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SEASONAL VARIATIONS OF PHYSICO-CHEMICAL PARAMETERSOF GANGAWATER AT GHAZIPUR CITY, UTTAR PRADESH, INDIA

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ABSTRACT

An assessment of the seasonal variations of the river water quality of GangaRiver at Ghazipur. ranges of the estimated physico-chemical parameters are mentioned as temperature (20.4^0C -31.9^0C), pH(7.3-8.86), TDS(313mg/L -387mg/L), EC(297µmhos/cm -367µmhos/cm), Alkalinity(175mg/L -327mg/L), TH (127mg/L -200mg/L), sulphate(16.2mg/L -37.2 mg/L), phosphate(0.41mg/L -0.96mg/L), nitrate(0.41mg/L -0.96mg/L), chloride (20.5mg/L -31.3mg/L), DO (5mg/L -6.5mg/L),BOD (5.3mg/L -15.2mg/L) and COD(11.2mg/L -30.1mg/L). EC, BOD and COD were above the USPHS and BIS standards at all the sites of Ghazipur. Correlation coefficient revealed varied positive and negative correlations in the physicochemical parameters of the river water.

INTRODUCTION

Water is a substance of great environmental importance. Water is one of the compounds, giving life and purity is directly related to human life. It is described as 'the liquid of life' and has two measurements that are firmly connected, amount and quality.The world is challenged due to the availability of freshwater (Hamzah *et al*., 2016). Industrialization and wide ranges of human activities have demanded good quality water while its pollution is increasing day by day by natural and anthropogenic activities (Haritash *et al*., 2014). Based on the existing circumstances, it is quested that in near future, good quality water, on account of the ever-growing population and industrialization, will become a scare commodity and as such, normal living of humidity will become very difficult because of this, a suitable and viable technology for purifying water has become essential. In India, the river is considered as the mother of civilization, they worshipped as God. Among all rivers, Ganga is requested as the cradle of Indian civilization.

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The Ganga is the symbol of our prosperity our culture, our heritage, our civilization and our philosophy. The river Ganga is originated from Gangotri as Bhagirathi,Latitude 30^0 55'N, 79^0 70'E of Himalaya, It travels the total length of about 2525km and finally drains into the Bay of Bengal (CPCB report, 2013). In Uttar Pradesh, the river Ganga covers a total length of about 1000kms. Ghazipur is the eastern part of Uttar Pradesh. The present study has revealed the seasonal variations in the Physico-chemical data of Ganga at Ghazipur in the year 2017-18 and 2018-19. The present study aims to assess, the variations of seasonal surface water quality of the river Ganga at Ghazipur.

