The statistical analysis of Groundwater at Durgapur using GIS

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***Abstract*— Groundwater is the most suitable source of our drinking water. Contamination of such water sources is a big problem that creates a health hazard. The groundwater quality has been studied at the different points located in the Durgapur Sub-Divisional area. The water sample's physical and chemical parameters were evaluated during all seasons. The parameters like alkalinity, total dissolved solids, hardness, colour, turbidity, pH, dissolved oxygen were tested in the laboratory. To assess the quality of groundwater, each parameter has been compared with the standard desirable limit of that parameter in drinking water as prescribed by IS 10500-2012 and a comparison of different parameters. Statistical analysis has been performed and a correlation coefficient matrix has been evaluated.**

Keywords*— Groundwater, pH, turbidity, DO, TDS, hardness, correlation coefficient, and statistical analysis.

I. INTRODUCTION

In the world, water is the universal solvent. Water is an important resource for humans existing in our world. In our day-to-day life water is an essential thing. Below the land surface everywhere groundwater is available. 0.6% of groundwater in the world is suitable for drinking [1]. Groundwater is less polluted than compared to surface water but now-a-days due to increasing civilization enhanced population, urbanization, and industrialization groundwater is getting polluted. It is contaminated directly by the mixing of disposal of hazardous wastewater and industrial effluents to the groundwater [1].

The objective of the study is to assess the quality of groundwater of the industrial area of Durgapur locality for using drinking. Physico-chemical parameters of groundwater have been determined and statistical analysis has been performed. The correlation coefficient matrix of different water parameters has been determined. The Geological Information System (Arc GIS 10.8) is also used for mapping and selecting the position for collecting groundwater [5].

II. STUDY AREA

A. Location of sampling point

Durgapur is one of the important industrial areas, its geographical area is 154 km^2 and its latitude is 23°55' N and 87°32'E. Our study area is Durgapur industrial zone. Yearly rainfall is 1391ml. There are four groundwater collecting points in our project. That points are Bhiringi, City Centre, Rajbandh, and C Zone (shown in Fig. 1). Four water samples were collected from every sampling point and the total collected samples were eighteen. The study area is located between 23^{0}47' N to 23^{0}56'N latitudes and 87^{0}276' E -87^{0}293'E [4].

B. Geology

Durgapur area is situated on the bank of the river basin. It enters the alluvial plain of Bengal and the topography is an undulating character. It is just beyond the coal-bearing area of Raniganj. Its laterite decomposition consists of composing rock of quartz grain and sandy gravel beds. These are true conglomerates and laterite gravel [2].

C. Climate condition and Rainfall and Temperature

The summer season is hot and dry and the rainy season is hot and cloudy here. The temperature of the Durgapur region typically varies from 53°F 1938.55 mm (annual value to 99°F but rarely below 48°F and above 107°F.[3] The maximum amount of rainfall) and lowest rainfall are 1119mm [10]

D. Table 1. Location of sampling point

Sample No.	Location of sampling point		
	Place	***Latitude***	***Longitude***
S1.	Bhiringi	23°5569'N	87°2768'E
S2.	City centre	23°5391'N	87°3647'E
S3.	Rajbandh	23°4768'N	87°3935'E
S4.	C- Zone	23°5542'N	87°3163'E

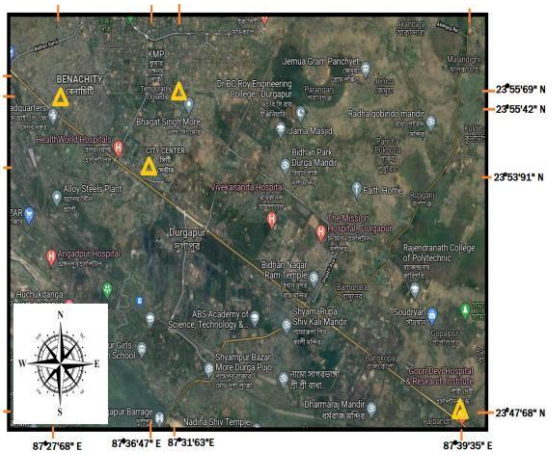

Fig.1: Groundwater collecting point of Durgapur zone

III. MATERIAL AND METHOD

Water samples were collected at four different points (already mentioned) and at every point, four samples were collected. Water samples were collected in cleaned polythene bottles. The collected water was kept in the sterilized bottle separately. The following parameters like pH, total hardness, turbidity, color, DO, BOD, and COD. Were tested in our laboratory (shown in Fig. 2) by following standard methods (shown in Table 2).

TABLE 2. List of Parameters and Methods of Determination

Sl. No.	Method	
	Parameters	***Method of determination***
1.	PH	pH meter
2.	Total hardness (mg/l)	EDTA method
3.	Turbidity	Nephelometric turbidity meter
4.	DO	DO meter
5.	BOD	BOD incubator
6.	COD	COD incubator with the spectrophotometer

Fig. 2: Photos of a few laboratory tests.

IV. RESULTS AND DISCUSSION

After testing, the above-mentioned physio-chemical parameters of collected water, the mean value, and standard deviation were calculated and shown in Table 4. From Table 4, it is observed that the pH value of groundwater is mostly alkaline and its range is 7.0 - 8.4. According to IS 10500-2012, the permissible limit of pH value is 6.5 to 8.5. It is seen that from table 3 the pH of all samples are within the permissible limit.

