Assessment of Groundwater Quality with Available Physicochemical Parameters in Madaragalli Village, Mysore Taluk, Mysore District, Karnataka, India

Mohammed Aleem Pasha
Department of Geology
Central University of Karnataka
Kalaburagi 585367 karnataka, India

Abstract

Groundwater is a renewable natural resource that is over exploited for drinking as well as industrial and agriculture purposes all over the world. The quality of the groundwater depends on its physical, chemical and bacteriological characteristics. The quality of drinking water is directly related to human health. Samples are collected from bore wells from different locations such that they are spatially distributed in the study area. The concentration of all the parameters are within the permissible limits for all the samples except sample number 3 where the concentration of bicarbonate, magnesium and total hardness is above the permissible limits. The present study revealed that all the sampled wells of Madaragalli village are yielding the water that is very hard which may not be suitable for consumption. The author suggests the people living in the study area to purify the water before consumption.

Key words: Groundwater, Madaragalli, Total Hardness, Mysore, Groundwater quality

INTRODUCTION

Groundwater is a renewable natural resource that is over exploited for drinking as well as industrial and agriculture purposes all over the world. Groundwater is an important source of drinking water for about 70% of Indian population [1]. Access to good quality drinking water is everyone's right. The quality of groundwater depends on the number of

natural and anthropogenic factors. These factors may change the quality and may pollute the groundwater making it unsafe for human consumption. The quality of the groundwater depends on its physical, chemical and bacteriological characteristics. The precipitated water is relatively free of mineral elements until it comes into contact with the soil and rocks. As a result minerals are dissolved and carried into solution. The concentration of these elements are depends on the minerals present, the length of residence time and the amount of dissolved carbon dioxide in water. The anthropogenic causes are involved in increase of concentration of these parameters. In the rural areas some of the groundwater sources are used for both domestic as well as agricultural purposes. The quality of drinking water is directly related to human health. Therefore the main aim of the present study is to understand the quality of the groundwater in the study area.

STUDY AREA

The study area is the village Madaragalli which belongs to the Mysore District, Karntaka, India. Madaragalli village is situated between $12^{O}13'$ north latitude and $76^{O}40'$ east longitude and is covered by the survey of India topographic sheet 57 D/12. Map 1, shows the location of the study area. The total area of the village is 311.6 hectares. The average elevation of the study area is 680 meters above mean sea level.

Map 1. Location map of the study area; Madaragalli, Mysore District.

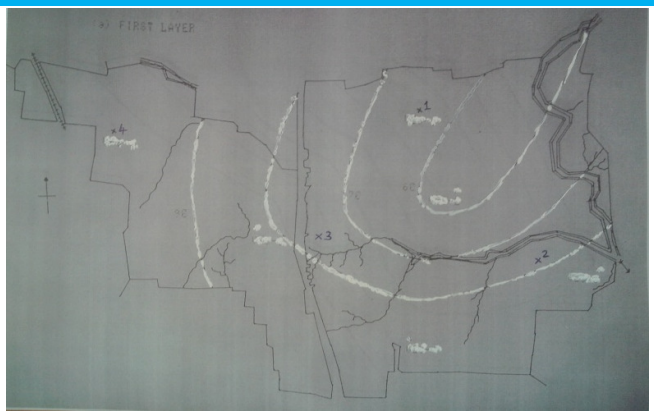
The average annual rainfall in the study area is 798 mm where most of the precipitation is received from the southwest monsoon. The annual average maximum temperature in the study area is 33.4^{O}C and the minimum temperature is 20.9^{O}C. The most dominant rock types in the study area are the peninsular gneisses. The general trend of the gneisses is N5^{O}W – S5^{O}E with a dip of 75^{O} towards southwest. The gneisses are traversed by thin bands of quartzite with varying thickness.

METHODOLOGY

A total of 4 samples are collected from bore wells from different locations such that they are spatially distributed in the study area. Standard procedures of the sample collection are followed for the collection of groundwater samples. Samples are collected in 1 litre PVC bottles. The bottles are thoroughly washed and rinsed twice with the water of sample collecting wells before filling to the brim. Care has been taken to avoid presence of any air gap in the sample cans. Sample cans are properly sealed first with airtight cork and then closed with a cap. Samples are properly labelled and date and location are mentioned on it for future reference. Such collected water samples are sent to the laboratory for the groundwater quality analysis immediately and are analysed within 24 hours.

RESULTS AND DISCUSSION

Map 2, shows the locations of the sampling points in the study area; Madaragalli village map. Table 1, shows the sampling locations along with some of the groundwater quality parameters of the study area with its acceptable and permissible limits as per WHO standards [2]. Table 2, shows some of the statistical parameters of above mentioned groundwater parameters of the study area.