MATERIAL AND METHODS

The Ghazipur is the part of Middle Gangetic Plain, situated 25^0 19'N to $25^0$54' N latitude and 83^040' E to 83^0 58' E longitude with a area about 3384 square kilometer. India census 2011 reported the population 3,622,727. In Ghazipur, Govt. alkaloids and Opium factoryis situated. Here, products of opium are extracted and manufactured. Also here many industries are situated like Agro-manufacturing unit like
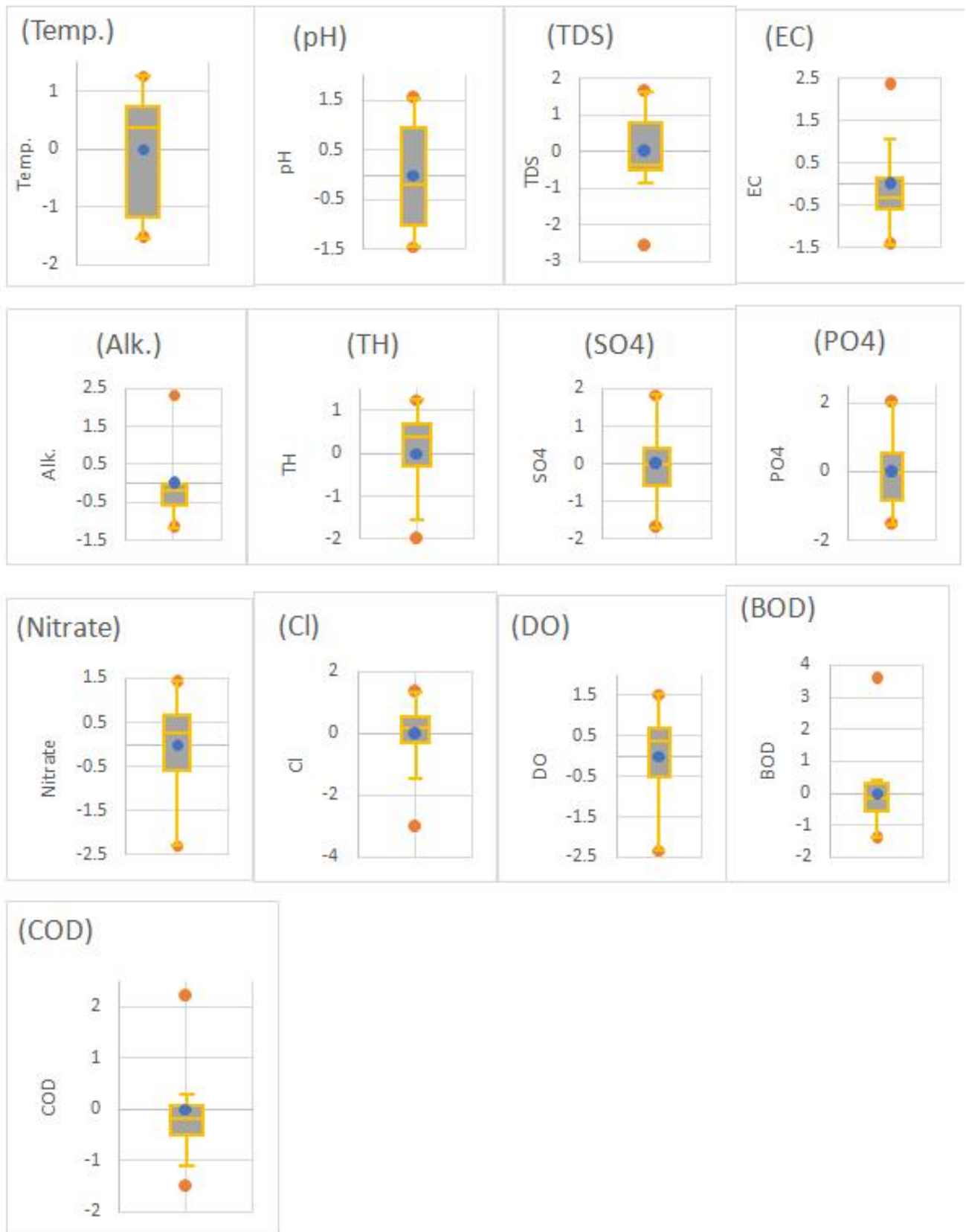
Fig. 1. Box plot of the physico-chemical parameters of the river Ganga at Ghazipur for both year 2017 to 2019

Shukbir Agro; Nandgaj distillery (Alcohol manufacturing); small Plastic and textileunits; Leather tanning; laundry chemicals; Paints and Dyes;motor garages and workshops; Water bottling plants, Battery water distillation plants and anticorrosive plating. Discharge of sewage, industrial water and agrochemicals and fertilizers are the major source of water pollution.

