



Assessment of Water Quality Status of Water Bodies Using Water Quality Index and Correlation Analysis in and Around Industrial Areas of West District, Tripura, India

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ABSTRACT

Industrialization, urbanisation and agricultural development cause pollution in water bodies due to the discharge of wastewater directly or indirectly. The present study aims to assess the water quality of water bodies in and around A D Nagar, Badharghat, Dukli and Budhjungnagar Industrial Estates, West Tripura during pre-monsoon and post-monsoon in the year 2016 to 2018. Biological parameters namely DO, BOD, Total Coliform, Faecal Coliform and COD, Physico-chemical parameters namely pH, EC, TDS, Bicarbonates, Chlorides, Sulphates, Total Hardness, Calcium, Magnesium etc. and heavy metals were analysed using standard methods as prescribed by APHA. The analysed parameters were compared with the standards prescribed by BIS. The BOD values for all the water bodies were beyond the prescribed standard limit except the pond located at the southern side of Jutemill, Hapania (S-3) during pre-monsoon season. The Total Coliform values for water bodies located at the eastern and northern side of Badharghat Industrial Estate were beyond the prescribed standard limit. The seasonal variations of water quality have also been observed. Water Quality Index values reflected that the 75% of surface water samples were of poor quality and 25% were of good quality in both the season. Correlation study revealed that positive and significant correlations between the pairs of selected parameters in surface water samples were observed. This study reveals that the surface water of these water bodies needs proper treatment before consumption and it also needs to be protected from the domestic as well as industrial contamination.

INTRODUCTION

Freshwater is essential to support the living creature as it helps in the growth of the entire living organism. The main source of freshwater comprises the lotic (rivers and streams) and lentic (ponds and lakes) water bodies. The rising population, industrialisation and urbanisation change the quality of freshwater. Generally, these resources are degrading gradually due to anthropogenic impacts, lack of awareness among people and lack of legal and institutional framework (Gulia et al. 2017, Pavan & Banerjee 2015). The water bodies, especially ponds are generally small in size but these are valuable sources of water in rural areas for the purpose of domestic, irrigation, fisheries etc. The rainwater is one of the main sources of such village ponds. The water of ponds is being polluted mainly due to discharge of wastes from the residential area, sewage outlets, detergents, automobiles oil waste and industrial wastewater (Ancy & Shaji 2016). In India, approximately 70% of water becomes contaminated due to the release of domestic sewage and industrial effluents into freshwater bodies (Sheetal & Sudan 2017). It is very much important

to know the quality of water before its consumption since the consumption of water containing impurities will cause various water-borne diseases. From the literature survey, it has been found that there is no water quality report of freshwater bodies in and around the A. D. Nagar, Badharghat, Dukli and Budhjungnagar industrial estates. Therefore, the present study was designed to assess the status and quality of selected pond water.

STUDY AREA

The West Tripura district is the largest among the eight Districts of Tripura and lies approximately between latitude 23°16' to 24°14' north and longitude 91°09' to 91°47' east having an area of approximately 983.63 sq. km. and population of 9.17 lakhs as per Census India, 2011. The major four industrial estates such as A.D. Nagar (8.41 acres), Badharghat (20.525 acres), Dukli (45.77 acres) and Bodhjungnagar Industrial Estate (535.73 acres) are located in the West Tripura District. The three industrial estates such as A.D. Nagar, Badharghat, Dukli Industrial Estate are located in the urban area nearer to Agartala, State capital and the

distance between these estates are very less. The Bodhjunnagar Industrial Estate is located in a rural area that is far away from the Agartala [TIDC]. The industries such as distillery, rubber-based unit, waste recycling units, thermal power plants, steel rolling plant, food processing, stone crusher, brick kilns, dairy, automobile, pharmaceuticals, rubberwood treatment, spices, tyre & tube, hot mix plant, latex processing, cattle feed etc. are found in the study areas and have high water pollution potential (Singh & Karmakar 2017). The details of sampling locations and study maps are illustrated in Table 1 and Fig. 1 respectively.

