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IMPACT OF INDUSTRIALIZATION ON THE PHYSICO-CHEMICAL PARAMETERS OF THE AMI RIVER

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Abstract— **Rapid industrialization, along with other human activities, has had a negative impact on the environment in India. Major industries lack of insufficient effluent treatment facilities. It contributes to environmental degradation. Present study of the physicochemical analysis of Ami River. Samples were collected from GIDA sector-13, Gorakhpur. Physicochemical parameters were studied one year 2020-2021. All parameters reported less or more than standard permissible limits of CPCB and WHO. pH reported 8.5 to 8.85. Temperature 32° C in summer, color brownish black and brown in site-1 and site-2, odor, pungent smell recorded site-1 and site-2, turbidity 48 NTU in summer, EC 111.1 µmhos/cm^2 in rainy season, TSS 1300 mg/L, TDS 597.56 mg/L, free CO_2 12 mg/L, DO 2.0 mg/L in summer, BOD 1167 mg/L in winter, COD 1063.5 mg/L, in summer, very higher than permissible limit. The value found above 0.5 has been highlighted and considered the relationship study. The correlation analysis is identified that EC, COD, BOD, CO_2, turbidity, TSS, alkalinity, observed higher-level correlation with water quality parameters in all seasons. These studies prove that the river is carrying a heavy load of organic waste that exceeds its dilution, self purification capability. High anthropogenic activities, improper sanitation and direct discharge of effluent by industrial and domestic sewage that is finally altered into the below class E- categories water.**

Keywords—**Industrialization, Industrial effluents, Ami River, Physico-chemical parameters, WHO.**

I. INTRODUCTION

For all the life forms, water is a crucial abiotic component. The quality of life has always been significantly influenced by the quantity and quality of water available. The two have a close relationship to the use of water and the state of the economy progress. Water is necessary for ecosystems to survive. Water resources are crucial for the development of the people as well as the health of the natural world and its ecosystems [1]. Due to its important contribution to economic growth and human welfare, industrialization is seen as the cornerstone of development initiatives, yet it comes at an inevitable cost and with issues in terms of contamination of the water and air resources. Water bodies in particular are becoming contaminated as a result of wastewater discharge [2]. Industrial effluents are main hazards to the native biodiversity in fresh water [3, 4]. Threats from industrial effluents to the hydrology of the ecosystem and the river system. Release of effluents results in modification to the structure and makeup of the community. Frequently, these effluents contain heavy metals, which may leading to a bioaccumulation problem [5]. Because of the country's increasing industrialization, there has been a tremendous increase in the contamination of natural water sources [6] . When pollutants are directly or indirectly dumped into water bodies without proper treatment to eliminate hazardous substances, environmental degradation results [7-8]. Pollution will undoubtedly have an impact on the nutritional value of it. These contaminants, which are present in fish and aquatic bodies but are not physicochemical, are extremely damaging and affect the community-level organization, by tainting the very crucial food web, which eventually has an impact on people's health [9,10,11,12].Minamata disease cases reported in Japan 1956 [13]. The diseases have an effect on the brain; can cause insanity and leading to death, pollution of water by industrial effluents containing methyl-mercury. The Itai-Itai disease was caused by cadmium poisoning in Japan prefecture factory. Cadmium poisoning causes damages to the joints softens the bones and causes the body to shrinks and the affected people suffer a painful death [14]. Toxic and hazardous wastes settle in river water as bottom sediments in industrial effluents, health hazards in both urban and rural areas water-dependent population supply for domestic use [15]. The environmental landscape is characterized in large part by the degradation of water quality, the depletion of aquatic species, demanding immediate global attention level [16]. Industrial effluents produced a significant amount of significant impact on the contamination of water bodies, as a result of these effluents, the physical, chemical and biological alter of the receiving body of water [17]. Increased impermeable land surface in urban areas leads to harsh and drastic changes in the natural order of things [18]. The most important step to understanding and deliberating about the sorts of water pollution increasing effective reduction strategies is monitoring [19]. Water qualities determine the physical, biological and chemical composition [20]. The chemical composition of substances like heavy metals, pesticides, detergents, and petroleum [21]. The Ami River is 147 km long and covers approximately 5000 hectares with 330 villages. Water plays an influential role in the social, environmental, and economic value of an aquatic ecosystem. It benefits agriculture, fishing, drinking water supply, recreation from heavily populated areas. The aim of the study is describing the seasonal variation of physicochemical parameter of water influenced by industrial effluents and to identify the most influence variation observed. Focus on trying to identifying contaminants in the river, calculating the water pollution index, and then enforcing regulations to reduce water pollution.