All samples were collected in three consecutive seasons during the year 2017-18 and 2018-19viz., during summer, Monsoon, and winter. Samples were collected from the three sampling sites i.e., Upstream (G1), Midstream (G2) and Downstream (G3). Sampling bottles and equipmentwere rinsed with double-distilled water and then soaked in 3% nitric acid. Samples were collected by dipping the bottle 30cm into the river water and
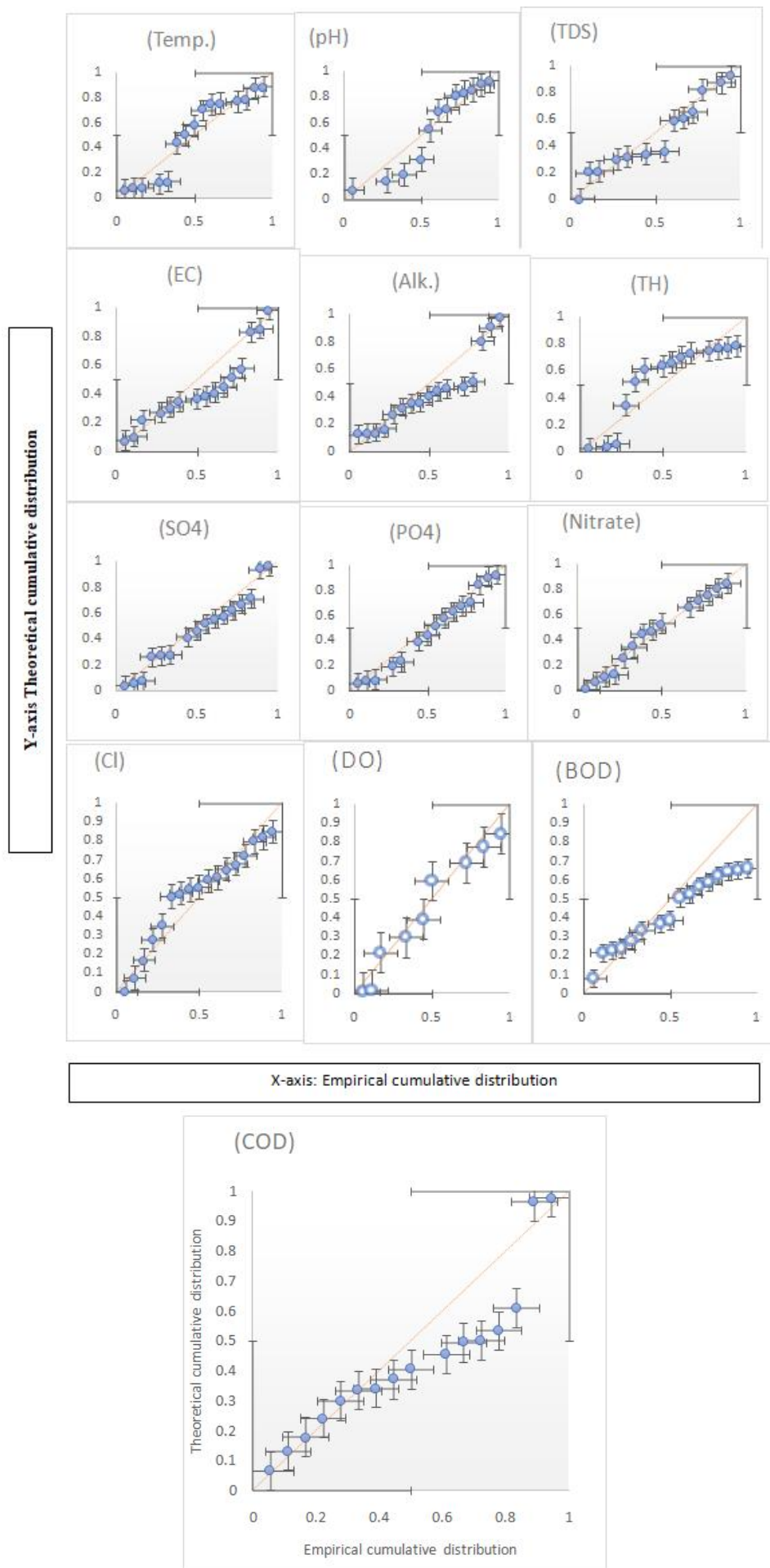
Fig.2. P-P plot with standard error of the physico-chemical parameters of the river Ganga at Ghazipur for year 2017 to 2019

Table-1 Seasonal variation in Physico-chemical parameters with their mean and standard deviations of river Ganga at Ghazipur for year 2017-18

