BILINGUAL PUBLISHING CO.
Pioneer of Global Academics Since 1984

Hydro Science & Marine Engineering
https://ojs.bilpublishing.com/index.php/hsme

ARTICLE

Application of Water Quality Index (WQI) and Regression Analysis of Groundwater in Budigumma Village, Anantapur District, Andhra Pradesh

Ambiga K*

Department of Civil & Strucutral Engineering, SCSVMV, Enathur, Kanchipuram, 631561, Tamilnadu, India

ARTICLE INFO

Article history
Received: 24 November 2019
Accepted: 5 December 2019
Published Online: 31 December 2019

Keywords:
Groundwater
Physical characteristics
Chemical characteristics
Water classification
Water Quality Index
Correlation and Regression

ABSTRACT

The research work is aimed at assessing the subsurface or groundwater suitability for human use or consumption depends upon the calculated water quality index values, correlation coefficient and regression analysis. The water quality index (WQI) is main important tool to calculate the characteristics of drinking water quality in rural, urban and industrial area. Different parameters which is measured and determination of the water quality index for selecting parameters. Further to study the correlation and regression method in this research work. Totally fifteen groundwater samples were collected from the Budigumma Village Anantapur district in the state Andhra Pradesh in India. Nine water quality parameters has been considered for the computation of water quality index such as pH, total dissolved solid (TDS), total hardness (TH), calcium (Ca), magnesium (Mg), nitrates (NO3), chlorides (Cl), sulphates (SO4), fluorides (F). The World Health Organization (WHO) has been assessed to the suitability of groundwater for drinking purposes or other uses for public and determining of WQI. This WQI index values ranged from 97.78 to 108.37. The study shows that 87% area comes under the poor category of drinking purposes and the remaining 13% comes under as good water for drinking purposes as per the WQI classification. The correlation and regression analysis gives as an outstanding device for the calculation of different parameter values within realistic degree of precision. The subsistence of strong correlation or relationship between the total hardness and magnesium is determined. The analysis of selected parameters revealed that proper treatment before use or consumption and protected from more contamination.

1. Introduction

In the world, groundwater is main basis of water supply using for human consumption. Groundwater occurs about all over the place under the aquifer [1]. Groundwater is a fixed resource and it is an infrequent advantage in various parts of the world. The water is a limited supply in the countries where the opposition is unrestrained among industry, domestic use and agriculture [2].

The quality of groundwater has develop into main water resource subject to quick raise in population, rapid built-up development, increasing petroleum and mining

**Corresponding Author:*
Ambiga K,
Department of Civil & Strucutral Engineering, SCSVMV, Enathur, Kanchipuram, 631561, Tamilnadu, India;
Email: ambigacivil.scsvmv@gmail.com

 DOI: https://doi.org/10.30564/hsme.v1i2.1455

operations and as well use of pesticides and fertilizers in agriculture [3]. In India, many population use subsurface water as its main basis of drinking water [4]. Hence it develops into very significant to frequently verify the quality of groundwater to protect it.

Water Quality Index (WQI) is main important tools to converse in sequence on the water quality to the disturbed people and strategist [5]. This WQI is a arithmetical formula used to change into various great number of quality of groundwater data into a particular quantity or number. The study of groundwater quality in the research area has been calculated for the various groundwater samples using the method of weighted arithmetic index [6].

The study of the research area mainly deals with the WQI and analysis of correlation and regression method in Budigumma Village, Anantapur district in the state Andhra Pradesh, India.

This is main problem to create the environmental perception of a situation or fact among the peoples.

2. Materials and Methods

Totally fifteen groundwater samples were collected in the well sample station in Budigumma Village, Anantapur district in the state Andhra Pradesh. As per rule of standard, collection of the groundwater samples were analysed by physico - chemical characteristics of nine parameters such as pH, total dissolved solid (TDS), total hardness (TH), calcium (Ca), nitrates (NO_3), magnesium (Mg), chlorides (Cl), sulphates (SO_4), fluorides (F). These parameters were determined as per standard as presented in Table 1. Different instruments used for different parameters were accurate or calibrated prior to make use of detect readings[7]. Concordant readings for different parameters were to make certain accuracy and precision of results.

2.1 Water Quality Index (WQI)

Determination of Water Quality Index (WQI) is the following steps.

(1) Each nine parameters has been allocated a weight (wi) for overall water quality [7].

(2) Nitrate and Fluoride parameter has been allocated to the weight of 5 and 4 [8].

(3) Relative weight is calculated by weight of each parameter divided by summation of weight of each parameter. Nine parameters value as presented in Table 2.