MATERIALS AND METHODS

In the present study, the sampling was done during morning hour (8 am to 9 am) in the month April-May (pre-monsoon) and October-November (post-monsoon) in the year 2016 to

2018. The water samples were collected in hard polyethene bottles of 1.5 litre capacity with stopper. Each bottle was washed with 2% nitric acid and then rinsed three times with distilled water (Khawaja & Aggarwal 2016). The samples were collected from three different points and were mixed to prepare an integrated sample. After sample collection, some physical, as well as chemical reactions, would change the quality of the water sample; therefore to minimize this change the samples were preserved as early after the collection. The water samples were preserved by adding chemical preservatives and by lowering the temperature (Kumar et al. 2014). The temperature was measured by thermometer immersed directly in the water body. The parameters like pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) were measured *in situ* using the potable HI 98130 Combo pH/EC/TDS meter (Hanna Instruments). The Dissolved Oxygen was fixed instantly on the spot and analysed immediately

Table 1: Details of sampling locations in and around A D Nagar, Badharghat and Dukli and Budhjunnagar Industrial Estates.

Sample No	Locations	Latitude	Longitude
A D Nagar, Badharghat and Dukli Industrial Estates			
S-1	Pond located at eastern side of Badharghat Industrial Estate	N 23°47′44″N	E 91°16′10″ E
S-2	Pond located at northern side of Badharghat Industrial Estate	N 23°47′51″ N	E 91°16′12″ E
S-3	Pond located southern side of Jutemill, Hapania	N 23°47′1″ N	E 91°16′5″ E
S-4	Pond, Chowhan Para, Dukli	N 23°47′3″ N	E 91°17′32″ E
Budhjunnagar Industrial Estate			
S-5	Community Pond, ADC Birbal Para	N 23°53521 N	E 91°22741 E
S-6	Pond, Rajchantai	N 23°53567 N	E 91.22730 E
S-7	Pond, Laxmipur, Dulal Debnath	N 23°51724 N	E 91°20588 E
S-8	Lake, Rajarband	N 23°52550 N	E 91°20348 E

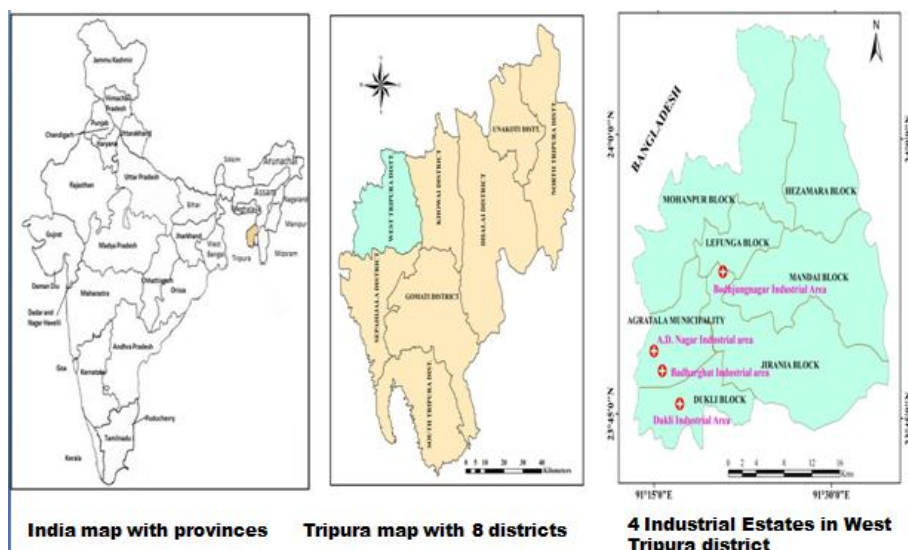


Fig. 1: Map showing the A D Nagar, Badharghat, Dukli and Budhjunnagar Industrial Estates in West Tripura district, India.

as per Wrinkler's method with Azide modification. BOD was measured followed by incubation of BOD bottle at 21°C for 5 days. COD was determined by the potassium dichromate open reflex method. Total Coliform and Faecal Coliform were determined by the Multiple Test Tube method. Turbidity was measured by a Nephthalo turbidity meter. Total Hardness, calcium (Ca) and magnesium (Mg) were measured complex-metrically, chloride (Cl⁻) was measured following argento-metric analysis and sulphate (SO₄²⁻) and phosphate was measured by spectrophotometer (Thermo fisher: Evolution 201), fluoride (F⁻) was measured colourimetrically. Heavy metals were analysed using atomic absorption spectrophotometer (Perkin Elmer AAS 700). The other parameters were analysed by using the standard methods Prescribed by APHA (APHA 2005). The quantitative analytical data are presented in Table 2. Water quality indices have been calculated for every selected location of the study areas to assess the drinking water quality. Correlation analysis was also carried out for the water quality data to predict the inter-relationship between the parameters.

