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Analysis of Ground Water Quality of Sangli-Miraj-Kupwad Industrial Area by Correlation And Regression Method

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Abstract: ***The present study was carried out to assist find impact of industrial activities on the ground water quality in Sangli-Miraj-Kupwad Industrial area. The total area taken under study is 390.11 Hectares. 17 representative samples were collected from various sources such as bore well and surface water for analysis of physico-chemical and biological parameters. The physical parameters such as pH, Electrical Conductivity (EC), Total dissolved solids (TDS), Turbidity, Total Hardness, Magnesium, Sodium, Potassium, Sulphate, Nitrate, Chlorine were analyzed. Heavy Metals such as Copper, Ferrous, Cadmium, Mercury, Lead and Arsenic were analyzed to know the present situation of ground water quality. Results were compared with World Health Organization (WHO) and Bureau of Indian Standards (BIS). Ground water was found to be polluted at few sample collection sites and also heavy metals concentration such as Mercury, Arsenic and Lead are more than the standard limits. At present groundwater is not used for drinking purpose. The Correlation and Regression method for prediction of parameter values within reasonable degree of accuracy.***

Keywords: Groundwater, water quality, bore well, water supply, correlation, regression method

1. Introduction

Ground water is the principal source of drinking water in our country and indispensable source of our life. The problem of ground water quality is acute. Groundwater is particularly important as it accounts for 88 % of the drinking water in rural area [2]

The water pollution in industrial area is caused due to rapid growth of industries, direct disposal of untreated effluents on land, leading to soil pollution and this water further percolates into groundwater. Lack of awareness among the people is one of the reasons for increase in the water pollution in an industrial area.

Different industries in an industrial area also lead to different waste water quality, including heavy metals viz., arsenic, lead, mercury, cadmium, etc The wastewater quality is also a function of the physico-chemical and biological parameters, and could be subjective as it depends on a particular intended use [2]. Water is also essential raw material for photosynthesis and therefore it is important for crop production [2]. Almost 70% of water in India has become polluted due to the discharges of domestic sewage and industrial effluents into natural water sources [2].

The classification, modeling and interpretations of monitoring data are the most important steps in the assessment of water quality.

Life is not possible on this planet without water. It exists in three states namely solid, liquid and gas. It acts as a media for both; chemical and biochemical reactions and also as internal and external medium for several organisms [2]. According to Central Pollution Control Board, 90% of the water supplied in India to the town and cities are polluted, out of which only 1.6% gets treated. Therefore, water quality management is fundamental for the human welfare [2].

Correlation analysis measures the closeness of the relationship between chosen independent and dependent variables. If the correlation coefficient is nearer to +1 or –1, it shows the probability of linear relationship between the variables x and y . This way analysis attempts to establish the nature of the relationship between the variables and thereby provides a mechanism for prediction or forecasting [2].

2. Study Area

Sangli-Miraj-Kupawad industrial area situated at Miraj taluka in Sangli District, Maharashtra, India. Its geographical coordinates are 16° 52' 0" North, 74° 34' 0" East.

3. Methodology and Materials

3.1 Methodology

The groundwater samples are collected in polyethylene bottles from 17 respective bore-well stations in study area. The bottle was rinsed before the sampling after collection the bottles are labeled on field. 8 samples collected from Kupawad industrial area and 9 samples collected from Miraj industrial area and named KBW1, KBW2, KBW3, KBW4, KBW5, KBW6, KBW7, KBW8,and MBW1, MBW2, MBW3, MBW1, MBW4, MBW5, MBW6, MBW7, MBW8, MBW9. After sampling analysis is done for the following parameters pH, EC, TDS, magnesium, sodium, potassium, carbonates, chlorides, sulphates, nitrate, chlorine, DS, copper, ferrous, cadmium, mercury, lead, arsenic and total hardness as per the standard procedure. The results were compared with WHO (world health organization) and BIS (Bureau of Indian standards). The statistical analysis has

been carried out which consist of correlation and Regression between each parameters.

