Journal of Chemical, Biological and Physical Sciences

An International Peer Review E-3 Journal of Sciences

Available online at www.jcbsc.org

Section D: Environmental Sciences

CODEN (USA): JCBPAT Research Article

Impact of Makar Sankranti Festival on Water Quality of the River Narmada at Hoshangabad (Madhya Pradesh)

Agnibhoj Deepa[1], Wanganeo Raina Rajni [2], Wanganeo Ashwani [1] and Kumar Pramod[1]

[1]Department of Environmental Sciences and Limnology, Barkatullah University, Bhopal, India

[2]Department of Zoology, Govt. Science & commerce college Benazir, Bhopal. India

Received: 26 May 2016**; Revised:** 18 June 2016**; Accepted:** 22 June 2016

Abstract: Mass bathing in sacred water bodies is an age-old ritual in India. Organized outdoor bathing is an important in situ utilization of water bodies, which demands water quality requirements for drinking as well as bathing purposes. This paper summarises the water quality of the River Narmada at Hoshangabad (Madhya Pradesh). The study was carried out during Makar Sankranti festival for two consecutive years i.e. 2009-10, during mass bathing activities. Pre, during and post festival, water samples were collected from three selected points of the Sethani Ghat viz., the main bathing platform (locally called Sethani Ghat), Circuit House (upstream of the River Narmada) and Mangalwara ghat (downstream of the River Narmada). The analysis carried out for physico-chemical parameters revealed significant variation during the festival period in some parameters. The study indicated that the river water quality deteriorated to such an extent as make it unfit for the drinking and other domestic purposes during auspicious days. The amount of solid waste generated during the festival period in the vicinity of the River Narmada is raising deep concern regarding its normal utilization. Present paper emphasises the necessity of adopting conservation strategy on war footing for the Narmada River as it has been prioritized for potable purpose for Bhopal Township.

Keywords: Festival, makarsankranti, pilgrims, water quality.

INTRODUCTION

From the Vedic period mass bathing in pious rivers during festive periods has been a common practice in our country. Besides this rivers have been used for drawing potable water. However, with the enhancement in human population the potable quality of rivers is getting jeopardized. The anthropogenic impact (enhancement in population) is leaving a marked negative impact on the wellbeing of the human race itself. The preservation of age old practice at the cost of human health is unfortunately being ignored time and again. Under this practice Hoshangabad situated on the banks of holy River Narmada is one such place where more than two lakh pilgrims congregate at Sethani ghat (built by Jankibai Sethani in the nineteenth century) on various occasions, round the year to have a holy dip in the river (believed to give salvation to the soul) **Fig.1.**

