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Repercussions of tourism on water quality of River Ganga in Lower Himalayas

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A B S T R A C T

The repercussions of religious tourism on water quality of River Ganga was assessed in Haridwar region of lower Himalaya, India. To achieve that goal, five monitoring stations were selected to analyze various physico-chemical including microbial parameter (MPN) of river water. The concentration of highly varied parameters (COD, Cl^{--}, $SO4^{--}$, Zn and MPN) were 13.55 mg/L, 38.43 mg/L, 270.39 mg/L, 6.87 mg/L and 1979.83 per 100 ml respectively during huge mass gathering whereas, in pre and religious event the concentrations were found slightly lower. The observation of present study can be useful to preserve and conserve the river water quality from waste generated due to high tourism activities and could be helpful for better water resource management.

K E Y W O R D S

River Ganga | Tourism | Kanwar Mela | Haridwar | MPN

C I T A T I O N

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Introduction

The 'Kumbh Mela' is held every three years and it is one of the biggest religious festival in the all over the world. Hindus don't get much attention since their religion does not advocate violence and simply has weird beliefs including a strong reliance on astrology. Spread from early January to the end of April and rotating between 4 Indian cities, it involves mass bathing in the Ganges. The Kumbh Mela ("Pitcher Festival") peaks on three major bathing days when naked, ash-smeared sadhus charge into the water at a time decreed by astrologers. The spot where they bathe is where the river is said to leave the Himalayan Mountains and start its long journey across the plains of northern India before flowing into the Bay of Bengal. It is also where, in Hindu mythology, a few drops from a pitcher containing the nectar of immortality fell during a fight between gods and demons. The other drops fell at Allahabad, Nasik and Ujjain -- the other Kumbh Mela cities. River pollution is a very serious problem in all over the world. In developing countries, as much as 70 percent of industrial waste and 80 percent of domestic waste is said to flow untreated into rivers (World Water Development Report 2012).

Direct exposure to untreated water is blamed for a variety of health risks: infections, chronic illnesses, reproductive issues and premature mortality of children who live on the river banks. Indirect exposure through contaminated food chains and groundwater imparts a health risk even at substantial distances from the site of pollution (World Health Organization 2008a and 2008b). The Ganges basin is the part of the combined Ganga-Brahmputra-Meghna basin spread across China, Nepal, India and Bangladesh (Figure 1). Out of the total drainage basin area roughly 80%, is located in India covering around one-fourth of the country's total geographical area and thus is biggest river basin of India (Tripathi et al., 2017). Festivals are very important and heartiest to every person of India. During festival seasons a lot of peoples come to Ganga Snans to cleanse themselves. After death of the people dump their asthia in Ganga River it is a tradition of India because they think that Ganga gives mukti from the human world. Khumbha Mela is a very big festival of the world and billion peoples come to Ganga Snans at Allahabad, Hardwar in India. They through some materials like food, waste or leaves in the Ganges for spiritualistic reasons. The river flows through 29 cities in which cities population living above ten lakhs. A large proportion damp the solid and liquid wastes in Ganga river like domestic usage (bathing, laundry and public defecation), Sewage wastes, unburnt dead bodies through in Ganga river. Patna and Varanasi cities are more responsible to water pollution in Ganga and 80 % sewage wastes are responsible to water pollution of Ganga.

India has a unique place due to its religious, political, historical, geographical, environmental, socio-cultural, and as an emerging economic power not only in South Asian Countries, but also in the world (Yasir and Srivastava, 2016). Almost all the communities as Hindus, Muslims, Sikh and Christians are lived together and celebrated their auspicious events of happiness and sorrows together. Countless industries lie on the bank of the Ganga River from Uttarakhand to West Bengal like chemical plants, textile mills, paper mills, and fertilizer plants and hospitals waste. These industries are 20 % responsible to water pollution and run off solid waste and liquid waste in the Ganga River. It is very dangers to water quality, their chemical properties and riverine life (Rai, Basant 2013) Celebration of festivals has great importance in Haridwar. As people of different religions and communities of national as well as foreign gathered here and take parts in celebration of festivals and in Haridwar. The festival Kanwar Mela is organized every year in the month of July in Haridwar and it is devoted for the worship of Almighty God Shiva.

