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EFFECTS OF INDUSTRIAL AND HUMAN WASTES ON THE WATER QUALITY ON DIFFERENT WATER BODIES IN UTTAR PRADESH STATE

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ABSTRACT

Dissolved Oxygen (DO), Biochemical/Biological Oxygen Demand (BOD), Total Coliform (TC) and Faecal Coliform (FC) etc. are the water quality parameters that indicate quality for human use and the sustenance of aquatic organisms in water. This study was conducted to evaluate the water quality parameters and the effect of organic and inorganic waste material on water quality and seasonal variations. Data were collected from Uttar Pradesh State Pollution Control Board (UPPCB) website on different rivers of U.P. to evaluate the DO, BOD, TC and FC. Comparisons were done in four categories of water bodies such as Group-A (Ganga upper stretch), Group-B (Ganga down stretch), Group-C (Other water bodies upper stretch) and Group-D (Other water bodies down stretch) in different months and upstream and downstream. DO ranged from0-11mg/L in 2015 to 0-13.5mg/L in 2018. BOD was from 0- 108mg/L in 2015 to 1.1- 96mg/L in 2018. Total Coliform was also significant from 130-330000MPN/100mL in 2015 to 350-350000 MPN/100mL in 2018. Faecal Coliform was significant from 70-220000MPN/100mLin 2016 to 110-220000 MPN/100mL in 2018.Though the DO in few of the sites was in recommended sites the BOD levels in corresponding sites were high indicating the water is not able to rejuvenate itself due to pollution burden and making it unfit for use. It is likely to affect to agriculture, humans, animals, and environment. The TC and FC counts were several hundred times above the recommended levels and unfit for human use without treatment. There is need of remedial measures on war footing before it's too late.

Keywords: DO, BOD, Total Coliform, Faecal Coliform, Water Pollution, U.P. State, Human Waste, Industrial Waste.

INTRODUCTION

River basin has been a major source of water supply and fertile land which favors human settlement (Mouri et al. 2011). In the olden days civilizations flourished along riversides. In the modern era, industrial and irrigation activities are developed where rivers constitute the main inland water body. Increased demands for water due to exponential population growth and developmental activities exerted pressure on natural water resources like rivers and lakes often polluting river bodies with large municipal sewage, industrialwastewater discharges, and seasonal runoff from an agricultural field changing the physicochemical properties of water (Wang et al. 2008, Singh 2014, Water for Life' 2005–2015, Reza 2016). Such changes in the property of water may have serious consequences on aquaculture, fisheries and agricultural production and human use are observed in the plain regions of the rivers hence they are more vulnerable getting affected (Kumar et al. 2015, Gyawali 2012, Thareja et al. 2011, "Status of Water Quality in India 2011).

All developing countries including India are facing a challenge in balancing growth without damaging natural environment through sustainable development. Rapid population growth is seen in urban areas generally in river plains. The Ganga basin accounts for a little more than one-fourth (26.3%) of the country's total geographical area and is the biggest river basin in India, covering the entire states of Uttarakhand, Uttar Pradesh (UP), Bihar, Delhi, and parts of Punjab, Haryana, Himachal Pradesh, Rajasthan, Madhya Pradesh, and West Bengal. It travels a total of 2525 kms in India and about half of this is in the state of Uttar Pradesh (National Mission for Clean Ganga (NMCG). Major point sources of pollution in river Ganga are discharge of untreated/partially treated sewage from urban centers, discharge from open drains carries sewage, industrial wastewater, returned storm water

discharge from major tributaries discharge of untreated/ partially treated/treated wastewater from industrial units (National Mission for Clean Ganga (NMCG), Status Paper on River Ganga State of Environment and Water Quality 2009). About 2723.3 MLD of municipal sewage wastewater discharged per day in urban centers along river Ganga against treatment capacity of 1208.8 MLD per day (Status Paper on River Ganga State of Environment and Water Quality 2009). In addition, pollution of river water by industrial effluents is another cause of concern (Status Paper on River Ganga State of Environment and Water Quality 2009, Central Pollution Control Board 2013). Major contributors of industrial effluents include tanneries, leather, fertilizer, paper, pulp, sugar and chemical/fertilizer from agricultural use.

Central Pollution Control Board (CPCB) has set up State Pollution Control Boards in different states which monitor standards of water quality in different rivers flowing in the respective states. CPCB has 57 water quality monitoring stations on river Ganga which are run by State Pollution Control Boards, to assess water quality, of which 20 are in the state of Uttar Pradesh. Uttar Pradesh Pollution Control Board publishes data on water quality parameters, dissolved oxygen, biological oxygen demand, total coliform and faecal coliform value after testing of water samples from different locations of different rivers including river Ganga in UPstate[National Mission for Clean Ganga (NMCG), Status Paper on River Ganga State of Environment and Water Quality 2009, Central Pollution Control Board 2013]. Dissolved oxygen, Biological/Biochemical oxygen demand, Total coliform and Faecal coliform are the parameters that represent the significance of water for using purpose such as drinking, bathing and washing. Water qualities of river basins are directly affected by the untreated waste, salinization, suspended sediments, viruses, oil and grease etc. Effect of urbanization on water quality is evidenced by a long-term monitoring and analysis of fecal coliform in stream water-quality in the city of Atlanta (Peters 2009).

Although several reports on the assessment of water quality in the Ganges in different cities in Ganga basin and few other rivers in UP state are available (Singh 2017, Chaurasia 2011, Thareja 2011), a few reports available on seasonal variations (Naseema 2013, Mishra 2009), the data on the status of water quality in the Ganga and other rivers and water bodies from all the cities (sampling stations) in the Uttar Pradesh state that too with seasonal variation is rare. With a view to provide seasonal variations of water quality in the river Ganges and other bodies in the state of Uttar Pradesh through the analysis of selected water quality parameters (DO, BOD, TC and FC) for three consecutive years which would serve as a useful tool for further ecological assessment and monitoring of the river quality. Very little information is available about the overall status of water quality and seasonal variations in the rivers flowing in the state of Uttar Pradesh. Ganga Action Plan and few other schemes focused mainly on Ganga. The present report focuses on the water quality parameters of all the rivers and water bodies in the state of Uttar Pradesh.

