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Short Communication

Impact of Pryagraj Kumbh-2019 on water quality and plankton communities of the river Ganga

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ABSTRACT

Anthropogenic activities put remarkable pressure on the ecological conditions and sustainability of many aquatic ecosystems. The present study was to understand the impact of mass bathing during a short period (two months) on the various physico-chemical parameters of water quality and planktonic fauna and flora of the river Ganga at Prayagraj. Dissolved Oxygen revealed sharp decline of oxygen in the downstream centre, after mass bathing. Chemical Oxygen demand, Total Dissolved Solids, Chloride and Specific Conductivity increased after every *snan* gradually. During mass bathing period reduction in Bacillariophycae percentage and increase in Chlorophyceae was a prominent feature. On the advancement of mass bathing, increases in the number of planktonic groups as well as increase in number of taxa were recorded due to the increase in organic nutrients owing to anthropogenic activities. Palmer algal genera organic pollution index varied between 12 and 19 indicating medium pollution. COD was found to be significantly different between before and after mass bathing.

INTRODUCTION

The Ganga is a holy, spiritual and national river of India. After originating from Gangotri, the river enters the plains at Haridwar, then passing through various cities of Uttar Pradesh, Bihar, Jharkhand, West Bengal and finally falls into the Bay of Bengal at Gangasagar. During the course of its flow, different right and left bank tributaries join it at different locations. The Yamuna river, a right-bank tributary, confluences with Ganag at Prayagraj (earlier known as Allahabad) forming Sangam (confluence-a sacred place) with mythological Saraswati river. At the interval of six years and twelve years, there is a huge congregation of people to take holy bath at this place known as Kumbh and Mahakumbh respectively. Last Kumbh was organized in Prayagraj during mid-January 2019 to mid-March 2019 to take a spiritual dip in the Sangam on five different bathing dates viz. Makar Sankranti (15.1.2019), Mauni Amavasya (4.2.2019), Basant Panchmi (10.2.2019), Maghi Poornima (19.2.2019) and Mahashivratri (4.3.2019). It was estimated that more than 20 Crores people had taken bath during this Kumbh. On Mauni Amavasya maximum crowd (more than 12 Crores), was present and participated in the bathing process. People stay here (near confluence) for a long period as Kumbh Mela which completed in approximately two months. Human activities during this period may affect the river Ganga as anthropogenic activities put remarkable pressure on the ecological conditions and sustainability of many aquatic ecosystems (MEA, 2003). These activities not only increase the quantities of nutrients but also change forms and proportion of nutrients to the environment which can lead to adverse effects on water quality such as eutrophication and food web structure (Glibert, 2012). Any change beyond the limit of tolerance may affect the population of different organisms favorably or unfavorably, thus affecting the population of a species. Water quality of any river is also affected by mass bathing activity (Das *et al.*, 2014). If the fluctuation in parameters of an abiotic factor does not follow a particular pattern then it will be difficult for species to survive in such uncertain environments (Patil and Patil, 2012; Semwal, and Akolker, 2006). Human interference exhorted tremendous strain on aquatic communities besides deteriorating water quality (Arora *et al.*, 2013; Kulshesthra and Sharma, 2006). Algal flora and fauna either planktonic or periphytic are considered as an indicator of the aquatic

environment and used in bio-monitoring studies as they are the living component of an ecosystem and serves as a wonderful tool for measuring the change in water quality (Bilgrami and Duttamunshi, 1985, Chakraborty *et al.*1959, Venkateswarlu and Reddy,1985). Yet, various workers studied the impact of Kumbh and Mahakumh Mela on water quality, but their study time and place varied (Khanna *et al.*, 2012 & Singh *et al.*, 2015). Riverine ecology at Prayagraj is different due to local climatic conditions, river's physical conditions and the confluence of Ganga, with the river Yamuna. So present investigation was taken to understand the impact of mass bathing, on water quality and planktonic fauna and flora of the river Ganga at Prayagraj