The pilgrims (Devotees of God Shiva) come to Haridwar, take holy bath in Ganga River and perform religious rituals and finally they return to their place with Ganga water (Ganga Jal) and offer it to the Shivlingam in the temple of God Shiva at their destinations (Charles, 1903; Khullar and Khullar, 2004). Pilgrims have some positive impacts such as direct or indirect income of the residential people, popularity of their region/spot besides these positive impacts pilgrims also have some negative impacts and creates burden on the local residents and environment by affecting the ecosystem of the concern area and its resources. In this way, pilgrimage exerts a heavy burden not only on the total sanitary and health-hygiene, infra-structure and life supporting systems of the city but on the reverine ecosystem of holy river Ganga. Therefore, it is necessary to monitor the impact of pilgrimage through scientific study, especially on festive occasions round the year on the environmental condition of city and river.

Municipal sewage constitutes 80 per cent by volume of the total waste dumped into the Ganga, and industries contribute about 15 percent. The majority of the Ganga pollution is through organic waste, sewage, trash, food, and human and animal remains. Naturally, as a consequence of rise in massive number of these pilgrims and tourists, the consumption of all commodities also rises. This leads various types of pollution i.e. water, noise, solid waste, air of varying physico-chemical nature. It was being experienced for many years that the Haridwar city is experiencing a growing pressure of pilgrims and tourists to meet out their various types of routine as well as special needs. In the present study an attempt has made to find the impact of religious-touristic activities during auspicious occasions on water quality of Ganga River and solid waste generation in religious spots (Bhadula and Joshi, 2014). Kanwar Mela is biggest annual celebration at Haridwar which receives millions of Pilgrims within a short period of 15 days.

In Kanwar Mela, millions of Hindu pilgrims from the neighboring districts of Uttar Pradesh, Uttarakhand, Haryana, Bihar, Delhi etc. visit Haridwar or Gaumukh and Gangotri (the origin spot of river Ganga) to have a holy dip in River Ganga. Ritually they also carry the holy water of Ganga in small pitchers kept in two baskets fitted to a semicircular bamboo carrier, called Kanwar, to offer (pour) over the head of the Lord Shiva (Shivalingam) on the 14th day of Lunar dark fortnight, in the Solar month of Cancer. A number of Hindu religious fair and festivals are held annually, several of which are bathing fairs held on the bank of Ganga at Haridwar, such as Somwati Amavasya, Kartik Poornima, Shravan Amavasya, Kartik Poornima, Ganga Dussehra etc. The holy city of Haridwar is home to some of the most sacred Hindu rituals and one can always see Hindu pilgrims and devotees from round the globe gather at Haridwar to offer prayers on auspicious occasions, having a dip in the sacred Ganga River.

Kanwar Mela is one of the most famous sacred events in Haridwar, which receives around 3.0 to 5.0 million pilgrims during a course of 15 days. In major festive occasions like Kanwar Mela, Haridwar city administration as well as local shopkeepers get a huge amount of earning. The Kanwar Mela provides a good short period business to the Kanwar makers, who easily earn and save for a full year, in these 15 days. The local shopkeepers enhance the variety of products like t-shirts with picture of Lord Shiva, Kanwar decorative items, water cane etc. Every year, the city administration makes some new policies and take steps one or two month prior to Kanwar Mela and tries to provide good facilities to pilgrims as well as local people. Along with these positive impacts, during the Kanwar Mela, pollutants increase in water and in the ambient atmosphere. It was observed that during Kanwar Mela, Kanwariyas also offer old Kanwar, milk, curd, ghee, flower, coins and other religious materials into the water of river Ganga. In the absence of

proper disposal system, the carry bags and polythene in which pilgrims carry their offerings are dumped along the river side which remain either floating on the water surface or cover the river bed substratum which is hazardous for the aquatic life (Shanker and Joshi, 1997).