MATERIALS AND METHODS

Study Area

The state of Uttar Pradesh lies between latitudes 23˚ 45' N and 31˚ 30' N and longitudes 77˚00' E and 85˚00' E covering a total area of 2,94,413 sq. kilometers and can be divided broadly into three physiographic units, the Himalayan region with 17 percent total area having 4 percent of the population, the Gangetic plain with 70 percent of total area having 90 percent of population and the Bundelkhand and Vindhya plateau in the south with 13 of total area having 6 percent of the total population. The major river systems are the Ramganga, the Yamuna, the Ghaghara, and the Gomti. Soil is mostly alluvial soil type. Climate of the entire UP state is subtropical, with moderate to severe winter season. Winter season begins in October to February and the summer months are March to mid-June. Most of the rainfall is through south-west monsoon with annual rainfall range from 600mm to 2000 mm, southern region being the least. July and August are the wettest months. About 199,581,477 people live in the state of Uttar Pradesh with a population density of 828/km^2 depend mainly on river Ganga for water and this population depends on river water mainly on major river systems for domestic, industrial, irrigation and fisheries use and also serve as main sink for people living in cities along theriverbanks.

UP State Pollution Control Board monitors river water quality by taking samples from different rivers at different locations in UP and results of the chemical analysis are published as reports of water quality parameters viz. DO, BOD, Total Coliform and Faecal Coliform. Hence, this study was conducted on secondary data collected from the reports of UP Pollution Control Board published data on different rivers and different cities of Uttar Pradesh on pollutants, water quality parameters for different months of October 2015 to September 2018 (Kumar 2015). The present study

comprises of 63 sampling stations spread over Uttar Pradesh State. The monitoring network covers 13 rivers, 2 lakes and 2 ponds. Site wise summary is presented in Table-1 and 2. For the ease of analysis the Ganga and other rivers and water bodies werecategorized into four groups A,B, C and D. Group A is upper stretch of Ganga, Group B is down stretch of Ganga, Group C is upper stretch of other river bodies/ lakes and Group D is down stretch of other water bodies in U.P. state. Data were summarized and summary statistics is given in form of the minimum, median, maximum range and p-value calculated by Kruskal Wallis Test. Seasonal variations were calculated after summarizing month wise data; 3 months of 2015 (October, November and December), 12 months of 2016 (January to December), 12 months of 2017 (January to December) and 9 months of 2018 (January to September). The graphical representations of seasonal changes are presented in Figure 1 to 4. Summarize the data and calculate using of SPSS Software, version 17 and Excel software.

RESULTS

The water quality of all four groups of water bodies indicate DO, BOD, TC and FC rarely meeting the water quality criteria of WHO standard limits at majority of locations. The minimum, median, maximum values of DO, BOD, TC and FC from different water bodies in the state of Uttar Pradesh with their P-values parameters for the period October 2015 to September 2018 are represented in Table 3. DO range observed as 6.3 to 11 mg/L and higher values were observed in upper stretch of group A and group C in 2015 (P-value - 0.04) whereas higher values were noted in Group C and

Table 1. Sampling site's for different rivers and water bodies in Uttar Pradesh

Sites Group	Names of the sample sites
Group A (Ganga River Upstream)	1. Beraj, Bijnor, 2. Muzaffar Nagar, 3a. Brijghat, Garmukteshvar, Hapur, 3b. Garmukteshwar, Hapur, 4a Anupshahar (upstream), Bulandshahar, 4b. Anupshahar (downstream), 4c. Rajghat, Bulandshahar, 4d. Kachalaghat, Bulandshahr, 5. Farrukhabad, 6a. Upstream, Kannoj, 6b. Downstream, Kannoj, 7a. Bithoor, Kanpur, 7b. Bheravghat Kanpur, 7c. Upstream, Kanpur. 7d. D.S. Shukla Ganj, Kanpur
Group B (Ganga River) Downstream	1a. Gola Ghat, Kanpur, 1b. Jujmau Bridge, Kanpur, 1c. Downstream, Kanpur, 2. Dulma, RaiBareli, 3. Kalakkar, Pratapgarh, 4. Kadaghat, Kosambi, 5a. Upstream, Allahabad, 5b. Downsteam, Allahabad, 5c. After joining Tamsa river, at Sirsa, Sonbarsa, Allahabad, 6. Vindhyachal, Mirzapur, 6b. Downstream, Mirzapur, 7. Chuanr Ponton Bridge, Sonbhadra, 8a. Upstream Varanasi, 8b. Downstream, Varanasi, 9a. Downstream, Tarighat, Ghazipur, 9b. After joining Gomti River, Bhusola, Ghazipur.
Group C Other Rivers Upstream	1. Varuna River, Varanasi, 1a. Varuna , before joining Ganga, Varanasi, 2. Kali River, Meerut, 3a. Kali , Kannoj, 3b. Ramganga, Kannoj, 4. Sai River, Uannav, 5. Sai river, Jonpur, 6. Hindon river, Saharanpur, 7. Hindon, Noida, 8. Hindon, Gram-Bapursi, Baghpat, 9. Gomati, Sitapur, 10a. Gomati, Upstream, Lucknow, 10b. Gomati , Downstream, Lucknow, 11. Gomati, Jonpur, 12. Gomati Before joining Ganga, Rajvari, Varanasi, 13. Saryu, Faizabad, 14.Yamuna, Shahapur, Mathura
Group D Other Rivers, Downstream	1. Yamuna, Mathura, 2. Yamuna, Vrindavan, 3. Yamuna, Allahabad, 4a. Son River (Upstream Rihand Dam, Sonbhadra, 4b. Rihand Dam (Son River downstream), Sonbhadra, 5. Ghaghara River, Gorakhpur, 6. Ghaghara, Turtipur, Devariya, 7a. Rapti River, Domangarh, Gorakhpur, 7b. Rapti, Rajghat, Downstream, Gorakhpur, 8. Ramgar Lake, Gorakhpur, 9. Betwa River, Hamirpur, 10. Govind Sagar (Sutlej River), Jhansi, 11. Samarpur Lake, Solan, Raebareli, 13a. Mahil pond, Jalon, Jhansi, 13b. Lakshmi Pond, Jhansi