4. Results And Discussion

Table 1: Quality parameters of ground water samples.

	pH	EC	TDS	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate	Chlorine	DS	Copper	Ferrous	Cadmium	Mercury	Lead	Arsenic	TH
KBW1	7.06	1.35	0.88	12.36	14.95	0	186	0	34.2	105	1050	0.12	0	0	0	0	0.61	550
KBW2	6.75	1.59	1.05	15.24	210.2	0	144	68.6	85.1	132	1080	0.2	0.75	4.8	20.36	4.45	0	580
KBW3	6.83	1.21	0.78	10.2	210.2	5.1	144	58.1	2.8	140	1200	0	1.04	0	0	0	0.26	500
KBW4	6.65	4.52	2.97	10.2	60.03	0	662	0	15.7	147	1260	0	0	0	0	13.04	0.3	2090
KBW5	7.12	1.39	0.91	11.52	130.2	5.1	188	0	26.9	150	1200	0.14	0.8	0	0	0	0.26	600
KBW6	6.68	1.68	1.12	12.24	120.1	5.1	186	0	35.8	177	1110	0.15	4.98	0	91.56	0	0.49	700
KBW7	7.01	1.68	1.13	10.08	94.99	0	200	0	27.4	131	1200	0	0	0	0	0.15	0	600
KBW8	6.82	1.53	1.01	10.56	25.07	0	256	0	33.6	118	930	0.2	0.81	0	0	0.57	0.44	650
MBW1	7.11	0.82	0.54	10.32	140.1	0	73.5	88.8	18.5	76	930	0.67	0	0	0	0	0	260
MBW2	6.6	3.85	2.53	10.56	190.2	0	564	0	49.8	153	960	0	0	0	0	2.78	0	1350
MBW3	7.74	0.57	0.37	10.44	150.2	10	144	113	23	12	1050	0	0	0	17.44	5.27	0	130
MBW4	6.8	1.52	0.98	10.2	5.06	0	144	0	32	147	960	0	0	0	0	0	0.28	610
MBW5	6.57	2.9	1.92	12.24	295.1	0	480	0	29.7	155	1260	0.62	0	0	0	18.78	0	1130
MBW6	6.73	2	1.33	11.16	155	5.1	270	0	17.9	144	1050	0	0	0	0	1.19	0	960
MBW7	6.67	2.29	1.52	11.16	60.03	5.1	382	0	16.8	123	810	0.12	1.53	0.12	0	10	0.55	840
MBW8	7	8.35	5.51	24.48	310.3	5.1	1754	0	68.3	55	1800	0.41	0.97	0	0	2.6	0	2990
BIS	6.5-8.5	-	5	30	-	-	250	200	45	250	500	0.05	2	0.01	0.001	0.05	0.1	200
WHO	6.5-8.5	-	-	30	200	-	250	300	50	250	500	0.05	2	0	0.001	0.01	0.01	500

(All parameters are mg/lit exept pH, EC and Turbidity in NTU)

pH :- pH is an important for water sampling, the pH value of respective samples was 6.6 to 7.74 well within the desired standard limit .

Electrical conductivity (EC):- It gives a measure of dissolved solid present in water. The EC values of few station points KBW4, MBW2 and MBW8 was above the limit indicating that dissolved salt were present in the water samples.

Total Dissolved solid (TDS):- All the samples are within prescribed limits.

Magnesium: Observed range of magnesium content is within standard limit.

Sodium: - Sodium concentration was found to be above the prescribed limits for stations KBW2, KBW3, MBW4 and MBW8 which more than 200mg/lit.

Potassium: - Potassium concentration of respective samples ranges from 0 to 10.14mg/lit, which is well within the prescribed limit.

Sulphate: - Sulphate content observed during test is between 0-122.8 mg/lit within desired standard limits.

Nitrate: - It is observed that, at few stations, content of Nitrate is more than required standard limits. The content value and station are KBW2 with 85.12 mg/lit, MBW2 with 49.84 mg/lit and MBW8 have 68.32 mg/lit in water samples.

Chlorides: It is observed that Chloride concentration of respective samples ranged from 73.5-1753.5 mg/lit. There are total 7 stations whose chloride concentration are more than 250 mg/lit, which are KBW4, KBW8, MBW2, MBW5, MBW6, MBW7 and MBW8. The highest level chloride concentration is 1753.5 mg/lit at station MBW8.