(4) Quality rating scale (qi) is calculated by concentration (C_i) of each parameter and divided by standard values (S_i) [9]. The result values of each parameter is multiplied by hundred [10].

(5) Sub Index of i^{th} parameter is calculated by relative weight and quality rate [11] as shown in Table 3.

(6) Water Quality Index values are determined and classified into excellent water (<50), good water (50 -100), poor water(100-200), very poor water(200-300), water unsuitable for drinking(>300) [12,13] as presented in Table 4.

2.2 Correlation Coefficient (r)

(1) Let independent parameter(x) and dependent parameter (y) are the variables.

(2) X_i and Y_i be n pairs of experimental or observed values of x any y variables (i =1, 2, 3……n).

(3) Calculate the correlation coefficient (r) between the independent parameter(x) and dependent parameter (y) variables using SPSS 18 software [13, 14].

(4) Observed values of all parameters (a and b) were calculated from the software.

2.3 Regression Equation

The correlation study among different quality of water parameters, the regression analysis found out using software SPSS 18 [14]. The regression equation ($y = a\ x + b$) was used as a arithmetical or mathematical device in order to calculate different dependent parameters (y) of water quality by alternating the values for the independent parameters (x) and also a and b are constant variables.

Table 1. Statistics value of the analytical result of the parameters

Sl.No.	Water Quality Chemical Parameter	Minimum reading	Maximum reading	Mean value	Value of Standard. Deviation	Number of samples
1	Total Dissolved Solids (TDS) in mg/l	1015	1200	1107.67	57.535	15
2	pH	7.6	7.9	7.753	0.1060	15
3	Total Alkalinity (TA) in mg/l	60	550	371.33	102.878	15
4	Total Hardness (TH) in mg/l	320	440	397.33	41.312	15
5	Calcium (Ca) in mg/l	80	120	96.00	20.284	15
6	Magnesium (Mg) in mg/l	34	46	41.73	4.131	15
7	Nitrate (NO_3) mg/l	26	28	27.40	.632	15
8	Chloride (Cl) in mg/l	240	320	264.00	29.472	15
9	Fluoride (F) in mg/l	1.10	1.20	1.153	.0516	15
11	Sulphate (SO_4) in mg/l	72	86	76.53	4.502	15

DOI: https://doi.org/10.30564/hsme.v1i2.1455

3. Results and Discussion

The results revealed that the study area which is based on water must be odourless, colourless and no turbidity. The analysis of physical characteristics of groundwater has turbidity as 2 NTU and iron as 0.02 mg/l present in fifteen samples. Statistics of the analytical results of groundwater water samples as shown in Table 1. The results shown that measured parameters at various points is not excessively high and among the measured values of these parameters at different locations is not excessively high and distinction range is very fine. The characteristics tests were determined make use of standard systematic methods, so as to minimize the determinate errors.

3.1. Water Quality Index (WQI)

World Health Organization (WHO) Indian standards, assigned weight (wi) and calculated relative weight (Wi) of nine parameters as shown in Table 2.

Table 2. WHO standards, assigned weight (wi) and calculated relative weight (Wi) of each parameter

Parameters	WHO -Indian Standard	Weight (wi)	Relative Weight (Wi)
pH	6.5 - 8.5	4.0	0.1333
TDS	500-2000	4.0	0.1333
TH	300-600	2.0	0.0667
Ca	75-200	2.0	0.0667
Mg	30-100	2.0	0.0667
Nitrate	1 - 45	5.0	0.1667
Chloride	250-1000	3.0	0.1000
Flouride	1-1.5	4.0	0.1333
Sulphate	200-400	4.0	0.1333
Total		**30.0**	**1.0000**

Table 3. WQI values for fifteen samples

Well No.	1	2	3	4	5	6	7	8
WQI	107.8	108.4	104.8	101.8	97.8	103.8	108.1	100.7
Well No.	9	10	11	12	13	14	15	
WQI	112.5	105.4	102.1	103.7	106.1	104.4	98.8	

Table 4. Classify Water quality based on the range of WQI value

Range of WQI Value	Classification of Water quality	Well Number	Percentages of Well Water Samples of nine parameters
<50.0	Excellent	Nil	0
50.0 -100.0	Good	5,15	13
100.0 – 200.0	Poor	1,2,3,4,6,7,8,9,10, 11,12,13,14	87
200.0 – 300.0	Very poor	Nil	0
>300.0	Unfit for use	Nil	0