Table 2. Number of sampling sites (n=) of groups (Gr.) of different water bodies

Water Quality Parameters	Water Bodies Group	No. of samples sites (N=)			
		2015	2016	2017	2018
DO mg/L	Gr. A	11	11	13	15
	Gr. B	10	10	13	16
	Gr. C	14	15	15	13
	Gr. D	14	14	16	14
BOD mg/L	Gr. A	10	10	13	15
	Gr. B	11	11	13	16
	Gr. C	16	16	16	16
	Gr. D	16	16	16	16
Total Coliform MPN/100mL	Gr. A	10	10	13	15
	Gr. B	11	11	13	15
	Gr. C	16	16	16	15
	Gr. D	16	16	16	16
Faecal Coliform MPN/100mL	Gr. A		10	13	13
	Gr. B		11	13	13
	Gr. C		16	16	16
	Gr. D		16	16	16

Group D for the year 2016 (P-Value- 0.004). The DO range observed for that year ranged from 0 to 11.9 g/L. We observed a reversal in trend with group A and C reporting the highervalues in the year 2017 again P-value is 0.57. Interestingly we observed higher DO values in both the upper streams Group A and group C with ranges 0-13.5 mg/L, (P-value is 0.258) in the year 2018 (Table 3).

High fluctuation in DO observed from October to December months was shown as a negatively skewed whisker box for group A (Fig. 1a1) whereas for the group C it was positively for the year 2015 (Fig 1a2). The fluctuation observed for the year 2016 was on higher side in January to December, for group A, whereas for other groups followed the fluctuation pattern to group A. We observed negatively and positively values equally for the rest of the months (Fig. 1b). For the year 2017 high DO values were observed throughout the year for group C except in the month of June and it was represented as positively skewed in the whisker plot (Fig. 1c). We observed similar pattern for other groups also. Again, we observed a higher fluctuation in DO for group A in the year 2018 in the months of January toSeptember instead of October to December as observed in the year 2015 (Fig.1d).

The overall BOD observed was 0-108 mg/L (P-value-0.002), which is higher in group A and B for the year 2015, whereas groups C and D reported higher values in the year 2016 with range from 1.1-136.3 mg/L (P value- 0.002) respectively. We observed similar trend in group C and D in the year of 2017 and 2018 with BOD value 1.2-120 mg/L (P values-0.01) and 0.9-96 mg/L (P value-0.001) in 2017-18 respectively. Higher fluctuation was shown in BOD from October to December in group A for the year 2015 except for the month of November, the whisker plot was shown as

Table 3. Minimum, median, maximum and p-values of water quality parameters of year 2015-2018

Water Quality Parameters	Water Bodies Group	2015				2016				2017				2018			
		Mini-mum	Med-ian	Max-imum	P-Value	Mini-mum	Med-ian	Max-imum	P-Value	Mini-mum	Med-ian	Max-imum	P-Value	Mini-mum	Med-ian	Max-imum	P-Value
DO mg/L	Gr. A	6.3	7.8	9.5	0.04	6.24	8.05	8.45	0.004	5.7	7.65	11.3	0.57	5.7	7.7	11.6	0.258
	Gr. B	7.5	8	9		4.6	8	9.87		5	7.45	9.4		2.8	7.75	11	
	Gr. C	0	8.1	11		0.2	7.5	10.2		0.5	7.7	11.8		0.2	7.6	13.5	
	Gr. D	0	7.45	8.9		0	7.45	11.9		0	7.16	9		0	6.9	10.5	
BOD mg/L	Gr. A	1.9	2.6	5.4	0.002	1.1	2.55	4.8	0.002	1.2	3.2	5	0.01	0.9	2.54	5	0.001
	Gr. B	2.2	4	5.3		2.1	4.2	8.8		2.3	4.2	6.4		2	3.75	8.5	
	Gr. C	2.4	4.8	68		2.3	5.4	78.1		1.9	4.88	120		1.8	4.9	84	
	Gr. D	0	2.8	108		1.3	3.3	136.3		1.4	3.7	95		1.1	5	96	
Total Coliform MPN/100mL	Gr. A	130	1500	58000	0.003	110	855	9000	0.001	130	610	9200	0.001	350	1655	6300	0
	Gr. B	2000	19650	49000		2100	33500	120000		2000	11000	130000		2200	15500	110000	
	Gr. C	940	22000	330000		200	18250	350000		400	17000	360000		790	19000	350000	
	Gr. D	500	6300	84000		340	6375	90000		400	9500	180000		700	11000	160000	
Faecal Coliform MPN/100mL	Gr. A					70	495	3400	0.001	90	250	6300	0.001	120	1700	4300	0.001
	Gr. B					1000	15000	58000		1100	7000	58000		1100	7400	58000	
	Gr. C					68	12750	220000		110	8000	220000		110	7900	220000	
	Gr. D					170	3700	58000		250	5750	90000		130	3300	92000	

Water Quality Parameters Trend in Different Water Bodies in Different Years of Uttar Pradesh