Dissolved Solids (DS):- DS present in respective samples ranges between 810-1260mg/lit. The concentration of DS is more than standard limits of 500mg/lit.

Ferrous: - Ferrous concentration of all stations within the standard limit of 2PPM, except KBW6 which is 5PPM.

Cadmium: - Cadmium is found at all stations within the standard limit of 0.003PPM, except KBW2 with 4.8PPM and MBW7 with 0.12PPM that concentration of these two stations is more than standard limits.

Mercury:- Mercury concentration few station such as KBW2 with 20.36PPM, KBW6 with 91.56PPM, MBW3 with 17.44PPM is more than the standard limits.

Lead: - Lead concentration of all stations ranges between 0.57PPM to 18.78PPM except KBW1, KBW3, KBW5, KBW6, MBW1 and MBW4. The results found are concentration is more than standard limit.

Arsenic: - Concentration of arsenic at few stations is more the range between 0.28 PPM to 0.61PPM.

Total Hardness: - Concentration of almost all station is more than standard value; respective sample ranges 130-2990mg/l.

5. Statistical Analysis

In statistics, correlation is a broad class of statistical relationship between two or more variables. The correlation study is useful to find a predictable relationship which can be exploited in practice. In water quality it is used for the measurement of the strength and statistical significance of the relation between two or more parameters. [4] Correlation analysis measures the closeness of the relationship between chosen independent and dependent variables. If the correlation coefficient is nearer to +1 or –1, it shows the probability of linear relationship between the variables x and y. The correlation between the parameters is characterized 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 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 [4].

In this study, the relationship of water quality parameters with each other in the data of water analyzed was determined by calculating Karl Pearson's correlation coefficient, R, by using the formula as given below.

$$R = \frac{\sum(X-\bar{X})(Y-\bar{Y})}{\sqrt{\sum(X-\bar{X})^2 \sum(Y-\bar{Y})^2}}$$

Were X- variables of X- variable

$\bar{X}$ – Average values of X

Y- Variables of Y-variable

$\bar{Y}$ –average values of Y

To determine the straight linear regression, following equation of straight line can be used.

If the values of correlation coefficient 'r' between two variables X and Y are fairly large, it implies that these two variables are highly correlated. In such cases it is fissile to try linear relation in the form-

The values of empirical parameters 'a' and 'b' are calculated with the help of the following equation. [4]

$$Y = a + bX$$

$$Y = \frac{\sum XY - \bar{Y}\sum Y}{\sum X^2 - \bar{X}\sum Y}$$

$$Y = \frac{\sum XY - \bar{Y}\sum Y}{\sum X^2 - \bar{X}\sum Y}$$

In this study the value of correlation coefficient R is obtained by using the Karl Pearson's formula for water quality parameters which shows that relationship between two or more parameters in table 2.

After the linear regression analysis of water quality parameter it is found that one parameter based on one or more parameters, like EC is based on pH, TDS, TH, Mg and DS as shown in table 3.

The study of correlation regression between different water quality parameters was carried out by using Microsoft Excel 2007.