MATERIALS AND METHODS

Ecological sampling was carried out at two sites viz. upstream of Prayagraj/Allahabad at Shankar Ghat (Allahabad up-Ald up $25^0 30' 30''$ N & $81^0 52' 11''$ E), where Ganga enters in the city and downstream at Chhatnaag (Allahabad down-Ald dn $25^0 24' 54''$ N & $81^0 54' 38''$ E), where Ganga leaves the city after the confluence with the river Yamuna. Physicochemical parameters were studied by the method APHA 2005 (APHA, 2005). For plankton analysis 50 liters of river water was filtered by bolting silk plankton net (no.25, mesh size 0.3-0.4 mm) and preserved in 4% formalin and analyzed under a microscope (Welch, 1952). For the study of post-Kumbh impact, samples of periphyton were collected during April-2019 by scrapping one cm area from the substrate of Ganga river bank and fixed in 4% formalin and analyzed in laboratory. Water was collected from the same place and time for biotic and abiotic studies of various parameters. Pollution index was calculated according to Palmer (1969).

RESULTS AND DISCUSSION

Dissolved Oxygen

Dissolved oxygen ranged from 8.3 to 15.68 ppm and declined sharply after mass bathing, on the first two *snan*. From Basant Panchmi onwards oxygen depletion was not noticed. On maximum crowd day i.e. Mauni Amavasya oxygen reduced from 15 to 8.94 ppm. The second maximum crowd was on Makar Sankranti, on this day it declined from 15.6 to 11.5 ppm. On other bathing days, the only minor difference was noticed as the crowd also reduced to 2-4 corers and the Ganga at Prayagraj was receiving continuous flowing water (Table 1).

Total Dissolved Solids (TDS)

A gradual increase in TDS was noticed from the first bath to the third bath (Table 1). Increase in TDS may be due to the accumulation of body dust during mass bathing It ranged from 275.6 to 407.2 ppm in this period.

Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD)

Chemical oxygen demand is the measure of oxygen required for chemical oxidation. Its values are generally higher than BOD values when organic matter contains a large amount of biologically resistant substances. In the present investigation, COD was invariably higher than BOD at all the time of water collection. In general COD and BOD both increased after every mass bathing. BOD ranged from 3.8 to 5.6 ppm (Mauni Amavasya snan) and COD ranged from 37.0 to 96.3 (Mauni Amavasya snan). The values of both the parameters were in the permissible limit (Table 1) being maximum on Mauni Amavasya because maximum people prefer to take bath on this occasion. Significant difference in COD was observed at Allahabad up and down during these bathing dates through statistical analysis.

Chloride

This is an indicator of salinity or increased pollution. During Kumbh its value increased in first two baths and then gets stabilized.

Specific conductivity

Data on Specific conductivity, a measure of electrolytes, indicated gradual increase during different bathing dates and maximum was observed on Basant Panchami (812 µs/cm).

Alkalinity

During mass bathing water was enough productive. Total alkalinity was maximum during Basant Panchmi as supported by planktonic abundance also.

Hardness

This ranged from 72-168 ppm, usually increase in hardness after mass bathing was recorded. Hardness favored growth of Zygnemaceae, and salinity *Chlorella*.

Plankton

A total of 47 planktonic taxa were recorded, among phytoplankton (39 taxa), 14 taxa from Bacillariophyceae, 21 taxa from Chlorophyceae, 3 taxa from Myxophyceae, 1 from Euglenophyceae and among zooplankton (8 taxa) 7 from Rotifera and 1 from Cladocera were recorded during mass bathing from the river Ganga at Prayagraj. Among Bacillariophyceae *Melosira, Synedra, Asterionella,* and *Tabellaria* were most dominant, among Chlorophyceae. *Chlorella, Spirogyra, Elakatothrix, Actinastrum and Scenedesmus* were most abundant species/genera. *Brachionus* species were dominant zooplankton. Other planktonic genera were as follows-

