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Statistical Analysis of Groundwater sample of Heeranagar village of Neemkathana block of Sikar India

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ABSTRACT
The present study was done to assess the suitability of groundwater for portability and other consumption purposes. Seven different Physico-chemical parameters were taken into account to calculate the Water Quality Index (WQI) based on a recommended agency like the Bureau of Indian Standards (BIS) and the World Health Organization (WHO). The total alkalinity of groundwater in the Heeranagar village was observed higher. The mean value for parameter nitrate is 68 mg/L, and the standard deviation calculated is 15.13 which is higher than the BIS (IS 10500: 2012) acceptable limit of 45 mg/L. The mean value of the parameter fluoride for the assessment period is 1.64mg/L, and the standard deviation calculated is 0.49 which isalso higher than the acceptable limit. Due to higher concentrations of nitrate, fluoride, and higher the values of TDS, WQI is not excellent for the selected village sample source.

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I. INTRODUCTION

Groundwater is an essential and vital component of our life support system. 85 % of the rural population of the country uses groundwater for drinking and domestic purposes.Nitrate is a very common constituent in groundwater, especially in shallow aquifers.The Bureau of Indian Standards (BIS) has specified drinking water quality standards in India to provide safe drinking water to the people.Water is an essential natural resource for sustaining life. Water quality is an essential parameter to be studied when the overall focus is sustainable development keeping mankind at the focal point.(Saxena 2015). The correlation provides an excellent tool for the prediction of parametric values within a reasonable degree of accuracy (Venkatachalam and Jabenesan, 1998).The natural chemical content of groundwater is influenced by the depth of the soils and sub-surface geological formations through which groundwater remains in contact.

Groundwater in shallow aquifers is generally suitable for use for different purposes and is mainly of Calcium bicarbonate and mixed type. However, other types of water are also available including Sodium-Chloride water. Groundwater quality deterioration can be caused by broadly two ways; (i) anthropogenic - those caused by manmade activities like industries, urban sewage and waste landfills, mining etc. (ii) geogenic

The highest value being 3080 mg/L found in Bikaner, Rajasthan. Fluoride is an essential constituent in minerals such as fluorite, apatite, cryolite and topaz. Minerals like biotite, muscovite and hornblende may contain considerable per cent of fluoride

Of the 85 million tons of fluoride deposits in the earth crust world-wide, 12 million are found in India (Teotia and Teotia 1994)

II. Material and Methods

Table 1: List of Parameters and Methods of Determination

Parameters	**Methods of determination**
pH	pH Meter
TH(mg/l)	EDTA Method
Ca(mg/l)	Titration Method
Mg(mg/l)	Titration Method
TDS(mg/l)	Potentiometric Method

F^-(mg/l)	UV Spectrophotometric Method
SO_4^{2-}(mg/l)	Turbid meter Method
NO_3^-(mg/l)	Spectrophotometer

Assessment of groundwater of Heeranagar village in Neemkathana block

Groundwater samples of Heeranagar village collected from Month of Aug-2020 to July-2021 and tested for different selected physico-chemical parameters. The results of physico-chemical parameters shown in the table 2.

Table 2: Water testing data of Heeranagar village in Neemkathana

Water testing of Heeranagar village in Neemkathana block								
Para. / Month	pH	Total alkalinity, mg/L	Total hardness, mg/L	Cl^-, mg/L	SO_4^{2-}, mg/L	NO_3^-, mg/L	F^-, mg/L	TDS, mg/L
Aug-20	8	340	370	100	19	97	2.01	865
Sept-20	8	330	290	90	34	74	1.85	640
Oct-20	7.9	340	260	150	28	47	0.84	710
Nov-20	8	360	510	80	14	78	2.02	680
Dec-20	8.2	330	300	80	15	63	1.8	680
Jan-21	7.6	320	310	120	17	72	1.74	800
Feb-21	8	440	380	100	15	55	1.94	500
Mar-21	7.9	260	180	70	18	56	1.93	600
Apr-21	7.4	290	150	120	41	85	0.83	680
May-21	7.9	260	180	70	16	49	1.88	570
Jun-21	7.6	260	180	70	15	109	0.85	670
Jul-21	7.9	250	160	70	23	64	1.98	635

Table 2 includes the testing results of groundwater in Heeranagar village for selected parameters, for the assessment period of Aug.-2020 to July-2021.