Table 2. Correlation Matrix for Different Ground Water Parameters

Parameters	pH	EC	TDS	Magnesium	Sodium	Potassium	Chloride	Sulphate	Nitrate	Chlorine	DS	Copper	Ferrous	Cadmium	Mercury	Lead	Arsenic	TH
pH	1																	
EC	-0.272	1																
TDS	-0.273	1	1															
Magnesium	0.023	0.763	0.764	1														
Sodium	-0.053	0.468	0.469	0.572	1													
Potassium	0.520	-0.031	-0.030	0.152	0.229	1												
Chloride	-0.132	0.981	0.981	0.824	0.499	0.083	1											
Sulphate	0.623	-0.408	-0.409	-0.111	0.216	0.329	-0.331	1										
Nitrate	-0.106	0.416	0.417	0.684	0.364	-0.227	0.406	-0.032	1									
Chlorine	-0.815	-0.099	-0.098	-0.329	-0.137	-0.421	-0.246	-0.617	-0.082	1								
DS	0.068	0.753	0.753	0.776	0.617	0.162	0.784	-0.166	0.324	-0.183	1							
Copper	-0.038	0.184	0.186	0.363	0.459	-0.238	0.238	0.153	0.188	-0.204	0.228	1						
Ferrous	-0.227	-0.015	-0.013	0.154	0.008	0.326	-0.013	-0.155	0.088	0.306	0.035	-0.009	1					
Cadmium	-0.127	-0.103	-0.102	0.236	0.210	-0.206	-0.142	0.332	0.680	0.059	-0.051	0.042	0.019	1				
Mercury	-0.064	-0.158	-0.155	0.043	0.010	0.281	-0.171	0.053	0.172	0.214	-0.031	-0.045	0.879	0.139	1			
Lead	-0.320	0.282	0.283	0.005	0.286	-0.096	0.241	-0.096	-0.065	0.088	0.117	0.285	-0.174	0.044	-0.151	1		
Arsenic	-0.185	-0.213	-0.214	-0.213	-0.676	-0.016	-0.215	-0.386	-0.276	0.270	-0.325	-0.251	0.455	-0.224	0.241	-0.108	1	
TH	-0.336	0.984	0.984	0.693	0.399	-0.061	0.946	-0.463	0.338	-0.012	0.738	0.132	-0.019	-0.122	-0.157	0.327	-0.158	1

Table 3: Linear correlation coefficient R and regression equation for some pairs of parameters, which have significant value of correlation

Pair of Parameters	R^2-Value	Regression Coefficient		Regression equation
		a	b	
EC-pH	0.074	6.980	0.041	EC=-0.041x+6.980
EC-TDS	0.999	-0.002	0.059	EC=0.659x-0.002
EC-TH	0.968	45.36	370.8	EC=370.8x+45.36
TDS-Chloride	0.962	125.2	316.6	TDS=316.6x-125.2
TDS-TH	0.968	46.75	561.7	TDS=561.7x+46.75
Mg-Cl	0.678	-775	94.16	Mg=94.16x-775
TH-Cl	0.895	-125.2	0.535	TH=0.535x-125.2
pH-K	0.270	-36.82	5.717	pH=5.717x-36.82
pH-SO_4^{2-}	0.388	-542.1	81.73	pH=81.73x-542.1
EC-Mg	0.582	8.748	1.422	EC=1.422x+8.748
Mg-Na	0.327	-42.9	14.81	Mg=14.81x-42.9
Mg-NO_3^-	0.468	-15.22	3.944	Mg=3.944x-15.22
Mg-DS	0.601	526.8	48.81	Mg=48.81x+526.8
TDS-DS	0.566	-910.2	133.8	TDS=133.8x-910.2
EC-DS	0.556	910	88.29	EC=88.29x+910
DS-Cl	0.614	-122	1.423	DS=1.423x-122
NO_3^-- Cd	0.462	-0.974	0.039	NO3=0.039x-0.974
TH-DS	0.544	906.8	0.229	TH=0.229x+906.8

