Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 4, Issue 4; April-June, 2017, pp. 339-342

http://www.krishisanskriti.org/Publication.html

Assessment of Ground Water Quality in Terms of Water Quality Index and Regression Analysis of Water Quality Parameters

Suman.K.Dhaka[1] and Narendra Bhaskar[2]

[1]A P Goyal Shimla University
[2]Senior Engineer, Civil Design, SJVN Ltd
E-mail: [1]sumandhaka13@gmail.com, [2]naren.bhaskar@gmail.com

Abstract—*Present work is aimed to access ground water quality in terms of water quality index by Weighted Arithmetic Index Method. Total 22 groundwater samples and ten water quality parameters of each sample are considered in this study. Water quality is good at seven stations and very poor and unsuitable for drinking at ten stations. High water quality index is due to high turbidity, high concentration of Fluoride and iron. Correlation of selected parameters is analyzed and found that Electrical conductivity has significant correlation with Alkalinity, nitrite, sodium, and sulphate. Regression equations relating correlated parameters were formulated. A comparative study is also done with Indian standard and WHO standard for drinking water.*

Keywords*: Groundwater quality, regression analysis, water quality index, correlation*

1. INTRODUCTION:

Water is one of the most important substances on earth. All plants and animals must have water to survive. Among all available sources of water, groundwater is most decentralized and dependable source of water for millions rural and urban families. It accounts for nearly 80 percent of the rural domestic water needs and 50 per cent of the urban water needs in India (Dinesh el. al, 2006). In recent years the rapid growth in population, urbanization and industrialization created adverse impact on groundwater in both quantitative and qualitative aspect. Pollution of groundwater due to industrial effluents and municipal waste in water bodies is a major concern in many cities and industrial clusters in India (Kittu, 1995).

2. STUDY AREA:

Study area is located in Solan district of Himachal Pradesh state. Solan is one of the south-western districts of Himachal Pradesh having geographical area of 1,936 sq km. The district lies between north latitude 30°44'53" to 31°22'01" and east longitude 76°36'10" to 77°15'14". The district is bounded by Bilaspur district in north-west and Mandi district in the north, Shimla and Sirmaur districts in east and south-east respectively. The climate of the district is sub-tropical in the valley and tends to be temperate on the hilltops. Maximum precipitation occurs during July to September. Average annual rainfall in the district is about 1140.86 mm. precipitation as snowfall also occurs in the higher reaches up to 1000 m elevation and as rainfall in low hills and valleys of the district. Mean maximum and minimum temperature ranges between 32.2°C (May) and 0.6°C(January)

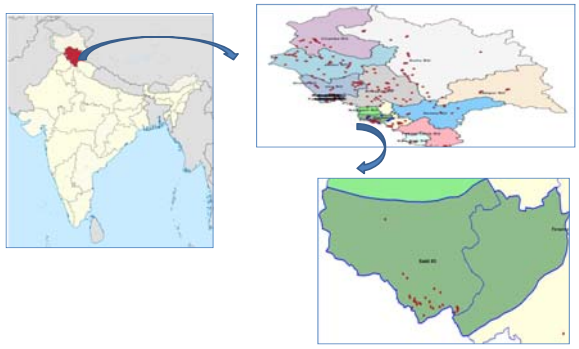

Fig. 1: Study Area Map Showing Ground Water Quality Monitoring Stations

Baddi is an industrial town in the Southwestern Solan district . The town lies on the border of Himachal Pradesh and Haryana states in the Shivalik Hills, around 35 kilometres west of Solan. Baddi is home to multiple pharmaceutical companies who have established manufacturing plants and R&D hubs in the town. The town is Asia's biggest Pharmaceuticals hub. In addition to pharmaceutical companies, Baddi also houses a total of 2,120 factories belonging to leading FMCG and textile companies.