Bacillariophyceae: *Melosira, Synedra, Nitzschia, Cymbella, Navicula, Asterionella, Tabellaria, Fragilaria, Gyrosigma, Cocconeis, Rhopalodea, Neidium, Cyclotella, Stephnodiscuss.*

Chlorophyceae*: Ankistrodesmus,Chlorella, Spirogyra, Elakatothrix, Hydrodictyon, Closterium, Ulothrix, Protococcus, Actinastrum, Scenedesmus, Coelestrum, Zygnema ,Mougeotia, Sirogonium, Gleocapsa, Micrataenium, Tribonema, Selenastrum, Oocystis, Pediastrum, Westella.*

Myxophyceae: *Spirulina, Phormidium, Merismopedia.*

Euglenophyceae:*Lepocynclis*

Rotifera: *Brachionus, Asplanchna, Testudinella, Keratella, Mytilina, Euchlaneis , Monostyla*

Cladocera:*Daphnia*

On advancement of mass bathing, increase in number of planktonic groups (3-6) as well as increase in number of taxa (13 to 23 taxa) were recorded, as anthropogenic activities may increase organic load which was reflected in presence of above mentioned taxa of green algae, Rotifera (Laal and Karthikeyan, 1993) and Euglenophyce (Hosmani, 2013), as all are indicators of organic pollution. Still pollution level increased gradually and was very low as the Ganga at Prayagraj received more discharge of flow from upstream barrages for mass bathing and also there was less industrial as well as domestic effluent in the river during Kumbh period. Hence bathing of such a huge crowd of crore people, river water quality was not deteriorated, only in the end accumulation of nutrients increased on last *snan parv* (4.3.2019) and Myxophyceae appeared.

Gradual increase in planktonic abundance is presented in (Fig.1). In this period Bacillariophyceae ranged from 10% (Ald dn) to 48.6% (Ald up) while Chlorophyceae ranged from 50% (Ald up) to 88.1 % (Ald dn). As mass bathing advanced, increase in Chlorophyceae reached upto 88.1% on Basant Panchami snan, after that slight decrease in abundance started. Sudden increase of plankton abundance on Maghi Poornima snan was due to various species of *Melosira, Spirogyra and Brachionus*. No abiotic parameter was correlated with this sharp increase. This may be due to accumulation of flowing planktonic filamentous taxa like *Spirogyra* or minimum COD (3.9) and other water nutrients favored luxuriant growth of *Spirogyra*.

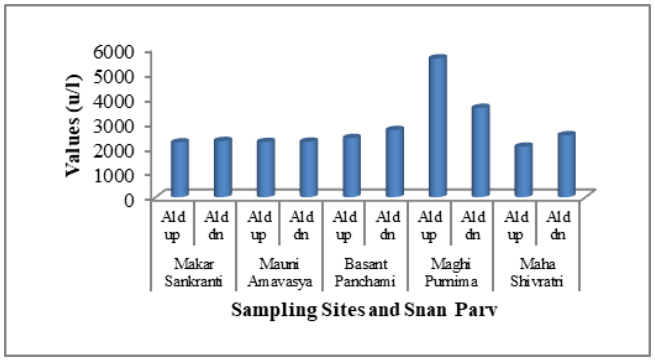

Fig.1 Plankton abundance (u/l) during Kumbh-2019

During mass bathing period reduction in Bacillariophycae percentage contribution and increase in Chlorophyceae contribution was prominent feature as can be observed from Fig. 2. Similarly, increases in Rotifer contribution were also noticed as they feed upon primary producers and direct association was noticed. On last *snan* date Myxophyceae (10%) and Euglenophyceae (2.4%), were also recorded along with three planktonic groups recorded previously. Hence throughout the period Chlorophyceae contributed more than 50%, suggesting tolerance towards changing environmental conditions or available nutrients were favourable for growth of Chlorophyceae (Carins, and Parker, 1972).