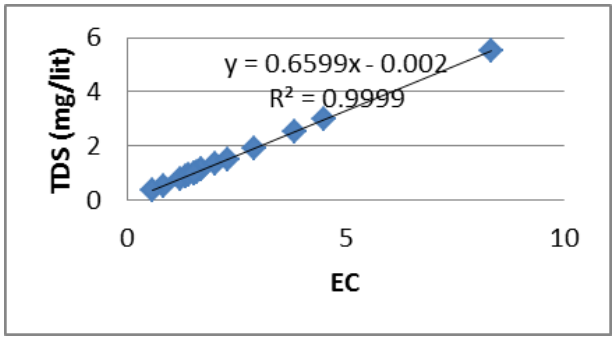

Figure 1: Linear plot between EC and TDS

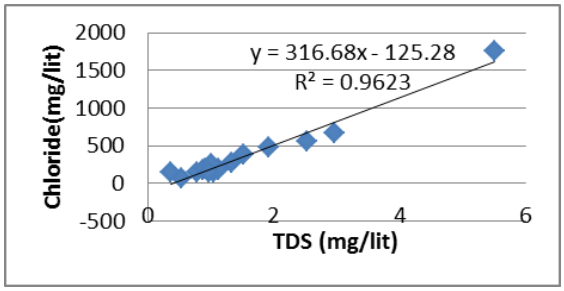

Figure 2: Linear plot between TDS and Chloride

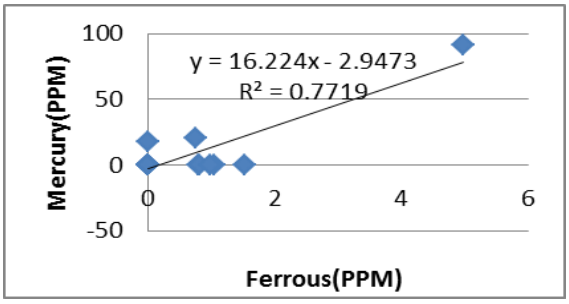

Figure 3: Linear plot between Ferrous and Mercury

6. Conclusion

It is found that the ground water quality of Sangli-Miraj-Kupwad industrial area is affected due to exceed concentration of Sodium, Chloride, Nitrate, DS and heavy metals (like Mercury, Lead, Cadmium and Arsenic) than the standard limits. The correlation results shows that EC and TDS are highly correlate with DS, Magnesium and Chloride. The regression method is shows in the form of mathematical equation between EC and TDS in fig.1, TDS and Chloride in fig.2 and Ferrous and Mercury in fig.3. After present study it is clear that the ground water in study area is not drinkable.

References

[1] David Noel S and Rajan MR, "Impact of Dyeing Industry Effluent on Groundwater Quality by Water Quality Index and Correlation Analysis," Department of Biology, Gandhigram Rural Institute-Deemed University, Gandhigram-624302, Tamilnadu, India. vol. 2, 2014.

[2] Rajdeep Kaur and R.V. Singh, "Correlation Analysis of Groundwater Quality of Bichhwal Industrial Area Bikaner, "International Jurnal of Chemical, Environmenatal and pharmaceutical research Vol-2, pp-146-151, 2011.

[3] R.V.Kupwade and A.d.Langade. "Pre and Post Mansoon Monitoring of Ground Water Quality in Region near Kupwad MIDC, sangli, Maharashtra." International Jurnal Of ChemTech research Vol-5,pp-2291-2294 2013

[4] Sudhakar Gummadi, Swarnalata.G, Z.Vishanuvardhan,Harika.D "Statistical Analysis of the Groundwater Sampales rom Bapatla Mandal, Guntur District,Andra Pradesh, India.Vol-8, pp27-32 2014

[5] S.Devi and R. Premkumar "Physicochemical analysis of Gorundwater smaples near Indutrial Area, Cuddalore District, Tamilnadu,India," International Jurnal Of ChemTech research Vol-4,pp-29-34 2012

[6] Sami G.Daraigan, Ahmed S.Ba-Mosa,Manal H.Obid, "Linear Correlation analysis study of drinking water quality data for Al-mukalla city,Hadhramout,Yemen,"Vol-1,pp-1692-1701,2011.

[7] A.Ravi Kumar, S.Mazhar Nazeeb Khan and R.sivannesan, "A Correlation and Regression Study on the Ground Water of Vaiyampatti Village, Tiruchirappalli District," Vol-4(5),pp-1847-1852, 2012.

[8] Abdul Saleem, Mallikarjun N. Dandigi and K.Vijay Kumar, "Correlation- Regression model for phyico-chemical quality of groumdwater in the south Indian city of Gulbarga,"Vol-6,pp-353-364,2012

[9] Muthulakshmi L,Ramu A,Kannan.N, Murugan A, "Application of Correlation and Regression analysis In Assesing GroundWater Quality," International Jurnal Of ChemTech research Vol-5,pp-353-361, 2013

[10] V.K.Parvathavarthinand and T. Senthilnathan, "The Groung Water Assesment of an industrial Town Near South Channai City," Indian J. Environmental Protection Vol-34, pp-65-70, 2013.

[11] V.Rajesh Babu and A.Murugesan, "Impact of industrial pollution on Ground Water in North Channai," Indian J. Environmental Protection Vol-33, pp-720-728, 2013.

[12] Kumar A, "Water Pollution" C.K.Jain,C.P.Kumar and M.K.Sharma, "Ground water Quality of Ghataprabha Command Area, Karnataka . Nisha Enterprises, New Delhi. 2004