3.4.6.1 pH

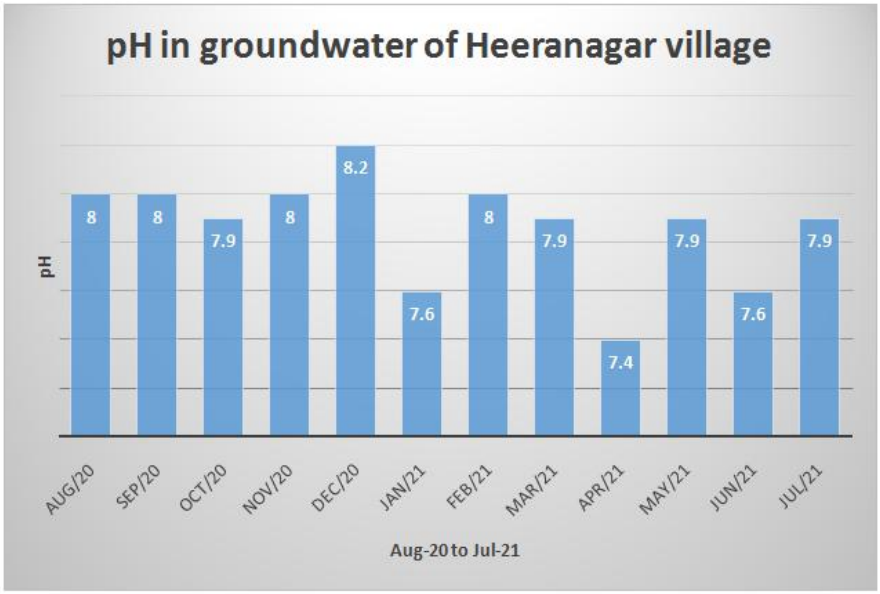

Figure 1: pH of groundwater in Heeranagar village of Neemkathana block

Figure 1 shows the variation of pH value for the assessment year varying between 7.4 -8.2. The minimum pH 7.4 observed in moth of April -2021, and maximum pH 8.2 observed in the month of Dec-2020. The mean value for pH is 7.87, while the standard deviation calculated is 0.22. The pH of the groundwater of Heeranagar village also observed within (BIS IS 10500: 2012) acceptable limit 6.5 – 8.5.

Total alkalinity

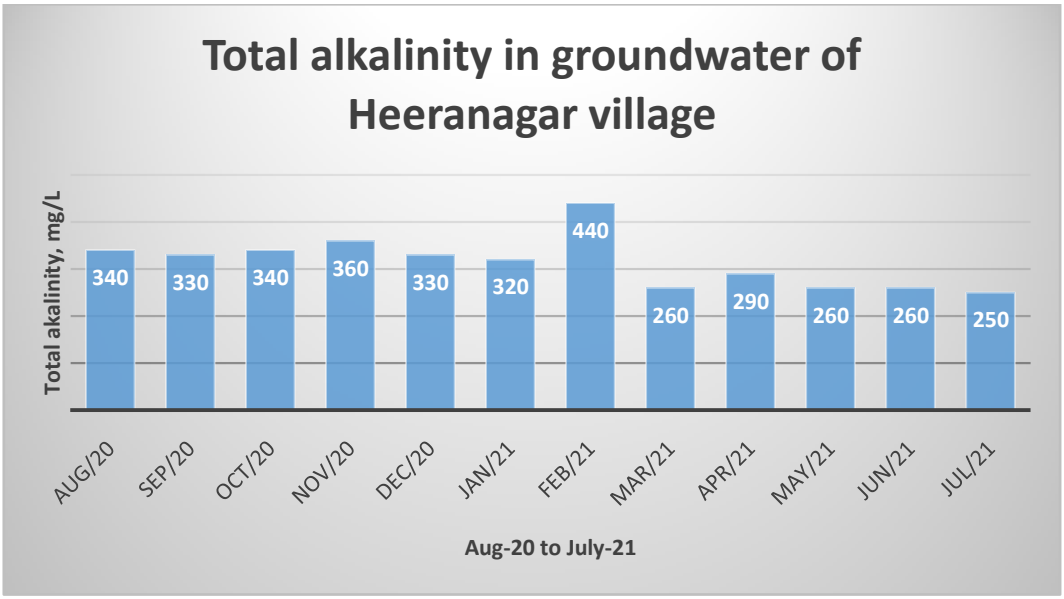

Figure 2: Total alkalinity in groundwater of Heeranagar village in Neemkathana block

