Evaluation of the Physico-Chemical and Bacteriological Parameters of Gomti River in Sultanpur, Uttar Pradesh

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Abstract

Gomti, the only river system of Sultanpur was studied for 16 prime physico-chemical and 2 bacteriological parameters at six locations (viz., Kurwar, Golaghat, Dhobighat, Shmashan Ghat, Papar Ghat and Dhopap Ghat) of the district, for a period of one year for various seasons. The samples were collected in the month of January, May and August-2018 to study the seasonal variation in different parameters. For the Physico-chemical study, the analysed parameters are Temperature, Colour, Odour, Turbidity, Total Hardness, pH, Electrical Conductance (EC), Total Dissolved Solids, Alkalinity, Free Ammonia, Sulphates, Chlorides, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Free CO_2. Total Coliforms MPN/100 ml and Faecal Coliforms MPN/100 ml is evaluated for Bacteriological eastimation. The water samples were analysed by emulating the Standard Methods for the Examination of Water and Waste Water, 21st Edition (APHA-2005). The river water quality is getting deteriorated day by day with an increase in the population and their over water consumption. Drinking, washing clothes and utensils, discharging of sewage waste, sand dredging, boating, fishing, open defecation and religious ritual activities along the stretch are generating serious threats to the flora and fauna of the river by changing physico-chemical and bacteriological quality of the river.

The seasonal trends were discussed to comprehened anthropogenic interferences on the river stretch. Correlation analysis was also studied in between various physico-chemical and bacteriological parameters. By comparing with the tolerance limits of Bureau of Indian Standards (BIS: 10500-2012), it is concluded that the Gomti river in Sultanpur is very polluted. Considerable variation of many patameters from their standard values indicates that water of this river is not suitable for domestic uses. Continuous monitoring and treatment is required to keep the river living and suitable for aquatic biota as well as people depending on it.

1. INTRODUCTION

Rivers are vital and vulnerable freshwater systems that are critical for the sustainance of all the forms of life. However, the declining quality of the water in these systems threatens their sustainability and is therefore a cause of concern. Dissolved solids cause colour and odour in water which becomes disagreeable and unhygienic. The pollution in water reduces the oxygen content in it and enhances the BOD and COD. The pH of water due to pollution deviates from their accepted standard value and makes water harmful. Bacteriological counts exceeding the permiscible limits in a water body tells about the risk of waterborne diseases in its domestic use. [1]

A survey of literature has revealed that a number of investigations have been conducted on

the water quality of some Indian rivers such as Ganga at Varanasi, Ghazipur and Uttarakhand [2, 3] Kavery in Karnataka and Tamil Nadu [4], Bori in Osmanabad [5], Shivnath in Durg [6], Alaknanda, Bhagirathi, Mandakini and Yamuna in Uttarakhand [7], etc. It also indicated that the study of river Gomti is very scarce and many of the parameters have also not been determined. To consider this fact, I evaluated the physico-chemical and bacteriological parameters of river Gomti at district Sultanpur. For this purpose I collected the water samples of different seasons between the time period of January 2018 to August 2018, and analyzed different parameters of water quality in the laboratory. The water samples were collected from six different sampling stations. These are Kurwar, Golaghat, Dhobighat, Shmashan Ghat, Papar Ghat and Dhopap Ghat. Kurwar, Golaghat and Papar Ghat sampling stations were selected for the study because maximum city drains shed their polluted discharges in the river at these points. Dhobighat is the place which is used by dhobies to wash clothes. They dispose the used soap and detergent in the river directly and polluting it. Shmashan Ghat is the place where cremation of human dead bodies are done and the left over ashes of bones and used wood are dumped into the river which pollutes it. Dhopap Ghat is a point of mass bathing on festivals which pollutes the river heavily. The sampling stations and a part of the river are shown in Fig. 1.

The following physico-chemical and bacteriological parameters of water were estimated by using the standard methods [Amercian Public Health Association (APHA), 2005].

1.1 Physico-chemical Parameters

1. Temperature
2. Colour
3. Odour
4. Turbidity
5. Total Hardness
6. pH
7. Electrical Conductance (EC)
8. Total Dissolved Solids (TDS)
9. Alkalinity
10. Free Ammonia
11. Sulphates
12. Chlorides
13. Dissolved Oxygen (DO)
14. Biochemical Oxygen Demand (BOD)
15. Chemical Oxygen Demand (COD)
16. Free Carbon Dioxide