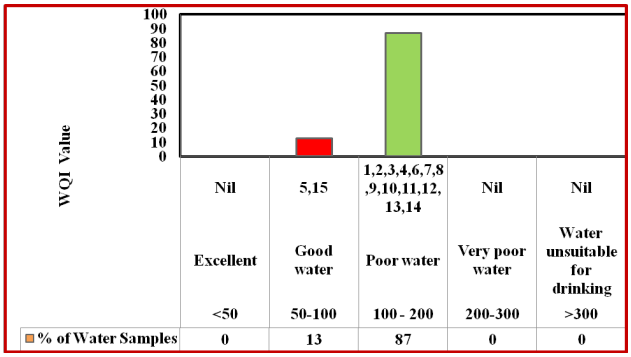

Figure 1. Percentage of well sampling points

The results revealed that, totally nine parameters contain pH, total hardness (TH), calcium (Ca), total dissolved solid (TDS), magnesium (Mg), nitrates (NO_3), chlorides (Cl), sulphates (SO_4), fluorides (F) has been used by WQI. The range of WQI calculated from (97.79-108.37) as presented in Table 3. Classification of water quality based on the range of WQI value as excellent water has less than 50.0. WQI values for the well number as zero. Good water quality has been WQI values in the range of 50.0 – 100.0 for the well number 5 and 15 as 13% of water samples as presented in Table 4. Poor water has water quality index (WQI) values ranged from 100.0 – 200.0 for the various well number 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13 and 14 as 87% of water samples are present as shown in Figure 1. Very poor quality have WQI values ranged from 200.0 – 300.0 for the well number as zero. The water is unfit for usage has WQI values greater than 300.0 for well as zero.

3.2 Correlation Analysis

The result of the correlation analysis revealed that Total hardness (TH) has positive and significant correlation or relationship with Magnesium (Mg) has value of 1.000 and also week correlation with calcium, nitrate, chloride, fluoride and then negative correlation with sulphate. TDS has week correlation with pH, Calcium, Sulphate and then negative correlation with Total alkalinity, Total Hard-

DOI: https://doi.org/10.30564/hsme.v1i2.1455

Table 5. Correlation values of ten parameters

Parameters	TDS	pH	TA	TH	Ca	Mg	Nitrate	Cl	F	SO_4
TDS	1									
pH	0.297	1								
Total Alkalinity	-0.467	-0.302	1							
Total Hardness	-0.033	-0.226	-0.268	1						
Calcium	0.132	-0.027	-0.285	0.327	1					
Magnesium	-0.033	-0.226	-0.268	1.000	0.327	1				
Nitrate	-0.159	0.085	0.024	0.044	-0.089	0.044	1			
Chloride	-0.032	-0.073	0.168	0.150	0.459	0.150	0.368	1		
Fluoride	-0.232	0.096	-0.162	0.205	-0.327	0.205	0.394	0.038	1	
Sulphate	0.215	0.056	-0.261	-0.391	0.025	-0.391	-0.331	-0.276	-0.254	1

ness, Magnesium, Nitrate and Chloride. pH has week correlation or relationship with Nitrate and Fluoride then negative correlation or relationship with Calcium(Ca), Sulphate (SO_4), Total alkalinity (TA), Total Hardness (TH), Magnesium (Mg) , Chloride (Cl) and Fluoride. Total alkalinity has week correlation or relationship with Nitrate (NO_3) and Chloride, then negative correlation or relationship with Calcium, Sulphate, Total Hardness, Magnesium and Fluoride. Calcium has week correlation or relationship with Magnesium, Sulphate and Chloride, then negative correlation or relationship with Nitrate and Fluoride. Magnesium has week correlation or relationship with Nitrate, Fluoride and Chloride, then negative correlation or relationship with Sulphate. Nitrate has week correlation or relationship with Fluoride and Chloride, then negative correlation or relationship with Sulphate. Chloride has week correlation with Fluoride then negative correlation with Sulphate. Fluoride has negative correlation or relationship with Sulphate. Different parameter has positive (+ve), negative (-ve) and week correlation or relationship as shown in Table 5. The regression equation for dependent and independent variables and R^2 values are shown in the Table 6.

3.3 Regression Equation or Analysis

The regression equation or analysis revealed that pairs of parameters such as independent and dependent variables or parameters establish to have improved and higher level of important or significance in their correlation or relationship coefficient are studied below. The regression equations for some pairs of parameters as shown in Table 4. Linear Plot between pairs of parameters as shown in Figure 2 to 6.

