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# Statistical Analysis of Groundwater sample of Sirohi village of Neem ka Thana block of Sikar (Rajasthan) India

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## Abstract

*In this study, the statistical analysis of groundwater of Sirohi village of Neemkathana block, Sikar (India) has been presented. Groundwater samples were taken from the selected sites strictly as per BIS norms. The TDS level of Sirohi village was found to be more than the acceptable limit of 500 mg/L. The higher TDS will affect human health. Neemkathana block in Rajasthan is a semi-arid zone, due to a continuous decrease in the value of rainfall, the rate of recharge of the water aquifer is imbalanced by yield. The average discharge from wells in alluvium ranges from 40m3/day to 90m3/day. Such kind of situation makes contamination to be at the extreme.*

## Keywords

*Water, physio-chemical parameters, Water Quality Index, correlation diagram*

## 1. Introduction

An essential compound for survival all living on this planet. Water may be in solid, liquid, or vapour states, the liquid state has uttermost importance. Surface water and groundwater is available for all the purposes of the world population. Water a limited natural not revival resource has less a availability and facing the problem of contamination which converting to pollution. Groundwater is classified into two categories such as young, and old. Groundwater is young if entered into aquifer after 1950(AC). Young groundwater contains "tracers" like Tritium, CFCs, and SF6, components produced by human activities. Water entered into aquifer before 1950 (AC) is known as old, which contains naturally occurring isotopes. Argon-39 tracer is used for the groundwater which entered into aquifer between 50 - 1000 years ago, tracker Carbon-14 is used for the groundwater entered between 1000-30000 years, and years. Pawar et al. (1998) states the water is a general solvent, so it has the capability to dissolve all natural compounds. Therefore, the alarming salts contained in groundwater due to local pollutants and affected the groundwater quality adversely. Gupta and Sukla (2004) classified the water according to the degree of hardness as soft water (0-75 mg/L), moderately (75-150 mg/L), hard water (150-300 mg/L) and above 300 mg/L is very hard. Approximately world's one-third population of the globe is using the groundwater for drinking purposes (Nickson et al., 2005). Anthropogenic, Geogenic contamination are assumed to be responsible for degradation of quality of water. If the groundwater gets contaminated by pollutants, then the quality of groundwater cannot be restored, if we try to stop the pollutants to further add from the source, therefore, it is very important to monitor regularly groundwater and to find possible techniques to maintain its quality (Ramakrishnaiah et al., 2009). Parvizishad et al. (2017) reviewed the adverse effects of Nitrate and Nitrite in drinking water and food on human health. Low concentrations of nitrite and nitrate could have a shielding effect on the cardiovascular system, blood pressure regulation and maintaining homeostasis of vessels. Jehan et al. (2009) studied that TDS presented in the groundwater in the form of carbonates and bicarbonates, which may be released from the host sedimentary rocks, like limestone and dolomite, into the groundwater aquifer. Such types of dissolved solids have the size of course and cause suspension. Siddiqui et al. (2011) observed the impact of the cement industry on the groundwater quality in the vicinity of the plant. GSI and CGWB stated that aquifers in Sikar district are extended in lateral and vertical directions.

**Table 1.** Aquifer in Sikar district are extended in lateral and vertical directions

| **Sediments** | **Ground water in Quaternary sediments** | **Ground water in hard rock formations** |
|---|---|---|
| Types of sediments | Sand,<br>Gravel,<br>Pebbles<br>Clay With 'Kankar' | Quartzite,<br>Schist,<br>Phyllite,<br>Gneiss<br>Amphibolite |
| Hydrogeological unit. | Single hydrogeological unit. | Weathered mantle and in joints and fractures |
| Depth of water table | Thickness lies between 30 and 80 m | Upto143 mbgl |
| Thickness of water table | Thickness of saturated zone generally varies from 10 to 50 m. | 7.5 mbgl (Dariba in Neem ka Thana block) to 48.50 mbgl |
| Type of aquifer | Under unconfined and semi-confined | Under unconfined condition |
| Average discharge/day | Average discharge of wells in alluvium ranges from 40$m^3$/day to 90$m^3$/day | Formation varies from 10 $m^3$/day to 30 $m^3$/day. |

This communication studied the experimental estimations of physio-chemical parameters after that statistical analysis along with mean value, standard deviation and correlations were carried out which yielded the water quality index of Sirohi

village in Neemkathana block of Sikar district.