II. MATERIAL AND METHOD

Study Area

The Ami River originates from Sikhara Tal, Siddharth Nagar and before flowing on to Basti, Sant Kabir Nagar and Gorakhpur. It travels 102kms between origin and destination, of which polluted sections located between Rudhauli, Basti, Sohgaura, and Gorakhpur of approximately length of 80 kms. At present time, 37 (Left Bank: 17 and Right Bank: 20) villages located on the banks of this polluted river. According to population of these villages are 42,345 as per the survey of 2011. Taking Decades growth into report, the estimated population in 2019 would be approximately 48,725 and estimated sewage generation would be around 5.3 MLD. There are generally 12 water polluting industries in the catchment area of the concerned (alarmed) stretch of Ami River, These industries have effluent treatment plants. Some industries have zero liquid discharge as per charter, while some other industries are discharging its effluent on land as per imposed by UPPCB conditions. Taking place through 03 drains is industrial discharge in the River. One of three drains , one drain is mixed drain which is carry treated industrial effluent as well as untreated sewage.

Sampling Site

This Drain originates from the nearby area of GIDA. It carries both treated and untreated effluent of industries in GIDA and untreated domestic effluent discharged from industries in GIDA. This drain meets River Ami near vill Bhansar. The Sarya drain meeting point is located at Latitude: 26.718722 N & Longitude: 83.21747 E. The Sarya drain spans approximately 4.92Km. Sarya drain carries 12 MLD of sewage generated by GIDA industries, and approximately 3 MLD treated industrial effluent discharge by industries in GIDA.

- Location is at Adilapar Village, which is also extremely critical because industrial effluent from GIDA is discharged through a drain into the River and the pollution load is moderately high.
- 22 km from Gorakhpur, in the industrial sector of GIDA sector-13, in the village –Bharsar, close to Adhila Bazaar
- Select 4 Sampling Site:-
- Site- 1- Ramlila Samiti (Effluent After Treatment)
- Site -2 -Located near Semrahwa Baba Mandir (Just Entry Point into River) 200
- Site -3 -Meter up Stream River.
- Site -4-200 Meter Downstream River.

Sampling

Sampling was done from the morning 8Am to 9Am at the study sites in rainy and winter and summer at the regular intervals. Sample taken 2 litters plastic gallons appropriate care was used to avoid any annoyance due to the loose-fitting sediments and rock present in river water. It was kept in mind; put to avoid entrance of needless air bubbles the cap was applied in the river itself after sample bottle was packed up to the rim. The collected samples were brought immediately to the laboratory and physico chemical parameters of water samples were estimated by the help of methods provided in APHA manual guide of water and waste water management, 2005. [22].

Method of Analysis

Physiochemical Analysis

Samples collected were evaluated by the Turbidity, Electric Conductivity, and pH, Total dissolve Solids (TDS), Total Suspended Solids (TSS), and Dissolved Biochemical Oxygen Demand (BOD), and Oxygen (DO), Chemical Oxygen Demand (COD). Alkalinity, free Carbon Dioxide (CO_2). APHA, 1998[22] (Table-1), were used for analysis of water samples. Results are compared with standards given by the Central Pollution Control Board (CPCB) and World Health Organization (WHO).

Physical parameters such as temperature color and odor were noted down on the spot itself before to the collection of samples.

Statistical Analysis

MS Excel 2007 (12.0.6787.5000) SP3 MSO (12.0.6607.1000), analyzes data value are expressed mean Standard deviations (Mean±SD). Analysis of correlation matrix in rainy, winter and summer.

Table.3. APHA manual guide of water and waste water management, 1998. [22].

S.NO	PARAMETERS	INSTRUMENT USED	METHODOLOGY
1	**TEMPERATURE(°c)**	Thermometer	Instrumental
2	**Color**	Visually	Visually
3	**Odour**	Physiological Sense	Physiological sense
4	**pH**	pH Meter	Instrumental
5	**Electrical Conductivity (µs/Cm)**	Conductivity Meter	Instrumental
6	**Turbidity(NTU)**	Turbidity Meter	Instrumental
7	**Total Dissolve Solids (mg/L)**	Hot Air Oven , Crucible , Weighing Machine Sprit Lamp	Instrumental Evaporation at 103°C-105°C
8	**Total Suspended Solids(mg/L)**	Centrifuge Tube, Centrifuge , Hot Air Oven ,Desiccator	Instrumental Method
9	**Dissolve oxygen (mg/L)**	BOD bottle (capacity 300mi), burret,pipettes, beaker (capacity 500ml)	Winkler Method
10	**Biochemical oxygen Demand (mg/L)**	BOD bottles (capacity 300 ml),incubator,bekar, conical flask ,tie-pod stand	BOD Iodometeric Method (3-day set on 25±2°C)
11	**Chemical oxygen demand (mg/L)**	Beaker , pipettes , conical flask, measuring cylinders ,	open reflux method
12	**Free Carbon Dioxide(mg/L)**	Burette , tie-pod stand ,beaker ,measuring	Titration method
13	**Alkalinity (mg/L)**	Beaker , conical-flask , tie-pod stand	Titration method