Map 2. Locations of the sampling points in the Madaragalli village.

Table 1. Some of the groundwater quality parameters of the study area with its acceptable and permissible limits.

Acceptable Limits	6.5-8.5	250	200	250	200	75	30	200
Permissible Limits	6.5-8.5	1000	400	1000	400	200	100	600
Sample No	**pH**	**CO3 mg/L**	**HCO3 mg/L**	**Cl mg/L**	**SO4 mg/L**	**Ca mg/L**	**Mg mg/L**	**TH**
1	8.55	48	436.1	50.4	14	19.2	64.3	312.916
2	8.11	38.4	392	58.8	4	65.6	54.7	389.364
3	7.99	38.4	485.1	218.4	16	59.2	120.9	646.108
4	7.86	28	387.1	140	16	49.6	83.5	468.02

Table 2. Statistical parameters of physicochemical parameters of groundwater in the study area.

Sample No	pH	CO3 mg/L	HCO3 mg/L	Cl mg/L	SO4 mg/L	Ca mg/L	Mg mg/L	TH
Total	32.51	152.8	1700.3	467.6	50	193.6	323.4	1816.408
Average	13.004	61.12	680.12	187.04	20	77.44	129.36	726.5632
Median	8.11	38.4	436.1	140	16	59.2	83.5	468.02
Max	8.55	48	485.1	218.4	16	65.6	120.9	646.108
Min	7.86	28	387.1	50.4	4	19.2	54.7	312.916
StDev	0.299	8.168	45.682	78.811	5.744	20.547	29.261	142.810

pH

The pH is not having a direct impact on the health and no health based guideline value is proposed. Yet, it is one of the important water quality parameter. pH is a measure of hydrogen ion concentration, (H+) ranging from 0 to 14 pH. A solution having a pH below 7 is acidic and above 7 is alkaline or basic. Water is having a pH of 7 and is known as neutral. The permissible limits of pH for drinking water range between 6.5 and 8.5. In the study area the pH of the groundwater varies from 7.86 to 8.11 which are falling well within the permissible limit. Figure 1, shows the concentration of pH in the study area.

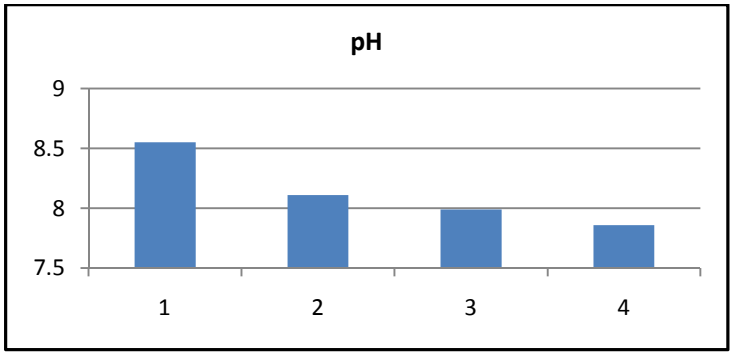


Figure 1. pH concentration in the study area.

CARBONATE AND BICARBONATE

Figure 2 and 3, bar graph showing the concentration of carbonates and bicarbonates in teh study area respectively. Carbonates are predominantly present in sedimentary rocks but may present in igneous and metamorphic rocks as well to some extent. Since, the dominant rock types in the study area are gneisses the presence of carbonate is less and the concentration noticed in the study area is within the permissible limits. The concentration of the carbonate in the study area ranges between 28 and 48 mg/l with a median value of 38 mg/l. Similarly, the bicarbonates are ranging between 387 and 485 mg/l with a median value of 436 mg/l. The sample number 2 and 4 are within the permissible limits but the reaming two samples show slightly higher values. In over all, bicarbonates are dominating the area than the carbonate ions suggest that the water is fresh.

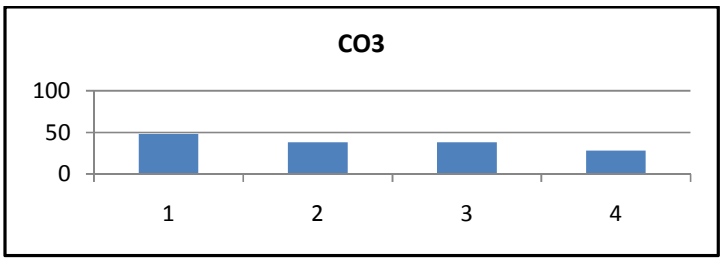


Figure 2. Carbonate concentration in the study area.

