Assessment Of Groundwater Quality In Mattampally - Mellacheruvu Areas, Suryapet District, Telangana State, India

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Abstract: Water plays a major role in supporting human life. Much of the water used for drinking, irrigation, and industrial activities. Rapid urbanization and industrialization have lead to deteriorate groundwater quality. Consuming contaminated water may lead to different diseases, which causes adverse health effects. Therefore, it is vital to ensure a good quality of water supplied to the community, which meets the desired standards. A field study has been conducted to assess the groundwater quality in Mattampally – Mellacheruvu areas, Suryapet district, Telangana. Water samples from 75 locations are collected in the pre-monsoon season (June 2011), and their respective physicochemical parameters are analyzed. Granite, Quartzite, and Limestone are the principal rocks found in the area. NW part of the study area has higher values of Total dissolved solids, Chlorides, Nitrates and Bicarbonates, whereas NE part of the area has a higher concentration of Sodium, Potassium, and Sulphate. Plots of Gibbs diagram shows that area is rich in rock dominance. Hence, our results suggest that groundwater quality in the study area is affected by rock composition and there is a need to treat water before supplied to the local community. Poor agriculture practices should be substituted to reduce the impact of fertilizers.

Index Terms: Groundwater Quality, Mattampally-Mellacheruvu areas, Physicochemical parameters, Rock-dominance.

1 Introduction

Groundwater acts a vital source in providing drinking water for growing population. Majority of the population depended on water for several daily needs. Over-exploitation of water resources has caused some areas as dominant in water shortage, improper dumping of waste, the release of industrial and human effluents into river water bodies is still considered a major threat of contamination. Agriculture activities, industrial activities, and human activities are polluting the study area. So, it is necessary to analyze the physicochemical parameters to find out the quality of groundwater. Canals are passing through the study; it is also causing the groundwater pollution by bringing the wastage and pesticide concentration. The study area, which falls in the southeastern fringe of Suryapet district, Telangana State, India, is the land of paddy fields, open scrub area, and opencast mine area. There is no right quality of water for drinking, irrigation, and industrial. Agriculture runoff consisting of fertilizers applied to the fields and also industries located in and around may be the reason for the source of contamination, allowing the contaminants to penetrate into aquifers. In this study an attempt has been made to study the groundwater quality for drinking water purpose and Gibb's diagrams showing the controlling the mechanism of groundwater for pre-monsoon (June 2011) in Mattampally-Mellacheruvu areas, Suryapet district, Telangana State, India.

1.1 Study Area

The study area locates on the southeastern fringe of the Suryapet District, Telangana State, India, and falls in Mattampally, Mellacheruvu and Huzurnagar revenue mandals. It is about 500 sq km and falls in topo sheet nos.56 p/13, 56 p/14 and extends from latitude 16^0 42' - 16^0 50'N and longitude 79^0 50'-80^0 0'E. Three main tributaries of Krishna river are Elagavagu, Uravagu, and Mamidimottavagu, flow in the study area. There is limestone, tile mines and cement industries situated in and around the village. More than 70% of the village population depends on agriculture for their livelihoods. Our study area consists of 22- villages which is shown in Fig.1