Sites	Season	Temp. (C)	pH	TDS (mg/L)	EC (umhos/cm)	Alkalinity (mg/L)	TH (mg/L)	SO4 (mg/L)	PO4 (mg/L)	Nitrate (mg/L)	Cl (mg/L)	DO (mg/L)	BOD (mg/L)	COD (mg/L)
	summer	31.9	8.31	352	341	175	178	16.2	0.96	0.57	29.4	5.7	8.81	16.7
Ghazipur	Monsoon	26.9	8.81	391	300	203	127	23.1	0.67	0.53	28.5	5	6.51	17.2
Upstream	Winter	20.4	7.8	365	317	256	127	29.5	0.88	0.74	29.1	6	7.4	16.2
	summer	29.1	8.7	351	321	315	178	27	0.45	0.81	24.4	5.8	7.5	18.3
Ghazipur	Monsoon	27.7	7.6	382	309	217	185	25.4	0.74	0.81	20.5	5.7	6.6	13.2
mid-stream	Winter	20.9	7.5	354	297	197	200	38	0.55	0.9	28.1	6.1	15.2	28.1
	summer	30.3	8.1	351	364	212	160	28	0.64	0.73	30	5.1	8.7	18.9
Ghazipur	Monsoon	26.2	7.3	382	317	178	189	18	0.73	0.41	27	5.7	5.3	14.2
downstream	Winter	20.8	7.6	354	367	219	171	25.4	0.53	0.69	28	6.3	7.4	16.8
	Mean	26.0222	7.96888	364.666	325.8889	219.111	168.333	25.6222	0.683	0.6877	27.2222	5.71111	8.15777	17.73
	SD	4.09682	0.510282	15.11438	24.36502	40.81787	24.46767	6.047364	0.155	0.1473	2.8322	0.4039	2.6915	4.038

Table-2 Seasonal variation in Physico-chemical parameters with their mean and standard deviations of river Ganga at Ghazipur for the year 2018-19

Sites	Season	Temp.(C)	pH	TDS (mg/L)	EC (umhos/cm)	Alkalinity (mg/L)	TH (mg/L)	SO4 (mg/L)	PO4 (mg/L)	Nitrate (mg/L)	Cl (mg/L)	DO (mg/L)	BOD (mg/L)	COD (mg/L)
	summer	32.1	8.32	313	343	177	186	17.2	0.69	0.58	30.2	6.1	8.83	17.65
Ghazipur	Monsoon	30	8.85	368	319	207	121	22.8	0.81	0.65	31.3	6.5	6.66	19.31
Upstream	Winter	22.2	8.56	366	324	215	132	30.1	0.86	0.76	30.5	6.2	7.21	18.3
	summer	30	8.6	353	312	306	187	27.6	0.43	0.88	28.2	6.1	8.1	18.8
Ghazipur	Monsoon	29.7	7.8	378	327	219	183	26.2	0.71	0.83	25.6	6.2	8.5	11.2
mid-stream	Winter	21.8	7.5	345	314	206	186	37.6	0.62	0.96	28.6	6.3	8.4	29.2
	summer	32.2	8.5	353	316	273	177	28.6	0.46	0.85	28.9	5.6	8.9	20.3
Ghazipur	Monsoon	29.8	7.5	387	312	183	180	23	0.53	0.81	26.5	5.8	6.9	15.3
downstream	Winter	21.8	7.5	346	318	222	188	36.2	0.62	0.96	28.3	6.1	8.2	30.1
	Mean	27.733	8.1255	356.5556	320.5556	223.1111	171.1111	27.7	0.636667	0.808889	28.67778	6.1	7.966667	20.01778
	SD	4.196	0.516	20.47823	9.286922	39.05963	24.21407	6.105007	0.139044	0.121513	1.737033	0.249444	0.787302	5.740652

Table 3. Pearson's correlation matrix of a physico-chemical parameter of river Ganga at Ghazipur for the year 2017-18