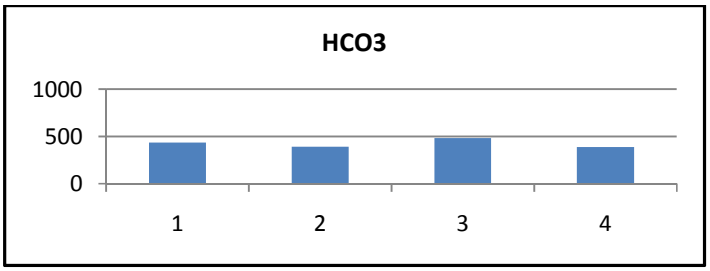


Figure 3. Bicarbonate concentration in the study area.

CHLORIDE

Chloride ion is a natural form of chlorine and soluble in water. The major sources of chloride in natural water are sedimentary rocks. The concentration of chloride is low in water unless the water is brackish or saline and it is usually less than 100 mg/l [3]. No

health based guidelines are proposed for chloride and sulphate; and high concentration of chloride imparts a salty taste to water. Chloride plays an important role in balancing levels of electrolytes in blood plasma but excess consumption may lead to hypertension, osteoporosis, renal stones and asthma [4]. Figure 4 and 5, bar graph shows the concentration of the chloride and sulphate in the study area respectively. The concentration of the chloride in the study area is ranging between 50and 218 mg/l which is within the permissible limits for all the samples.

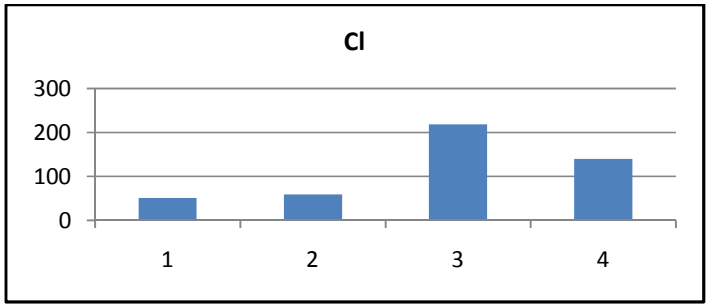


Figure 4. Chloride concentration in the study area.

Sulphate ion is derived from the sulphide minerals present in the rocks through oxidation process. Excess consumption of sulphate may cause laxative effect, catharsis, dehydration and gastrointestinal irritation [3,4]. The concentration of sulphate in the present study area is ranging between 4 and 16 mg/l with a median value of 16 mg/l which is within the acceptable limits. The reason for the low concentration of sulphate in the samples could be the rocks present in the study area as the water in igneous and metamorphic rocks generally contains less than 100 mg/l of sulphate concentration [3].

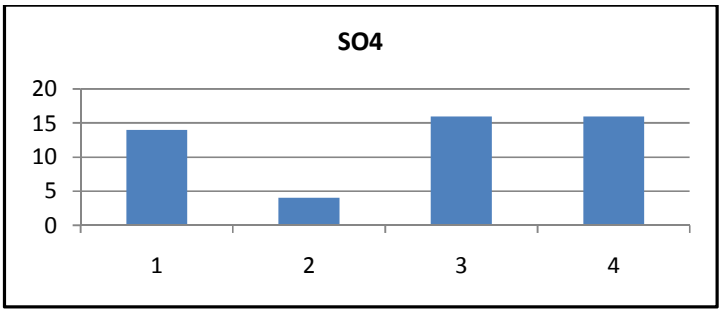


Figure 5. Sulphate concentration in the study area.

CALCIUM

Calcium is one of the important and widespread elements in minerals present in almost all types of rocks and is abundantly found in groundwater. Major source of calcium is silicate minerals of igneous and metamorphic rocks and carbonate minerals of sedimentary rocks. Calcium is one of the essential nutrients required for the normal growth in humans especially bones. Inadequate intake may cause osteoporosis, nephrolithiasis (kidney stones), colorectal cancer, hypertension and stroke, coronary artery disease, insulin resistance and obesity [2]. Figure 6, shows the bar graph of concentration of calcium in the study area. The calcium concentration is ranged between 19 and 65 mg/l in the study area which is well within the acceptable limits. The reason for the occurrence of low concentration of calcium in the groundwater in the study area could be due to the absence of calcic minerals in the gneisses as Its abundance in water is due to its widespread occurrence and higher solubility and the range of its availability depends on the solubility of calcium carbonate and sulphate [4].