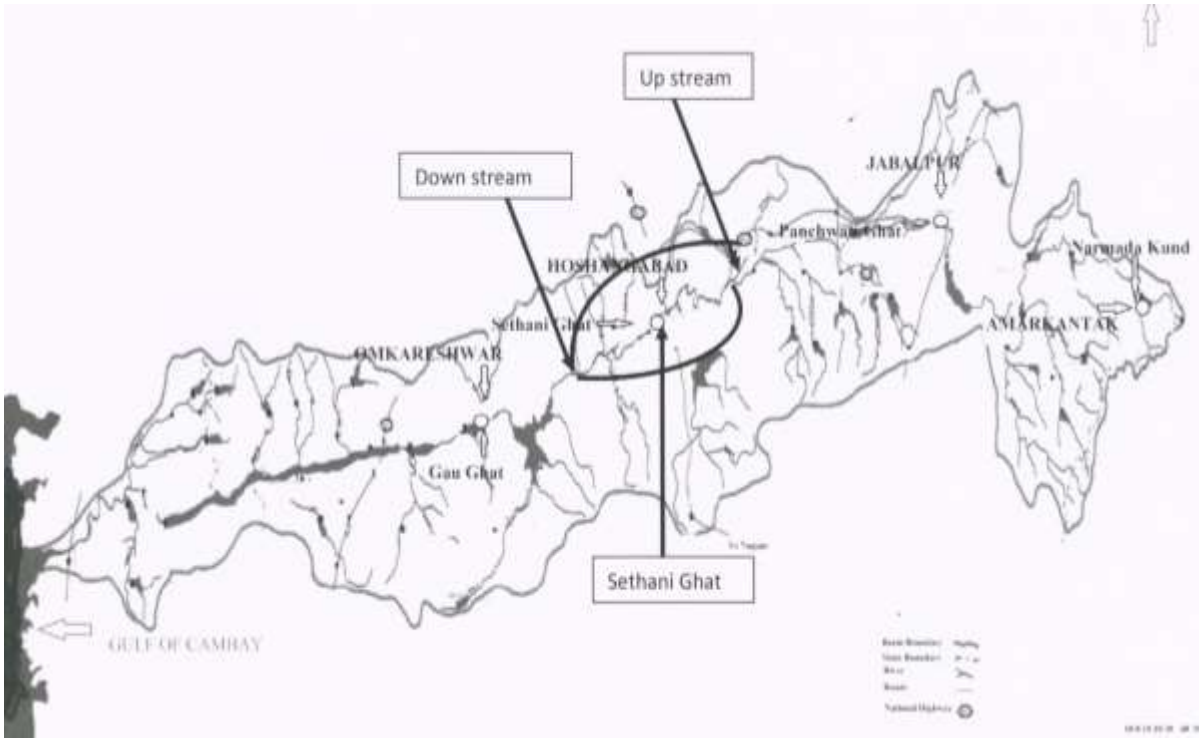


Fig.1: Map of Narmada river showing sampling sites

Makar Sankranti is one such occasion when huge congregation of people of all ages take a holy dip in the river. Massive bathing, washing and other activities by millions of pilgrims during this period leave a marked negative impact on the quality of water. Apart from washing with detergents, pilgrims offer milk, curd, ghee, coconut, flowers, coins, and idols, ashes of departed ones, hair from shaved head and other religious material into the water. Many a times such offerings are bought in polythene carry bags. In the absence of proper disposable system or deliberate human negligence/ carelessness, the polythene bags are dropped in the water or near the sides of the water body. These non-biodegradable materials remain either floating on the water surface or settle down at the river bed. This is hazardous to aquatic life and drastically affects the functioning of micro-environment in and around the river.

The present paper reveals the results of a limnological study carried out during the festival of Makar Sankranti in the month of January (Hindu month of Magh) 2009 and 2010.

MATERIALS AND METHOD

The sampling locations during Makar Sankranti festival (January 14) were selected in relation to various human activities along the shoreline of River Narmada. Field studies were undertaken during the year 2009-10. Three sampling stations chosen at the bank of Sethani ghat are as follows:

Station I: three hundred meters up stream near Circuit House where no mass bathing activity was recorded.

Station II: the main bathing platform (locally called Sethani ghat) where mass bathing takes place

Station III: three hundred meters downstream of the river near Mangalwara ghat.

Water quality assessments were made at the above mentioned three sites, before, during and after completion of festival. Physico-chemical parameters were analysed following standard methods[1-2]. Observation on solid waste was done from different spots of Sethani ghat. The quantity of solid waste was analysed based on their bulkness around the ghat. The whole mass was analysed on the basis of its physical characteristics.

RESULTS AND DISCUSSION

The result of physico-chemical parameters of has been presented in **Table 1 and Fig's 2-7:** It is inferred from the results that the ambient atmospheric temperature is affected partially by the enhanced human activity in and around the river in the form of mass bathing. The water temperature values obtained from the observed sites viz., Sethani ghat, Circuit house (upstream) and Mangalwara ghat (downstream site) revealed the influence of water velocity and steep gradient of the place.

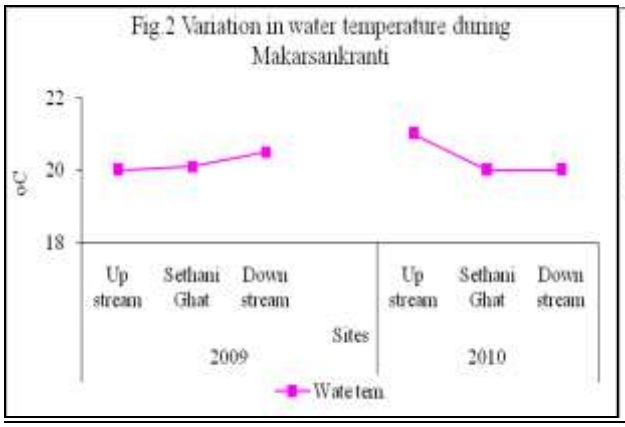
On Makarsankranti during 2009 at upstream, the water temperature varied from 20^{o}C-25 ^{o}C. Sethani ghat on the other side recorded a range of 20.1^{o}C-23^{o}C while at downstream the range of water temperature was 20.5^{o}C-24^{o}C, while during 2010 the values of water temperature depicted an overall range of 20^{o}C-21^{o}C at each of the sites. Temperature during the first year of study was more as compared to the second year of study period. Gupta *et al.*,[3] studied the water temperature in Mandakini river before, during and after Deepawali. The temperature varied within a narrow range of 25^{o}C-26^{o}C. Gangwar and Joshi[4] while working on the impact of mass bathing on water quality of river Ganga (at Har ki Pauri) Haridwar reported mean water temperature of 13.2^{o}C, 13.8^{o}C and 13.44^{o}C during pre-bathing, main bathing and post bathing days. In our study it was observed that post bathing values were comparatively higher indicating thereby the influence of on-going activities on water temperature. Devi and Belgali[5] also observed rise in temperature as a result of religious activities.