III. RESULT AND DISCUSSION

The data collected by sampling all three seasons are analyzed and the results are discussed here for various water quality parameters.

pH

pH is an important parameter for determining water quality. It determines the water acidity or alkalinity. The pH of water fluctuated range of 8.6 in rainy, 8.5 in winter and 8.85 in summer mentioned in (Table-2). The water which has pH value above neutral pH 7, then, it means that water is polluted by strong base or several other bases and also pH records provides the information about the types of contaminants discharged in the river are both acidic or basic. pH of treated effluents was 8.6 in rainy, 8.5 in winter and 8.85 in summer (Table-2), (Table.3), which was more than permissible limit of industrial effluents. The Most favorable pH ranged for sustainable aquatic life is pH 6.5 to 8.2. [24]. The pH of effluents was less than optimal, which can be harmful to aquatic flora and fauna where effluents are released. Our result is support the same as Tiwari et al. [25]. Seasonal variation show in Figure .1. (a).

Temperature

The temperature of the river water varied across all sites and for a variety of reasons. The highest temperature recorded was 32 °C at site-1 in the summer, and the lowest was recorded in Winter at site -3, and site-4 mentioned in (Table-2) and Seasonal variation show in Figure.1. (b). Temperature is an important physical property of the water ecosystem and is affected by the quality, types of nutrients, and habitat surrounding the water body. It has an impact on the growth and survival of the flora and fauna. Microbial activity increases as the temperature of the water body. The increase in water temperature is caused by the types of industrial effluents discharged in the form of waste by products of ongoing chemical reactions by heavy machines, heavy metals, and toxic chemicals. Our results agree these values with the temperature values reported by other authors [26, 27, 28, and 29]. Water temperature should be considered when calculating metabolic rates and photosynthesis production, complex toxicity, dissolved oxygen and extra dissolved gas concentrations, conductivity and salinity, oxidation reduction potential (ORP), pH, water density [30].

Color

Including color data, observed visually reveals that the river water has noticeable colour differences from natural color appearance from sampling location. According to CPCB norms approved for categories water (Table-3), there shouldn't be a noticeable color in the river water. As a result, it is clear that the site-1and site-2 reported blackish brown color, site-3 reported brown color and site- 4 (Table-2), is yellowish in rainy, reddish brown, dark brown, brown and yellowish color reported in winter and same as it is winter color reported in summer . Thus, it is noticeable that the stretch of the Ami River from selected these sites is influence by the release of industrial effluents into the river. It is observable from the (Table -2), that the color of water entirely depends on the nature of effluent discharged via the industry there on the bank of the river. The color alter is the indication of serious pollution forced in the water body. Light penetration in the deepness of the water body is affected and sequentially growth of flora and fauna is changed. Because light is required for growth of plants and photosynthesis and result of this fishes thriving on phytoplanktons find problem to stay alive in such an antagonistic condition.

Odor

Based on the odor, it can be drained that Ami River facing unfavorable condition, which can be seen in the light of odor reported in all the sites. The appropriate norms for class-A-water recommend that here should be no unpleasant color present in the river. So, it also indicates the serious pollution in site-1 is having alcoholic smell and site 2 having pungent smell. Odor data collected by direct smelling presented in **(**Table-2) opposing to the river water is characterized via pungent smell starting sampling locations.

Turbidity

Turbidity is a determined cloudiness and lack of clarity appropriate to suspended solids which are unseen with naked eyes. High concentrations of particulate matter influence light penetration and productivity, recreational values, and habitat quality [31]. Particles also serve as a home for other pollutants, particularly metals and bacteria. For this reason, turbidity readings can be used as an indicator of potential pollution in a water body [32]. Figure- 1(c). Treated effluent was dense with40.75 NTU in rainy season, 34 NTU in winter and 48 NTU in summer turbidity reported. Turbidity indicates the extent of pollution and particles accumulation to some extent.

Electrical Conductivity

Electrical conductivity is a measure of an aqueous solution's ability to carry an electric current. This skill is directly related to the concentration of ions in water electrical conductivity. The salinity or total salt content of water can be determined using this simple method. A dissolved salt is commonly found in wastewater effluents, from domestic sewage and industrial waste [33]. The electrical conductivity is reported in ami river was as where as 111.1 µmhos/Cm^2 in rainy, 94.25 µmhos/Cm^2 in winter and 108.4 µmhos/Cm^2 in summer mentioned (table-2). The electrical value in effluent is higher electrical value can be harmful to the aquatic environment. Seasonal variation show in Figure1. (d).