Tourism is not only important, but of vital importance for many countries especially for the under-developed and developing economies. There are a large number of pilgrimage sites in India and individuals who go to these spots, go to relax and gain virtue. Haridwar district is the most prominent religious and spiritual center of Uttarakhand state. On a yearly average 80 lac tourists visit Haridwar city and this is affecting the socioeconomic environment of the district in a positive direction. To attract the tourists towards a tourist place the infrastructure plays an important role. Haridwar is an excellent place settling at the foot of Shivalik mountain range where Ganga rises in all its force. It is said that Haridwar has been sanctified by the presence of three Gods, Brahma, Vishnu and Mahesh. Lord Vishnu is said to have left his footprint on a stone that is set in the upper wall of Har-ki-Pauri where holy Ganga touches it all the time (Statistical Diary of Haridwar 2016).

Pilgrimages are not a destination only for our religious faith but they also strengthen our national unity and promote brotherhoodness also. Now the time has to come when these should be used to earn foreign exchange also keeping guarded our cultural heritage. On domestic front Pilgrim Tourism can be very helpful for regional development, employment generation, and can enroot again the cultural values. Many modern social evils, which are caused by materialism, can be cured with the help of religious tourism. Religious tourism generates revenue in a way as no other kind of tourism does. It has a distinct edge over other kinds of tourism due to the pull of huge crowds in the form of tourists (Chattopadhyay, 2006). Pilgrim tourism to holy places (tirtha-yatra) is an ancient and continuing religious tradition of the Culture of Hindus. Here religion, as a cultural dimension, assumes the vital role and central focus of tourism in which the tourists (pilgrims) from all strata of the Hindus participate. In pilgrim tourism, the dimension of religion forms the basis of tourism of pilgrimage by offering the reward of purification of the soul and attainment of objectives related to the problems of mundane existence. Hindus from time immemorial were attracted to their numerous holy sites spread throughout India. Pilgrimage is thus a pan-human and pan Indian phenomenon, the meaning of which within the traditional structure of each religion, if not, within castes and communities. In this study, the impact of tourism and mass gathering on water quality of River Ganga was assessed by observing the hydro-chemical and microbiological parameters in lower Himalayan region.

Materials and Methods

Description of sampling sites

Haridwar is situated on the bank of river Ganga at the foot hills of Shivalik range of mountain that constitute the outer Himalaya, at an elevation of 965ft from sea level. The position of the globe is latitude 20^0, 58’ N and Longitude at 78^0, 13’ E. Haridwar is well connected by road to National Highway 58, between Delhi and Mana pass. Nearest railway stations are at Haridwar, with direct links to all major cities of India. The nearest airport is Jolly Grant Airport, Dehradun, though Indira Gandhi International Airport, New Delhi. From the ancient time Haridwar city has significance value in Hindu Mythology. The ancient name of Haridwar is mayapur and name Haridwar reflect Hari and Dwara means Hari-ka-dwar or we can say the Gate of God. Many pilgrims come to visit Haridwar every year or every month even every day. Many religious gathering occurred in this Holly City. Some of

well famous gathering come to see at Kanwar Mela, which held two times in each year. One Kanwar Mela is organized in Monsoon season in hindi we say it Sawan Kanwar Mela and other one is organized in spring season. Among all five sampling sites Bhimgoda Barrage was controlled site.