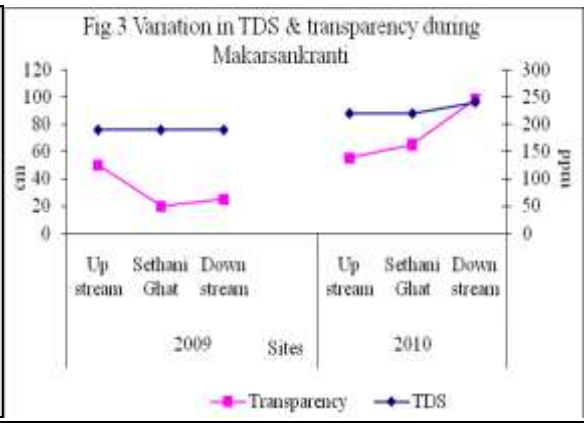
The Secchi transparency recorded higher values upstream (bottom of the river could be easily seen). At Sethani ghat the transparency values ranged from 20 cms (during bathing) to 54 cms (post bathing) while at downstream the values of transparency varied within a range of 25 cms (during bathing) to 75 cms (during pre-bathing). On the other hand during 2010 the values of transparency varied from 55 cms-65 cms, 65 cms-140 cms and 98 cms-130 cms at upstream, Sethani ghat and downstream respectively. Gangwar and Joshi[4], however, while working on Ganga revealed mean values of transparency as 97.90 cms (pre bathing), 96.10 cms (main bathing) and 97.70 cms (post bathing) during Magh Purnima festival at Haridwar. During the study period it was observed that minimum transparency values were recorded during bathing activity indicating thereby the impact of disturbance caused due to bathing. The lowest value of transparency at Sethani ghat was observed due to intense bathing activities along with various religious activities during the festival period.

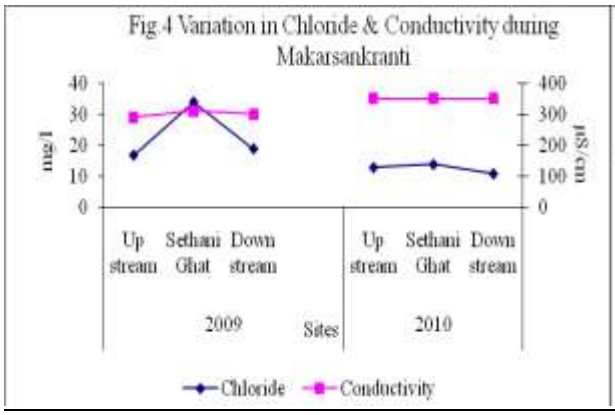
Table1: Physico-chemical characteristics of Hoshangabad during pre-bathing, bathing and post-bathing days of Makarsankranti during 2009-10