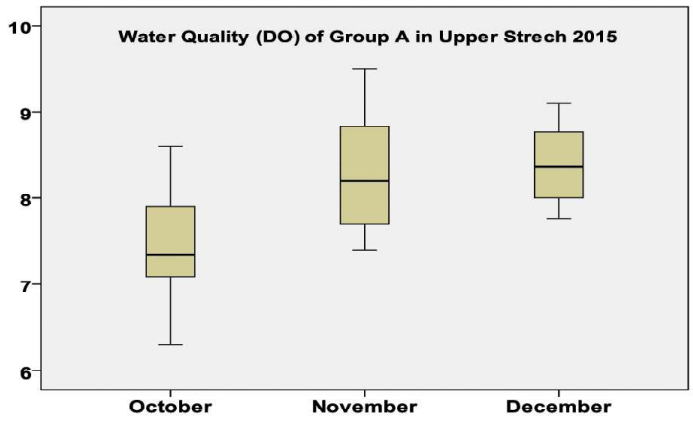

Fig. 1a1. Water Quality trend of Group A Dissolved Oxygen mg/L for 2015

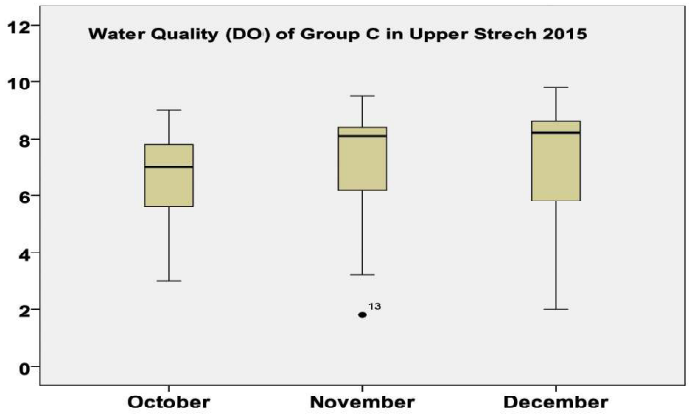

Fig. 1a2. Water Quality trend of Group C Dissolved Oxygen mg/L for 2015

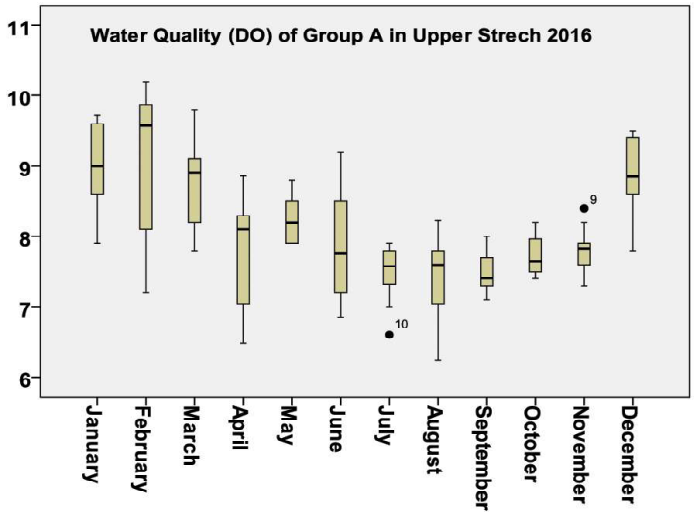

Fig. 1b. Water Quality trend of Group A Dissolved Oxygen mg/L for 2016

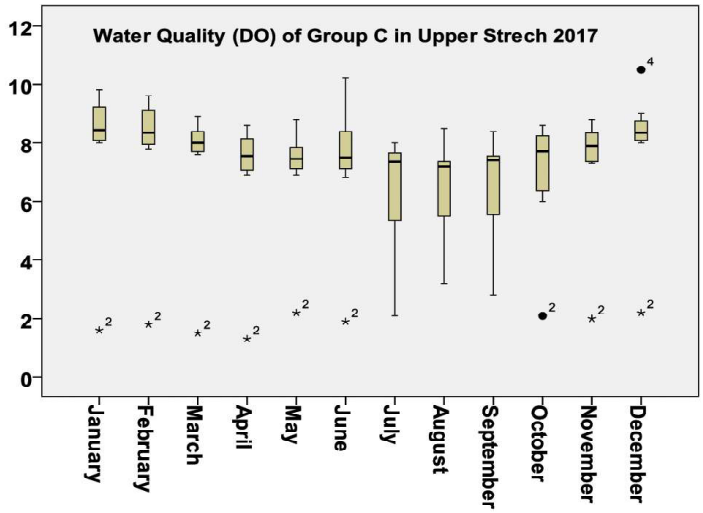

Fig. 1c. Water Quality trend of Group C Dissolved Oxygen mg/L for 2017

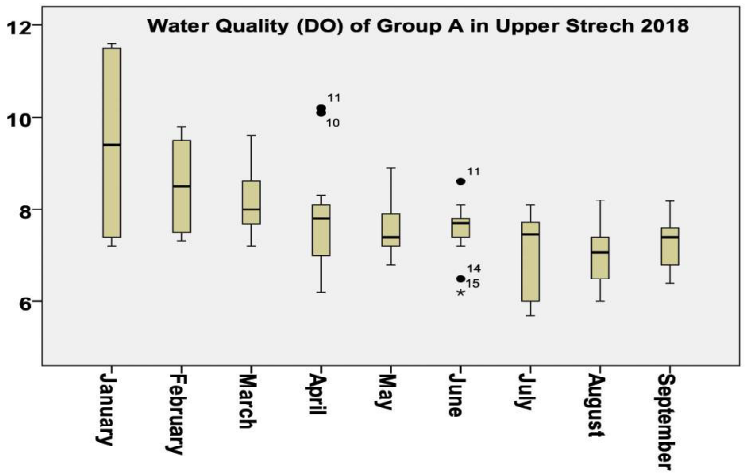

Fig. 1d. Water Quality trend of Group A (DO mg/L) for 2018

positively skewed. We observed similar pattern in other group also, further we observed outliers values which fell far from quartiles (Fig. 2a). Fig 2b depicts the variations in BOD in wave pattern season wise for group A. Most of the whisker plot boxes in the plot were negatively skewed throughout the year 2016. Similar pattern was observed in other groups for that year.

Seasonal change observed for the year 2016 shows that majority of the boxes in the plot are negatively skewed, similar pattern was observed for other groups also. For group B all wicker boxes exclude the months of June, July, November and December are positively skewed, other groups reported similar variation in the year 2017 (Fig. 2c). Group A did not report major variations in the year 2018 except for months of March and April which are negatively skewed. Similar observed were noted for other groups for that year (Fig. 2d).