Table 1: Details of all sampling sites

Site no.	Sampling sites	Type of system	Latitude	Longitude	Elevation (m)
1	Bhimgoda Barrage	River Ecosystem	29°57'23.30" N	78°10'58.27" E	289
2	Har Ki Pauri	Canal Ecosystem	29°57'18.83"N	78°10'14.46"E	293
3	Mayapur Dam	Canal Ecosystem	29°56'31.55"N	78° 9'20.65"E	282
4	Jatwara Bridge	Canal Ecosystem	29°55'9.74" N	78° 6'12.83" E	284
5	Bahadrabad, Haridwar	Canal Ecosystem	29°55'11.72" N	78° 2'26.47" E	278
6	Roorkee	Canal System	29°51' 23.89" N	77° 53' 0.43"E	267

Note: (BGB- Bhimgoda Barrage, HKP- Harki Pauri, MD- Mayapur Dam, JB- Jatwara Bridge, BPPH- Bhadrabad Pathari Power House, R- Roorkee).

Sample collection and analysis

During this study we divided sampling period in three times as one is pre Kanwar Mela, During Kanwar Mela and Post Kanwar Mela 2018. During pre Kanwar Mela samlpes was collected from each five sites to know the quality of Ganga Water before Kanwar Mela, and during Kanwar Mela we collected samples daily for 10 days from all 5 sites and during post Kanwar Mela we collected samples from all five sites one time. We use sterilize PVC bottles for collecting samples, we also use an ice bucket for preserve the sample at -15 oC. During this study we collected overall 60 samples, in pre Kanwar Mela 5 sample were collected from all five sites and during Kanwar Mela we collected 5 samples from all sites for 10 days means total no. of sample during Kanwar Mela was 50 and in post Mela sampling we collected total 5 samples from all study sites. Sampling was done before 11am at each time. A potable water analysis kit was use to analysis some parameters as DO, pH, TDS, Conductivity, to avoid changes in these parameters. The name and model no. of water analysis kit which we use is TOSCON TMULTI 27 electrochemical analyzer (Kamboj et al., 2017; Matta et al., 2018f). Other rest parameters were analyzed in laboratory as per standard method (APHA, 2012).

Results and discussion

In this short time study, we studied 17 physio-chemical and microbial parameters namely as Temperature, pH, EC, TDS, DO, BOD, COD, TA, TH, NO3-, SO4--, Cl-, Fe, Ni, Cu, Zn and MPN species. We analyzed pH, EC, TDS, DO, Temp. at the sampling spot. We collect the sample in Sterilized PVC bottle and used Ice bucket to store the collected sample to reduce the occurring

changes in water characteristics. For analysis heavy metals as Fe, Ni, Cu and we use Atomic Absorption Spectrophotometers Model No ECIL AAS4129 (PC-based) and to analyze the Nitrate (NO_3^-) and Sulphates (SO_4^-) we use UV spectrophotometers. The analyzed results of all selected parameters have been mentioned in Table 2, This Table is showing the average result during Kanwar Mela. Pre Mela and Post Kanwar Mela sampling was done for comparative study or to look what changes occurred in Ganga Water quality during Kanwar Mela. The physiochemical characteristics of Ganga water have analyzed. The water quality has checked on seasonal basis at different 20 sites of Ganga and its tributaries in Himalaya region. In present study physiochemical characteristics namely as Light Intensity, Temperature, Conductivity, Turbidity, Velocity, TS, TDS, TSS, DO, COD, BOD, Alkalinity Hardness, Acidity, Phosphorus as P and Total TKN have analyzed and result are described below as per mentioned tables.

Temperature: Temperature of any ecosystem paly a very critical role to maintain its biodiversity. During this whole study, there was no significant changes occurred in River water temperature. Bhadula and Joshi, (2014) reported the range of temperature between 10.5-24.8 ^{0}C for pre and during festive days at Har ki Pauri site. Maximum temperature value(20.2°C-24.4°C) was reported in summer season for theGanga River water at Allahabad (Raghuvanshi et al., 2014). Temperature is known to influence the pH, alkalinity and DO concentration in the water (Kumar et al. 2010).

pH: pH shows the nature of water whether it is acidic (<7) or basic (>7). During this study there was no significant changes occurred. It was recorded more than 8.18 to 8.27 pH at each sampling period which were within permissible limits 6.5 to 8.5 pH as per CPCB Guidelines. A constant pH values were recorded throughout the study period which is due to the buffering capacity of water. Many of research studies observed the similar pH values during the monitoring of Ganga River water quality (Sood et al., 2008; Sati et al., 2011; Arora et al., 2012).