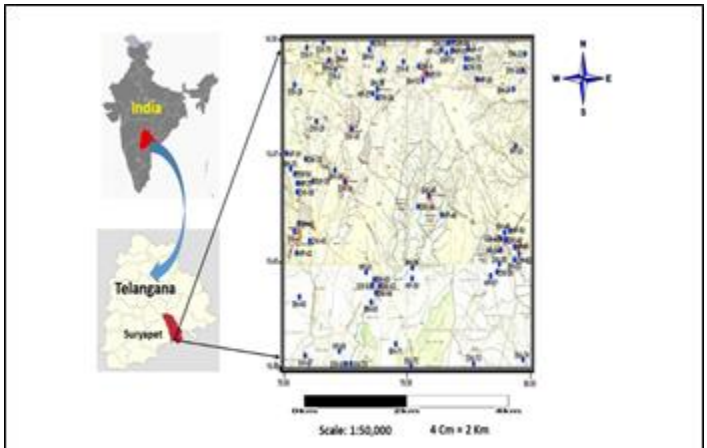

Fig.1.Map showing the study area of Mattampally – Mellacheruvu areas

2 Materials And Methods

A total number of 75 samples from different sites based upon variations in rock compositions have been collected to study the groundwater quality. The minimum, maximum, average values of the various physicochemical attributes and compared with standard BIS values[1] as shown in table.1. Different physicochemical parameters such as pH, Electrical Conductivity(EC), Total Dissolved Solids (TDS), Carbonates(CO_3), Bicarbonates (HCO_3) are analyzed as per the standard procedure of APHA[2], Lithium(Li), Sodium(Na), Potassium(K), Magnesium(Mg), Calcium(Ca), Fluoride(F), Chloride(Cl), Bromide(Br), Nitrate(NO_3), Phosphate(PO_4), Sulphate(SO_3) are analyzed following the standard procedure of USEPA, 300.1 (United States Environmental Protection Agency).

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Table.1. *Results of Physicochemical analysis for the samples of Mattampally – Mellacheruvu areas*

S. No	Parameter	Unit	Min	Max	Average	BIS specification for drinking water (Desirable limits)
1	pH	-	6.40	8.10	7.41	6.5 - 8.5
2	TDS	mg/l	430.00	2660.00	1008.31	500
3	EC	µs/cm	540.00	3300.00	1263.90	-
4	Li^{+}	mg/l	0.12	0.25	0.14	No relaxation
5	Na^{+}	mg/l	17.73	349.48	122.49	200
6	K^{+}	mg/l	0.28	318.81	36.53	No relaxation
7	Mg^{2+}	mg/l	2.21	98.56	28.12	30
8	Ca^{2+}	mg/l	8.91	278.25	45.68	75
9	F-	mg/l	0.34	2.51	0.94	1
10	Cl-	mg/l	22.70	890.76	207.05	250
11	Br-	mg/l	0.18	13.94	0.97	-
12	No^{3-}	mg/l	0.77	396.87	70.69	45
13	Po_4^{3-}	mg/l	0.31	0.70	0.38	-
14	So_4^{2-}	mg/l	15.42	704.14	148.83	200
15	CO_3^{2-}	mg/l	BDL	69.00	10.40	200
16	HCO^{3-}	mg/l	67.10	979.05	308.41	200

(BDL=Below Detection Limit)

2.1 Geology of the Area

The study area forms a part of the stable southern Indian peninsular shield consisting of the peninsular gneissic complex (PGC), Dharwar supergroup, and younger intrusives and Kurnool group of rocks. The PGC occupies a significant part of the study area and comprises (Ggn) granite, granodiorite and granite gneiss with Xenolith of tonalite, trondhjemite, pyroxene granite, granodiorite amphibolites and biotite schist. These rocks are tough and moderately dense. Metabasalts, acid volcanic and banded hematite quartzite of Dharwar supergroup expose in the NNW- part of the study area; those are very hard and dense. The Dolerite dykes intrude within the peninsular gneissic complex and Dharwar rocks. These types of basic intrusives are tough and dense. In the southern part of the study area and along the northern bank of the Krishna River the rocks of an Archean peninsular gneissic complex are unconformably overlain by sedimentary rocks of 1100 – 600 m.y. Ages, consisting of the Kurnool group. The Kurnool group of rocks comprises calcareous (chemical precipitates) sediments (limestones) and quartzite with the conglomerate. Limestones are hard and compact, and quartzite with conglomerate is hard and massive.

3 Results And Discussion

Various physicochemical parameters for the water samples collected from Mattampally-Mellacheruvu areas are analyzed, and their impact on human health is well described below.

3.1 pH

The minimum and maximum values of pH are 6.4 and 8.1. The average amount of Ph is 7.41(following the BIS values), all values of pH are within the desirable limits except sample. no.38 (pH =6.4), sample.no.38 is located in NW-part of the study area. The groundwater in the study area is suitable for drinking water purpose. The concentration of pH in the water is outside the desirable limit (6.5 to 8.5), the water will affect the mucous membrane and water supply system.