Total Suspended Solid (TSS)

TSS reported in Ami River all three season reported as 1300 mg/l in rainy, 742.5 mg /l in winter and 868.5 mg/l in summer **(**Table 1). Seasonal variation show in Figure 1. (e). Reported TSS is higher than the permissible limit (Table 1). This result indicates the heavy organic and inorganic pollution in the river according to Oberrecht [34] explain why increase in turbidity and TSS can often indicate potential contamination, pollution, not just a drop in water quality. When TSS concentration is due to organic matter, the presence of bacteria, protozoa, and viruses are more likely [35].

Total Dissolved Solids (TDS)

TDS in all three seasons are reported where as 597.56 mg/l in rainy, 592.58mg/l in winter and 587.92 mg/l in summer. Seasonal variation shows in Figure 1. (f).TDS is reported higher than the permissible limit **(**Table-2). TDS is a measurement of inorganic salts, organic matter and other dissolved solids toxicity. In the ionic composition of water and the toxicity of individual ions, TDS are a significant contributor to the water quality. Deterioration resulting in aesthetic issues, a decline in fisheries resources depletion and serious ecological degradation of aquatic environments [36]. Reduce light penetration in water, resulting in low productivity of ecosystem.

Alkalinity

Alkalinity data shown in **(**Table-2) reveals that alkalinity values are high at many of the sample locations, which also reveals that the amount of organic waste supplied of these places is decomposing at a fairly high rate. This necessitates the treatment of industrial waste water that enters the river near these points. Seasonal variation shows in Figure 1. (g).

Free Carbon Dioxide (CO_2)

In the effluents and domestic wastes discharged in the river, resulting in the highest CO2 level ever recorded (Table-1**)**. During the rainy season, river carry runoff soil and clay and pollutant from catchment areas, as well as industrial effluents, are responsible for moderate CO2 levels.

Dissolved oxygen (DO)

DO report 2.6 mg/l in rainy, 2.3 mg/l in winter and 2 .0 mg/l in summer and Seasonal variation shows in Figure 1. (i). DO is less than permissible limit of CPCB (Table-2). These results indicate the heavy pollution in river ami. This result is agreed with Tiwari et al. [25] and Kumar et al. [37]. The quantity of oxygen in aquatic environments is available to fish, invertebrates, and every organism in the water [38]. Mainly aquatic plants and animals necessitate oxygen to survive; fish, for example, cannot live in water with less than 5 mg/l DO [39]. The low level DO is a sign of contamination in the water and is a key feature in determining water quality, pollution control, and treatment processes [40]. DO assist in adaptable metabolic processes in plant and animal communities and acts as an indicator of pollution in aquatic ecosystems [41]. The decreased DO might be noticeable to the discharge of hot waste water from the industry [42]. DO vary depending on temperature. The oxygen solubility decreases as temperature increases [43].

Table 1. Physical and chemical parameters of water sample collected from sites included in present study of Ami River of year 2020-2021, Rainy season (July-2020-August 2020), Winter (December 2020-Febraury 2021) and Summer season (March 2021-June2021).

Parameters	Seasons	Chosen sites: Site-1	Site-2	Site-3	Site-4	Mean	SD	Standard value set by CPCB (central pollution control board)	Reference value set by WHO (world health organization
pH	R	8.9	8.6	8.4	8.5	8.6*	0.21	5.5-8.5	6.5-8.5
	W	8.9	8.6	8.2	8.5	8.5*	0.28		
	S	9.1	8.9	8.6	8.8	8.85*	0.20		
Temperature(°C)	R	30	29	28	28	28.27*	0.95	not exceed 5◦C than receiving water temperature	not exceed 5◦C than receiving water temperature
	W	22	22	21	21	21.5*	0.57		
	S	32	30.5	29	30	30.37*	1.25		
Colour	R	Blackish brown	Blackish brown	Brown	Yellowish	-	-	Not applicable	Not applicable
	W	Reddish brown	Dark brown	Brown	Yellowish				
	S	Reddish brown	Dark brown	Brown	Yellowish				
Odour	R	Alcoholic	Pungent	Earthy	Earthy	-	-	Not applicable	Not applicable
	W	Pungent	Pungent	Earthy	Earthy				
	S	Pungent	Pungent	Earthy	Earthy				
Turbidity(NTU)	R	49	40	38	36	40.75*	5.73	10NTU	5-25 NTU
	W	38	34	30	34	34*	3.266		
	S	55	45	40	42	48*	6.78		
Electric conductivity(µmhos/ Cm²)	R	140.4	120	90	94	111.1	23.6	2000 µmhos/Cm²	1000 µmhos/Cm²
	W	124.5	87.4	83.2	81.9	94.25	20.3		
	S	109	113	106	105.7	108.4	3.39		
TSS(mg/l)	R	1940	1130	1110	1020	1300*	429.3	20 mg/L	NA
	W	990	760	670	550	742.5*	186.0		
	S	1170	978	729	597	868.5*	255.6		
TDS(mg/l)	R	599.91	598.11	597.10	595.12	597.56*	1.99	100 mg/l	500 mg/L
	W	592.8	591.5	593.25	592.77	592.58*	0.75		
	S	587.81	588.1	587.74	588.06	587.92*	0.17		
Alkalinity(mg/l)	R	477	396	374	330	334.25*	61.61	600 mg/L	120mg/L
	W	490	405	387	385	416.75*	49.75		
	S	545	527	515	512	524.75*	14.97		
Free CO_2(mg/l)	R	15	15	10	10	12.5	2.88	NA	NA-
	W	11	6	4	4	6.25	3.30		
	S	15	11	11	10	11.75	2.21		