	Temperature	pH	TDS	EC	Alkalinity	TH	SO4	PO4	Nitrate	Cl	DO	BOD	COD
Temp.	1												
pH	0.536504	1											
TDS	-0.02016	-0.04413	1										
EC	0.186362	-0.02807	-0.57548	1									
Alk.	-0.07516	0.389587	-0.28432	-0.03149	1								
TH	0.113654	-0.48338	-0.28903	-0.00963	-0.20964	1							
SO4	-0.57834	-0.18769	-0.31939	-0.24348	0.339705	0.057471	1						
PO4	0.207588	-0.08298	0.228406	-0.04557	-0.45212	-0.27752	-0.4977	1					
Nitrate	-0.27807	-0.06861	-0.49282	-0.08612	0.509064	0.218123	0.834986	-0.41264	1				
Cl	-0.1275	0.133096	-0.33933	0.36215	-0.32094	-0.39534	0.000879	0.217922	-0.30876	1			
DO	-0.65403	-0.56803	-0.40336	0.058823	0.183874	0.413282	0.293698	-0.13124	0.371904	-0.14199	1		
BOD	-0.28509	-0.16031	-0.52958	-0.16901	-0.13345	0.389424	0.716205	-0.22817	0.611479	0.261675	0.296044	1	
COD	-0.32001	-0.02457	-0.48352	-0.19917	-0.02065	0.279341	0.751443	-0.42816	0.535938	0.344525	0.194563	0.945575	1

Table 4. Pearson's correlation matrix of a physico-chemical parameter of river Ganga at Ghazipur for the year 2018-19

	Temperature	pH	TDS	EC	Alkalinity	TH	SO4	PO4	Nitrate	Cl	DO	BOD	COD
Temp	1												
pH	0.427211	1											
TDS	-0.00539	-0.11868	1										
EC	0.241603	0.183677	-0.54672	1									
Alk.	0.159225	0.395107	0.024371	-0.4725	1								
TH	0.091168	-0.62215	-0.33467	-0.01263	0.160934	1							
SO4	-0.81665	-0.43525	0.037061	-0.54696	0.277755	0.173175	1						
PO4	-0.33251	0.205131	0.071281	0.499642	-0.58771	-0.71141	-0.12134	1					
Nitrate	-0.54342	-0.58182	0.198057	-0.69951	0.434755	0.487185	0.874404	-0.50133	1				
Cl	-0.08283	0.680909	-0.45476	0.27352	-0.0884	-0.65984	-0.13977	0.467554	-0.53443	1			
DO	-0.37049	0.151921	-0.0435	0.187059	-0.2737	-0.46725	0.07807	0.691967	-0.20895	0.37183	1		
BOD	0.146476	-0.16905	-0.63406	0.342479	0.281514	0.715687	0.158004	-0.4061	0.238867	-0.22649	-0.3422	1	
COD	-0.67038	-0.31583	-0.43772	-0.31522	0.051942	0.167806	0.750065	-0.12462	0.538871	0.277948	0.13765	0.170674	1

capped tightly. The water samples were kept in ice packs box till transported to the laboratory. The pH, temperature, TDS, EC, alkalinity, total hardness, Sulphate, Phosphate, nitrate, chloride, Dissolve Oxygen, BOD, and COD were chosen for water analysis and estimations were followed standards methods sets by APHA, 2005 and BIS, 2012.pH, Temperature, EC,and DO were estimated onsite by the automated Real-time data logger, model YK-200WA, Germany. Evaporation method is used for TDS determination. Chlorine by Argentometric method, sample titrated with 0.02N silver nitrate using potassium chromate as an indicator. Nitrate and Phosphate wereanalyzed by Perkin Elmer UV/VIS Spectrophotometer. For the determination of the BOD and COD, sample water is fixed on-site in a Borosilicate'sBOD bottles of 300 ml and avoid air bubbles. BOD is analyzed by Modified Winkler method. COD was calculated by Dichromate reflux method using ferroin indicator.