## 2. Material and Methods

### 2.1. Site Selection

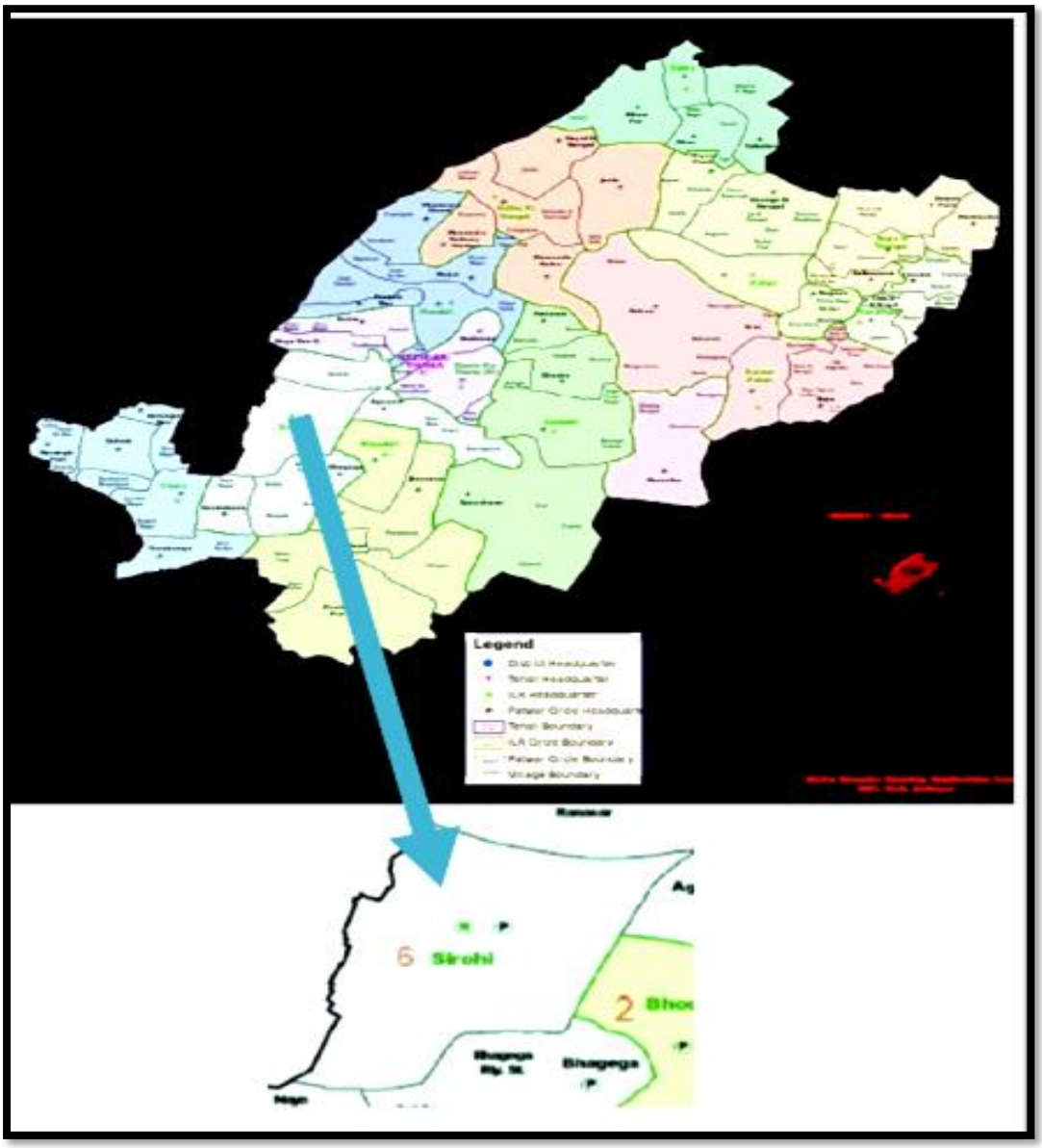


**Figure 1.** Sirohi village Neemkathana block (Source: election commission)

Geographical location Sirohi village 27.701141° N and 75.713143° E, geographical area of village is 2242.56 hectares, and total population of 12,608 peoples (census 2011). There are about 2,073 houses in Sirohi village. Neemkathana is nearest town to Sirohi which is 6km away. Neemkathana block is over-exploited, and hydrological formation of Sirohi village is Older Alluvium. One cement production plant with a production capacity of 6.25 MTPA is established 10 years ago, and in vicinity sev-

eral open cast mines are operated by different agencies. Due to unavailability of surface water peoples of Sirohi village are dependent on groundwater. CGWB report states that the groundwater level of Sirohi village is 20m bgl.

## 2.2. Water Sample

Groundwater samples were taken from a handpump which is the main source of drinking water for the villagers. A 1-liter water bottle is used for the sampling, the sample test started from august 2020 to July 2021.

**Table 2.** List of Parameters and their 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 |
| SO42- (mg/l) | Turbid meter Method |
| NO3- (mg/l) | Spectrophotometer |

**Table 3.** Water testing data of Sirohi village in Neemkathana block

| Water testing of Sirohi Village in Neemkathana block | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Para. Month** | **Ph** | **Total alkalin-ity, 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 | 7.7 | 500 | 610 | 600 | 272 | 8 | 0.95 | 2430 |