DO(mg/l)	**R** **W** **S**	2.6 2.1 1.5	2.9 2.6 1.9	2.3 2.4 2.3	2.6 2.2 2.6	2.60 2.328 2.07	0.24 0.22 0.47	**4 mg/L**	**6 mg/L**
BOD(mg/l)	**R** **W** **S**	1085 1180 760	910 1160 840	990 1050 740	970 1280 860	900.75* 1167.5* 800*	72.6 94.2 58.87	**30 mg/L**	**5 mg/L**
COD(mg/l)	**R** **W** **S**	1170 1187.53 1246.08	1113 1040.64 1104.72	1080 993.76 981.28	1054 746.88 921.92	1104.25* 992.20* 1063.5*	50.0 183.1 143.5	**250 mg/L**	**10mg/L**

NA- Not Available, *- Higher than permissible limit of standards.

Table .3. Water Quality Criteria CPCB (Designated Best Use Classification of Surface) 2019. [23]

Designated Best Use	Quality class	Primary water quality criteria
Drinking water source without conventional treatment but after chlorination	**A**	Total coli form organisms (MNP*/100) shall be 50 or less pH between 6.5and 8.5 Dissolve .Oxygen 6mg/l or more Biological oxygen demand 5 days 20°C 2mg/l or less
Outdoor bathing(organised)	**B**	Total coli form organisms (MNP*/100) shall be 500 or less and pH between 6.5and 8.5 Dissolve .Oxygen 5mg/l or more Biological oxygen demand 5 days 20°C 3mg/l or less
Drinking water sources after conventional treatment and disinfection	**C**	Total coli form organisms (MNP*/100) shall be 5000 or less and pH between 6and 9 Dissolve .Oxygen 4mg/l or more Biological oxygen demand 5 days 20°C 3mg/l or less
Propagation of wild life and fisheries	**D**	pH between 6.5 to 8.5 and Dissolve .Oxygen 4mg/l or more Free ammonia (as N) 1.2 mg/l or less
Irrigation , industrial cooling controlled waste disposal	**E**	pH between 6.5 to 8.5 and electrical conductivity at 25C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/l
	Below E	**Not meeting A,B,C,& E criteria**

Biological Oxygen Demand (BOD)

BOD concentration is reported 900.75 mg/l in rainy, 1167.5 mg/l in winter and 800mg/l in summer. These findings show that the river is highly polluted. Highest BOD reported in winter mentioned in (Table-2) and seasonal variation show in Figure.2. (j). The standard permitted level of industrial effluents of BOD is 350 mg/l. And CPCB permissible limit of BOD is 30mg/l. Our finding is higher than the permissible limit. The value of BOD in water samples was an indicator of organic waste entering the canal. The presence of additional waste products or pollutants in the Ami River is suggested by the high BOD values. (Table-.2). This could be due to organic matter escaping into the canal, primarily from fecal deposition by surrounding population. Canal water transported a significant amount of organic matter from domestic sewage and industrial effluents during flow. As a result, immediate action is required to manage the pollution load entering the river.