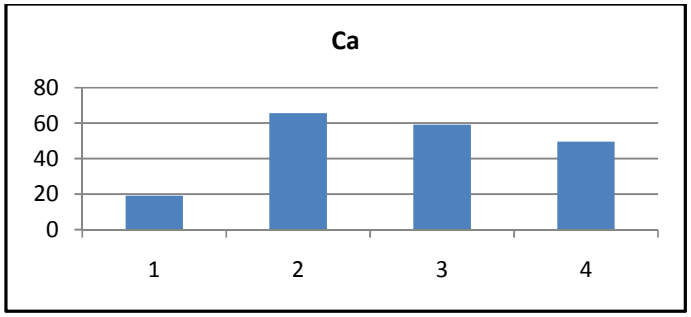


Figure 6. Calcium concentration in the study area.

MAGNESIUM

Figure 7, shows the bar graph of concentration of magnesium in the study area. Magnesium usually occurs in lesser concentration than calcium in groundwater [2,4]. Concentrations higher than the permissible limits impart water an unpleasant taste and make the water unfit for drinking [4,5]. Recent reports suggest an inverse relationship between magnesium and coronary heart disease mortality and type 2 diabetes mellitus is noticed [2]. The magnesium concentration is ranged between 54 and 120 mg/l in the

study area. All the samples show the concentration within the permissible limit except sample number 3 which is slightly higher than the permissible limits.

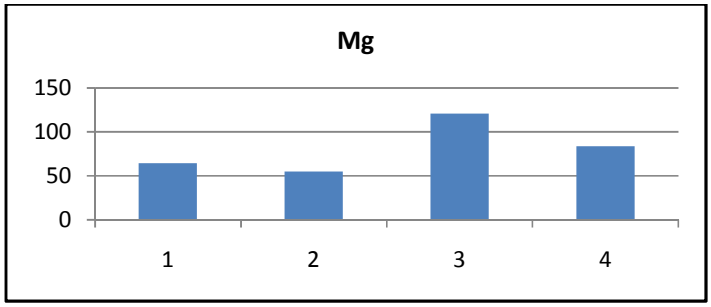


Figure 7. Magnesium concentration in the study area.

TOTAL HARDNESS (TH)

Total hardness is a sum of calcium and magnesium hardness which is expressed as an equivalent quantity of calcium carbonate [2]. The high hardness may cause precipitation of calcium carbonate and encrustation on water supply distribution systems [6]. Figure 8, shows the bar graph of concentration of TH in the study area.

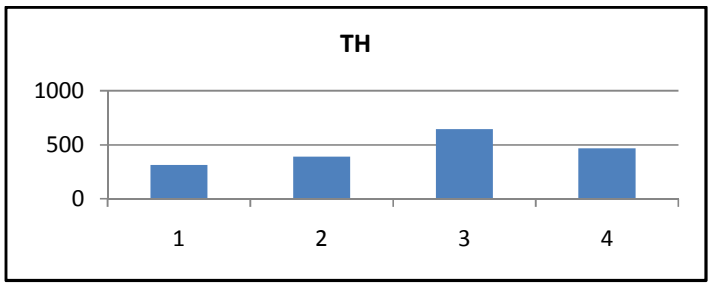


Figure 8. Total Hardness concentration in the study area.

The concentration of TH range between 312 mg/l and 646 mg/l with a median value of 468 mg/l in the study area. Except the sample number 3 all the other samples showing the values within the permissible limits. Table 3, shows the details of type of water available in the study area. It is observed from the table that people living in the study area are consuming very hard water.

Table 3, shows the details of type of water available in the study area.

Type of water	Range	No of samples in study area	Percentage of area of the study area
Soft	<60mg/l	0	0
Moderately hard	60-120 mg/l	0	0
Hard	120-180 mg/l	0	0
Very hard	>180 mg/l	4	100

Hard water may not pose a serious threat to human health but may cause to form kidney stones. Exposure to hard water has been suggested to be a risk factor that could exacerbate eczema. The hardness in water feels unpleasant on skin and may cause itching and drying of skin. Scales that forms inside the water pipes due to encrustations reduces the carrying capacity and affects the water distribution system. Scale that forms within appliances, pumps, valves, and water meters causes wear on moving parts. Increases power consumption [2].

CONCLUSION

The present study shows the total hardness concentration in Madaragalli village is ranged between 312 and 646 mg/l with a mean value of 468 mg/l. The present study revealed that all the sampled wells of Madaragalli village are yielding the water that is very hard. The sampled wells in the study area are having very high hardness of water which is above the permissible limits and may not be suitable for consumption. The concentration of all the parameters are within the permissible limits for all the samples except sample number 3 where the concentration of bicarbonate, magnesium and total hardness is above the permissible limits.

The hardness of the water may cause some health concerns, affect the water distribution system and may increase the power consumption. Therefore, the author is of the opinion and suggests that the people living in Madaragalli village must purifywater before consumption and the local public administration in the public water supply system should provide purified water as a public health concern if it has not done already.

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