Figure 2 shows that the total alkalinity variation for the assessment period Aug-2020 to Jul-2021 is 250 mg/L-440 mg/L. The maximum total alkalinity 440 mg/L (as $CaCO_3$) is observed in the month ofFeb -2021, and the minimum total alkalinity 250 mg/L is observed in the month of July-2021.The mean value for the assessment period is 315 mg/L, and the standard deviation calculated is 55.02. The total alkalinity of groundwater in the Heeranagar village observed higher than the BIS (IS 10500: 2012) acceptable limit of 200 mg/L (as $CaCO_3$).

Total hardness

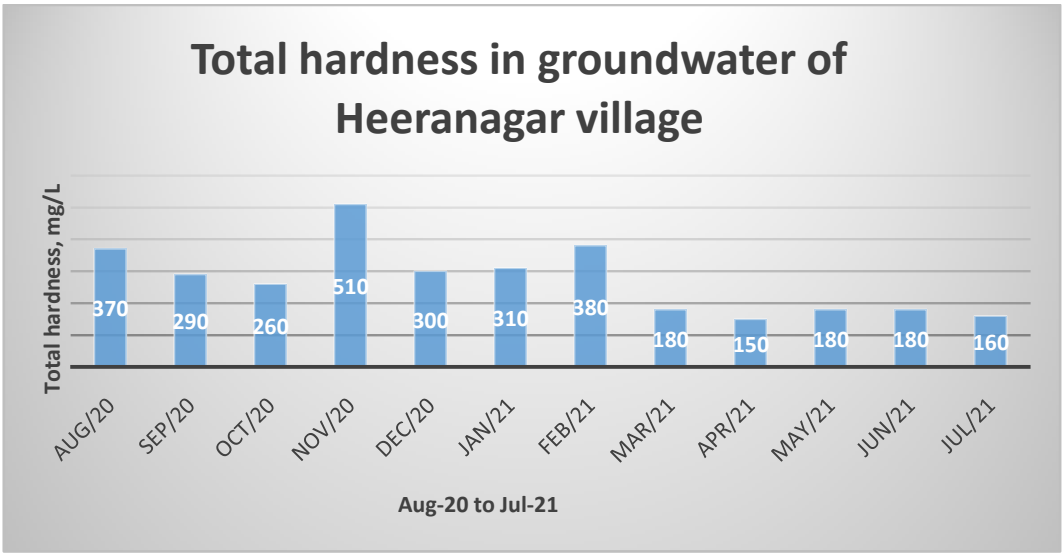

Figure 3: Total hardness in groundwater of Heeranagar village in Neemkathana block

Figure 3shows that the total hardness (as $CaCO_3$) variation for the assessment period Aug-2020 to Jul-2021 is 150 mg/L-510 mg/L. The maximum total hardness 510 mg/L observed in the month of Nov-2020, and the minimum total hardness 150 mg/L is observed in the month of April-2020. The assessment parameter mean value is 272.5 mg/L and the calculated mean deviation is 110.13 and observed slightly high than the BIS (IS 10500: 2012) acceptable limit of 200 mg/L.