Chemical Oxygen Demand (COD)

COD of collected samples found very high show in (Table-2); rainy, summer show high COD as compare to winter and seasonal variation show in (Figure .2.(k). The recommended range of COD according to CPCB is 250mg/l and the reference range of the standard industrial effluents is 100 mg/l, while in the analysis of ami river water, the finding value is where much higher. In all the seasons. Our findings agree with Tiwari et al. [25] and Kumar et al. [37]. The available dissolved oxygen in water determines Chemical Oxygen Demand. High COD levels reduce the amount of dissolved oxygen available to aquatic organisms [44]. A High level of COD indicates low available amount of dissolved oxygen ,which has adverse cause on aquatic flora and fauna) [45].

Table. 4. Correlation matrix analysis result (rainy season).

	pH	**Temperature**	**Turbidity**	**EC**	**TSS**	**TDS**	**Free CO_2**	**DO**	**BOD**	**COD**	**Alkalinity**
pH	**1**										
Temperature	0.992795	1									
Turbidity	0.937923	0.971215	1								
EC	0.52598	0.460552	0.384192	1							
TSS	0.809891	0.831618	0.886512	0.67315	1						
TDS	0.174304	0.057683	-0.17746	0.446889	-0.19183	1					
Free CO_2	0.758266	0.826811	0.936971	0.222539	0.868823	-0.5056	1				
DO	-0.78607	-0.814683	-0.88368	-0.63744	-0.99811	0.251679	-0.88713	1			
BOD	0.108786	0	-0.23808	0.236831	-0.34547	0.973368	-0.56171	0.402092	1		
COD	0.369882	0.410426	0.546813	0.589014	0.844538	-0.45969	0.681932	-0.8631	-0.6438	1	
Alkalinity	0.882176	0.914859	0.967823	0.526732	0.972887	-0.23018	0.941127	-0.97298	-0.34025	0.734934	1

Table. 5. Correlation matrix analysis result, (winter season)

	pH	Temperature	Turbidity	EC	TSS	TDS	Free CO_2	DO	BOD	COD	Alkalinity
pH	1										
Temperature	0.8	1									
Turbidity	0.9899495	0.7071068	1								
EC	0.8377537	0.6654256	0.8304599	1							
TSS	0.7601697	0.8222244	0.7020685	0.9304548	1						
TDS	-0.3390185	-0.6596287	-0.2440611	0.0938547	-0.1180395	1					
Free CO_2	-0.5321064	-0.140028	-0.5940885	-0.8318346	-0.6147745	-0.6057523	1				
DO	-0.4426423	0.1301889	-0.5523448	-0.5904978	-0.2605423	-0.6390797	0.8932746	1			
BOD	0.6340992	0.792624	0.5604698	0.8603284	0.9827745	-0.1066252	-0.5378725	-0.1349419	1		
COD	0.5200462	0.7682275	0.4318074	0.7697755	0.9416776	-0.1327262	-0.4316858	0.0012616	0.9872318	1	
Alkalinity	0.2610089	0.7320981	0.1350447	-0.0142111	0.2849258	-0.9355522	0.5660569	0.7500565	0.3279835	0.3909227	1

Table .6. Correlation matrix analysis result (summer season).

	pH	*Temperature*	*Turbidity*	*EC*	*TSS*	*TDS*	*Free CO_2*	*DO*	*BOD*	*COD*	*Alkalinity*
pH	1										
Temperature	0.966988	1									
Turbidity	0.941316	0.955753	1								
EC	0.961158	0.994463	0.920243	1							
TSS	0.927242	0.900107	0.982439	0.855387	1						
TDS	0.803477	0.914281	0.925028	0.883228	0.847032	1					
Free CO_2	-0.53452	-0.30151	-0.35221	-0.29806	-0.48411	0.025991	1				
DO	0.377964	0.426401	0.142314	0.518272	0.019017	0.20625	-5.2E-16	1			
BOD	0.888618	0.749391	0.804171	0.727635	0.876518	0.52108	-0.83946	0.093111	1		
COD	0.9127	0.975747	0.976691	0.951402	0.919545	0.976536	-0.17883	0.269215	0.681842	1	
Alkalinity	0.685108	0.758767	0.534011	0.820361	0.407352	0.596531	-0.04689	0.906313	0.348615	0.649837	1