3.2 Electrical Conductivity

Electrical conductivity (EC) values range from 540 (µs/cm) to 3300 (µs/cm) in the study area with the corresponding average amount of 1263.90 (µs/cm). Highest EC value observed towards the NW- part of the study area in the sample. No.30 [Ec-3300 (µs/cm)] and shows higher values towards the NE, NW- part of the area, orderly sample.nos.15, 19, 23(NE-part of the study area) and 34, 38, 41, 42 (NW-part of the study area) respectively. Surface run-off allows fertilizers to be washed away from the paddy fields and makes water to be enriched with nutrients, leading to an increase in EC values. The semi-arid climatic condition, high evaporation, and salinity in NE, NW-part of the study area considered as another reason for the higher values of EC observed.

3.3 Total Dissolved Solids (TDS)

TDS represents the total number of dissolved solids present in a water sample[3]. The range of TDS from 430 (mg/l) to 2660 (mg/l) in the study area (following BIS values), the average value of TDS is 1008.31(mg/l), It is not crossing the permissible limit [2000(mg/l)]. Nearly 89% of the samples are exhibit TDS values outside the desirable limit [500 (mg/l)], nearly 11% of samples are within the desirable limit. Most of the percentages of samples are outside the desirable limit; it causes the palatability decreases and may cause gastrointestinal irritation. The TDS shows the highest value

towards the NW- part of the study area in the sample. No.30 [TDS-2660 (mg/l)] and shows higher values towards the NE-part of the area in sample. nos. 19, 23 with concentrations, orderly, 2240(mg/l), 2110(mg/l).TDS observed to be higher in NW and NE-part of the study area, and is strongly correlated with EC. Since the increase in total dissolved solids is directly proportional to EC. Industrial, agricultural waste and leaching of ions may be the reason for the increase in TDS.

3.4 Carbonates and Bicarbonates

Carbonates in the dug wells, drilled wells present moderately in very low concentrations. Carbonates values are within the desirable limit [200(mg/l) - BIS values] in groundwater, the minimum value of carbonate is below the detection limit, and the maximum value of carbonate is 69.0 (mg/l) in the sample. No 15. The average value of carbonate is 10.40 (mg/l), so it is suitable for drinking purpose. The desirable and permissible limit of carbonate is 200 (mg/l) - 600 (mg/l), beyond this limit taste, becomes unpleasant. Among the major anions and cations, the bicarbonate (HCO^{-3}) is the dominant one, the range of bicarbonate from 67.10(mg/l) to 979.05 (mg/l) in the study area (following BIS values), the average value of bicarbonate is 308.41(mg/l), It is not crossing the permissible limit [600(mg/l)]. Nearly 54% of the samples are exhibit bicarbonate values outside the desirable limit [200 (mg/l)], nearly 46% of samples are within the desirable limit. Most of the percentage of samples are outside the desirable limit, the desirable and permissible limit is 200 (mg/l) -600 (mg/l), and beyond limit taste becomes unpleasant. The bicarbonate shows the highest value towards the NW- part of the study area in the sample. No.26 [979.05 (mg/l)] and shows higher values, orderly in the sample.nos; 9, 1, 4, 39, 40, 34, 37, 25, 59 with concentrations, respectively 649.7 (mg/l) (NE-part of the study area), 625.3 (mg/l), 732.0 (mg/l), 692.4 (mg/l), 643.5 (mg/l), 829.6 (mg/l), 661.9 (mg/l), 735.1 (mg/l) (NW-part of the study area), 607.0 (mg/l) (SE-part of the study area). Presence of carbonate minerals and their dissolution while water charged with carbon dioxide passes through soil give bicarbonates[4].