RESULT AND DISCUSSION

In thepresent investigation, the distribution of physicochemical parameters of the river Ganga at Ghazipur for the different season has been illustrated in table 1 and table 2 for the year 2017-18 and 2018-19 respectively. The average value of temperatures was estimated 26.02±4.097 for the year 2017-18 and 27.73±4.197 for the year 2018-19. The maximum temperature was observed in summer season in both of the year followed by Rainy and winter season.The average value of pH was estimated 7.969±0.510 for the year 2017-18 and 8.26±.0516 for the year 2018-19. Alkaline pH was accessed by Singh *et al*., 2016 at Ghazipur, Ballia, and Buxar; Naseema et. al, 2013 at Kanpur; Yadav *et al*., 2011at Ghazipur for river Ganga. The average value of TDS was estimated 364.67±15.11 for the year 2017-18 and 356.56±20.478 for the year 2018-19. Seasonally, in a rainy season-high and low in winter, similar observation found by Singh *et al* 2016 and Yadav *et al*., 2011 in Ganga river at Ghazipur Arya *et al*., 2013 at Kanpur. The average value of EC was estimated 325.89±24.36 for the year 2017-18 and 320.56±9.29 for the year 2018-19.The water of river Ganga has good electrical conductivity, similar findings observed by Tiwari *et al*., 2018, Singh *et al*., 2018 and Yadav *et al*., at Ghazipur; Naseema *et al*., 2013 at Kanpur. The average value of Alkalinity was estimated 219.11±40.82 for the year 2017-18 and 223.11±39.06 for the year 2018-19. The average value of total hardness was estimated 168.33±24.468 for the year 2017-18 and 171.11±24.21 for the year 2018-19. The average value of sulphate was estimated 25.62±6.05 for the year 2017-18 and 27.7±6.11 for the year 2018-19.

The average value of Phosphate was estimated 0.683±0.155 for the year 2017-18 and 0.637±.139 for the year 2018-19. Sikandar 1987 and Shukla 1989 and Yadav 2011 finds similar trends. The average value of Nitrate was estimated 0.688±0.147 for the year 2017-18 and 0.809±0.122 for the year 2018-19. The average value of Chloride was estimated 27.22±2.83 for the year 2017-18 and 28.68±1.74 for the year 2018-19. In summer the value of chloride is high, low in the rainy seasons. Similar findings have been recorded by Shukla et.al, 1989 and Tripathi *et al*., 1982 of river Ganga at. The average value of dissolved oxygen was estimated 5.71±0.403 for the year 2017-18 and 6.1±0.25 for the year 2018-19. Seasonally, the values are highest in winter and lower in summer. DO increases with the temperature decreases. In summer microbial activity is very high, due to this oxygen demandis high for the decomposition of organic matter thus DO decrease.The average value of BOD was estimated 8.16±2.69 for the year 2017-18 and 7.97±0.79 for the year 2018-19. BOD values are high in the summer season, the similar finding is also reported by Yadav *et al*., 2011; Tiwari *et al*., 1983; Sikandar *et al*., 1987; and Shukla et. al, 1988 for the river Ganga.

The average value of COD was estimated 17.73±4.04 for the year 2017-18 and 20.09±5.74 for the year 2018-19. Similar trends estimated by Shukla et al.,1989 in Varanasi and Yadav *et al*., 2011 in Ghazipur for the river Ganga. Graph of box plot indicates the distribution of the physico-chemical data of the Ghazipur in a less space rather than histogram or density plot. Correlation coefficient revealed varied positive and negative correlations in physicochemical parameters of the river Ganga. Water in Table 3 and Table4. In the year 2017-18 temperature and pH shows a moderate positive correlation (r= 0.536 and p=0.05). Temperature and EC shows positive correlation (r=0.1863, p=0.05). pH shows a +ve correlation with alkalinity and chloride and a negative correlation with TDS, EC, TH, Sulphate, Phosphate,DO, BOD, and COD. Alkalinity shows positive correlation nitrate (r=0.509, p=0.05). TH shows a +ve correlation with sulphate, nitrate, DO, BOD and COD. Sulphate shows strong positive correlation with nitrate (r=0.8349, p=0.05). Phosphate shows the +ve correlation with chloride (r=0.371, p=0.05). In the present study, physicochemical parameters concluded significant spatial and temporal variations. These variations occurred by the domestic sewage and industrial discharge in the river. EC, BOD and COD were above the USPHS (1997) and BIS (IS10500:2012) standards 300umhos/cm, 5mg/L, and 4mg/L respectively. This study will provide valuable information for the governmental bodies to predict the water quality of the River water in Ghazipur and also find the extent of pollution.

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