3. LITERATURE REVIEW:

There are a number of methods to analyze water quality data that vary depending on informational goals, the type of samples, and the size of the sampling area. One of the most effective ways to communicate information on water quality trends is by use of the suitable indices (Dwivedi & Pathak, 2007). Indices are based on the values of various physico-chemical and biological parameters in a water sample. Initially, WQI was developed by Horton (1965) in United States by selecting 10 most commonly used water quality variables like dissolved oxygen (DO), pH, coliforms, specific conductance, alkalinity and chloride etc. Ramakrishnaiah et al. (2009) used water quality index to assess groundwater quality of Tumkur Taluk, Karnataka State. 17 parameters such as pH, electrical conductivity, TDS, total hardness, bicarbonate, carbonate, chloride, sulphate, phosphate, nitrate, fluoride, calcium, magnesium, sodium, potassium, iron and manganese are used to calculate water quality index and water quality is divided in 5 categories. Muthulakshmi et al. (2013) studied correlation of water quality parameters and determined linear regression models for highly correlated parameters.

4. METHODOLOGY

The Department of Environment & Scientific Technologies was set up on April 13, 2007 with objectives to improve the effectiveness of environmental management, protect vulnerable ecosystems and enhance sustainability of development. This department monitors groundwater quality and surface water quality. There are total 259 ground water stations located in Himachal Pradesh and out of these 22 stations are located in study area. Water quality indices are calculated for these stations Correlation coefficients are analyzed and linear regression is done to find the relation between water quality parameters which have correlation coefficient greater than 0.5 .

Water quality indices are calculated at all 22 stations using Weighted Arithmetic Index Method (Ansari & Hemke , 2013).Water quality index is given by following formula

$$WQI_i = \frac{\sum(WQR)_i \times (W)_i}{\sum W}$$

Where WQI_i =Water quality index of i^{th} parameter

WQR_i =water quality rating of i^{th} parameters

W_i = Relative Weightage of i^{th} parameter, $RW_{i=}1/S_i$, S_i= Standard permissible value of i^{th} parameter

Water quality index is calculated in 3 steps as explained below.

First step: a relative weightage of each parameter is calculated by taking reciprocal of standard permissible value for that parameter. The relative weightage of iron is highest among all the parameters. Relative weightage of all the selected parameters are given in table below.

Table 1: Relative Weightage of Water Quality Parameters

S. No	Parameter	Standard permissible value	Relative Weightage(W_i)
1	PH	7	0.1429
2	Turbidity	1	1.0000
3	Total Hardness	300	0.0033
4	Chloride	250	0.0040
5	Total Dissolved Solids	500	0.0020
6	Alkalinity	200	0.0050
7	Fluoride	1	1.000
8	Sulphate	200	0.0050
9	Nitrate	45	0.0222
10	Iron	0.3	3.3333
			∑Wi= 5.517746032

Second step: water quality ratings are calculated for each parameter at each station. Water quality rating is given by the following formula:

$$WQR_i = \frac{(C_i - V_i)}{(S_i - V_i)} \times 100$$

Where is WQR_i water quality rating of i_{th} parameter

C_i = value of the water quality parameter obtained from the laboratory analysis,

S_i = value of the water quality parameter obtained from recommended Indian Standard

Parameter,

V_i = the ideal value which is considered as 7.0 for pH and zero for all other parameters

Third step: In last step water quality sub indices are calculated for each parameter by multiplying relative weightage and water quality rating and divided by sum of relative weights.

$$SI_i = \frac{(WQR)_i \times (W)_i}{\sum W}$$

SI_i= Sub index for i_{th} parameter, WQR_i = Water quality rating of i^{th} parameters W_i = Relative Weightage of i^{th} parameter,

Water samples are divided in 5 categories according to value of water quality index.