Water Quality Index: Water Quality Index (WQI) represents a large number of water quality data to a single numerical value. It signifies the composite influence of various water quality parameters on the overall quality of water (Ramakrishnaiah et al. 2009). In this study, the water quality index has been calculated considering selected important parameters. The WQI has been calculated by using the standards of drinking water quality recommended by the BIS (BIS 1991). Three steps have been followed to calculate WQI. In the first step, selected parameters have been assigned a weight (wi) according to its relative importance in the assessment of drinking water quality. The weightage has been given to the parameters according to their importance in water quality assessment.

In the second step, the relative weight (Wi) is calculated with the help of the following equation:

$$W_i = \frac{w_i}{\sum_{i=1}^n w_i}$$

Where, Wi is the relative weight, wi is the weight of each parameter and n is the number of parameters.

In the third step, a quality rating scale (qi) for each parameter is calculated by the following equation:

$$q_i = (C_i / S_i) \times 100$$

Where, Ci is the concentration of each chemical parameter in each water sample in mg/L, and Si is the Indian drinking water standard for each chemical parameter in mg/L.

Using the relative weight and quality rating scale values SI for each parameter is calculated. WQI is thus calculated using the equation mentioned below:

$$SI_i = W_i \cdot q_i \quad \dots(1)$$

$$WQI = \sum SI_i \quad \dots(2)$$

Correlation coefficient: Correlation represents the degree of mutual relationship among two variables. The correlation coefficient (r) is the percentage of difference in the dependent variable explained by the independent variables. The positive sign or values signify the positive correlation correspondingly negative values signify the negative correlation between two variables (Magroliya et al. 2018).

The relationship between two parameters was established by calculating Karl Pearson's correlation coefficient, r, by using the formula as given

$$r = \frac{n \sum xy - \sum x \sum y}{\sqrt{n \sum x^2 - (\sum x)^2} \sqrt{n \sum y^2 - (\sum y)^2}} \quad \dots(3)$$

Where r = Karl Pearson's correlation coefficient, y = Dependent variable, x = Independent variable and n = Number of Observations. If the correlation coefficient is closed to +1 or -1 predicts a good relationship between two variables x and y, and the correlation coefficient r = 0 predicts no relationship between two variables. The correlation between the parameters is considered as strong, when it is in the range of +0.8 to 1.0 and -0.8 to -1.0, moderate when it is having a value in the range of +0.5 to 0.8 and -0.5 to -0.8, weak when it is in the range of +0.0 to 0.5 and -0.0 to -0.5 (Saxena et al. 2016 and Heydari et al. 2013).

RESULTS AND DISCUSSION

The season-wise minimum, maximum, mean and standard deviation values of the water quality parameters are given in Table 2. The results were compared with drinking water standards [BIS].

The pH values varied between 6.27 to 7.36 with a mean of 6.83 during pre-monsoon and 6.01 to 6.86 with a mean of 6.39 during post monsoon seasons. The pH value was in decreasing trend from pre-monsoon to post-monsoon which may be due to the dilution of rainwater (Rashmi 2016). Electrical conductivity is the ability of an aqueous solution to pass electric current which depends on ions and their total concentration, mobility and temperature. The EC values recorded were in the range of 84.67 to 224 μScm^{-1} with a mean of 154.17 μScm^{-1} during pre-monsoon and 104 to 190.7 μScm^{-1} with a mean of 153 μScm^{-1} during post-monsoon seasons. The high EC value indicates the presence of salts and ions in higher concentration (Bajpai et al. 2012). Turbidity is the measure of the light scattered

Table 2: Physico-Chemical Characteristics of Pond water in and around A D Nagar, Badharghat, Dukli and Budhjungnagar Industrial Estate *Units of all the parameter are in mg/L except pH, EC (μScm^{-1}) and Turbidity (NTU).