Chloride

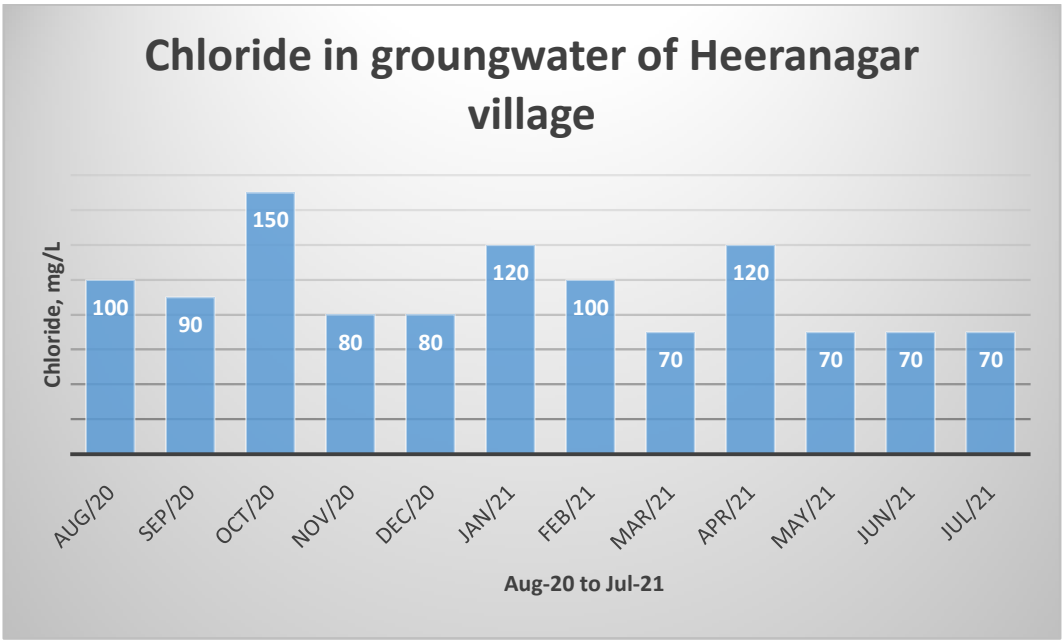

Figure 4 : Chloride in groundwater of Heeranagar village in Neemkathana block

Figure 4 shows that the chloride concentration variation for the assessment period Aug-2020 to Jul-2021 is 70 mg/L-150 mg/L. The maximum chloride 150 mg/L observed in the month of Oct-2020 and the minimum chloride concentration 70 mg/L is observed in the month of May–2021 to July-2021. The mean value for the parameter is 93 mg/L, and the standard deviation calculated is 25.70 and is within the BIS (IS 10500: 2012) acceptable limit of 250 mg/L.

Sulphate

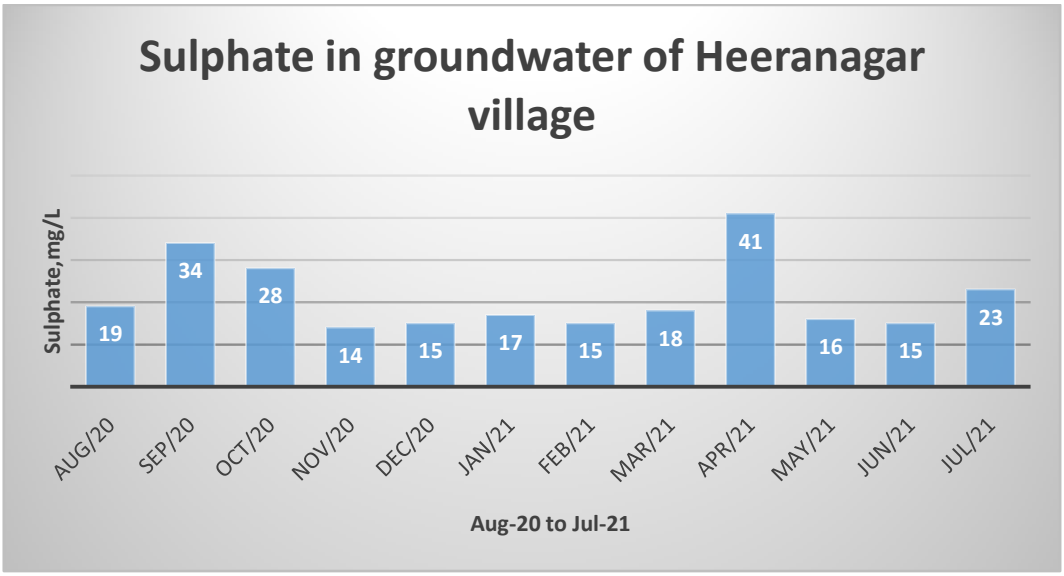

Figure 5: Sulphate in groundwater of Heeranagar village in Neemkathana block

Figure 5 shows that the sulphate concentration variation for the assessment period Aug-2020 to Jul-2021 is 14 mg/L-41 mg/L. The maximum sulphate 41 mg/L observed in the month of April-2020 and the

minimum sulphate 14 mg/L is observed in the month of Nov -2020. The mean value for the assessment period is 21 mg/L and the standard deviation calculated is 8.70 and is within the BIS (IS 10500: 2012) acceptable limit of 200 mg/L.