Palmer algal genera index for organic pollution

According to Palmer (1969), organic pollution tends to influence the algal flora more than many other factors in the aquatic environment such as water hardness, trophic status, light intensity, pH, Do, rate of flow, size of the water body and other types of pollutants. Palmer organic pollution index varied between 12 and 19 indicating medium pollution.

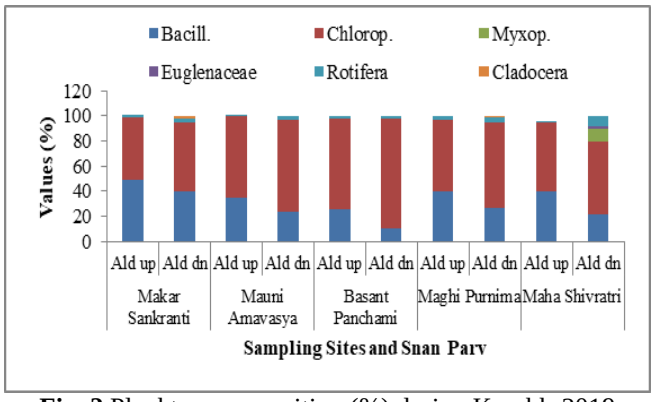

Fig. 2 Plankton composition (%) during Kumbh-2019

Statistical analysis based on biotic parameters like plankton and abiotic physicochemical parameter are presented in Table 2 revealed that only COD was found to be significant at before mass bathing center and after mass bathing centers of the river Ganga. As chemical oxygen demand is related to pollution, so this parameter indicated an increase in pollution load after Kumbh Mela in the river Ganga at Allahabad/ Prayagraj.

Post Kumbh scenario of flora and fauna

Plankton are floating organisms while periphyton are static in nature, therefore they retain any change in nutrients for a longer period. During mass bathing in Kumbh, river banks were disturbed due to human activities but after Kumbh periphyton sampling and analysis revealed a clear picture of organic nutrients accumulation as reflected by dominance of Myxophycae by 83% in Prayagraj downstream area of the river Ganga after confluence, in comparison to 12 % Myxophycae in Prayagraj upstream area.

Similarly after kumbh plankton population was contributed by all major algal groups such as, Bacillariophyceae (5 taxa), Chlorophyceae (18 taxa), Myxophyceae. (18 taxa), (1 taxa), Euglenophyceae (2 taxa), and Protozoa (7 taxa) with almost similar composition. Dominant taxa observed during this period were *Melosira, Nitzschia, Chlorella, Scenedesmus, Merismopedia, Lepocynclis* and *Coleps, Stylonychia*. While during mass bathing period dominant taxa were *Spirogyra, Elakatothrix and Chlorella, Synedra and Asterionella* and other groups were absent. Accumulation of organic matter in the river bottom developed Myxophycae, Euglenophycae and Protozoa as taxa of these groups can survive in polluted water very well and are also known as organic pollution indicator groups (Hutchinson, 1957). Post Kumbh period studies (April 2019) revealed increase in Biological Oxygen Demand as compared to Kumbh *snan* period, Biological oxygen demand gives an idea of quantity of biodegradable organic substances present in water, which is subjected to aerobic decomposition of microorganism. Thus, it provides a direct measurement of state of pollution. This is also reflected by abundance of pollution tolerant algal groups like Myxophyceae, Euglenophyceae and Protozoa.

Table 1: Water quality parameters during Kumbh 2019 of the river Ganga at Prayagraj