| Sept-20 | 7.5 | 560 | 570 | 550 | 280 | 10 | 0.9 | 2090 |
| Oct-20 | 7.8 | 410 | 390 | 500 | 229 | 15 | 0.54 | 2020 |
| Nov-20 | 7.9 | 490 | 480 | 440 | 212 | 23 | 0.8 | 1910 |
| Dec-20 | 7.9 | 280 | 750 | 460 | 207 | 27 | 0.85 | 1940 |
| Jan-21 | 8.2 | 530 | 600 | 590 | 202 | 15 | 0.83 | 1740 |
| Feb-21 | 8 | 600 | 600 | 560 | 201 | 21 | 0.96 | 1860 |
| Mar-21 | 7.5 | 460 | 490 | 360 | 204 | 20 | 0.92 | 1840 |
| Apr-21 | 7.6 | 450 | 420 | 380 | 201 | 26 | 0.95 | 1810 |
| May-21 | 7.4 | 440 | 480 | 320 | 209 | 21 | 0.98 | 1930 |
| Jun-21 | 7.3 | 450 | 410 | 390 | 231 | 18 | 0.88 | 1870 |
| Jul-21 | 7.8 | 480 | 450 | 310 | 213 | 27 | 0.98 | 1845 |

## 3. Results and Discussions

### 3.1. Assessment of Groundwater of Sirohi Village in Neemkathana Block

Groundwater samples of Sirohi village collected from Month of Aug-2020 to July-2021 and tested for different physio-chemical parameters. The tested physio-chemical parameters result of Sirohi village are shown in table 3.

Table 3 includes the testing results for the period of Aug.-2020 to July-2021. Parameter pH has no unit while all the selected parameters are shown in mg/L. For the assessment of the groundwater parameters, BIS (IS 10500:2012) standard is selected which have acceptable, and permissible limits for each parameter, but for nitrate no relaxation is given in permissible limit.

Figure 2 shows the variation of pH value for the assessment year from August 2020 to July 2021 is pH is varied between 7.3- 8.2. The minimum pH is 7.3 is observed in the month of June -2021, and maximum in the Jan -2021. The pH value is slightly higher from the neutral value 7.0 in the assessment year.