Parameters	Pre monsoon				Post monsoon			
	Min	Max	Mean	SD	Min	Max	Mean	SD
Temperature	26	27	26.46	± 0.33	25.17	25.38	25.42	± 0.23
pH	6.27	7.36	6.83	± 0.49	6.01	6.86	6.39	± 0.35
EC	84.67	224	154.17	± 50.44	104.7	190.7	153	± 32.64
TSS	16	40	26.67	± 9.27	19.33	42	30.25	± 7.47
TDS	48	134	96.92	± 31.35	66.67	130	97.54	± 22.30
Turbidity	33.05	197.67	84.46	± 53.08	36.34	197.7	88.88	± 51.74
TH	38.86	51.31	44.83	± 4.48	44.85	59.78	51.87	± 4.98
Total N	17.77	41.35	25.86	± 8.05	18.73	43.93	27.45	± 8.19
DO	5.18	6.45	5.75	± 0.38	5.29	6.23	5.66	± 0.29
BOD	3.51	4.7	4.08	± 0.45	3.77	4.98	4.46	± 0.41
COD	24.67	36.67	29.67	± 3.89	28	34.67	31.25	± 2.51
TC	376.7	520	447.92	± 56.96	426.7	540	484.17	± 38.70
FC	220	283.3	255.83	± 24.48	253.3	353.3	298.33	± 38.38
HCO ₃	25.84	105.1	54.43	± 30.71	29.25	89.26	52.51	± 24.28
Cl	13.7	22	19.44	± 2.72	15.37	25.14	21.35	± 2.96
SO ₄	10.89	28.77	19.03	± 5.75	13.23	31.19	20.88	± 6.15
PO ₄	0.14	0.73	0.34	± 0.24	0.2	1.1	0.44	± 0.33
NO ₃	0.25	2.12	0.99	± 0.74	0.26	2.66	1.21	± 0.98
Na	1.63	25.82	7.18	± 8.85	1.79	29.86	8.11	± 10.13
K	0.55	15.36	3.39	± 5.14	0.62	17.06	3.78	± 0.96
Ca	7.12	9.1	8.24	± 0.75	7.96	10.64	9.39	± 0.98
Mg	4.42	7.23	5.84	± 1.08	5.23	7.97	6.82	± 1.08
F	0.19	0.4	0.30	± 1.08	0.21	0.39	0.32	± 0.07
Fe	0.71	3.41	1.68	± 0.93	0.76	3.39	1.76	± 0.98
Mn	0.1	0.81	0.27	± 0.26	0.12	0.79	0.28	± 0.24
Pb	0.01	0.026	0.02	± 0.01	0.01	0.024	0.02	± 0.01
Cd	0.002	0.007	0.004	± 0.002	0.001	0.01	0.005	± 0.003
As	0.0002	0.019	0.01	± 0.01	0.0004	0.027	0.01	± 0.01
Cu	0.02	0.05	0.03	± 0.01	0.017	0.05	0.03	± 0.01
Zn	0.04	0.45	0.19	± 0.16	0.04	0.4	0.18	± 0.14
Cr	0.02	0.04	0.03	± 0.01	0.017	0.037	0.03	± 0.01

by suspended particles. The clay, silt, organic matter, phytoplankton and other microscopic organisms cause turbidity in pond water. Turbidity ranged from 33.05 to 197.67 NTU and 36.34 to 197.7 during pre-monsoon and post-monsoon seasons respectively. The maximum turbidity in water was recorded during post monsoon season which may be due to accumulation of sand, clay, silt, dung and various other pollutants along with rainwater from the surrounding area (Kumar et al. 2014). The oxygen can be dissolved in water from air or is formed by the photosynthetic organism like algae and aquatic plants. The oxygen is poorly soluble gas