Table 6. Pairs of parameters (x and y) and regression equation with R^2 value

X and Y Parameters (y - dependent; x – independent)	**Regression Analysis or Equation**	**R^2**
TDS (y) –TH(x)	y = -0.045x + 1125	0.001
TDS (y) -Cl^- (x)	y = -0.062x + 1124	0.001
TDS (y) - SO_4^{2-}(x)	y = 2.744x + 897.6	0.046
TDS (y) - Ca^{2+}(x)	y = 0.375x + 1071	0.017
TDS (y) - Mg^{2+}(x)	y = -0.457x + 1126	0.001
TH (y) - Ca^{2+}(x)	y = 0.666x + 333.3	0.107
TH (y) - Mg^{2+}(x)	y = 10x – 20	1.000
Ca (y) - Cl^-(x)	y = 0.315x + 12.63	0.210
Ca (y) - SO_4^{2-}(x)	y = 0.112x + 87.36	0.000
Mg (y) - Cl^-(x)	y = 0.021x + 36.17	0.022
Mg (y) - SO_4^{2-}(x)	y = -0.359x + 69.21	0.153

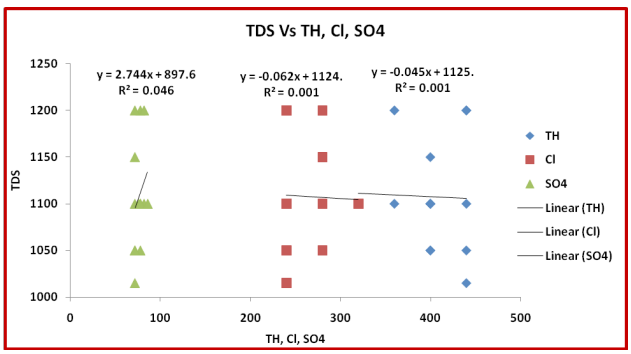

Figure 2. Linear Plot between TDS Vs TH, Cl and SO_4

DOI: https://doi.org/10.30564/hsme.v1i2.1455

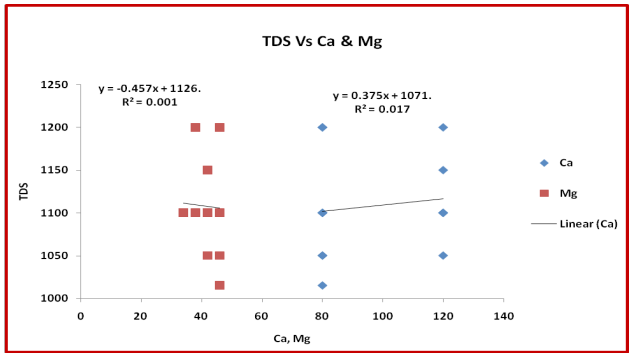

Figure 3. Linear equation plot between TDS Vs Calcium and Magnesium

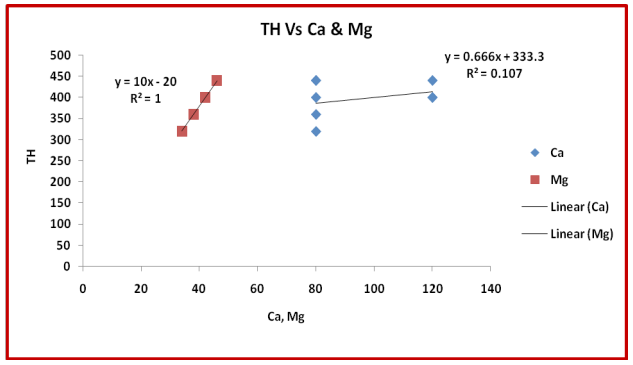

Figure 4. Linear equation plot between Total Hardness Vs Calcium and Magnesium

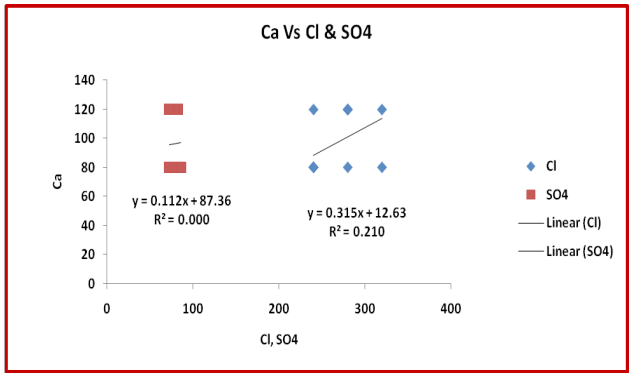

Figure 5. Linear equation plot between Ca Vs TH, Cl and SO_4

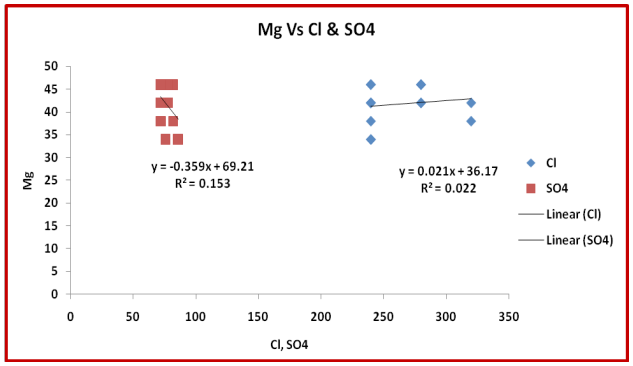

Figure 6. Linear equation plot between Mg Vs Cl and SO_4

4. Conclusions

The well water samples collected from the various sampling points in Budigumma village was analyzed. The study of experimental analysis on well water quality using nine physical and chemical characteristics indicate that check the water may be good and poor. The study revealed that the range of WQI values from 97.79 - 108.37. The Percentages of Well Water Samples of nine parameters were determined that the maximum in thirteen sample points. The WQI values of the study area has higher value which indicates that been indicated that deteriorate or depreciate water quality. The result of the correlation and regression analysis that Total hardness has strong positive correlated with magnesium. The remaining parameters are weak correlated and negative correlation with some others parameters. The physical and chemical analysis shows that the well water of the study area requires certain measure of treatment prior to consumption or utilization, and it also requires to be protected since the risks of contamination. The research study helps us to know the quality of the water and also to extend suitable management practices to protect or shelter the groundwater resources.

References