3.5 Calcium and Magnesium

Calcium (Ca) content falls within the desirable limit [75 (mg/l)] in the majority of the samples. The range of Calcium from 8.91(mg/l) to 278.25 (mg/l) in the study area (following BIS values), the average value of Calcium is 45.68(mg/l), It is not above the permissible limit [200(mg/l)]. Nearly 14% of the samples are exhibit Calcium values outside the desirable limit [75 (mg/l)], nearly 86% of samples are within the desirable limit. Most of the percentage of samples is within the desirable limit, the desirable and permissible limit range is 75 (mg/l) - 200 (mg/l), beyond limit encrustation in water supply structure and adverse effect on domestic use[5]. The Calcium shows the highest value towards the NW- part of the study area in sample.No.30 [278.25 (mg/l)]. Concentration upto 1800(mg/l) may not cause any physiological reactions in humans, but it is not suitable for washing, bathing and laundering purposes. Sample No. 30 is exhibited values far beyond the desirable limit. Though the sources of Ca in groundwater resources are crystalline limestone, granitic terrain, dolerite dyke and quartzite with conglomerate, also contributes for increase in Ca. Prolonged agricultural activities prevailing in the study area may also directly or indirectly enhance mineral dissolution in groundwater. The concentration of Mg is less when compared with that of Ca in the study area. The range of magnesium from 2.21(mg/l) to 98.56 (mg/l) in the study area (following BIS values), the average value of magnesium is 28.12(mg/l), It is not above the desirable limit [30(mg/l)] and permissible limit [100(mg/l)]. Nearly 38% of the samples are exhibit magnesium values outside the desirable limit [30 (mg/l)], nearly 62% of samples are within the desirable limit. Most of the percentage of samples is within the desirable limit, the desirable and permissible limit range is 30 (mg/l) - 100 (mg/l), beyond limit encrustation in water supply structure and adverse effect on domestic use. The magnesium shows highest value towards the NE- part of the study area in the sample. No. 19 [98.56 (mg/l)]. The chemical composition of different rock types may influence the concentration of Mg in groundwater.

3.6 Sodium and Potassium

Sodium (Na) is known as one of the most naturally occurring cations, and its concentration in fresh waters is lower than that of Ca and Mg. But in the present study, the average concentration of Na is comparatively higher when compared with that of Ca and Mg. The permissible limits given by BIS is 200 (mg/l). The range of sodium from 17.73(mg/l) to 349.48 (mg/l) in the study area (following BIS values), the average value of sodium is 122.49(mg/l). Nearly 13% of the samples are exhibit sodium values outside the desirable limit [200 (mg/l)], nearly 87% of samples are within the desirable limit. Most of the percentage of samples is within the desirable limit. The sodium shows highest value towards the NE- part of the study area in the sample. No.23 [349.48 (mg/l)] and shows the higher values, orderly in sample.nos.15, 17, 19, 24, 25, 26, 30, 38, 41with concentrations, respectively 285.258(mg/l), 217.037(mg/l), 282.536(mg/l), 222.066(mg/l) (NE-part of the study area), 203.053(mg/l), 317.584(mg/l), 325.029(mg/l), 235.736(mg/l), 216.978(mg/l) (NW-part of the study area). Sample No. 23 [349.48 (mg/l)] is the registered value above the desirable limit. Since the NE- mainly granite gneisses, granites, dolerite dyke, and quartzite with conglomerate cover part (where the sodium shows the highest value). The minimum and maximum values of potassium are 0.28(mg/l)-318.81 (mg/l) in the study area, the average value of potassium is 36.53(mg/l). The potassium shows the highest value towards the NW- part of the study area in the sample. No. 34 [318.81 (mg/l)]. Sample No.34 [318.81(mg/l)] is registered value above the International drinking water standard of 12 (mg/l) (EEC&GERMAN Standards). Equal concentration of both Na and K seen in rocks, but due to weathering, some part of the K will be reduced to clay structure and thereby resulting in less concentration in water. Application of inorganic fertilizers can enhance K concentration in water levels thus making it unsafe to drink.

3.7 Chloride

The range of chloride from 22.70(mg/l) to 890.76 (mg/l) in the study area (following BIS values), the average value of chloride is 207.05(mg/l), It is not crossing the permissible limit [1000(mg/l)]. Nearly 25% of the samples are exhibit chloride values outside the desirable limit [250 (mg/l)], nearly 75% of samples are within the desirable limit. Most of the percentage of samples is within the desirable limit; the desirable and permissible limit is 250 (mg/l) - 1000 (mg/l), beyond the desirable limit the taste, corrosion cause[6]. The chloride shows the highest value towards the NW- part of the study

area in sample.No.30 [890.76 (mg/l)]. The possible sources of increase in chloride levels may be because of leaching of chloride-containing minerals such as apatite, rocks, industrial and agricultural waste[7].