5. RESULTS:

Water quality parameters are compared with drinking water guidelines of WHO and Bureau of Indian standards. Concentrations of sulphites and chlorides have 100 percent compliances with BIS and turbidity has minimum 32 percent compliance with BIS. Turbidity is exceeded permissible limit

of WHO at all the stations.A comparative study has been done with groundwater quality parameters and Indian and WHO standard of drinking water and reported as given below.

Table 2: Comparison Of Groundwater Quality With Bis And Who Standard

Parameters	Indian Standard	Percent compliance	WHO Standard	Percent compliance
PH	6.5-8.5	100	7-8	77
Turbidity, NTU	1	32	5	82
Total hardness as $Caco_3$ (mg/l)	300	73	100	0
Chloride (mg/l)	250	100	250	100
Total Dissolved solids (mg/l)	500	95	1000	100
Flouride (mg/l)	1	95	1	95
Sulphate (mg/l)	200	100	250	100
Nitrate (mg/l)	45	100	50	100
Iron	0.3	40	0.3	40

A large variance found in water quality indices at different locations in study area and the range of WQI is 50 to 834. WQI is above 400% at 4 stations and the maximum value of WQI is 834% at Burawala. Water quality indices are shown in the chart given below.

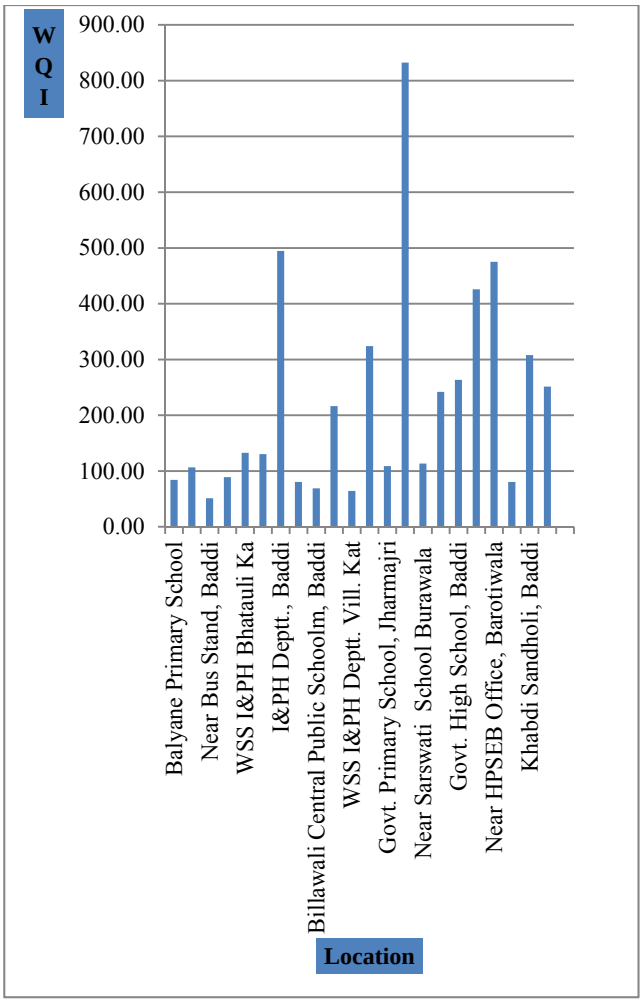

Fig. 2: Water Quality Index At Various Locations

Groundwater samples are classified in 5 categories as excellent, good, poor, very poor and unsuitable for drinking purpose as given in the table below.