Total Dissolved Solids: Solids presents in water occurred either in solution or in suspension. These both types of solids further distinguish passing through a fiber filter. By this process which solids retained on the top of filter is known as suspended solids and which passed through the filter is known as dissolved solids, but in this study we used potable water testing kit which mentioned above. During this study there was no significant changes occurred with a figure of 352.22 mg/L of controlled sampling before starting the Kanwar Mela and during Kanwar Mela it was found 352.57 mg/L. and after the Kanwar Mela we found 351.72 mg/L All results were found within limits of 2100 mg/L as per CPCB guideline. The presence of suspended solids in river water is may be due to the resuspension of sand and clay particles during waste discharge. (Daphne et al., 2011).

Dissolved oxygen: Dissolved oxygen plays a vital role in supporting aquatic life and to evaluate the degree of freshness of river. It also helps in determining the quality and organic pollution in the river (Wetzel and Likens, 2006). Dissolved oxygen is usually considered one of the most important parameters of water quality checking of rivers, lakes and streams. It is generally abbreviated as DO. As humans need oxygen they breath air as well as aquatic life like fish and organism required DO. The higher DO in water indicates the better water quality. During this Study the average DO of Controlled sampling or during Pre Kanwar Mela sampling was found 9.19 mg/L. and Post Kanwar Mela the DO was found 9.19 mg/L. and the concentration during Mela was found quite low as 7.75.

Biochemical Oxygen Demand: Bacteria and other microorganism use organic matter for food. Microorganism required oxygen for metabolic process or in other words when they metabolize organic matter they consumed oxygen. BOD is the amount of oxygen consumed during metabolize of organic matter. During this study, the average BOD was found a little more in comparison of Pre and Post Kanwar Mela sampling with a figure of 4.44 mg/L. and in Pre-Kanwar Mela Sampling it was found 3.57 mg/L. and in Post-Kanwar Mela sampling it was observed 3.59 mg/L. Rani et al. (2014) reported the BOD within the range of 3.9–4.4 mg/L during the study of Ganga River water on the occasion of Kanwar Mela 2013 at Haridwar. Parameters such as turbidity, COD, total alkalinity and total hardness, phosphate and nitrate were higher in some locations; this was because of increase in pollution load by domestic sewage, addition of nutrients, agricultural runoff and organic matter in water (Sharpley and Menzel 1987; Gupta et al. 2003; Sanap et al. 2006).

Time Parameters	Pre-Mela	During-Mela	Post-Mela
Temp. (0C)	18.28	18.14	18.32
pH	8.27	8.23	8.18
EC (µS/cm)	525.96	531.25	527.19
TDS (mg/L)	352.22	352.57	351.72
DO (mg/L)	9.19	7.75	9.19
BOD (mg/L)	3.57	4.44	3.59
COD (mg/L)	7.01	13.55	10.33
TA (mg/L)	152.56	161.41	143.67
TH (mg/L)	212.83	241.04	228.96
NO3- (mg/L)	64.66	71.51	51.38
SO4-- (mg/L	258.69	270.39	261.48
Cl- (mg/L)	26.23	38.43	22.96
Fe (mg/L)	5.28	5.93	4.56
Ni (mg/L)	BDL	BDL	BDL
Cu (mg/L)	0.135	0.135	0.13
Zn (mg/L)	3.025	6.87	3.07
MPN (/100m	1083.5	1979.83	1173.33

Table 3. Average value of various physico-chemical parameter during different phase of Kanwar Mela