Water Quality Parameters Trend in Different Water Bodies in Different Years of Uttar Pradesh

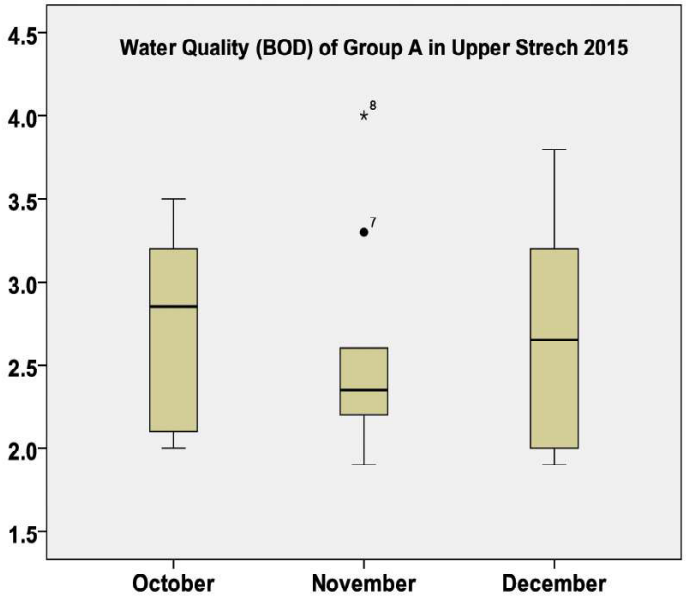

Fig. 2a. Water Quality trend of Group A Biological Oxygen Demand mg/L for 2015

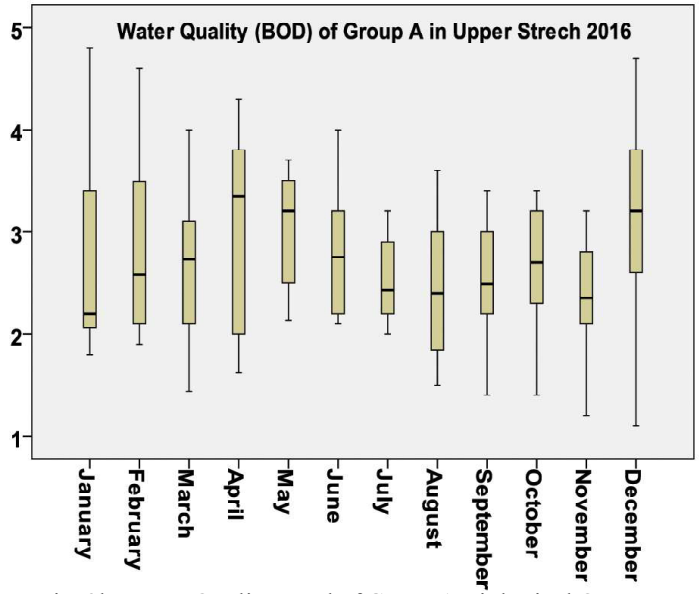

Fig. 2b. Water Quality trend of Group A Biological Oxygen Demand mg/L for 2016

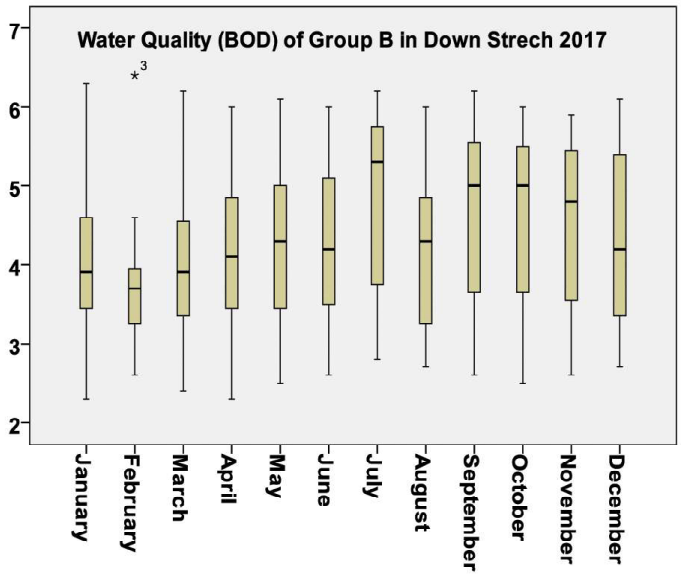

Fig. 2c. Water Quality trend of Group B Biological Oxygen Demand mg/L for 2017

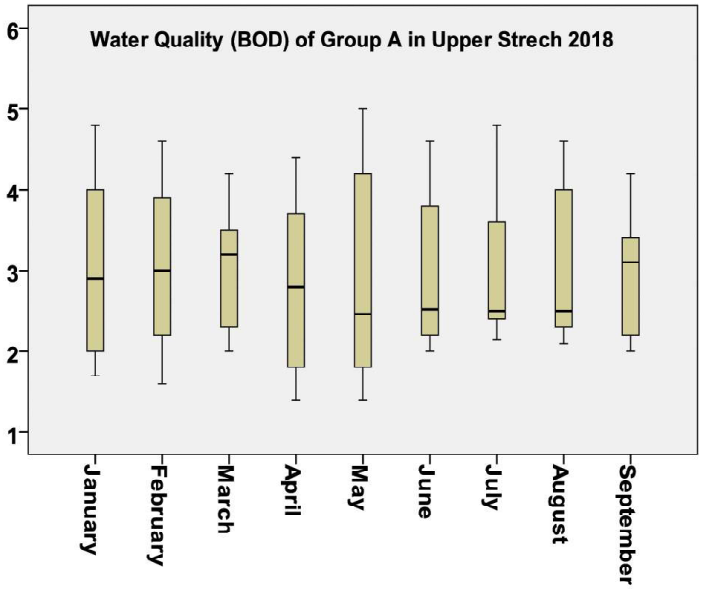

Fig. 2d. Water Quality trend of Group A Biological Oxygen Demand mg/L for 2018

Further, we observed Total coliform count for all groups which ranged 130-330000 MPN/100mL for the years 2015. A spike in values were observed for the group A and C (P-value-0.001) in the year 2015 and for the group B and C in the year 2016 with TC range 110-350000 MPN/100mL (P-value-0.001). For the year 2017 the TC range reported was 130-360000 MPN/1000mL (P-value- 0.001). TC range was observed 350-350000 MPN/mL the year 2018 (P-value-0.00) in which group C and D reported higher values (Table 3).