1.2 Bacteriological Parameters

1. Total Coliforms MPN/100 ml

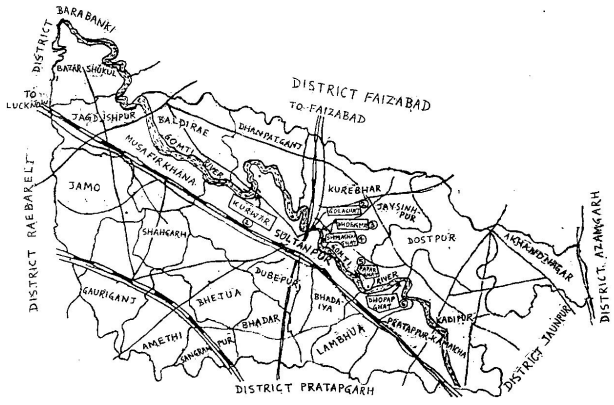

Fig.1: Sampling stations of river Gomti at Sultanpur

2. Faecal Coliforms MPN/100 ml

2. MATERIALS AND METHODS

In this study, the pollution status of Gomti river at district Sultanpur was evaluated on the basis of their physico-chemical and bacteriological investigation. The grab samples were collected from different sampling stations at the surface and at depth varying from 1-3 meters. A 2 Litre capacity plastic cans for Physico-chemical samples, 300ml glass bottles for BOD samples and 100ml autoclavable plastic bottles for Bacteriological samples were used to collect the surface water samples. For BOD, special care has been taken to avoid the entrapment of atmospheric oxygen

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during collection. Collected samples were brought to the laboratory carefully by preserving at -4^{0}C using thermocol box containing ice caps. Analytical methods used in water engineering are standard methods given in APHA: Standard Methods for the Examination of Water and Waste water, 21st Edition, 2005 [8]. A list of test methods is given in Table-1.

Table-1: Test methods used for analysis of different parameters

S. No.	Parameter	Unit	Test Method
1.	Temperature	^{0}C	By Thermometer
2.	Colour	mg/l	By Pt-Co Comparator
3.	Odour	TON	Using Threshold Odour Number (TON) Method
4.	Turbidity	JTU	By Jackson Candle Turbidity Meter
5.	Total Hardness (as $CaCO_3$)	mg/l	EDTA Titration
6.	pH	-	By pH Meter (Model 111 E)
7.	Electrical Conductance (EC)	µS/cm	EC Meter
8.	Total Dissolved Solids (TDS)	mg/l	Gravimetric Analysis (Filtration and weighing of residue)
9.	Alkalinity	mg/l	Alkalimetry
10.	Free Ammonia (as N)	mg/l	Alkalimetry
11.	Sulphates (as SO_4)	mg/l	By Titration
12.	Chlorides	mg/l	By Argentometric Titration
13.	Dissolved Oxygen (DO)	mg/l	Iodometric Titration (Winkler Method)
14.	Biochemical Oxygen Demand (BOD)	mg/l	5 days incubation at 20 ^{0}C and titration of initial and final DO
15.	Chemical Oxygen Demand (COD)	mg/l	Dichromate oxidation and titration with ferrous ammonium sulphate
16.	Free CO_2	mg/l	Acidimetry
17.	Total Coliforms	MPN/100 ml	Placing a small Durham tube upside down inside a larger tube containing lactose broth and incubated at 35 ^{0}C for 48 hours.
18.	Faeal Coliforms	MPN/100 ml	Following the same procedure as for Total coliform and incubated at 44.5 ^{0}C for 24 hours.

3. RESULTS AND DISCUSSION

It is found by the analysis that all the physico-chemical and bacteriological characteristics highly varied at all the sampling stations which indicates the heavy pollution stress of the river. The analysis report is given in Table-2 **(Annexure-I)** by comparing it with the tolerance limits of various parameters. Correlation coefficients between various physico-chemical and bacteriological parameters are shown in Table-3 **(Annexure-II)**. The seasonal variation in Total and Faecal Coliforms at different sampling stations is graphically expressed in Fig.2.

Temperature values in all the sites showed the same seasonal trend with winter minima and summer maxima. Colour and Odour values are lower in rainy season and higher in summer.

Temperature, Colour and odour shows negative correlation with pH, Turbidity and DO whereas positive correlation with rest all other parameters.

Turbidity values are higher in rainy season and lower in summer. This is may be due to sedimentation during summer season while turbulent during rainy season. It shows negative correlation with all other parameters.

Total Hardness of all the sites showed summer maxima due to reduced inflow and evaporation, and monsoon minima was due to increasing inflow and dilution [9]. Total Hardness had negative correlation with DO and Free CO_2 while positive correlaion with rest other parameters.

pH values in all the sites showed the same seasonal trend with summer minima and winter maxima. The winter maxima are due to the decreased decomposition rate owing to reduced microbial activity and increased algal productivity. The summer minima are due to increased decomposition rate which leads to acidification and hence lowered the pH. Most of the water samples are slightly alkaline due to presence of carbonates and bicarbonates [10].