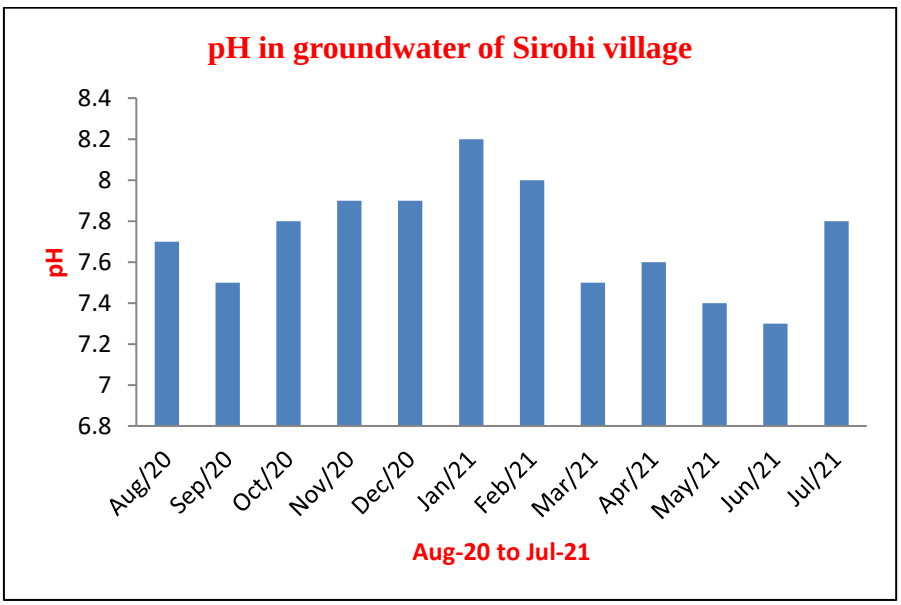


**Figure 2.** pH of groundwater in Sirohi village of Neemkathana block

### 3.2. Total alkalinity

Figure 3 shows the total alkalinity variation for the assessment period Aug-2020 to Jul-2021 is 280 mg/L-600 mg/L. The maximum total alkalinity 600 mg/L (as CaCO3) is observed in the month of Feb-2021, and the minimum total alkalinity is observed in the month of Dec-2020. The mean value of total alkalinity for the assessment period is 470.83 mg/L, and the standard deviation calculated by 80.

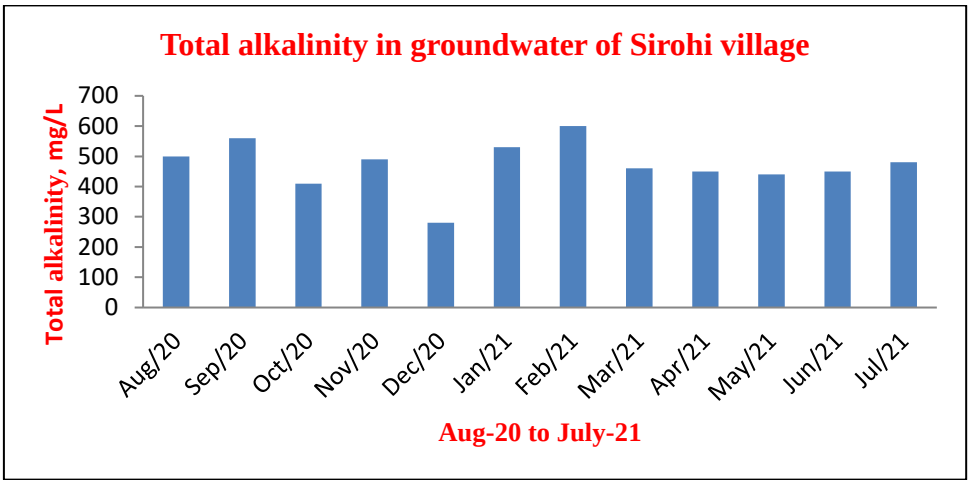


**Figure 3.** Total alkalinity in groundwater of Sirohi village in Neemkathana block

### 3.3. Total hardness

Figure 4 shows that the Total hardness (as CaCO3) variation for the assessment period Aug-2020 to Jul-2021 is 390-750 mg/L. The maximum total hardness is 750 mg/L observed in the month of Dec-2020 and the minimum total hardness is observed in the month of Oct-2020. The mean value for the assessment period is 520.83 mg/L, and the standard deviation calculated is 106.30. The higher values of chloride, suphate, and total hardness indicate that the total hardness of groundwater is due to permanent hardness. The total hardness of water is an aesthetic parameter.