Turbidity value range is 0.5 -1 mg/l. Where the Desirable limit according to the Indian Standard for Turbidity of groundwater is 1 NTU and the Permissible limit according to the World Health Organization for Turbidity of groundwater is 5 NTU, so all belong in the desirable limit [7].

TDS is one of the important parameters of groundwater. From Table 3 it is observed TDS range is 430 to 520 mg/l. So high-level concentration is 520 which is above the desirable limit. but it is below the permissible limit. According to WHO, it's the permissible limit and desirable limits are 1500 mg/l and 500 mg/l respectively. Durgapur zone underground soil texture is rocky type, so different types of minerals are deposited in water [8].

The hardness of the water in the groundwater range is 240 to 340 mg/ l. It depends on bivalent cations like Ca^{++} and $Mg^{++,}$ etc. In the groundwater different minerals are available also. Where the desirable limit and permissible limit according to the Indian Standard for the hardness of groundwater are 300mg/l and 600mg/l respectively.

Iron: Iron in water occurs in soil rocks and minerals. In the ground, different aquifers contact with solid minerals as a result water is mixed with minerals. The iron concentration level range is 0 to 50.0 mg/l. According to WHO 's recommendation, it is below 0.3 mg/l. It is observed from Table 3, the iron level is 0.063 – 0.182 mg/l. So, it is within the permissible limit [4].

A. Correlation Analysis

The correlation analysis was found using all variables. Correlation analysis shows linear relationships among the variables. A high correlation point represents a strong relationship between the two variables, and a low correlation represents weakly related variables. It gives some idea to the increasing and decreasing tendency of the Physico-Chemical parameter and its relation.

B. Correlation between variables

The correlation coefficients are represented in Table 5. It represents 49 correlation coefficients. From Table 5 it is observed that turbidity with other parameters (like TDS, DO, Alkalinity, Hardness, and Iron) are positive correlation that means these parameters increase then turbidity also increases. The correlation coefficient among TDS and alkalinity is the maximum negative value. TDS and alkalinity have a strong negative correlation.

FIG 3: PICTURES OF THE SOURCES OF COLLECTED WATER

TABLE 3: COLLECTED WATER SAMPLE

Parameters		COLLECTED SAMPLE			
	Unit	**S1**	**S2**	**S3**	**S4**
pH	---	7.62, 7.91, 7.64, 7.89,	8.4, 8.3, 8.3, 8.2,	7.60, 7.62, 7.64, 7.42,	7.96, 7.92, 7.86, 8.12,
Turbidity	NTU	0.60, 0.61, 0.72, 0.75,	0.90, 0.85, 0.81, 0.90.	0.82, 0.80, 0.83, 0.81,	0.90, 0.82, 0.85, 0.90,
Total Dissolved Solids	mg/l	517.5, 509.5, 490.3, 510.2,	475.16, 463.17, 456.60, 458.60	485, 492, 501, 488	453.07, 443.01, 460.50, 452.01
Dissolved Oxygen (DO)	mg/l	5.16, 5.51, 5.65, 5.51	6.86, 6.10, 6.28, 6.30	5.65, 5.71, 5.45, 5.85,	5.64, 5.71, 5.91, 5.44

Parameters	COLLECTED SAMPLE				
	Unit	S1	S2	S3	S4
Alkalinity	mg/l	190, 180, 192, 196	180, 193, 196, 184	198, 190, 192, 212	280, 285, 275, 272
Hardness	mg/l	340, 320, 326, 322	260, 263, 265, 258	321, 312, 310, 321	274, 271, 276, 272
Iron	mg/l	0.063, 0.060, 0.079, 0.076	0.182, 0.180, 0.184, 0.100	0.072, 0.082, 0.085, 0.085	0.091, 0.086, 0.081, 0.088

TABLE 4. BASIC STATISTICS OF GROUNDWATER

Parameters	Statistics				
	Unit	*Min*	*Max*	*Mean*	*Standard Deviation*
pH	---	7.62	8.4	7.91	0.3267
Turbidity	NTU	0.5	1	0.75	0.2061
Total Dissolved Solids	mg/l	437.3	517.5	473.26	30.82
Dissolved Oxygen(DO)	mg/l	5.16	6.86	5.795	0.6258
Alkalinity	mg/l	180	300	237.5	53.0919
Hardness	mg/l	340	240	280	37.4165
Iron	mg/l	0.0630	0.182	0.10025	0.0479

TABLE 5. CORRELATION MATRIX

parameter	Correlation Matrix						
	pH	*Turbidity*	*TDS*	*DO*	*Alkalinity*	*TH*	*Iron*
pH	1						
Turbidity	0.093	1					
TDS	-0.236	0.118	1				
DO	0.231	0.771	0.01	1			
Alkalinity	-0.365	0.020	-0.916	-0.404	1		
TH	-0.013	0.129	0.814	-0.505	-0.585	1	
Iron	0.369	0.886	0.146	0.989	-0.702	-0.051	1

V. CONCLUSION

The statistical analysis of collected sample data of groundwater has been performed in this study. The samples of groundwater have been collected from the area of the Durgapur Sub-Division. The different parameters of the groundwater sample are within the permissible limit as per the World Health Organization. Finally, a correlation coefficient matrix is provided based on the test results for future reference.

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