In the correlation analysis pH showed negative correlation with TDS, Chlorides, BOD, COD, Free

CO_2, Total Coliforms and Faecal Coliforms whereas positive correlation with rest others.

For Electrical Conductance, in all the stations minima observed in rainy season due to dilution with rain water and maxima in summer owing to evaporation. It showed negative correlation with DO and Free CO_2 while positive with others.

TDS values are lower in rainy season and higher in summer. It shows negative correlation with Total Hardness, Alkalinity, and DO whereas positive correlation with rest others.

Alkalinity reveals summer maximum and monsoon minimum values. It had negative correlation with DO and Free CO_2 while positive with others.

Free Ammonia express a summer maximum and rainy minimum values. It had negative correlation with DO and Free CO_2 while positive with rest others.

Sulphates were found to be maximum in summer and minimum in rainy season in all the locations. It has been negatively correlated with DO and BOD while positively correlated with rest others.

Chlorides were found maximum in summer while minimum in winter. It showed negative correlation with DO while positive correlation with others.

DO values were found maximum during winter and minimum during summer. DO showed negative correlation with BOD, COD, Free CO_2 as well as Total Coliforms and Faecal Coliforms.

Seasonal analysis reveals that BOD values are more during summer and less during winter. Correlation study exhibit positive correlation with COD, Free CO_2, Total Coliforms and Faecal Coliforms [2].

COD values discloses summer maxima and winter minima in this study. Correlation analysis express that it had positive correlation with Free CO_2, Total Coliforms and Faecal Coliforms.

Free CO_2 values also shows summer maxima and winter minima in this study. Free CO_2 had positive correlation with Total Coliforms and Faecal Coliforms.

Both Total and Faecal Coliforms in the present investigation exhibits more counts during summer followed by monsoon and winter. Summer maxima might be due to discharging of domestic wastes containing faecal matters to the river body and open defecation along the sides of the river bank. Winter minima might be due to cold climatic condition, which is not been supportive for bacterial duplication in a greater extent [11].

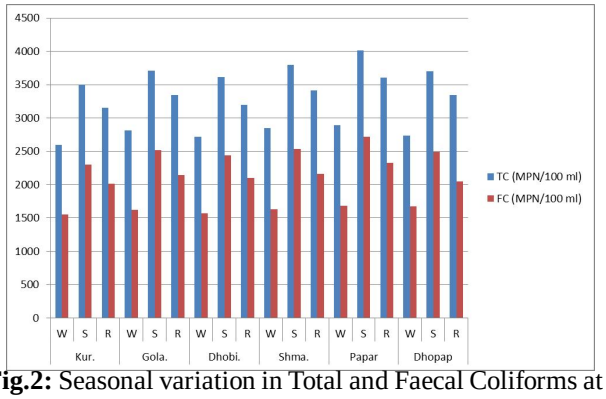

Fig.2: Seasonal variation in Total and Faecal Coliforms at different sampling stations

4. CONCLUSION

The research study concluded that the Gomti river at Sultanpur is very polluted and the water of this river is not fit for drinking, bathing and other domestic uses due to high BOD, COD and coliforms count. Continuous monitoring and treatment is required to keep the river living and suitable for aquatic biota as well as people depending on it. Some steps and awareness programs must be planned to educate local villagers to protect the precious river and its surroundings.

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(Annexure-I)

Table-2: Comparison of the values of different parameters at various sampling stations with their tolerance limits.