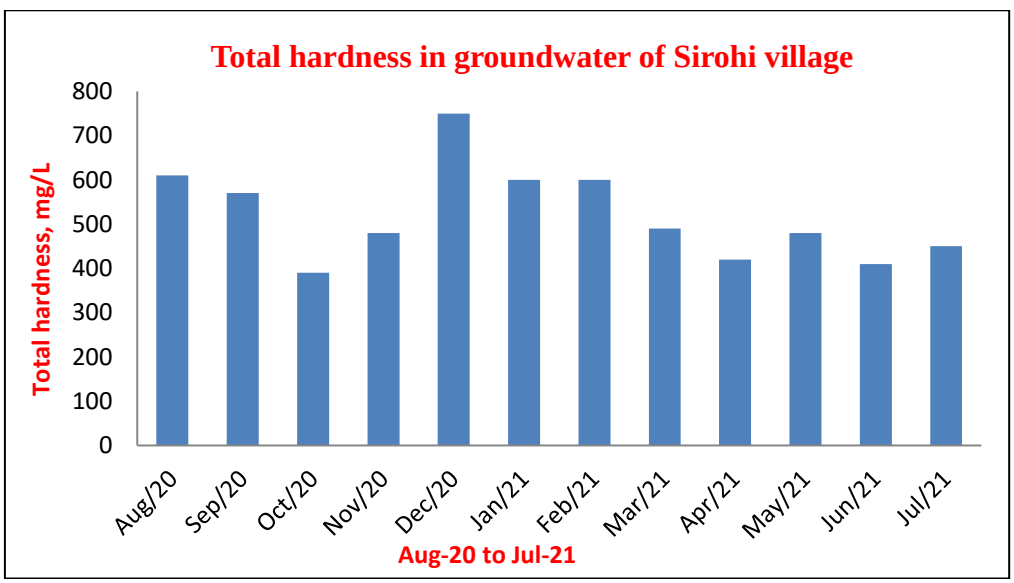


**Figure 4.** Total hardness in groundwater of Sirohi village in Neemkathana block

### 3.4. Chloride

Figure 5 shows that the chloride concentration variation for the assessment period Aug-2020 to Jul-2021 is 310-600 mg/L, the maximum chloride 600 mg/L observed in the month of Aug-2020, and the minimum chloride concentration 455 mg/L is observed in the month of July-2021. The chloride concentration of groundwater in the Sirohi village observed higher the BIS (IS 10500: 2012) acceptable limit of 250 mg/L for the whole assessment period, and value is close to permissible limit which can be used in absence of any alternative. The water quality of Sirohi village as per these reported parameters is found not good for the human health, due to corrosive nature of water in case of excess chloride water storage and supply can be contaminated.

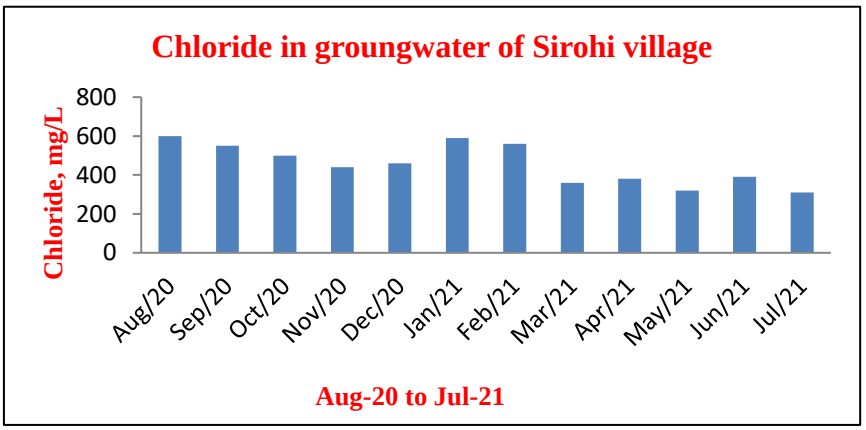


**Figure 5.** Chloride in groundwater of Sirohi village in Neemkathana block

### 3.5. Sulphate

Figure 6 shows the sulphate concentration variation for the assessment period Aug-2020 to Jul-2021 is 201 mg/L-280 mg/L. The Maximum sulphate 280 mg/L observed in the month of Sept-20 and the minimum sulphate 201mg/L is observed in the month of April-21. These values reveal that the sulphate concentration in groundwater of Sirohi village is observed higher than the BIS (IS 10500: 2012) acceptable limit of 200 mg/L.