Our observation on seasonal variation in TC noted as positively skewed whisker box for group B but other groups were negatively skewed (Fig. 3a and Fig. 3b) in the year 2015 and 2016. Fig.3c and Fig. 3d depict positively skewed for all groups in year 2017 but except January and March in year 2018 and data available up to September in 2018.

Water Quality Parameters Trend In Different Water Bodies in Different Years of Uttar Pradesh

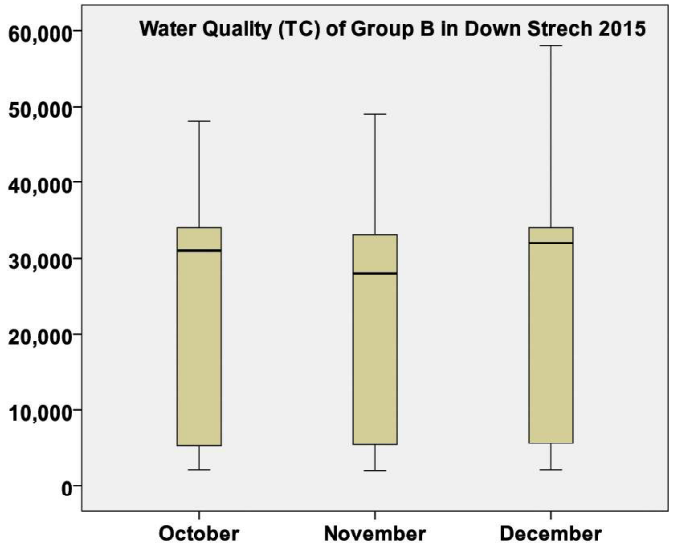

Fig. 3a. Water Quality trend of Group B Total Coliform for 2015

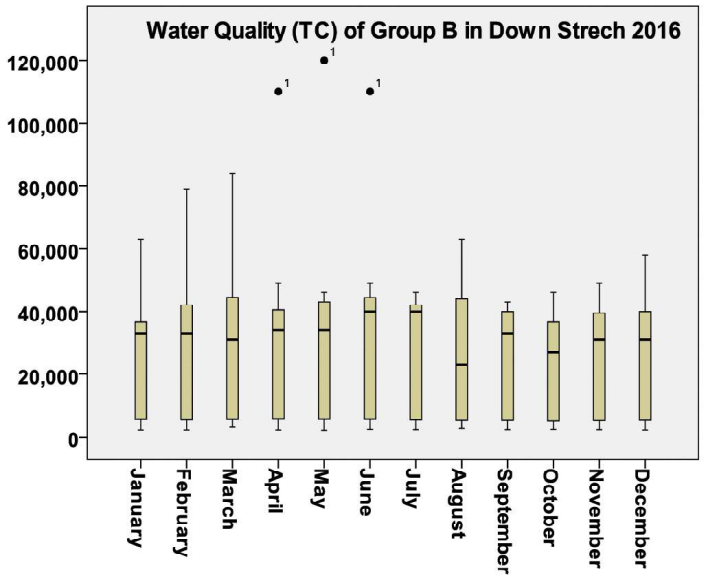

Fig. 3b. Water Quality trend of Group B Total Coliform for 2016

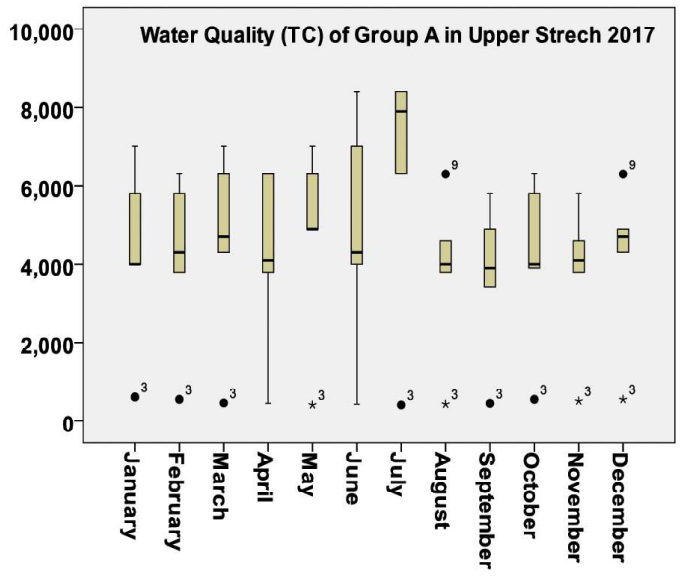

Fig. 3c. Water Quality trend of Group A Total Coliform for 2017

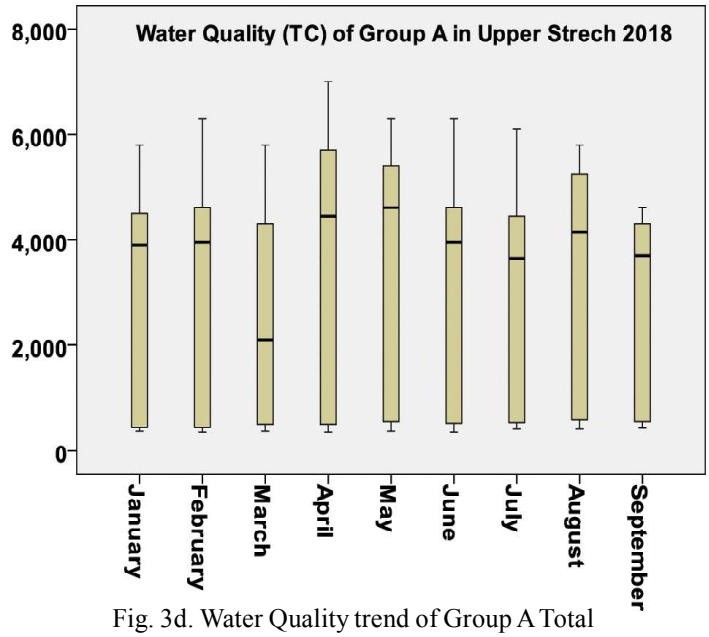

Fig. 3d. Water Quality trend of Group A Total Coliform for 2018

Faecal coliform (FC) values were observed for the years 2016, 2017 and 2018 only as the some are not available for 2015. Recorded FC values ranged from 68-220000 MPN/100mL and elevated levels were noted in