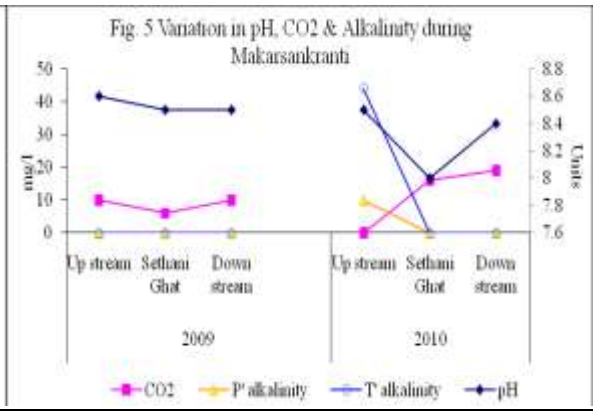
Parameters	2009									2010								
	Upstream (S9)			Sethani ghat (S6)			Downstream (S10)			Upstream (S9)			Sethani ghat (S6)			Downstream (S10)		
	PB	B	POB	PB	B	POB	PB	B	POB	PB	B	POB	PB	B	POB	PB	B	POB
Water tem. (^oC)	21	20	25	22	20.1	23	24	20.5	23	20	21	21	21	20	21	20	20	21
Transparency (cm)	transparent	transparent	transparent	54	20	25	75	25	36	transparent	55	65	140	65	100	130	98	100
TDS (ppm)	160	190	210	210	190	210	160	190	200	210	220	230	220	220	240	220	240	230
pH (Units)	8.7	8.6	8.6	8.9	8.5	8.4	8.7	8.5	8.6	8.4	8.5	8.4	8.6	8	8.6	8.6	8.4	8.7
Conductivity (μScm^{-1})	280	290	220	310	310	340	260	300	300	350	350	340	330	350	340	340	350	350
DO (mgl^{-1})	6	5.21	3.73	6	2.3	6.4	2.4	1.6	3.73	10	8	10.4	10	8	8.4	7.6	8.4	10.8
Free CO_2 (mgl^{-1})	ND	10	ND	ND	6	ND	ND	10	ND	ND	ND	ND	ND	16	ND	ND	19	ND
Total alkalinity (mgl^{-1})	10	ND	66	38	ND	48	16	ND	42	86	44	84	80	ND	102	80	ND	100
Total hardness (mgl^{-1})	114	118	150	118	124	158	122	124	180	154	148	152	146	152	174	148	154	158
Chloride (mgl^{-1})	10.9	16.9	9.9	12.9	33.9	12.9	10.9	18.9	14.9	13.9	12.9	12.9	12.9	13.9	13.9	14.9	10.9	15.9
Nitrate (μgl^{-1})	0.9	17	19	9	20	19	14	18	17	11	14	15	10	11	11.4	9	12	11.2
Orthophosphate (μgl^{-1})	110	92	39	50	35	38	40	40	37	107	95	103	160	81	146	146	126	151

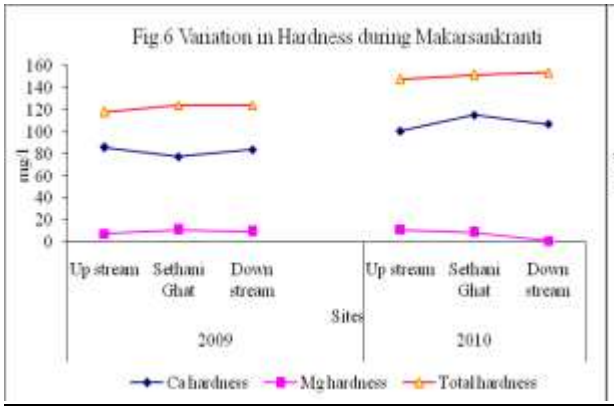
PB: Pre-bathing, B: Bathing, POB: Post-bathing











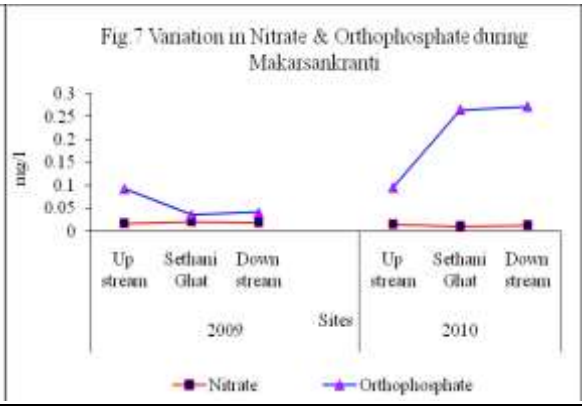


Fig. 2-7: The result of physico-chemical parameters.