in water and its solubility depend on the temperature of the water and its partial pressure. The minimum and maximum dissolved oxygen were recorded as 5.18 mg/L and 6.45 mg/L respectively during pre-monsoon season. BOD refers to the oxygen used by the microorganism in the aerobic oxidation of organic matter. Therefore with the increase in the amount of organic matter in the water the BOD increases. The BOD value ranged between 3.51 to 4.7 and 3.77 to 4.98 during pre-monsoon and post-monsoon seasons respectively. The BOD values of all the water samples were beyond the standard limit (BIS: 3 mg/L) in both seasons. The BOD value of

post monsoon season was more than pre monsoon season because of the presence of several microbes in water bodies, which accelerate their metabolic activities with the increase in concentration (Kumar et al. 2014). The Total Coliform numbers per 100 mL of water ranged from 376.7 to 520 and 426.7 to 540 during pre-monsoon and post monsoon respectively. Total Coliform count was increased from pre-monsoon to post-monsoon. The high concentration of organic matter of Faecal origin possibly arises from the industrial activities as well as residential inhabitants. Total hardness values ranged from 38.86 to 51.31 mg/L during pre-monsoon and to 44.85 to 59.78 mg/L during post-monsoon. TH is used to describe the effect of dissolved minerals (mostly calcium and magnesium) determining suitability of water for domestic, industrial and drinking purpose attributed to the presence of ferrous iron, bicarbonates, sulphates, chloride and nitrate of calcium and magnesium. High values of hardness are probably due to regular addition of large quantities of detergents used by the nearby residential localities which drain into the water bodies. The hard water can cause indigestion problem and possibilities of forming calcium oxalate crystals in urinary tracts (Deepa et al. 2016). Calcium and magnesium levels were found increased during post monsoon than pre monsoon seasons. The concentration of iron in the water samples varies from 0.71 to 3.41 mg/L and 0.76 to 3.39 mg/L during pre-monsoon and post-monsoon respectively. The recorded iron levels in water bodies were much higher than BIS standard. The high iron content may be due to the influence of rainfall infiltrating and dissolution of iron-bearing mineral rocks and soils which are leached into these water bodies (Sekar & Suriyakala 2016 and Idoko 2010). The considerable content of manganese was recorded in both seasons. The concentration of other heavy metals such as lead, cadmium, arsenic, copper, zinc and chromium were within the prescribed BIS standard limits during both seasons. The remaining parameters were within the BIS standard limit but seasonal variations were observed.

Water Quality Index: The weights assigned and relative weights for each parameter was given in Table 3. The Water Quality Index classification and its values have been presented in Table 4 and Table 5 respectively. The seasonal variation of WQI and Pie diagram of overall WQI in the study areas are shown in Fig. 2 and Fig. 3 respectively.

The WQI values revealed that the surface water quality was found as a poor category in almost all sampling sites in both seasons. It may be due to the ionic leaching, overexploitation and anthropogenic activities such as discharge of effluents from industrial, agricultural and domestic uses (Jena et al. 2013). It is observed that 75% of surface water of the sampling locations are of poor quality and 25 % of surface water are of good quality. This indicates that water samples

of the study areas are highly polluted. They are not suitable for drinking purposes and other useful human activities. The water quality index (WQI) indicates that sampling site S-5 is highly polluted compared to others. This site is nearer to the Budhjungnagar Industrial estate and receives more industrial effluents, wastes and sewage water.

Table 3: Relative weight of selected parameters.

Parameters	Standard (BIS)	Weight (wi)	Relative Weight (Wi)
TDS	500	5	0.052083333
HCO ₃ ⁻¹	200	1	0.010416667
Cl ⁻	250	5	0.052083333
SO ₄ ⁻²	200	5	0.052083333
NO ₃ ⁻¹	45	5	0.052083333
Ca	75	3	0.03125
Mg	30	3	0.03125
Na	-	4	0.041666667
K	-	2	0.020833333
Fe	0.3	5	0.052083333
Cr	0.05	5	0.052083333
Pb	0.05	5	0.052083333
Cu	0.05	2	0.020833333
Mn	0.1	5	0.052083333
Cd	0.003	5	0.052083333
Zn	5	1	0.010416667
pH	6.5-8.5	4	0.041666667
As	0.05	5	0.052083333
TH	300	3	0.03125
EC	300	1	0.010416667
F	1.0	5	0.052083333
Temp.	40	1	0.010416667
Turbidity	1	1	0.010416667
BOD	3.0	3	0.03125
DO	5.0	4	0.041666667
PO ₄	-	1	0.010416667
FC	-	5	0.052083333
COD	-	2	0.020833333
		Σwi = 96	ΣWi = 1

Table 4: WQI classification and results (Paul et al. 2016).