group B and C for year 2016 (P-value-0.001). FC range observed for the year 2017 was 90-220000MPN/100mL with group 5 C and D reported higher values 2017 (P value-0.001) and for the year 2018 similar observed for the groups C and D were made however the ranged from 110-220000 MPN/100mL (P-value-0.001) (Table 3).

Figure 4b shows faecal coliform in wave pattern for group B where most of the year whisker boxes were positively skewed except July, August and September in year 2016. Seasonal variation in FC also showed positively skewed in

Water Quality Parameters Trend in Different Water Bodies in Different Years of Uttar Pradesh

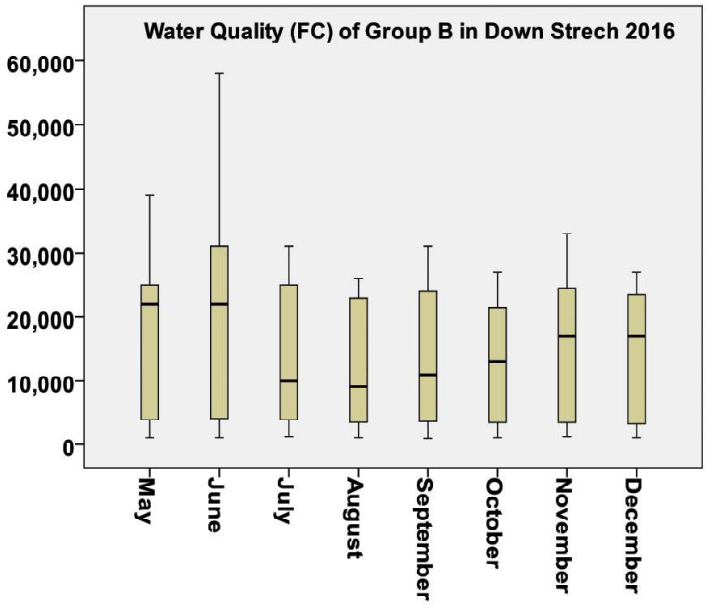

Fig. 4b. Water Quality trend of Group B Faecal Coliform for 2016

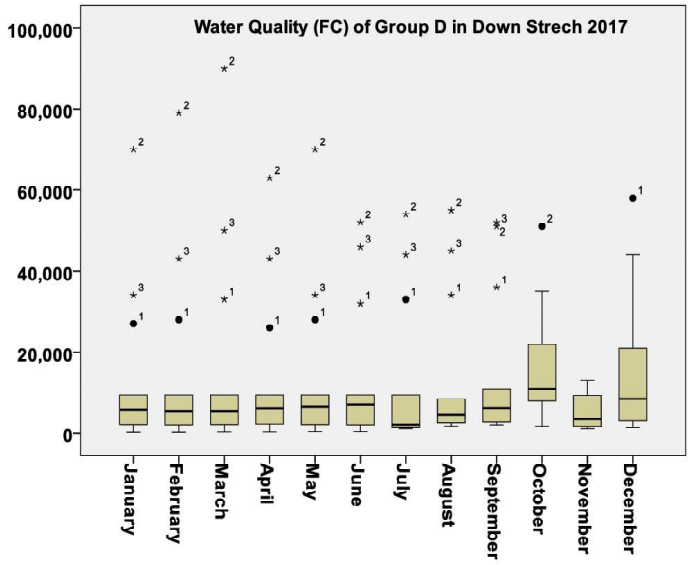

Fig.4c. Water Quality trend of Group D Faecal Coliform for 2017

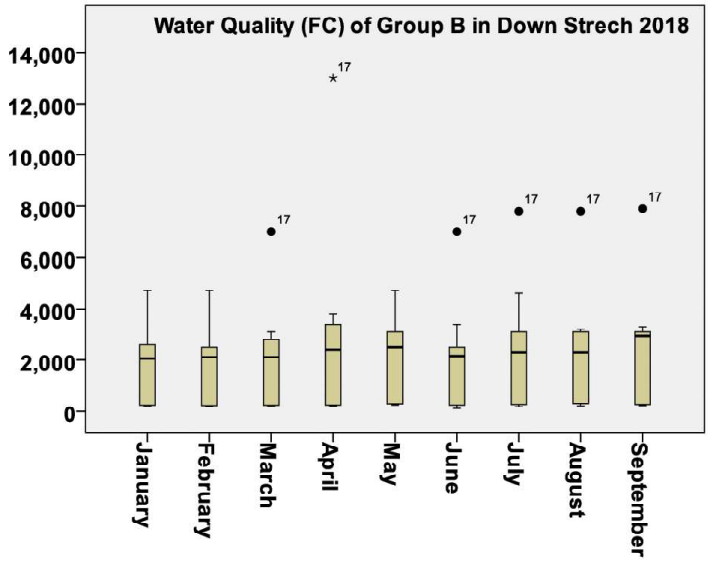

Fig. 4d. Water Quality trend of Group B Faecal Coliform for 2018

fig 4c of group B in the year 2017. Outlier was noted due the addition of new sites and high value for the year 2018.