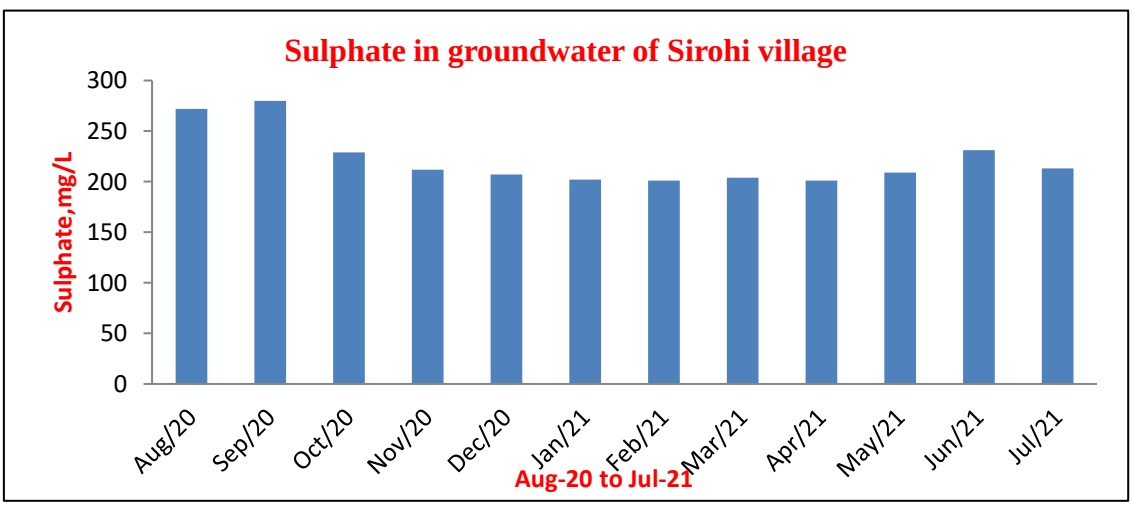


**Figure 6.** Sulphate in groundwater of Sirohi village in Neemkathana block

### 3.6. Nitrate

Figure 7 shows the nitrate concentration variation for the assessment period Aug-2020 to Jul-2021 is 8 mg/L-27 mg/L. The maximum nitrate 27 mg/L observed in the month of Dec-20 and July-21 and the minimum 8 mg/L nitrate is observed in the month of Aug-20. The mean value for the nitrate is 19.25 mg/L and the standard deviation calculated is 6.30.