Sites	Site 1			Site 2			Site 3			Site 4			Site 5			Site 6		
Parameters	Pre Mela	During Mela	Post Mela	Pre Mela	During Mela	Post Mela	Pre Mela	During Mela	Post Mela	Pre Mela	During Mela	Post Mela	Pre Mela	During Mela	Post Mela	Pre Mela	During Mela	Post Mela
Temp.	19.5	18.5	19.1	18.1	18.1	18.2	18.56	18.36	18.36	17.9	18.1	18.08	18.12	18.09	18.05	17.5	17.69	18.12
pH	8.12	8.22	8.32	8.24	8.26	8.14	8.5	8.34	8.26	8.2	8.22	8.14	8.13	8.21	8.11	8.42	8.12	8.13
EC	470.1	480.1	465	468.1	495.45	482.1	510.51	512.84	509.46	552.14	548.35	546.12	585.6	578.6	596.12	569.32	572.14	564.32
TDS	310.2	320.2	310.2	320.5	330.5	320.5	345.5	346.5	345.5	368.4	358.4	362.4	390.4	380.4	396.4	378.3	379.4	375.3
DO	9.9	8.9	9.9	9.2	7.8	9.2	9.34	7.54	9.34	8.79	7.49	8.79	8.8	7.39	8.8	9.12	7.41	9.12
BOD	2.65	2.88	2.95	3.9	5.5	3.9	4.1	4.98	4.1	3.4	4.87	3.4	3.88	4.18	3.78	3.5	4.25	3.4
COD	5.2	9.2	9.2	7.5	15.1	11.5	7.68	14.68	10.68	7.25	14.25	9.24	6.98	13.98	9.92	7.42	14.1	11.41
TA	134.3	144.3	142.1	153.2	163.2	143.12	160	171	141.1	143.3	165.3	131.11	168.68	168.78	158.65	155.9	155.9	145.91
TH	185.15	180.5	178.2	224.3	254.2	234.3	215.24	241.34	211.34	201.79	229.45	209.49	205.4	255.1	245	245.07	285.65	295.45
NO3-	51.2	55.3	45.3	69.04	79.04	49.13	71.5	72.7	51.15	74.2	78.1	54.11	59.6	71.5	56.16	62.4	72.4	52.41
SO4--	234.12	258.45	245.1	245.12	285.4	245.41	267.1	265.32	268.2	269.25	278.4	274.3	280.49	268.45	280.49	256.1	266.34	255.41
Cl-	18.5	25.1	17.45	19.1	28.33	18.33	21.1	37.59	27.51	27.4	39.4	27.4	35.14	41.43	22.41	36.15	58.75	24.65
Fe	4.34	4.68	4.12	4.68	5.5	4.1	5.21	5.68	3.92	5.68	5.98	4.68	4.9	5.89	4.41	6.86	7.86	6.12
Ni	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cu	0.1	0.1	0.12	0.15	0.15	0.14	0.13	0.13	0.12	0.12	0.12	0.13	0.17	0.17	0.13	0.14	0.14	0.14
Zn	2.9	2.9	2.62	2.65	3.45	2.98	2.79	23.25	3.18	2.96	3.89	3.12	3.6	3.9	3.4	3.25	3.84	3.14
MPN	990	1040	1080	1025	2075	1125	1103	2193	1193	1015	2013	1214	1153	2153	1123	1215	2405	1305

Table 2: Analysis result of Ganga Water Pre, During and post Kanwar Mela Sampling