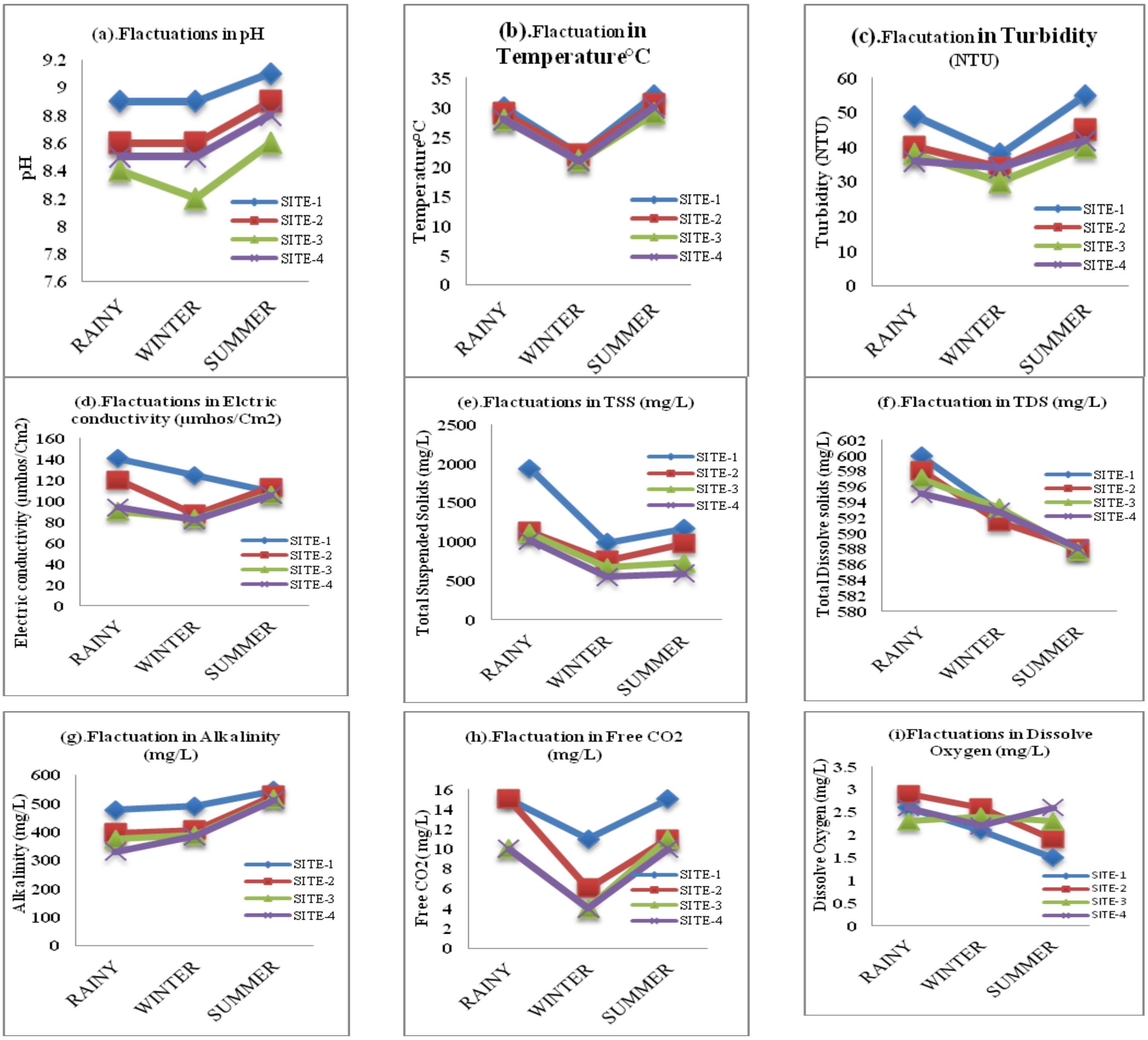

Figure.1. (a-i) show seasonal fluctuations in Ami River, (a). Fluctuations in pH, (b). Seasonal fluctuations in temperature, (c). Seasonal fluctuations in turbidity, (d). Fluctuations in electric conductivity, (e). Seasonal fluctuations in total suspended solids, (f). Fluctuations in total dissolve solids, (g). seasonal fluctuations in alkalinity, (h). Fluctuations in free carbon dioxide, (i). Seasonal fluctuations in dissolve oxygen.fiure show seasonl variations in Ami River.

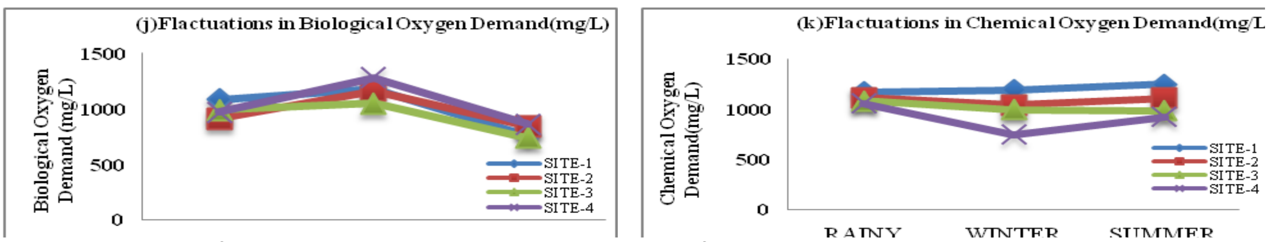

Figure.2. (j-k), seasonal fluctuations in Ami River (j). Show seasonal fluctuations in biochemical oxygen demand,(k) seasonal fluctuations in chemical oxygen demand in all three seasons (rainy, winter and summer).