WQI Value	Water Quality
<50	Excellent
50-100	Good
100-200	Poor
200-300	Very Poor
>300	Unsuitable

Table 5: Water quality status based on WQI.

Location No.	WQI			
	Pre Monsoon	Water Quality status	Post Monsoon	Water Quality status
S-1	124.18	Poor	122.03	Poor
S-2	135.33	Poor	139.46	Poor
S-3	92.41	Good	90.30	Good
S-4	74.79	Good	80.21	Good
S-5	178.59	Poor	182.93	Poor
S-6	119.60	Poor	123.79	Poor
S-7	116.85	Poor	143.48	Poor
S-8	122.17	Poor	139.37	Poor

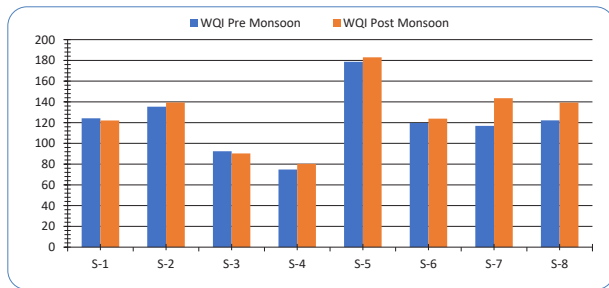


Fig. 2: Seasonal variation of WQI.

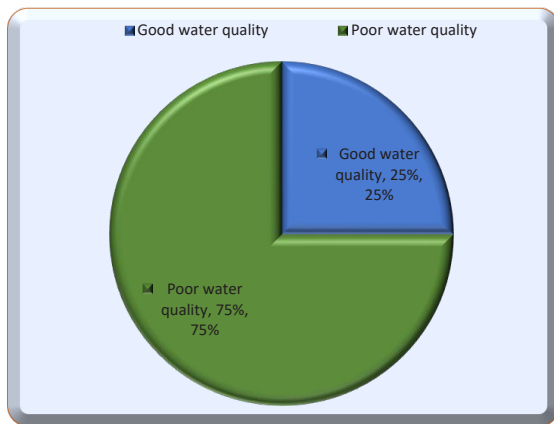


Fig. 3: Pie diagram of overall WQI.

Correlation analysis: The season-wise correlation coefficient (r) values are shown in Table 6 and Table 7 respectively. During pre-monsoon, Electrical conductivity was strongly correlated with TDS (+0.8142). Total Nitrogen was strongly correlated with PO_4 (+0.8865) and NO_3 (0.9360). HCO_3 was strongly correlated with Na (+0.8372) and K (+0.8073). Sodium was strongly correlated with K (+0.9750). During post monsoon, Electrical conductivity was moderately correlated with TDS (+0.6179), HCO_3 (+0.6573), Na (+0.5997), K (+0.5638) and BOD was strongly correlated with COD

(+0.8742) and Total Coliform (+0.8742) and HCO_3 was strongly correlated with Na (+0.8313)). During post monsoon DO was moderately negatively correlated with BOD (-0.5227) which signifies that BOD increases then DO will also decrease (Indu et al. 2015). TDS and EC are positively correlated because electrical conductivity is dependent on the dissolved ions. EC increases with the high value of TDS (Dhamodharan & Shanthakumar 2016). The hardness of water samples is positively correlated with the ions namely bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium, and magnesium which determine that the surface water of the study areas are hard water (Sen et al. 2011).