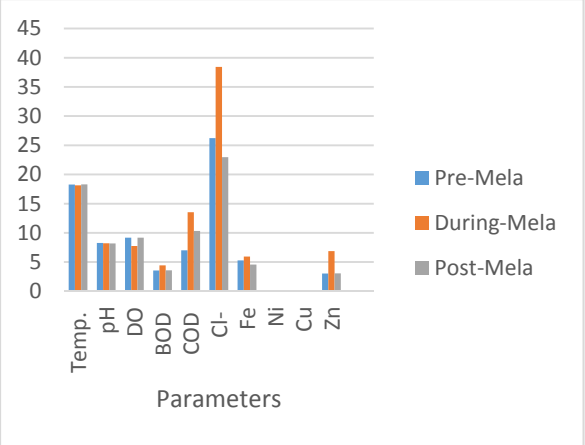
Chemical Oxygen Demand: COD is a parameter of water quality, in COD analysis measures all organic including non-biodegradable substances. It is a chemical test using strong oxidizing agents (Potassium Dichromate), Sulfuric acid and Heat. During this study a little difference was found in all three sampling periods. The maximum COD was observed during Kanwar Mela sampling period with a quantity of 13.55 mg/L. in both Pre and Post Kanwar Mela sampling it was found 7.01 mg/L and 10.33 mg/L respectively. Similarly, higher BOD/COD value (1.87–3.37/5.10–8.10 mg L^{-1}) was examined in summer season as compared with monsoon and winter season in the Ganga River water at Haridwar, India (Matta and Kumar 2015; Matta et al., 2017).

Total Alkalinity: Dissolved carbonate ions, bicarbonates ions of sodium, calcium and magnesium causes natural alkalinity. The contact between water and minerals in the ground is the major source of alkalinity. There was no big difference was occurred in total alkalinity during this study, but a little more alkalinity was found during Kanwar Mela with a quantity of 161.41 mg/L and in both pre and post Kanwar Mela sampling it was found 152.56 mg/L and 143.67 mg/L respectively. The mild fluctuations in alkalinity values may be due to the bathing activities as use of various soaps could be responsible (Sinha et al., 1991).

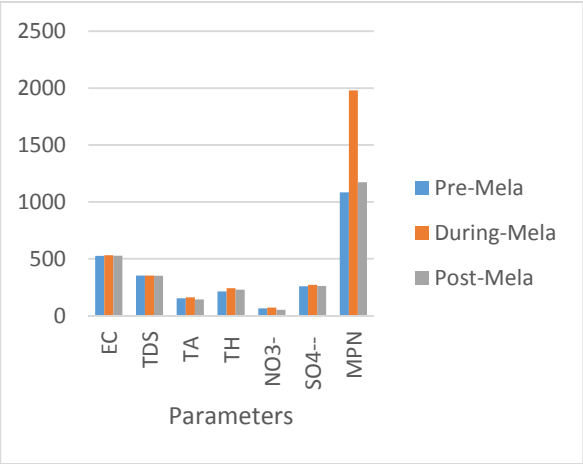
Total Hardness: The total hardness (TH) in river water is primarily regulated by the carbonates, bicarbonates, chlorides, sulphates, etc. of calcium and magnesium chiefly, whereas there are certain other chemical entities accounting for it (Haritash et al., 2016). Calcium, Ca2+ and magnesium, Mg2+ ions causes the most portion of hardness in natural occurring water. The maximum hardness was found during the Kanwar Mela with a figure of 241.04 mg/L and in pre and post Kanwar Mela it was found 212.83 and 228.96 mg/L respectively.

Nitrate (NO_3^-): Excessive nitrate concentration in drinking water pose an immediate and serious health effects. In this study we found Nitrate ions concentration maximum during the Kanwar Mela Samples with a figure of 71.51 mg/L and in pre and post Kanwar Mela it was found 64.66 and 51.38 mg/L respectively. High NO_3^- contamination of groundwater is found mainly in agricultural regions as a result of the widespread application of fertilizers and animal manure to agricultural land (Jalali, 2009). The reasons behind high concentrations of nitrate in a fast urbanized part of Varanasi might be poor sewage, leaking of fecal matter from the septic tanks and locally unmanaged landfill sites, NOx generated from vehicular traffic movement and poultry farms (Patel et al. 2016).