Table 3: Water Quality Classification Based On WQI Value

S. No	WQI value	Water quality	Percentage water samples
1	<50	Excellent	0
2	50-100	Good	32
3	100-250	Poor	23
4	250-350	Very poor	27
5	>350	water unsuitable for drinking	18

Table 4: Correlation Coefficients Of Water Quality Parameters

	PH	EC	TDS	Turbidity	DO	Alkalinity	So4	Na	K	No2
PH	1									
EC	-0.19	1								
TDS	0.03	0.73	1.00							
Turbidity	0.16	0.02	-0.09	1.000						
DO	-0.26	0.18	0.46	-0.189	1.					
Alkalinity	-0.05	0.55	0.48	0.143	0.17	1.000				
So4	-0.01	0.46	0.22	0.214	-0.223	-0.232	1.000			
Na	0.305	0.40	0.41	0.304	0.000	0.156	0.591	1.0		
K	-0.066	0.12	-0.1	-0.19	-0.193	-0.195	0.356	0.27	1	
No2	-0.269	0.41	0.31	-0.260	0.178	0.019	0.285	0.14	.20	

Electrical conductivity has significant correlation with Alkalinity, nitrite, sodium, and sulphate. Correlation between Electrical conductivity and total Dissolved Solids is highest. Correlation of TDS is significant with Dissolved oxygen, Alkalinity and sodium. Sulphates have good correlation with sodium.

6. CONCLUSION

Groundwater is being severely affected by industrial growth in the study area. Water quality is good only at few locations. Chlorides, sulphates, PH are within permissible limits and main concern in this area is high concentration of Iron and high Turbidity. Large spatial variability in Water quality indices indicates that groundwater being affected by some anthropogenic activities. Turbidity needed to be considered for further research to identify individual parameters causing it. The analysis reveals that the groundwater of the area needs some degree of treatment before consumption, and it also needs to be protected from the hazards of further contamination.

REFERENCES:

[1] Ansari, K., & Hemke, N. M. (2013). Water quality index for assessment of water samples of different zones in Chandrapur city. GROUND WATER, 3(3).

[2] Aris,AZ, Abdullah,M.H.& Kim, K.W., Hydrogeochemistry of ground water in Manukan Island, Sabah., The Malaysian Journal of Analytical Science, 2007, 11, (2), 407-413.

[3] Horton, R.K., "An index number system for rating water quality", J. Water Pollu. Cont. Fed., 37(3). 300-305. 1965.

[4] IS10500, B. I. S. (2012). Indian Standard Drinking Water–Specification (Second revision). Bureau of Indian Standards (BIS), New Delhi.

[5] Kittu, N. (1995). Status of Groundwater Development and its Impact on Groundwater Quality. Groundwater Availability and Pollution, The Growing Debate over Resource Condition in India. Monograph, Ahmedabad: VIKSAT-Natural Heritage Institute.

[6] Kumar, M. D., & Shah, T. (2006). Groundwater pollution and contamination in India: the emerging challenge. IWMI-TATA Water Policy Program Draft Paper, 1, 14.

[7] Muthulakshmi, L., Ramu, A., Kannan, N., & Murugan, A. (2013). Application of correlation and regression analysis in assessing ground water quality, Virudhunagar, India. International Journal of ChemTech Research, 5, 353-361.

[8] Rajankar, P. N., Gulhane, S. R., Tambekar, D. H., Ramteke, D. S., & Wate, S. R. (2009). Water quality assessment of groundwater resources in Nagpur Region (India) based on WQI. Journal of Chemistry, 6(3), 905-908

[9] Ramakrishnaiah, C. R., Sadashivaiah, C., & Ranganna, G. (2009). Assessment of water quality index for the groundwater in Tumkur Taluk, Karnataka State, India. Journal of Chemistry, 6(2), 523-530

[10] Saberi Nasr, A., Rezaei, M. and Dashti Barmaki M., "Groundwater contamination analysis using Fuzzy Water Quality index (FWQI): Yazd province, Iran", J Geope 3., (1). 47-55. 2013.

[11] S. L. Dwivedi and V. Pathak, "A Preliminary Assignment of Water Quality Index to Mandakini River, Chitrakoot,"Indian Journal of Environmental Protection, Vol. 27, No.11, 2007, pp. 1036-1038.

[12] WHO (World Health Organization) Guidelines for drinking water quality, 2nd Ed. 1993, Vol **1**, p 188.