CONCLUSION

The analytical data of water samples reveal that all the parameters show slight seasonal variations. It has been observed that the values of surface quality parameters of the study area are higher during the post-monsoon period reflecting the effect of monsoon and clearly indicated seasonal variation. The water quality indices (WQI) were in the range 74.79 to 182.93 and it is observed that 75% of surface water of the sampling location are of poor quality and 25% of surface water is of good quality. The bacteriological load in the water bodies was the main reason for its poor water quality. The application of the Water Quality Index (WQI) in this study has been found very useful in assessing the overall quality of water. The correlation study on water quality parameters showed that some of the parameters are correlated with each other. It is observed that some of the parameters have a positive or negative correlation between them. This study reveals that the surface water of these waterbody areas needs proper treatment before consumption. These water bodies need to be protected from domestic as well as industrial contamination. The promotion of an awareness campaign among industry owners as well as local people is required to maintain good water quality. The protection, conservation and rejuvenation of water bodies must be treated as an important national as well as international issue. This study may be used by the government policymakers as well as industrial entrepreneurs as baseline information regarding surface water quality in the industrial areas of the West Tripura district to take pollution control measures.

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Table 6: Correlation coefficients among various surface water parameters during Pre Monsoon Season.

	Temp	pH	EC	TSS	TDS	Turbidity	Hard-ness	Total N	DO	BOD	COD	TC	FC	HCO ₃	Cl	SO ₄	PO ₄	NO ₃	Na	K	Ca	Mg	
Temp	1																						
pH	0.2734	1																					
EC	-0.3911	0.4661	1																				
TSS	-0.3273	0.5588	0.9673	1																			
TDS	-0.3608	0.2889	0.8142	0.7132	1																		
Turbidity	-0.5449	-0.7924	-0.2445	-0.2371	-0.1581	1																	
Hardness	0.0826	0.1741	0.4473	0.5370	0.3198	0.1687	1																
Total N	-0.4222	-0.8442	-0.3471	-0.3373	-0.3903	0.9006	0.0924	1															
DO	-0.3066	0.6469	0.5483	0.7096	0.2634	-0.1644	0.2366	-0.2712	1														
BOD	-0.4675	-0.1266	0.2611	0.3407	0.1875	0.3178	0.0702	0.3689	0.5148	1													
COD	0.2878	0.1102	0.2725	0.4107	-0.0079	-0.0402	0.4489	0.0460	0.3685	0.4653	1												
TC	-0.5566	0.1494	0.4341	0.5034	0.3431	0.1073	-0.0002	0.1125	0.6970	0.4653	0.300144	1											
FC	-0.0228	0.4939	0.5986	0.7167	0.4689	-0.2527	0.4118	-0.2645	0.7247	0.7048	0.680582	0.750016	1										
HCO3	0.0355	0.8521	0.7175	0.7836	0.5460	-0.6109	0.4223	-0.6138	0.6706	0.2143	0.22875	0.442048	0.738913	1									
Cl	-0.3123	-0.6415	0.2655	0.1587	0.3921	0.5968	0.4548	0.5407	-0.3730	0.1967	0.200678	-0.01085	-0.00198	-0.26989	1								
SO ₄	0.1884	-0.3063	-0.7923	-0.8299	-0.7269	0.0448	-0.5227	0.2504	-0.5586	-0.4147	-0.61841	-0.4478	-0.74629	-0.49745	-0.37192	1							
PO ₄	-0.3502	-0.6742	-0.3317	-0.2591	-0.4331	0.7364	-0.0325	0.8865	-0.0029	0.6745	0.29997	0.42831	0.066124	-0.45139	0.319356	0.132973	1						
NO ₃	-0.3889	-0.9719	-0.3995	-0.4518	-0.3114	0.8922	-0.0733	0.9360	-0.4745	0.2447	-0.03303	-0.0277	-0.4066	-0.79601	0.635848	0.238753	0.784782	1					
Na	-0.3799	0.5685	0.7001	0.6749	0.6013	-0.3919	0.1717	-0.3592	0.5146	0.3227	-0.13898	0.576317	0.522547	0.837223	-0.13354	-0.278	-0.27664	-0.51949	1				
K	-0.3020	0.4693	0.6515	0.6141	0.5978	-0.3569	0.2440	-0.2831	0.3792	0.3411	-0.10147	0.540811	0.527491	0.807374	-0.00908	-0.2486	-0.21841	-0.44068	0.975009	1			
Ca	-0.1444	0.0197	0.3840	0.4156	0.0667	0.2530	0.7696	0.2701	0.0800	-0.1941	0.147782	-0.22352	-0.04722	0.185141	0.398642	-0.17773	-0.00708	0.098703	0.127917	0.147934	1		
Mg	0.1120	0.1120	0.5451	0.5975	0.5668	0.1439	0.8877	0.0503	0.2442	0.3547	0.525888	0.271936	0.64471	0.478925	0.581048	-0.70376	0.034376	-0.04984	0.287492	0.390831	0.46613	1	

Table 7: Correlation coefficients among various surface water parameters during Post Monsoon Season.