Table-1.Physico- chemical parameter of water of Kumbh Mela, 2019

Occasions	**Makar Sankranti**		**Mauni Amavasya**		**Basant Panchami**		**Maghi Purnima**		**Maha Shivratri**	
Date	**15-01-2019**		**04-02-2019**		**10-02-2019**		**19-02-2019**		**04-03-2019**	
Sampling Sites	**S-1**	**S-2**	**S-1**	**S-2**	**S-1**	**S-2**	**S-1**	**S-2**	**S-1**	**S-2**
Parameters										
Temperature (^{0}C) Air	23.5	18.5	22.9	22.9	23	23.5	27	26.5	28	27
Temperature (^{0}C) water	16.4	16.5	19.6	17	18.7	20	22.5	22	23.5	23
Transparency (cm)	28	21	37	39	32	36	29	36	32	36
pH (ppm)	7.7	8	8.16	8.2	8	8.8	8.1	8.4	7.7	8
Carbon dioxide (ppm)	0	0	0	0	0	0	0	0	4	0
Carbonate (ppm)	16	20	20	8	10	14	14	16	0	4
Bicarbonate (ppm)	90	100	132	108	140	150	122	134	144	134
Chloride (ppm)	21.3	29.82	17.5	36.92	20	17	23.5	21.8	22.01	24.85
Dissolved oxygen (ppm)	15.68	11.52	15	8.94	8.3	11.7	10.5	11.8	11.84	12.48
Sp.conductivity (µs/cm)	540.2	560.5	623	694	812	676.1	612	621	661.9	674.6
TDS (ppm)	275.6	290.9	313	347.3	407.2	338.6	301	308	334.6	338
Total Hardness (ppm)	104	132	72	152	160	132	116	168	140	152
Calcium (ppm)	22.45	25.65	12.83	22.44	38.47	35.27	24.88	30.46	22.44	33.66
Magnesium (ppm)	11.64	16.49	9.7	23.3	15.5	10.64	13.07	17.45	19.63	16.48
Phosphate (ppm)	0.126	0.145	0.031	0.121	0.014	0.024	0.021	0.03	0.018	0.015
Silicate (ppm)	0.994	1.357	0.424	1.073	0.03	0.047	0.908	2.274	0.024	0.106
D.O.M (ppm)	3.375	3.75	5.325	5.475	3.3	3.2	2.03	2.4	1.04	4.725
BOD (ppm)	3.8	4.3	5.2	5.6	4.8	5.1	3.9	4.4	3.72	4.2
COD (ppm)	37.04	66.672	81.488	96.304	44.45	70.376	29.632	70.73	37.04	77.784

Sampling Sites: S1- Shankar Ghat; S2- Chhatnag

Table-2 The difference of planktonic family and different water parameters

Planktonic Family				**Water Parameter**			
Parameters	**|t| Stat**	**P(T<=t) two-tail**	***p*|t|**	**Parameters**	**|t| Stat**	**P(T<=t) two-tail**	***p*|t|**
Bacillariophyceae	1.442287	0.187202	NS	Air Temperature	0.641262	0.539285	NS
Chlorophyceae	-0.26741	0.795921	NS	Water Temperature	0.240376	0.816084	NS
Rotifera	-0.96569	0.362479	NS	Transparency	-0.56077	0.590309	NS
Total Plankton	0.31617	0.759965	NS	Carbonate	-0.08998	0.930512	NS
				Bicarbonate	0.029948	0.976842	NS
				Chloride	-1.46282	0.181663	NS
				Dissolved Oxygen	0.646519	0.536046	NS
				Specific conductivity	0.089329	0.931016	NS
				Total Dissolved Solid	0.069348	0.946415	NS
				Total Hardness	-1.73607	0.120763	NS
				Calcium	-1.10654	0.300655	NS
				Magnesium	-1.12181	0.294482	NS
				Phosphate	-0.7232	0.490161	NS
				Silicate	-1.06592	0.317569	NS
				D.O.M	-0.99125	0.350594	NS
				BOD	-1.07776	0.312565	NS
				COD	-2.86932	**0.020851***	S

Note: NS= Non Significant; S= Significant

CONCLUSION

Mass bathing of 20 crore people in the river Ganga at Prayagraj exhibited a gradual increase in very slight pollution up to one month only (first two baths), then the river stabilized itself probably by its self-purification process. During mass bathing discontinuation of industrial and domestic effluent into the river and continuous release of water into the river from upstream barrages maintained the sufficient water in the river channel resulted in healthy flora and fauna which ultimately maintained the ecological condition of almighty river Ganga at Prayagraj Kumbh 2019. Therefore, it can be concluded that if the continuous flow is maintained in any river, anthropogenic activity like mass bathing may not disturb river ecology, only disruption of flow or non-availability of sufficient water can deteriorate river water quality.