3.8 Nitrate

The range of nitrate from 0.77(mg/l) to 396.87 (mg/l) in the study area (following BIS values), the average value of nitrate is 70.69 (mg/l), no permissible limit to the Nitrate. Nearly 37% of the samples are exhibit Nitrate values outside the desirable limit [45 (mg/l)], nearly 63% of samples are within the desirable limit. Most of the percentage of samples is within the desirable limit; the desirable and permissible limit is 45 (mg/l) no relaxation, beyond the desirable limit Methaemoglobinemia, takes place/may be indicative of pollution. The nitrate shows the highest value towards the NW- part of the study area in sample.No.38 [396.87 (mg/l)]. During the rainy season, the concentration of nitrates will be higher due to surface runoff as nitrate is loosely bound to soil[8, 9].

3.9 Phosphate

In natural water phosphates mostly ranges between 0.005(mg/l) and 0.020(mg/l). Phosphate values observed to be higher in all the samples collected. Its content in the present investigation ranges from 0.31(mg/l) to 0.70(mg/l) with an average of 0.38 (mg/l). The phosphate shows the highest value towards the NW- part of the study area in sample.No.8 [0.70 (mg/l)]. As the study area is dominant in agriculture practice and application of phosphate-rich fertilizer to the field is a common practice, it may be a possible reason for increased levels of phosphate in groundwater samples[10].

3.10 Lithium

Lithium content is very low in the study area, the range of lithium from 0.12(mg/l) to 0.25 (mg/l) in the study area (following BIS values), the average value of lithium is 0.14(mg/l), there is no standard value to lithium for drinking water purpose, no relaxation of lithium for drinking water purpose[11]. The lithium shows the highest value towards the SW- part of the study area in sample.No.42 [0.25 (mg/l)].

3.11 Fluoride

The range of fluoride from 0.34 (mg/l) to 2.51 (mg/l) in the study area (following BIS values), the average value of fluoride is 0.94(mg/l), It is not crossing the permissible limit [1.5 (mg/l)]. The average value of fluoride 0.94(mg/l) is within the desirable limit, so, the water uses for drinking water purpose in the study area. Nearly 36% of the samples are exhibit fluoride values outside the desirable limit [1.0 (mg/l)], nearly 64% of samples are within the desirable limit. Most of the percentage of samples is within the desirable limit; the desirable and permissible limit is 1.0 (mg/l) -1.5 (mg/l), beyond the desirable limit, it causes to fluorosis to the human beings. Fluoride may be kept as low as possible; the high fluoride may cause fluorosis[12]. The fluoride shows highest value towards the NW- part of the study area in sample. No.26 [2.51(mg/l)], this sample.no.26 [2.51(mg/l)] is located in Venkataramapuram village in the study area, this well water is not suitable for drinking water purpose and shows higher values, orderly in sample.nos- 13, 25, 32, 37, 48 with concentrations, respectively 1.958 (mg/l) (NE-part of the study area), 2.162 (mg/l), 1.525 (mg/l), 1.719 (mg/l) (NW-part of the study area), 1.743 (mg/l) (SE-part of the study area).

3.12 Sulphate

Range of sulphate from 15.42 (mg/l) to 704.14 (mg/l) in the study area (following BIS values), the average value of sulphate is 148.83(mg/l), It is not crossing the permissible limit [400(mg/l)]. Nearly 20% of the samples are exhibit sulphate values outside the desirable limit [200 (mg/l)], nearly 80% of samples are within the desirable limit[13]. Most of the percentage of samples is within the desirable limit; the desirable and permissible limits are 200 (mg/l) - 400 (mg/l), beyond the desirable limit, causes gastrointestinal irritation when magnesium or sodium is present. The sulphate shows highest value towards the NE- part of the study area in the sample. No.23 [704.14 (mg/l)] and shows higher values, orderly in the sample.nos; 24, 30, 41 with concentrations, respectively 467.523 (mg/l) (NE-part of the study area), 452.797(mg/l) (NW-part of the study area), 401.14(mg/l) (SW-part of the study area).

3.13 Bromide

The minimum and maximum values of bromide are 0.18(mg/l) -13.94(mg/l) in the study area (following BIS values), the average value of bromide is 0.97(mg/l). The bromide shows the highest value towards the SE- part of the study area in the sample. No.49 [13.94 (mg/l)]. The sample no.49 [13.94 (mg/l)] located in Mallareddygudem village[14].