	Temp	pH	EC	TSS	TDS	Turbidity	Hardness	Total N	DO	BOD	COD	TC	FC	HCO ₃	Cl	SO ₄	PO ₄	NO ₃	Na	K	Ca	Mg	
Temp	1																						
pH	0.8776	1																					
EC	-0.0016	0.1823	1																				
TSS	0.0240	0.2027	0.8541	1																			
TDS	-0.2637	-0.0613	0.6179	0.6071	1																		
Turbidity	-0.6247	-0.7302	-0.2316	-0.0419	-0.1176	1																	
Hardness	0.2839	0.0502	0.3326	0.5605	0.0674	0.3368	1																
Total N	-0.4756	-0.6996	-0.3198	-0.1056	-0.4054	0.8837	0.4070	1															
DO	0.7164	0.5628	-0.4892	-0.5322	-0.7755	-0.4672	-0.1544	-0.1871	1														
BOD	-0.7313	-0.6798	0.2090	0.2735	-0.0681	0.7000	0.1716	0.7325	-0.5227	1													
COD	-0.6913	-0.8016	-0.1559	-0.1822	-0.3809	0.7691	0.0581	0.8518	-0.2582	0.8742	1												
TC	-0.8132	-0.8000	-0.0426	-0.0777	0.0100	0.8757	0.0379	0.6837	-0.5706	0.8742	0.815951	1											
FC	-0.2797	-0.1459	0.1943	0.3683	0.1569	0.5229	0.2543	0.3107	-0.5140	0.5054	0.292303	0.410434	1										
HCO ₃	0.5186	0.7405	0.6573	0.7145	0.2988	-0.5857	0.2139	-0.5606	0.0328	-0.1880	-0.56905	-0.6172	0.225472	1									
Cl	-0.6605	-0.7298	0.3258	0.4702	0.3630	0.7213	0.5148	0.6723	-0.7734	0.7508	0.599126	0.672245	0.34838	-0.2471	1								
SO ₄	0.3392	-0.0343	-0.6527	-0.6358	-0.8007	-0.0334	0.0213	0.3280	0.7088	-0.1423	0.211462	-0.25153	-0.31136	-0.33709	-0.3055	1							
PO ₄	-0.4865	-0.5017	-0.3868	-0.2273	-0.5813	0.5633	-0.0794	0.7558	0.0840	0.6970	0.777496	0.513313	0.050141	-0.44091	0.330289	0.291179	1						
NO ₃	-0.7001	-0.8580	-0.4047	-0.3152	-0.3376	0.8481	0.0675	0.9014	-0.2357	0.7012	0.891484	0.81313	0.097135	-0.79637	0.62229	0.2226597	0.800533	1					
Na	0.1617	0.3132	0.5997	0.7003	0.3587	-0.3686	0.1919	-0.2771	-0.2362	0.1349	-0.2543	-0.43802	0.383879	0.831373	0.07063	-0.20813	-0.26251	-0.52009	1				
K	0.1256	0.2537	0.5638	0.7323	0.4035	-0.3240	0.2524	-0.2119	-0.2767	0.1428	-0.25808	-0.43912	0.320953	0.781625	0.165017	-0.20702	-0.21474	-0.45372	0.98022	1			
Ca	0.2262	0.3295	0.2766	0.6346	0.0215	0.2049	0.5677	0.1953	-0.1398	0.2708	-0.04855	-0.0865	0.71711	0.614497	0.190501	-0.18119	0.059163	-0.1758	0.592967	0.589277	1		
Mg	-0.2208	-0.2208	0.2205	0.3251	0.2009	0.3221	0.8306	0.3770	-0.2242	0.0515	0.076127	0.135315	-0.14548	-0.16435	0.593092	0.036769	-0.12529	0.230456	-0.14194	-0.03543	0.046599	1	

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