DISCUSSION

In the present study we observed the seasonal variations in four water quality parameters DO, BOD, TC and FC in the Ganga, others rivers and water bodies in the state of Uttar Pradesh. We observed that all the parameters showed considerable variations throughout the year across all the river groups and in majority of places the water quality is unfit for drinking and bathing.

It should be noted that the parameters observed for water quality determination under study are interrelated and must be studies together but not in isolation. Further, these factors are dependent nature as well as human interference. Temperature, intensity of sunlight, monsoon and human activity, agricultural and industrial effluents influence these parameters. WHO recommended values for DO and BOD for different activities are presented in Table 4.

We observed that in dissolved oxygen levels in few of the sites in all the four groups were in recommended levels but the corresponding BOD levels were way beyond the recommended levels (Supplementary data). Dissolved oxygen levels in water directly related to BOD. It is evidenced that when the stream waters are polluted with industrial effluents DO levels decreases, sometimes even '0' levels. Such '0' DO values observed in our study indicate high organic content in water in such cases due to higher oxidation demand higher BOD values may be recorded. High BOD values are generally observed when waters are contaminated with sewage, microorganisms, debris, or with the effluents of water treatment plants. In high BOD waters there will be DO deficiency reducing availability of oxygen to the organisms. Moderate BOD levels enrich the water with nutrients to such an extent causing 'algal blooms' affecting the quality of water. Since such algal blooms supersaturate the waters with oxygen with photosynthesis activity during day light, however all the released oxygen is utilized again by the plants and organisms during respiration bringing the DO levels to low such conditions are not favorable (Bahlaoui 1997, Dasgupta 2016, http://www.indiaenvironmentportal.org.in). Maintenance of BOD at optimum levels is necessary for the quality of stream water. BOD data reported in the present study BOD5, which implies that the amount of oxygen utilized over a 5-day period of incubation. These levels were comparable to the BOD levels observed in Godavari basin in the states of Madhya Pradesh, Maharashtra and one or two sites in the state of Telangana. Majority of river system maintained a balance in BOD levels (Wilkinson 2007). It is well known that temperature controls the reproductive activities of aquatic life in addition to the metabolic rates. Increase in temperature increases the metabolic rate thus increasing the DO of organisms, on the other side increasing temperatures decreases DO reducing the amount of DO availability creating a 'stressful' environment for aquatic life. The observed dip in DO levels in our study may corroborate

Table 4. Standard limits of water quality parameters given by WHO

Designated Best-Use	Class of water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	• Total Coliforms Organism MPN/100mL shall be 50 or less • Dissolved Oxygen 6mg/l or more • Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organised)	B	• Total Coliforms Organism MPN/100mL shall be 500 Dissolved Oxygen 5mg/l or more • Biochemical Oxygen Demand 5 days 20C 3mg/L or less
Drinking water source after conventional treatment and disinfection	C	• Total Coliforms Organism MPN/100mL shall be 5000 or less Dissolved Oxygen 4mg/l or more • Biochemical Oxygen Demand 5 days 20° C 3mg/l or less
Propagation of Wild life and Fisheries	D	• Dissolved Oxygen 4mg/L or more • Free Ammonia (as N) 1.2 mg/L or less

this (Bahlaoui 1997, Wilkinson 2007, Dasgupta 2016, http://www.indiaenvironmentportal.org.in 2017).

Coliforms are bacteria found in the digestive tracts of animals, including humans and aid in the digestion of food. They are discharged in to the environment through their waste.Coliforms pollute water and their presence indicates bad quality of water. These are **"indicator"** organisms, testing **for coliform bacteria can be an indication of other pathogenic bacteria.** There are two types of coliform such as Total Coliform (TC) and Faecal Coliform (FC). Total coliforms (TC) are a group of related bacteria that are found in soil and vegetation as well as in the intestines of mammals which are not harmful to humans with few exceptions. However it indicates the presence of pathogens which include variety of bacteria, parasites, and viruses that are potentially hazardous to humans if ingest them. Total Coliform bacteria enters water through human and animal waste, seepage or overflow from septic tanks, sewage treatment facilities, plant insects, rodents, flood water and surface runoff (Wilkinson 2002). Measurement of total coliforms is a useful indicator of other pathogens in the drinking water, the effectiveness of wastewater treatment of water treatment and the worthiness for the distribution system.

It is reported that faecal coliform concentration in different seasons are influenced by annual temperature changes, intensity of sunlight, monsoon and river flow in an year (Wilkinson 2002, 2007, Guidelines for Drinking-water Quality Third Edition Incorporating The First And Second Addenda Volume 1, 2008). Hence the faecal coliform concentrations in water systems are dynamic. Higher concentrations are observed during winter months and lower concentrations during summer months in the rivers flowing in the plains generally. However barring a few upstream sampling sites in group A, all the sampling sites in all the groups recorded TC and FC concentrations much above the WHO recommendation of 50or less MPN/100mL (www.cpcb.nic.in). The TC and FC concentrations were way above even 100 times more in majority of sites making the waters unfit for drinking and bathing without proper treatment.

To improve quality of water in rivers use of recycled and treated wastewater should be strictly implemented for industrial purposes like factories, distilleries. All urban centers should be equipped with proper sewage treatment plants matching to the capacity of wastegenerated specially at Hot Spot Locations identified and marked in the maps of various rivers. Effluents discharge shouldbe in proportion to self-cleaning capacity of rivers. To control municipal sewage flow into the rivers drains in cities should be cleaned before monsoon. Solid waste management should also be clearly supported through policy initiatives and ecofriendly waste disposal technology should be encouraged. Existing zero tolerance for industrial for industrial waste should be strictly implemented. Solid waste segregation, sewage disposal and treatment plans should become integral part urban planning for the existing and upcoming townships. The clock is ticking before any remedial measures become uselessIndia should take action to protect rivers water hence the quality of its water.

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