Parameter/ Sampling Station	Kurwar			Golaghat			Dhobighat			Shmashan Ghat			Papar Ghat			Dhopap Ghat			Tolerance Limit (BIS: 10500-2012)
	Win	Sum	Rain	Win	Sum	Rain	Win	Sum	Rain	Win	Sum	Rain	Win	Sum	Rain	Win	Sum	Rain	
Temperature (^{0}C)	20	28.1	27	21	28.4	26.7	21.2	28.6	26.3	19.5	29	26.8	19.2	29.2	27.1	20.8	29.5	26.4	10-15.6
Colour (on Pt-Co Scale), mg/l	95	135	80	100	145	75	105	155	85	75	110	70	85	115	65	80	115	70	300
Odour	200	245	185	185	230	160	175	210	145	155	200	140	170	215	160	160	205	140	300
Turbidity (JTU)	145	125	160	155	130	170	165	120	180	135	140	150	140	125	150	160	135	180	25
Total Hardness, mg/l	450	510	428	442	489	416	520	546	476	575	596	515	412	480	382	432	476	402	600
pH	8.4	7.8	8.1	8.3	7.9	8	8.5	8.1	8.3	8.5	8	8.2	8	7.6	7.9	7.9	7.4	7.7	6.5-8.5
Electrical Conductance (EC), µS/cm	340	362	308	342	358	311	355	362	320	369	380	332	330	345	305	334	352	316	750
TDS, mg/l	1750	1978	1665	1270	1540	1130	1625	1823	1540	1148	1438	1089	1728	1956	1630	1685	1842	1610	1500
Alkalinity, mg/l	176	230	160	168	206	145	282	316	260	285	317	252	185	205	154	193	225	170	200
Free Ammonia, mg/l	6	7	5.8	6.5	6.9	5.2	7.3	7.5	7.2	7.3	7.5	7.1	6.2	6.8	5.3	6.6	6.8	6.4	5
Sulphates, mg/l	264	280	253	272	287	260	380	402	365	270	291	245	240	272	226	275	300	267	400
Chlorides, mg/l	260	480	318	240	456	296	336	527	426	270	493	380	256	470	352	234	423	287	600
DO, mg/l	6.4	4.5	5.6	6.6	5	5.9	6.8	5.4	6.1	6.3	5.2	5.8	6.7	5.6	6.2	6.5	5.2	6	4
BOD, mg/l	8.5	10.3	9.4	8.3	9.8	9.2	8	9.2	8.7	8.6	9.5	9	8	9.1	8.5	8.8	10	9.4	3
COD, mg/l	22.4	29.3	27	20.3	27.5	24.7	19.1	25	23.2	19.8	26.4	24	18.8	24.6	22.3	21.7	28.8	25.4	1
Free CO_2, mg/l	6.3	8.3	7.5	6	7.8	7.2	5.7	7.5	7.1	5.3	6	5.8	5.6	7.2	6.9	5.9	7.8	7.3	6
Total Coliform MPN/100 ml	2600	3500	3150	2815	3713	3340	2715	3618	3200	2850	3800	3416	2895	4010	3608	2736	3704	3340	500
Faecal Coliform MPN/100 ml	1550	2300	2014	1623	2516	2145	1570	2442	2100	1627	2539	2160	1680	2715	2330	1676	2490	2050	500

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Table-3: Correlation coefficients between the Physico-chemical and Bacteriological parameters of Gomti river in Sultanpur

Parameter	Temp.	Colour	Odour	pH	Turb.	EC	TDS	Tot. Hard.	Alk.	Chl.	Sulph.	Free Amm.	DO	BOD	COD	Free CO_2	Tot. Col.	Faec. Col.
Temp.	1																	
Colour	0.431	1																
Odour	0.424	0.87	1															
pH	-0.636	-0.217	-0.328	1														
Turb.	-0.294	-0.689	-0.751	0.249	1													
EC	0.029	0.68	0.575	0.086	-0.666	1												
TDS	0.233	0.497	0.59	-0.504	-0.381	0.105	1											
Tot. Hard.	0.151	0.484	0.309	0.283	-0.481	0.865	-0.134	1										
Alk.	0.158	0.435	0.139	0.28	-0.343	0.749	-0.033	0.92	1									
Chl.	0.846	0.712	0.58	-0.354	-0.528	0.462	0.363	0.552	0.572	1								
Sulph.	0.138	0.552	0.171	0.254	-0.018	0.4	0.223	0.487	0.678	0.467	1							
Free Amm.	0.109	0.519	0.226	0.16	-0.346	0.786	0.057	0.852	0.898	0.527	0.635	1						
DO	-0.834	-0.61	-0.666	0.551	0.518	-0.36	-0.3	-0.364	-0.23	-0.793	-0.068	-0.258	1					
BOD	0.775	0.462	0.536	-0.648	-0.328	0.236	0.264	0.211	0.075	0.606	-0.013	0.151	-0.941	1				
COD	0.849	0.0451	0.542	-0.643	-0.274	0.121	0.32	0.129	0.017	0.648	0.004	0.065	-0.933	0.969	1			
Free CO_2	0.76	0.48	0.53	-0.619	-0.18	-0.126	0.506	-0.178	-0.2	0.564	0.136	-0.138	-0.755	0.778	0.837	1		
Tot. Col.	0.928	0.414	0.403	-0.687	-0.427	0.154	0.231	0.203	0.171	0.815	0.016	0.144	-0.772	0.672	0.71	0.614	1	
Faec. Col.	0.8	0.469	0.452	-0.68	-0.429	0.158	0.281	0.21	0.183	0.85	0.079	0.154	-0.804	0.705	0.754	0.666	0.99	1

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