[1] Patil Nirdosh et al. Study on the physico-chemical characteristics of groundwater of Gulbarga city Karnataka. International Journal of Applied Biology and Pharmaceutical Technology, 2011, 1 (2): 518-523.

[2] Bajpayee et al. Assessment by Multivariate Statistical Analysis of Ground Water Geochemical Data of Bankura, India, International Journal of Environmental Sciences, 2012, 3 (2): 870-880.

[3] Ahmad, I., et al. Determination of Water Quality Index (WQI) for Qalyasan Stream in Sulaimani City, Kurdistan Region of IRAQ, International Journal of Plant, Animal and Environmental Sciences, 2012, 2 (4): 148-157.

[4] Bharti, N., et al. Water Quality Indices Used for Surface Water Vulnerability Assessment, International Journal of Environmental Sciences, 2011, 2 (1): 154-173.

[5] Charmaine Jerome et al. Evaluation of Water Quality Index and Its Impact on the Quality of Life in an Industrial Area in Bangalore, South India, American Journal of Scientific and Industrial Research, 2010, 1 (3): 595-603.

[6] Elangovan, N.S., et al. Assessment of Groundwater Quality along the Coum River, Chennai, Tamil Nadu, Indian Journal of Chemistry, Article ID 672372. 10, 2013: 1-10.

 DOI: https://doi.org/10.30564/hsme.v1i2.1455

[7] Usharani, K., et al. Physico-chemical and bacteriological characteristics of Noyyal River and Ground Water Quality of Perur, India, Journal of Applied Sciences & Environmental Management, 2010, 14 (2): 29–35.

[8] Manjunatha H. Arvinda HB. and Puttaih ET. Subsurface water quality of Challakera Taluk, Kartnataka, Indian J.Env.Prot., 2011, 31(6): 511 - 513.

[9] BIS, Indian Standard for Drinking Water Specification – 10500. Bureau of Indian Standards, New Delhi. 1992.

[10] WHO Guidelines for Drinking Water, vol. 1, WHO, Geneva, Switzerland, 1984.

[11] Mohammad Alam and Pathak JK. Rapid Assessment of Water Quality Index of Ramganga River, Western Uttar Pradesh (India) Using a Computer Programme, Nature and Science, 2011: 1-8.

[12] Pathak. and Hemant. Evaluation of ground water quality using multiple linear regression and mathematical equation modeling, Annals of the University of Oradea, Geography Series, 2012, 2: 304-307.

[13] Saleem. Abdul. Mallikarjun Dandigi N. and Vijay Kumar K. Correlation-regression model for physico-chemical quality of groundwater in the South Indian city of Gulbarga, African Journal of Environmental Science and Technology, 2012, 6, 9: 353-364.

[14] SPSS 18 Software - Statistical Package for the Social Sciences

DOI: https://doi.org/10.30564/hsme.v1i2.1455