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Correlation matrix analysis

The correlation coefficient represents the relationship between the variables, and the measurement of one variable depends on the other variables or not. To determine the relationship between the physicochemical parameters of the water samples, correlation coefficients, have been recognized and a numerous significant correlations have been found [46]. A correlation matrix generated for 11 variables for three different seasons rainy, winter and summer (Table 4, 5, 6). The coefficient correlation ranges between-1 and+ 1. The values found above 0.5 have been highlighted and considered the relationship study. If the correlation coefficient is between 0.5 and 0.8, a moderate relationship considered, and 0.8 or above indicated, a strong relationship [47]. During rainy a strongly positive correlation is observed (table-4) between pH and temperature (0.992795), temperature and turbidity (0.971215), TSS and alkalinity (0.972887), turbidity and alkalinity (0.967823), free CO2 and alkalinity (0.941127), turbidity and free CO2 (0.936971), BOD and TDS (0.973368), turbidity and pH (0.937923), alkalinity and temperature (0.914859), alkalinity and pH(0.882176), TSS and turbidity (0.886512), free CO2 and TSS (0.868823), COD and TSS (0.844538), TSS and temperature (0.831618), free CO2 and temperature(0.826811), TSS and pH(0.809891). The moderately positive correlation is observed between pH and free CO20.758266, COD and alkalinity0.734934, freeCO2 and COD (0.681932), EC and TSS (0.67315). pH with TDS in rainy indicates the discharge of industrial effluents, sewage and human activities. In winter season (table 3), strongly correlated with temperature and DO (0.9983691), pH and Turbidity (0.9899495), EC and freeCO2 (0.9470013), TSS and COD (0.9416776), free CO2 and alkalinity (0.960753), TSS and alkalinity (0.941127), turbidity and free CO2 (0.936971), free CO2 and COD (0.920931), pH and alkalinity (0.8615842), turbidity and alkalinity (0.8468408), pH and EC (0.8365084), turbidity and EC (0.8365084), temperature and TSS (0.8222244), temperature and free CO2, (0.826811), pH and TSS (0.809891). the moderately positive correlation observed between pH and free CO2 (0.7922812), COD and Alkalinity (0.7871503), EC and COD(0.7704759), temperature and COD, (0.7682275), pH and TSS(0.7601697), turbidity and freeCO2 (0.739923), temperature and turbidity (0.7071068), turbidity and TSS (0.7020685). Due to the dilution effect in winter, strong correlation between pH with EC, COD; EC with COD, BOD; TDS with COD; COD with BOD. During summer season observed a strongly positive correlation between pH and turbidity (0.9899495), BOD and COD (0.9872318), TSS and BOD (0.9827745), EC and TSS (0.9304548), TSS and COD (0.9416776), free CO2 and DO (0.8932746), EC and BOD (0.8603284), pH and EC (0.8377537), turbidity and EC (0.8304599), temperature and TSS (0.8222244). The moderately positive correlation observed between temperature and BOD (0.792624), EC and COD (0.7697755), temperature and COD (0.7682275), pH and TSS (0.7601697), DO and alkalinity (0.7500565), temperature and alkalinity (7320981), temperature and turbidity (0.7071068), turbidity and TSS (0.7020685). The strong correlation between pH and temperature, in rainy and winter, pH and turbidity in summer, DO and temperature. The correlation analysis is identified that EC, COD, BOD, CO2, turbidity, TSS, alkalinity, observed higher-level correlation with water quality parameters in all seasons. The strong EC and TDS indicate that the suspension of salts, organic and inorganic pollution load in credited to EC. Though the positive correlation examined the water parameters is a sign that the anthropogenic and industrial activities were responsible for contamination of the assess groundwater parameters in the study area [49]. Our result results are agreed with singh et al. [48].

IV.CONCLUSION

The current study reveals that total dissolved solids, TSS, BOD, and COD is above permissible limit given by C. P. C. B.which may be harmful to the ecosystem. This treated effluents released directly into the Ami River, which may severely affect aquatic organism growth in the river. There is an urgent requirement of planning by the civil body to combat the pollution rate in River. This program will help in supporting the ecology and aquatic life in the Ami River. This must go a long way towards saving Ami river from the ferocity of industrial pollution.

Conflicts Of Interest

The authors state that they do not have any conflicts of interest.

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