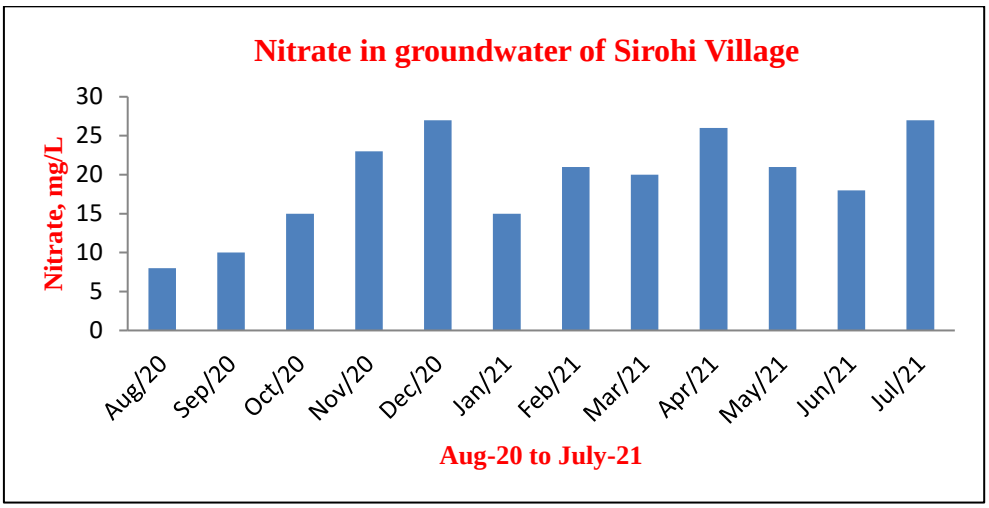


**Figure 7.** Nitrate in groundwater of Sirohi village in Neemkathana block

### 3.7. Fluoride

Figure 8 shows the fluoride concentration variation for the assessment period Aug-20 to Jul-21 is 0.54 mg -0.98 mg/L. The maximum fluoride 0.98 mg/L observed in the month of May-21and July-2021, and the minimum fluoride 0.54 mg/L is observed in the month of Oct-2020. The mean value for the fluoride concentration of the assessment period is 0.88 mg/L and the standard deviation calculated is 0.12.

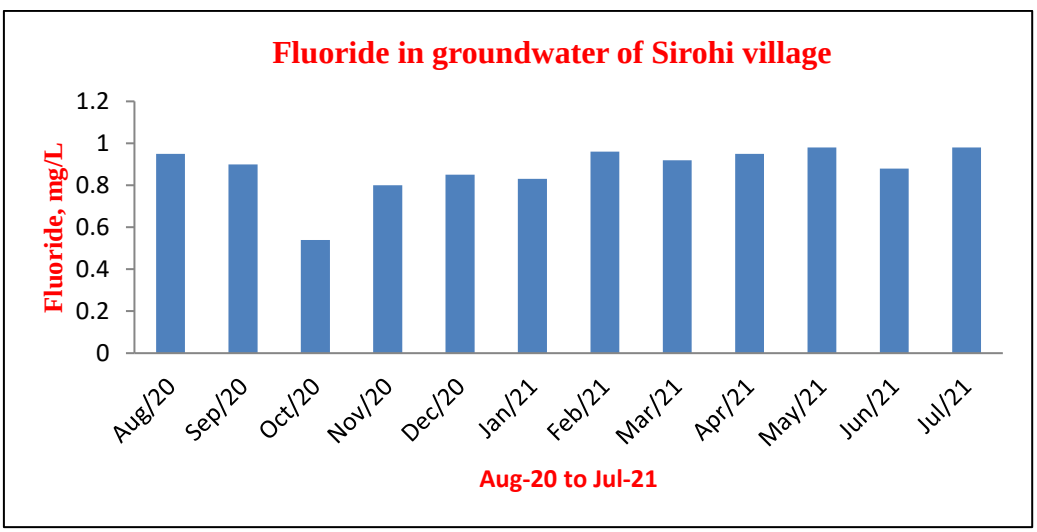


**Figure 8.** Fluoride in groundwater of Sirohi village in Neemkathana block

### 3.8. Total Dissolved Solids

Figure 9 shows that the Total Dissolved Solids (TDS) variation for the assessment period Aug-20 to Jul-21 is 1740 mg/L-2430 mg/L, and the mean value for the assessment period is 1940 mg/L. The maximum TDS 2430 mg/L observed in the month of Aug-2020 and the minimum TDS 1740 mg/L is observed in the month of Jan-2021. The result reveals that the Total Dissolved Solids (TDS) in groundwater of the Sirohi village was observed higher than the BIS (IS 10500: 2012) acceptable limit of 500 mg/L, TDS variation observed higher than the permissible limit of 2000 mg/L for three months and for the remaining observed more than 500 mg/L.