3.14 Gibb's Diagram

The Gibbs ratio of the cations (Na+K)/ (Na +K+Ca) [meq/l] of groundwater samples plots against TDS values. The plot in fig.2 indicates that 93.33% of the groundwater samples fall in the dominant rock category, 4% samples fall in the evaporation dominance, and the remaining 2.66% samples fall in the anthropogenic dominance field, whereas no sample fall in the precipitation dominance field.

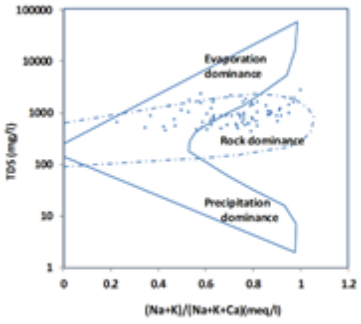

Fig.2. Gibbs diagrams showing the ratio of cations against TDS in groundwater.

The Gibbs ratio of the anions (Cl)/ (HCO_3+Cl) [meq/l] of groundwater samples plots against TDS values. The plot in fig.3 indicates that 92% of the groundwater samples fall in the dominant rock category, 4% samples fall in the evaporation dominance field, and the rest of 4% samples fall in the anthropogenic dominance field, whereas no sample fall in the precipitation dominance field[15]. Suggesting, rock-water interaction [16] is the major cause of intrusion of ions in water.

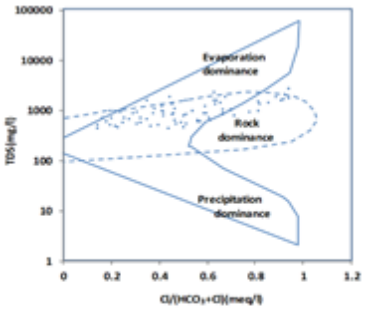

Fig.3. Gibbs diagrams showing the ratio of anions against TDS in groundwater.

4 Conclusion

The physicochemical analysis of the Mattampally–Mellacheruvu areas reveals that the groundwater contaminated through rock-water interaction. The average concentration of Carbonate (10.40 mg/l), Sulphate (148.83 mg/l), Chlorides (207.05 mg/l), Fluoride (0.94 mg/), Calcium (45.68 mg/l), Magnesium (28.12 mg/l), Sodium (122.49 mg/l), pH (7.41) are within their respective desirable limits (BIS values) in groundwater in the study area. So, the groundwater is suitable for drinking water purpose and irrigation purpose. The average concentration values of Bicarbonate (308.41mg/l), Nitrate (70.69mg/l), Total dissolved solids (1008.31mg/l) are outside their respective desirable limits (BIS values) in groundwater in the study area. Lithium is 0.14(mg/l), there is no standard value to lithium for drinking water purpose, no relaxation of lithium for drinking water purpose. Lithium shows the highest value towards the SW- part of the study area in sample.No.42 [0.25 (mg/l)]. Potassium shows the highest value towards the NW- part of the study area in the sample. No.34 [318.81(mg/l)], registered value above the drinking water standard of 12 mg/l (EEC&GERMAN Standards). Value of bromide is 0.97(mg/l) shown the highest towards the SE- part of the study area in the sample. No.49 [13.94 (mg/l)]. The average value of phosphate is 0.38 (mg/l), it is outside the natural water ranges from 0.005(mg/l) to 0.020(mg/l), the phosphate shows the highest value towards the NW- part of the study area in sample.No.8 [0.70 (mg/l)]. Fluoride shows the highest value towards the NW- part of the study area in the sample.No.26 (2.51mg/l), this nsample.no.26 (2.51mg/l) locates in Venkataramapuram village in the study area; this well water is not suitable for drinking water purpose and shows higher values towards the NE, NW parts of the study area. The desirable and permissible limit is 1.0 (mg/l) - 1.5 (mg/l), beyond the desirable limit, it causes to fluorosis to the human beings. Gibb's diagram shown rock weathering as the dominant process involving the changes in groundwater chemistry for most of the samples in the study area. Finally, this study suggests that deterioration of groundwater quality in Mattampally – Mellacheruvu areas is due to dominant in rock-water interactions, therefore proper monitoring and treating is needed to ensure supply of safe drinking water.

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