Nitrate

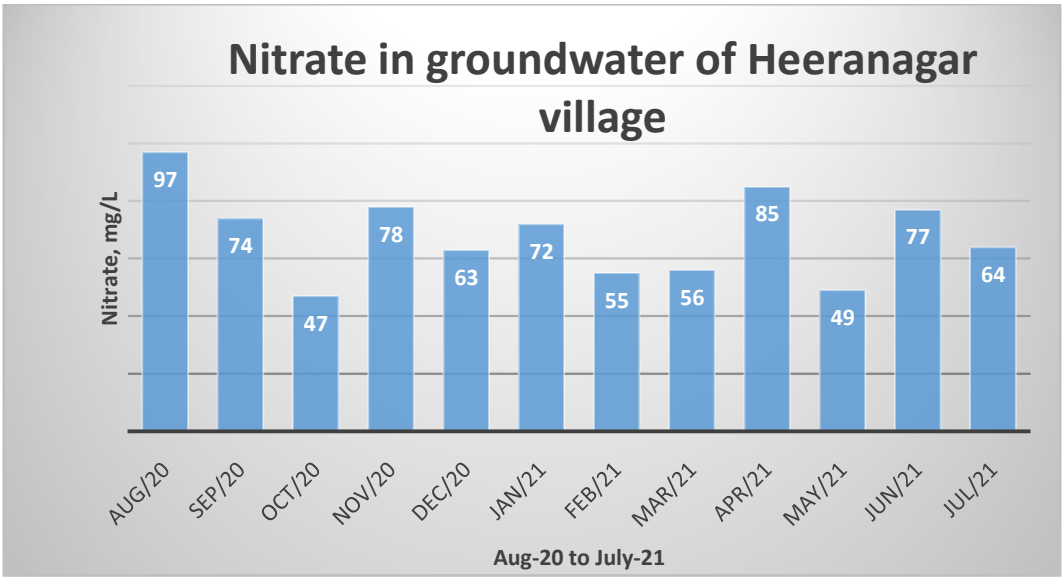

Figure 6: Nitrate in groundwater of Heeranagar village in Neemkathana block

Figure 6 shows that the nitrate concentration variation for the assessment period Aug-2020 to Jul-2021 is 47 mg/L-97 mg/L. The maximum nitrate 97 mg/L observed in the month of Aug-2020, and the minimum 47 mg/L nitrate is observed in the month of Oct-2020.The mean value for nitrate is 68 mg/L, and the standard deviation calculated is 15.13 and is higher than the BIS (IS 10500: 2012) acceptable limit of 45 mg/L.