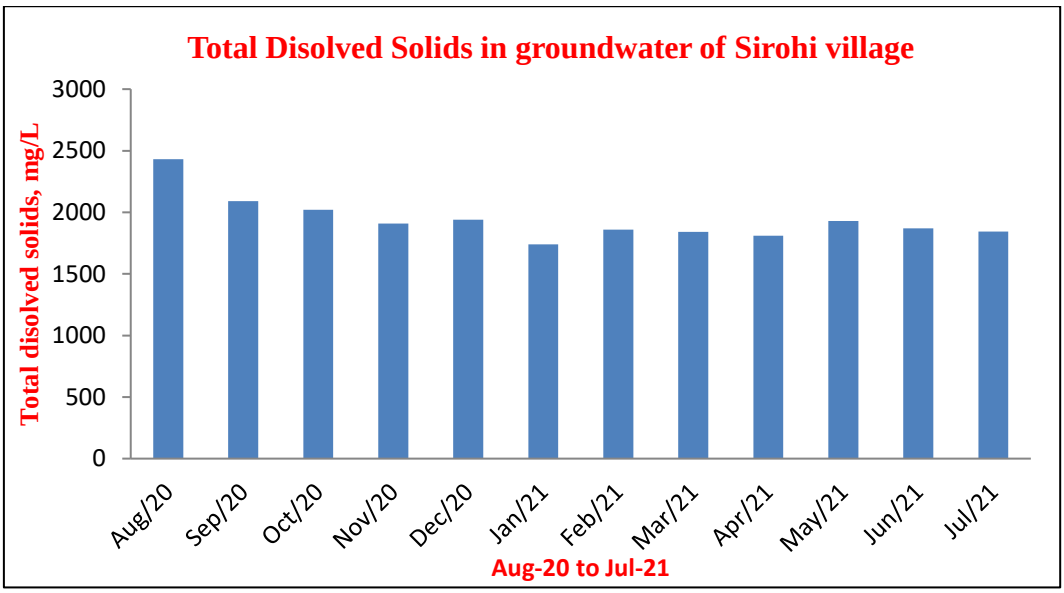


**Figure 9.** TDS in groundwater of Sirohi village in Neemkathana block

### 3.9. Correlation Analysis

Correlation Coefficient matrix of physio-chemical parameters for Sirohi Village in Neemkathana Block of Sikar District (August 2020 to July 2021) is shown in table 4. The strong correlation between TDS and pH (0.815), TDS and SO42- (0.826) were found. The moderate correlation between Cl - and pH (0.528), Cl - and total alkalinity (0.401), SO42- and total alkalinity (0.638), SO42- and total hardness (0.524), SO42- and Cl- (0.448), total hardness and pH (0.463), SO42- and Cl- (0.451), were found. The remains showed a weak correlation with other parameters.

**Table 4.** Correlation Coefficient matrix of physio-chemical parameters for Sirohi Village in Neemkathana Block of Sikar District (August 2020 to July 2021)

| Parameters | $P^H$ | Total Alkalinity, mg/L $CaCO_3$ | Total Hardness, mg/L | $Cl^-$, mg/L | $SO_4^{2-}$, mg/L | $NO_3^-$, mg/L | $F^-$ mg/L | TDS, mg/L |
|---|---|---|---|---|---|---|---|---|
| pH | 1 | | | | | | | |
| Total Alkalinity, mg/L $CaCO_3$ | 0.139 | 1 | | | | | | |
| Total Hardness, mg/L | 0.463 | -0.099 | 1 | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $Cl^-$, mg/L | 0.528 | 0.401 | 0.431 | 1 | | | | |
| $SO_4^{2-}$, mg/L | -0.339 | 0.638 | 0.524 | 0.448 | 1 | | | |
| $NO_3^-$, mg/L | 0.111 | -0.436 | -0.090 | -0.687 | -0.791 | 1 | | |
| $F^-$ mg/L | -0.268 | -0.139 | 0.218 | -0.269 | -0.042 | 0.207 | 1 | |
| TDS, mg/L | 0.815 | -0.110 | 0.241 | 0.449 | 0.826 | -0.662 | 0.031 | 1 |

## 4. Conclusion

The statistical analysis of the experimental estimated groundwater quality parameters of Sirohi village water samples yielded the range of variations, mean, standard deviation and coefficient of correlation. Results of the coefficient of correlations show the strong, moderate and weak relation between the physio-chemical parameters. Where it is observed that the TDS value of Sirohi village is much higher than the recommendations of BIS (IS 10500: 2012). It reveals that the groundwater of Sirohi is contaminated. Open-cast mining activities are operating on a large scale, depth level is so higher that during mining activities water emerges into mines, and by-product goes down with the process of to recharge of the water table which creates an imbalance of the physico-chemical parameters.

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