TDS values during Makarsankranti were usually high during post bathing. In 2009 the values varied from 160-210 ppm; 190-210 ppm and 160-200 ppm at upstream, Sethani ghat and at downstream sites respectively. While during 2010 the values fluctuated between 210-230 ppm; 220-240 ppm and 220-240 ppm at upstream, Sethani ghat and downstream respectively. Srivastava *et al.*,[6] however, reported TDS values of 283.57 ppm (before bathing), 369.52 ppm (main bathing) and 304.36 ppm (after bathing) in Ganga river on the occasion of Mahakumbh at Allahabad. Gangwar and Joshi[4] observed the highest value of total solids 194.20mg/l and lowest 157.22mg/l during bathing and pre-bathing days respectively.

During the present course of study, the pH of water remained generally alkaline with very little variation (8 to 8.9 units). pH values during 2009 in the present study at upstream varied from 8.6-8.7 units, while at Sethani ghat and downstream the values fluctuated from 8.4-8.9 units and 8.5-8.7 units respectively. During 2010 the values fluctuated from 8.4-8.5 units, 8-8.6 units and 8.4-8.7 units at upstream, Sethani ghat and downstream respectively. During the present study period no definite trend was depicted. Various workers while working on the impact of festivals on water quality have also depicted no significant variation in pH before, during and after the festival time. Gupta *et al.*,[3] reported pH range of 7.4-7.8 units, 7.2-7.4 units and 7.2-7.6 units before Diwali festival, during main Deepawali festival and after Deepawali festival respectively. Gangwar and Joshi[5] while working on the impact of Magh Purnima festival on Ganga river depicted mean pH of 8.3 units (pre-bathing), 8.9 units (main bathing) and 8.4 units (post bathing days). Further, no significant variation was observed in pH values by Srivastava *et al.*,[6] while working on Ganga river during Mahakumbh at Allahabad. The mean pH values registered by the authors were 8.65 units (before bathing), 7.92 units (main bathing) and 8.49 units (after bathing). However, Telang *et al.*,[7] have reported minimum pH (7.2 units) in Mangalwara ghat during post mass bathing on the occasion of Makarsankranti in Narmada river.

Specific conductivity values during 2009 at upstream in the present investigation varied from 220-290 μScm^{-1}, while at Sethani ghat and at downstream the values fluctuated from 310-340 μScm^{-1} and 260-300 μScm^{-1} respectively. During 2010 the values fluctuated from 340-350 μScm^{-1}, 330-350 μScm^{-1} and 340-350 μScm^{-1} at upstream, Sethani ghat and downstream respectively. The conductivity values did not depict any significant variation as was also observed by [3and 6] during Deepawali and Mahakumbh festivals respectively.

Dissolved oxygen is of great importance to determine the water quality for various purposes and its concentration in a water body indicates its ability to support aquatic life. DO values on the occasion of Makarsankranti during 2009 in our study varied from 3.73-6 mgl^{-1} at upstream while at Sethani ghat and downstream the values fluctuated between 2.3-6.4 mgl^{-1} and 1.6-3.73 mgl^{-1} respectively. During 2010, the values of DO varied from 8-10.4 mgl^{-1}, 8-10 mgl^{-1} and 7.6-10.8 mgl^{-1} at upstream, Sethani ghat and downstream respectively. Gangwar and Joshi[4] in their study on Ganga river on the occasion of Magh Purnima at Haridwar revealed mean values of DO as 9.74 mgl^{-1} (pre-bathing), 9.42 mgl^{-1} (main bathing) and 9.7 mgl^{-1} (post bathing) while Gupta *et al.*,[3] depicted range values of 7.1-7.5 mgl^{-1} (before), 6.0-6.4 mgl^{-1} (main Deepawali) and 7.0-7.3 mgl^{-1} (after Deepawali) in Mandakini river. Srivastava *et al.*,[6] on the other hand observed mean values of DO as 8.8 mgl^{-1} (before bathing), 7.8 mgl^{-1} (main bathing) and 8.4 mgl^{-1} (after bathing) in Ganga river during Mahakumbh in Allahabad. In all these studies no significant variation was found in the DO values during, before and after the occasion. Ujjania and Multani[8] while working on Tapi river also reported no major change in DO concentration during idol immersion. Further Kulshrestha and Sharma[9] also did not depict any major variation in DO values in Ganga river during Ardhkumbh. The values recorded were 9.7-15.2 mgl^{-1} (before dip) and 9.7-14 mgl^{-1} after dip. In our study during Makarsankranti it was generally observed that at all the sites during 2009-2010, DO concentration declined slightly during bathing activity which could be due to enhanced decomposition activity on account of upwelling of rich organic sediments together with deposition of organic matter in the form of pooja samagri. Gangwar *et al.*,[10] also has reported 6 % fall in DO due to mass bathing on Ram Navami festival in river Ganga at Har ki Pauri (Haridwar). However, in the present study the effect of mass bathing was slowly neutralized by assimilation capacity, turbulence and high water velocity.