Fluoride

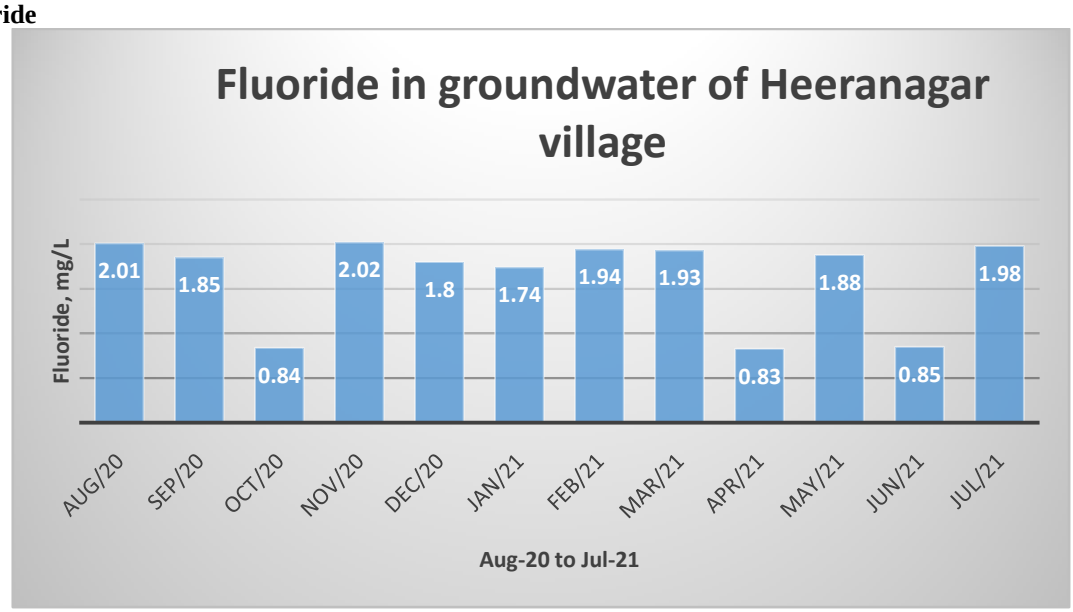

Figure 7: Fluoride in groundwater of Heeranagar village in Neemkathana block

Figure 7 shows that the fluoride concentration variation for the assessment period Aug-20 to Jul-21 is 0.83 mg/L -2.02 mg/L. The maximum fluoride 2.02 mg/L observed in the month of Nov-2020, and the minimum fluoride 0.83 mg/L is observed in the month of April-2021.The mean value of the parameter for the assessment period is 1.64 mg/L, and standard deviation calculated is 0.49 and is higher than the BIS (IS 10500: 2012) acceptable limit 1.0 mg/L, and permissible limit of 1.5 mg/L.

Total Dissolved Solids

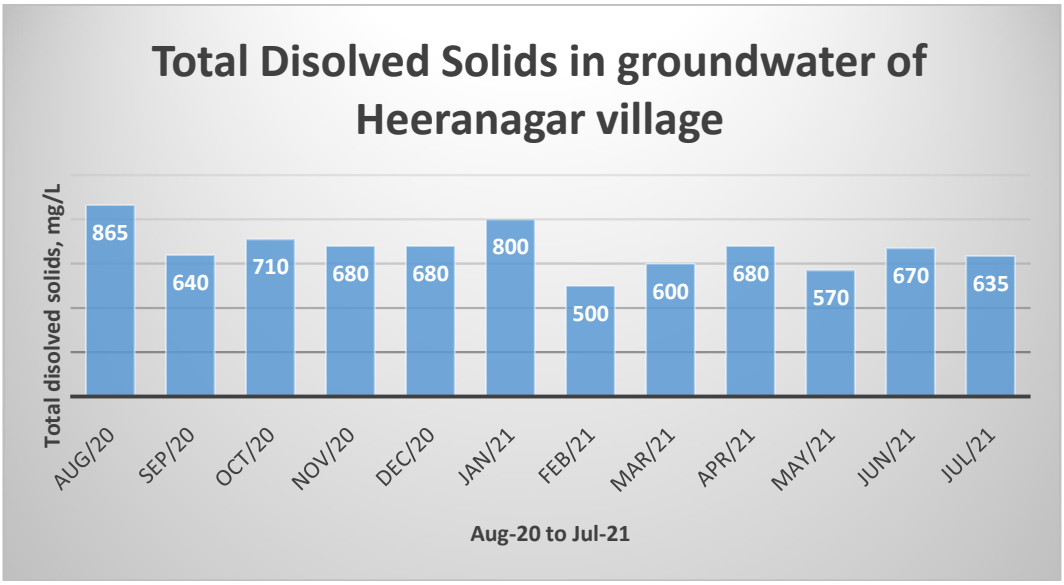

Figure 8: TDS in groundwater of Heeranagar village in Neemkathana block

Figure 8 shows that the Total Dissolved Solids (TDS) variation for the assessment period Aug-20 to Jul-21 is 500 mg/L-865 mg/L. The maximum TDS 865 mg/L observed in the month of Aug-2020 and the minimum TDS 500 mg/L is observed in the month of Feb-2021. The mean value for the assessment period is of TDS is 669.17 mg/L, and the standard deviation calculated is 96.64 and is higher than the BIS (IS 10500: 2012) acceptable limit of 500 mg/L for the whole year with an irregular trend of variation.