Sulfates ($SO4^-$): Sulfate ions occurs in natural water and in wastewater. If high concentrations are consumed in drinking water, there may objectionable tastes. A little high concentration of sulfate ions was found during Kanwar Mela with a figure of 270.39 mg/L and in pre and post Kanwar Mela samples it was found 258.69 and 261.48 mg/L. Seth et al. (2016) found the average concentration of sulphate varies from 6 ± 4.92 to 61 ± 54.95 and from 4 ± 2.55 to 16 ± 5.00 mg/L during pre-monsoon and post-monsoon seasons for different Himalayan Rivers of Kumaon Region, Uttarakhand, India.



a.



b.

Fig. 1 (a & b): Average values of all study parameters

Chlorides (Cl^-): Chlorides ions in drinking water do not have harmful effects on public health until unless the concentration of these ions found within limits if the concentration of chlorides ions in drinking water goes high it may cause harmful effects. During this study Cl- ions was found maximum with a figure of 38.43 mg/L during Kanwar Mela and in pre and post Kanwar Mela sampling it was found 26.23 and 22.96 mg/L respectively. Arora et al., (2012) observed the chlorine concentration in the range 0.7-23.33 mg/L. The source of chlorine might be the dirt and sweat of bathers (Sinha et al., 1991).

Iron (Fe): Iron as Fe, do not cause serious effects on human health. The maximum concentration was found 5.93 mg/L during Kanwar Mela, a little more than pre Kanwar Mela and post-Kanwar Mela with figure of 5.28 and 4.56 mg/L respectively. It may be attributed to the soil–water interface especially within the upper and lower part of the river stretch in the winter season (Reza and Singh 2010).

Nickel (Ni): Nickel is a chemical element with a usual symbol "Ni" During this study Nickel as Ni was not found in all three sampling period as Pre, During and Post Kanwar Mela. Haritash et al., (2016) reported the Nickel concentration ranged from 0.0105 to 0.0367 mg/l. The immediately higher values at a downstream site might be a result of wastewater added by a channel downstream of Triveni Ghat (Rishikesh).

Copper and Zinc: Copper and Zinc are non-toxic in small concentrations, and in fact they both are beneficial and essential for human health. These ions cause undesirable taste in water. During this study Copper concentration was found similar during all three sampling period, in pre, during and post Kanwar Mela. The Cu ions was found 0.135, 0.135 and .13 mg/L. It may be assigned to run-off from extensively farmed areas and domestic sewage (Ansari et al. 1999; Sharma et al., 2015). The maximum Zn concentration was observed during Kanwar Mela with a quantity of 6.87 mg/L and in pre and post Kanwar Mela it was found 3.025 and 3.07 mg/L respectively. Matta et al. (2018b; 2018d) reported the heavy metal concentration and categorizes the water quality into different quality classes on the basis of heavy metal pollution index.

Most Probable Number (MPN): The MPN is expressed in terms of the number of Coliforms per 100 ml sample, the maximum MPN species was considerable hike during Kanwar Mela samples with an average of 1979.83 and in pre and post Kanwar Mela the MPN species was found 1083.5 and 1173.33 respectively. More is the MPN of coliforms, higher is the extent of pollution in a water samples (Kulshrestha and Sharma, 2006) showed high bacterial load and water pollution (Bhadra et al., 2003)

Conclusion

The outcome of this study summarizes the impact of Pilgrimage Tourism on water quality of River Ganga during Kanwer Mela in 2018. In this study, the analysis of physicochemical and microbiological parameters showed the major changes in the concentration of MPN, SO4--, Zn, Cl- and COD during the study period. The variation in quality parameter revealed that the water quality at control site is less polluted among

the five selected sites. A comparison of water quality between pre and post religious activities with during Kanwar Mela shows the higher water pollution in Ganga River water due to huge gathering of pilgrimages. It is recommended that an appropriate strategy to reduce and control the wastes of religious-touristic activities in Haridwar region and to found Pilgrimage tourism as Eco-Pilgrimage.

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