The CO_2 values during Makarsankranti in our study were usually below the detection levels. However, a significant trend was observed during bathing period when CO_2 levels were high probably due to

enhanced decomposition activity. Further, the presence of free CO_2 strengths the contention of human impact on the functioning of a lotic system. Ujjania and Multani[8] while working on the impact of idol immersion also reported comparatively high free CO_2 values (18.8 mgl^{-1}) during immersion period as compared to pre immersion (17.2 mgl^{-1}) and during post immersion (17.6 mgl^{-1}) in Tapi river.

Total alkalinity on the occasion of Makarsankranti during 2009 in the present study varied from ND-66 mgl^{-1}, ND-48 mgl^{-1} and ND-42 mgl^{-1} at upstream, Sethani ghat and downstream respectively while during 2010, the values fluctuated from 44-86 mgl^{-1}, ND-102 mgl^{-1} and ND-100 mgl^{-1}. Post bathing values were comparatively higher during the occasion while, the values were below detection levels during bathing time on Makarsankranti.

Total hardness on the occasion of Makarsankranti fluctuated from 114-150 mgl^{-1}, 118-158 mgl^{-1} and 122-180 mgl^{-1} at upstream, Sethani ghat and downstream respectively during 2009 in our study, while during 2010 the values varied from 148-154 mgl^{-1}, 146-174 mgl^{-1} and 148-158 mgl^{-1} at upstream, Sethani ghat and downstream respectively. Post bathing values were comparatively high. Srivastava *et al.*,[6] however, recorded high mean values (177.9 mgl^{-1}) during main bathing in their study on Ganga river during Mahakumbh, at Allahabad.

Chloride, indicates the state of contamination of water. In our study the values of chloride on Makarsankranti during 2009 fluctuated from 9.99-16.9 mgl^{-1} at upstream, 12.9-33.9 mgl^{-1} at Sethani ghat and 10.9-18.9 mgl^{-1} downstream. While during second year the values fluctuated between 12.9-13.9 mgl^{-1} at upstream and Sethani ghat while downstream a range value of 10.9-15.9 mgl^{-1} was recorded. The bathing period values were usually higher. Gangwar and Joshi[4] reported highest value of chloride as 14.05mg/l during main bathing days and lowest (10.63mg/l) on pre-bathing days during Magh Mela at Sangam. Srivastava *et al.*,[6] also reported the highest range of chloride as 38.8mg/l during the bathing days and lowest as 23.8mg/l on preceding days in the river Ganga.

The values of nitrate-nitrogen during Makarsankranti during 2009 fluctuated from 0.9-19 μgl^{-1}, 9-20 μgl^{-1} and 14-18 μgl^{-1} at upstream, Sethani ghat and downstream while during 2010 the values ranged from 11-15 μgl^{-1}, 10-11.4 μgl^{-1} and 9-12 μgl^{-1} at upstream, Sethani ghat and downstream respectively. No significant trend was recorded. Srivastava *et al.*,[6] on the other hand reported slightly high values of nitrate-nitrogen during main bathing in Ganga river on the occasion of Mahakumbh at Allahabad.

The values of orthophosphate on the occasion of Makarsankranti during 2009 fluctuated from 39-110 μgl^{-1}, 35-50 μgl^{-1} and 37-40 μgl^{-1} at upstream, Sethani ghat and downstream respectively, while, during the next consecutive year (2010) the values of orthrophosphate fluctuated from 95-107 μgl^{-1}, 81-160 μgl^{-1} and 126-151 μgl^{-1} at upstream, Sethani ghat and downstream respectively. On the occasion of Makarsankranti pre bathing values were high. Srivastava *et al.*,[6] however, reported high values during main bathing day on the occasion of Mahakumbh in Ganga river at Allahabad, while Gangwar and Joshi[4] did not report any significant change in their study on Ganga on the occasion of Magh Purnima.