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REFERENCE

APHA, 2005. *Standard methods for the examination of water and wastewater*, 21st edn. American Public Health Association

Arora, N. K., Tiwari S. and Singh, S. 2013. Analysis of water quality parameters of river Ganga during Mahakumbh, Haridwar, India. *Indian J. Envirnt. Biol*., 34: 799-803.

Bilgrami K. S. and Duttamunshi, J. S. 1985.Ecology of river Ganges. Impact of human activities and conservation of aquatic biota. *Final Tech. Report* (May 78- april 85.) MAB prog. Bhagalpur Univt.

Carins, J.G., Lanza, R. and Parker, B. C. 1972. Pollution related structural and functional changes in aquatic communities with emphasis on fresh water algae and protozoa. *Proc. Acad. Nat. Sci. Philad*., 124: 79-127.

Chakraborty, R. D., Ray P. and Singh S. B. 1959. A quantitative study of the plankton and the physicochemical condition of the river Yamuna at Allahabad in 1954-55. *Indian J. Fisheries*, 6: 186-201.

Das, S.C.S., Joshi K. D., Alam A., Jha, D. N., Srivastava K. , Kumar V., Misra S.S., 2014 . Impact assessment of massive anthropogenic activity during Mahakumbh 2013 on biotic and abiotic parameters at Allahabad Uttar Pradesh. *Journal of the Kalash Science*, 2: 1-8.

Glibert, P. M., 2012. Ecological stoichiometry and its implications for aquatic ecosystem sustainability. *Current Opinion in Environmental Sustainability*, 4: 272–277.

Hosmani, S. 2013. Fresh water algae as indicator of water quality. *Univers. J. Environ Res. Technol*, 3:473-482.

Hutchinson, C. E. 1957. *A treatise on Limnology* vol. 1. John Willy and Sons Inc London.

Joshi K. D., Jha, D. N., A., Absar, Srivastava, S. K. and Kumar, V. 2014. Environment flow requirement of River Sone: Impact of Flow discharge on fisheries. *Current Science*, 107(3), 478-488.

Khanna D. R., Rakesh Bhutani, Bharti tyagi, Mukesh Ruhela 2012. Assassment of water quality of river Ganga during Kumbh mela 2010. *Environmental conservation* 13 (3):165-169.

Kulshesthra, H. and Sharma, S. 2006. Impact of mass bathing during Ardh Kumbh on water quality status of river Ganga. *J. Envt. Biol.*, 27:437-440.

Laal, A. K. and Karthikeyan, M., 1993 . Rotifers pollution or productivity indicators. *Current Science*, 65: 11 .

MEA. 2003. Millenium Ecosystem Assessment: ecosystem and human wellbeing, Washington DC: Island press. 200-266p.

Palmer C. M. 1969. A composite rating of algae tolerating algal pollution. *J. Phycology*, 5:78-82.

Patil, S. S., and Patil, S. S., 2012. Impact of mass bathing and other rituals on abiotic factors of Bhima river at Sangam. Gangapur, Karnataka, *Appl. Res. Devel. Inst. J.*, 6: 41-57.

Semwal, N. and Akolker. P. 2006. Water quality assessment of sacred Himalayan Rivers of Uttarakhand. *Curr. Sci.*91,486-496.Singh Shweta and Nath Satyendra 2015. Water quality analysis of R. Ganga and Yamuna during mass bathing Allahabad, India. *Universal Jr. of Envt & Tech*. 5:251-258

Venkateswarlu, V. and Reddy, M. 1985. Algae as bio monitoring in river ecology. *Symp. On Biomonitoring State- Environment.* 183-189.

Welch, P. S. 1952. *Limnological Methods*. The Blakistan Company, Philadelphia.