panchami	8.60	17.9	15	460	28.1	BDL	9.6	4.9	23	2000	<1.8
Pre Maghi Poornima	8.16	17	10	463	30.7	0.03	10	5	26.8	4500	2000
Maghi Poornima	8.28	18	10	340	15.9	0.02	10.4	6.7	28.7	13000	7800
Post Maghi Poornima	8.26	18	10	588	54.8	0.02	10.2	3.0	21.5	7800	2000
Pre Maha Shivratri	8.09	18	15	652	63.1	0.05	8.5	3.7	18.5	14000	7800
Maha Shivratri	8.35	18	10	531	42.7	BDL	9.0	5.4	22.5	17000	4500
Post Maha Shivratri	8.27	19	15	614	56.3	BDL	9.8	3.8	19.7	23000	13000

BDL: Below Detection Limit

Table 3 Water Quality at Sangam (Evening), Prayagraj

	pH	Temp (^{0}C)	Colour (Hz)	Conductivity (µS/cm)	Chloride (mg/l)	NH_3-N (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TC (MPN/100 ml)	FC (MPN/100 ml)
Pre Makar Sakranti	8.27	16	10	330	15	0.38	12	3.6	18.9	<1.8	<1.8
Makar Sakranti	8.67	16	10	362	31	0.33	13	5.4	16.9	11000	7800
Post Makar Sakranti	8.54	16	10	447	48.4	0.34	12.4	5.1	19.9	2000	2000
Pre Paush Poornima	8.5	17	10	399	28	BDL	12	5.2	20.3	2000	<1.8
Paush Poornima	8.32	16.5	10	448	33.4	BDL	10.6	4.4	15.9	4500	<1.8
Post Paush Poornima	8.23	17	10	367	20.3	BDL	10	4.2	22.1	2000	<1.8
Pre Mauni Amawasya	8.4	17	10	300	21.4	0.27	10.2	7.5	22.7	17000	4500
Mauni Amawasya	8.58	17	10	263	15.5	0.24	10.5	6.9	21.2	33000	7800
Post Mauni Amawasya	8.72	17	10	461	30.1	BDL	10.4	3.8	14.9	4500	<1.8
Basant Panchami	8.70	18.8	10	340	20.7	BDL	9.6	2.6	15.4	4500	2000
Pre Maghi Poornima	8.09	18	10	436	31.8	0.31	9.7	7.1	19.2	33000	23000
Maghi Poornima	8.19	19	15	443	32.7	0.26	10.1	6.6	23.7	7800	2000
Post Maghi Poornima	8.26	20	10	483	38.4	0.67	10.4	5.1	14.9	4500	2000
Pre Maha Shivratri	8.13	18	15	712	72.8	BDL	8.4	3.8	18.3	7800	<1.8
Maha Shivratri	8.24	19	10	608	46.6	BDL	10.4	4.0	13.7	33000	7800
Post Maha Shivratri	8.41	19	15	481	34	BDL	10.3	7.0	19.8	7800	4500

BDL: Below Detection Limit

Table 4 Water Quality of River Ganga at Deeha Ghat D/s in Prayagraj

	pH	Temp (^{0}C)	Colour (Hz)	Conductivity (µS/cm)	Chloride (mg/l)	NH_3-N (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TC (MPN/100 ml)	FC (MPN/100 ml)
Pre Kumbh Mela	8.10	16	15	636	63.9	0.34	10.2	4.5	17.6	2000	<1.8
Pre Makar Sakranti	8.49	16	10	628	57.8	0.37	10	3.4	11.4	2000	2000
Makar Sakranti	8.58	15	10	591	54	0.13	11	2.5	9.1	2000	2000
Post Makar Sakranti	8.48	15	10	548	66.4	0.38	11.2	4.7	22.3	13000	6800
Pre Paush Poornima	8.02	16	10	570	47.7	0.41	12.6	4.2	21.3	4500	<1.8
Paush Poornima	8.15	17	15	605	55.3	BDL	9.8	3.4	16.8	7800	<1.8
Post Paush Poornima	7.84	16	15	578	49.6	BDL	10.5	4.3	15.2	33000	2000
Pre Mauni Amawasya	8.10	17	15	467	46.6	0.13	9.9	2.6	14.2	4500	2000
Mauni Amawasya	8.43	17	15	502	51.4	0.14	10	3.0	20.9	49000	7800
Post Mauni Amawasya	8.56	17	10	492	50.5	0.12	15	3.4	11.7	7800	4500
Pre Basant Panchami	8.50	17.8	15	549	58.1	BDL	10.6	3.7	15.5	13000	2000
Basant Panchami	8.50	18.2	15	340	20.7	BDL	10.0	2.6	15.4	4500	2000
Post Basant Panchami	7.8	17.6	15	627	59.5	0.24	10.2	2.6	15.4	<1.8	<1.8
Pre Maghi Poornima	8.20	17	10	627	54.2	0.14	11	3.9	23.3	4500	2000
Maghi Poornima	8.25	19	15	604	54.2	0.13	10.8	3.6	23.3	4500	2000
Post Maghi Poornima	8.25	20	10	609	55.8	0.35	10.7	4.1	14.0	13000	4500
Pre Maha Shivratri	8.15	18.5	15	716	76.7	BDL	9.8	4.4	19.7	7800	2000
Maha Shivratri	8.22	20	15	608	70.8	BDL	10.4	3.7	14.3	11000	7800
Post Maha Shivratri	8.38	20	15	660	61.2	BDL	9.5	3.8	16.9	13000	7800

BDL: Below Detection Limit