Besides physico-chemical parameters, a study was conducted on various types of solid wastes in and around the river system at Sethani ghat during the Makarsankranti festival. The composition and quality of solid waste generated during the festive time is quite alarmining **(Table 2)**. Gangwar and Joshi[11] also have observed increase in solid waste from 775 kg at Har-ki-Pauri area to 4550 Kg during the ardh kumbh bathing festival.

From the results obtained, it is concluded at the end that some parameters were significantly linked with the activity during festival but mostly the waters did not depict a clear cut significant increase in

most of the chemical parameters after or during the activity. This may be due to the fact that river waters are dynamic systems wherein short term changes are not visualized immediately. However, such activities if continued may show cumulative effect in the long run, thereby jeopardising the very existence of the system.

Table-2: Nature of Solid waste observed during Makarsankranti

S.No.	Solid wastes	Location	Nature of solid waste	Amount of solid waste (based on bulkness)
1	Open defecated material	On the river bank	Organic waste	High
2	Worn out clothes	Heap of clothing lying both east and west side of temple closed to the river bank		High
3	Paper	River bank/ river		Low
4	Coconuts	Lying both near the shoreline & in floating condition in the river		Very high
5	Flower/Fruits	Lying both near the shoreline & in floating condition in the river		Very high
6	Plastics/Polythene	Lying both near the shoreline & in floating condition in the river		Very high
7	Metals/Glass	Alongside of Ghats (river bank)	Inorganic waste	Low
8	Miscellaneous	In small quantity around the Ghats (river bank)	Organic and Inorganic waste	Low

CONCLUSION

The overall observation on physico–chemical characteristics of Narmada River reveals significant anthropogenic impact on its functioning thus warning further enhancement in such activities in absence of proper management strategy. It is therefore, highly recommended to adopt proper management strategy in right earnest without further wasting any time before it is too late to reverse the actions as waters of River Narmada are to be used for potable purpose at a large scale now.

REFERENCE

1. APHA, Standard methods for the examination of water and waste water. 20th edition, American Public Health Association, Washington Aquaculture Engineering; 1998, 19: 119-131.
2. A.D. Adoni, Work book on Limnology. Deptt. of Environment. Government of India. Pratibha Publication, Sagar; 1985.
3. G.S. Gupta, L.N. Gupta, S.P. Parihar and J.S. Parihar, Mass bathing assessment of river Mandakini water quality, during Deepawali fair event at Chitrakoot. Int. J. Surf. Ground. Manag; 2014, 1(2), 96-103.
4. K.K. Gangwar and B.D. Joshi, Impact of mass bathing on water quality of the River Ganga during Magh Purnima at Haridwar. Nat. Sym. Lim; 2007, 61, 358-363.

5. O.J. Devi and S.L. Belgali, Water quality assessment from different districts of Southern Karnataka. Nat.Env.Poll.Tech; 2005, 4(4), 589-596.
6. R.K. Srivastava, A.K. Sinha and D.P. Pande, Water quality of the river Ganga at Phaphamau (Allahabad)-Effect of mass bathing during Mahakumbh. Envion. Toxico. Wat. quality: An int. J; 1996, 11, 1-5.
7. S. Telang, Y. Saxena and A. Chadurvedi, Effect of mass bathing on the water quality of Narmada river at district Hoshangabad, (M.P.) India. Curr. Worl. Environ; 2009, 4(1), 211-213.
8. N.C. Ujjania and A.A. Multani, Impact of Ganesh Idol Immersion activities on the Water Quality of Tapi River, Surat (Gujarat) India. Res. J. Biol; 2011, 1(1), 11-15.
9. H. Kulshrestha and S. Sharma, Impact of mass bathing during Ardhkumbh on water quality status of river Ganga. J. Environ. Biol; 2006, 27(2), 437-440.
10. K.K. Gangwar, B.D. Joshi and Deepali, Impact of mass bathing on water quality of river Ganga during Ram navmi festival of ardh-kumbh, at Har ki Pauri, Haridwar. Indi. J. Environ. Sci; 2008, 12(2), 107-110.
11. K.K. Gangwar and B.D. Joshi, A preliminary study on solid waste generation at Har ki Pauri, Haridwar, around the Ardh-Kumbh period of sacred bathing in the Ganga in 2004. Environmentalist; 2008, 28, 297-300.

Corresponding author: Agnibhoj Deepa:

[1]Department of Environmental Sciences and Limnology,
Barkatullah University, Bhopal, India