WATER QUALITY INDEX OF GROUNDWATER IN NEEMKATHANA

The water quality index is the calculated value which decided the quality of water in a particular area. The water quality classes as per water quality index score given byBathusha and Saseetharan.

Table 3: Water Quality Index and Class of Heeranagar Village in Neemkathana

Water Quality Index and Class of Heeranagar Village in Neemkathana		
Month	**Water Quality Index (WQI)**	**Water Quality Class (WQC)**
Aug-20	105.38	Poor Water
Sep-20	96.90	Good Water
Oct-20	47.89	Excellent Water
Nov-20	105.31	Poor Water
Dec-20	95.22	Good Water
Jan-21	89.45	Good Water
Feb-21	100.82	Poor Water
Mar-21	99.08	Good Water
Apr-21	45.73	Excellent Water
May-21	96.47	Good Water
Jun-21	48.45	Excellent Water
Jul-21	101.69	Poor Water

Table 3 reveals that the quality of water is observed Excellent in some months and Good & Poor quality in other months. The excellent water quality is observed in October, April and June and Poor quality observed in the July, August, November, and February months. **Correlation Matrix for groundwater of Heeranagar village in Neemkathana block**

Statistical assessment of groundwater with the use of Pearson's correlation coefficient (r) for the parameters tested during the assessment period Aug-20 to July-21for Heeranagar village and analysis is given below.

Table 4: Correlation Matrix for groundwater in Heeranagar village

Correlation Matrix for groundwater in Heeranagar village								
	pH	**Total alkalinity**	**Total hardness**	**Cl^-**	**SO_4^{2-}**	**NO_3^-**	**F^-**	**TDS**
pH	1.00							
Total alkalinity	0.39	1.00						
Total hardness	0.49	0.79	1.00					
Cl^-	-0.30	0.41	0.13	1.00				
SO_4^{2-}	-0.42	-0.14	-0.39	0.48	1.00			
NO_3^-	-0.29	0.01	0.25	0.00	0.21	1.00		
F^-	0.66	0.21	0.45	-0.50	-0.48	-0.02	1.00	
TDS	-0.17	-0.05	0.22	0.39	0.08	0.65	-0.12	1.00

Table 4 shows the Karl Pearson's correlation coefficient for the groundwater parameters of Heeranagar village. For any pair of parameters for groundwater of Heeranagar village Perfect positive (r = 1) and perfect negative(r =-1) relations were not observed. Very high degree (r = 1-0.9) not observed but sufficiently high degree (r = 0.9-0.75) relations observed for (Total Alkalinity - Total hardness). A moderate degree of positive relationship was observed for (Total alkalinity -pH), (pH- F^-) (Total alkalinity - Cl^-), (Total hardness- F^-), (SO_4^{2-} - Cl^-), (TDS - Cl^-), and (NO_3^--TDS).A moderate degree of negative relationship was observed for (SO_4^{2-} - pH), (NO_3^-- pH),(SO_4^{2-} -Total hardness), and (Cl^- -F^-).

III. Conclusions

The statistical analysis of the experimental estimated groundwaterquality parameters of Heeranagar village water samples yielded the range of variations, WQI, water class and coefficient of correlation.The total alkalinity of groundwater in the Heeranagar village observed higher. The values of physico-chemical parameters total alkalinity, nitrate, and fluoride and TDS are beyond theBIS (IS 10500: 2012) acceptable limit so it seems to be harmful to public health.On the basic of WQI,the class of water is poor, good and excellent also.Results of the coefficient of correlations show the strong, moderate and weak relation between the physico-chemical parameters but most of values are for moderate degree. Where it is observed that the TDS value of Heeranagar village much higher than the recommendations of BIS (IS 10500: 2012). It reveals that the groundwater of Heeranagar is contaminated so it is suggested tostate governmentprovide potable water under the same kind of project or under Jal Jeevan Mission of Government of India, so health issues among villagers of Neemkathana block due to excess TDS, fluoride, and nitrate in groundwater can be controlled.

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