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Study on groundwater analysis for drinking purpose in Mangalagiri Mandal regions, Andhra Pradesh, India

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Abstract
Water quality has become an important factor for water resources issue due to rapid increase of population, rapid industrialization, and unplanned urbanization. Hence, evaluation of groundwater quantity is important for drinking purpose, in the study area monthly wise groundwater samples are collected in selected regions and analyze to determine the physicochemical parameters to assess the quality. The analysis of different parameters such as pH, Turbidity, TDS, Total hardness, Calcium, Sodium, Potassium, Magnesium, Nitrate, Chloride, Fluorides, Alkalinity, and Iron were carried out as per standard methods in the laboratory. Results showed that Total Dissolved Solids (TDS), Total Hardness (TH), Calcium, Magnesium (Mg^{2+}), concentrations are very high and chloride (Cl^{-}), alkalinity were slightly high in few samples of the groundwater. The analysis reveals that the groundwater needs treatment before consumption for drinking purpose.

Keywords: Groundwater quality, physicochemical, standards, drinking

1. Introduction
Water demand in the society has to increasing demand of world population, and increasing urban needs, ground water is being extracted for irrigation, construction works, and industries, and households day by day. During summer seasons extensive withdrawal of groundwater for irrigation purpose is lowering the water table in the aquifer and also changing the chemical composition of water quality, Water is nature's most wonderful abundant and useful compound, Without food, human can survive for a number of days, but water is an essential that without water one cannot survive. Water is not only essential for the lives of animals and plants, but also occupies a unique position in industries (Sudhakar *et al*., 2014) [25], Ground water is defined as water in the saturated zone that fills the pore spaces between mineral grains or rock cracks in the sub-surface soil (Fitts 2002) [9], Ground water refers to water that inhabits all the pores, voids or cracks in geological formations comes from rain water catchment, rivers and lakes (Olumuyiwa *et al*., 2012) [19]. The groundwater is believed to be comparatively much clean and free from pollution than surface water. (Mangukiya *et al* 2012) [14], and the groundwater quality depends on the quality of recharged water, atmospheric precipitation, inland surface water, and on sub-surface geochemical processes (Vasanthavigar *et al* 2010) [19], The drinking water quality depends on many physicochemical parameters and their concentrations, which are derived from laboratory tests on water samples.(Mohammad *et al*, 2013) [15], In the present day, it has become a necessity to protect the groundwater resources against pollution (natural or anthropogenic), because they could have negative effects on the human health (Caliman *et al*., 2011; P. Srinivas *et al*., 2011) [4, 3]. Hydro chemical study is a useful tool to identify the suitability of the groundwater. (Akhil *et al*., 2017) [20], the most important fresh water source in the world, based on stability and importance, is the groundwater (Neag G., 2000) [16]. Hydro chemical study is a useful tool to identify the suitability of the groundwater in that the physical parameters taken into consideration like color, odor, turbidity and temperature, pH, and so on. (Sudhakar *et al*., 2014b) [24], the ground water is very important for existence of life. It is a liberal part of environment; hence it cannot be looked in isolation especially where high degree of dependence is upon ground water for drinking purpose.

2. Materials and method

2.1 Study area

Mangalagiri means the Auspicious Hill. It is a one of the town and Mandal in Guntur district of the Indian state of Andhra Pradesh. This place is one of the 8 important Mahakshetrams (sacred places) in India. It also forms a part of the Andhra Pradesh Capital Regionwith a population of 73, 613.and situated on National Highway 5 between Vijayawada and Guntur. The town was known to have existed since 225 B.C, located 16.43°N, 80.55°E, an average elevation of 29.08 m (95.4 ft).and about 26 km (16.2 mi) north east of the district headquarters, Guntur, and just 10 km (23 mi) south west of Vijayawada by road. It lies on hilly terrain. It falls under Seismic Zone 3, with the total area of 17.53 km^2 (Fig -1).

Fig 1: Study area Map

2.2 Sample collection

The Ground water samples were collected in selected regions in Mangalgiri mandal during six Months from January 2019.There are indicated as Sample,S1- Yerrupalem, S2- Dullas Nagar, S3- Nulakapet, S4- Tadepalli, S5- Prakash Nagar, the water samples in collected regions bore wells were pumped for 5min before taking the water samples. The samples were collected in previously sterilized and dried polyethylene bottles of capacity 1 litter.

2.3 Methods

The parameters include various physical and chemical constituents in each sample were determined such as pH, Turbidity, Total Dissolved Solids, Total Hardness, Calcium, Magnesium, Sodium, Potassium, Nitrates, Chlorides, Fluorides, Alkalinity, etc. The parameters analyzed in the laboratory according to lab procedures (APHA, 1985) [2], that are pH, total dissolved solids (TDS) were measured by Water Quality Analyzer. Magnesium (Mg) was determined titrimetrically using standard EDTA. Chloride (Cl) was determined by standard $AgNO_3$ titration, Sodium (Na+) by flame photometry. Nitrate (NO_3^-) and fluoride (F) were analyzed by using ion-sensitive electrode. The suitability of groundwater for drinking and other purposes may be assessed by comparing physical and chemical parameters of the study area with the guidelines recommended by World Health Organization (WHO, 2004) and BIS.

3. Results and Discussion

Analytical results of groundwater like pH, Total dissolved solids, Turbidity, Calcium, Magnesium, Chlorides, Nitrates, Potassium, Magnesium, Sodium, Chlorides, Total hardness, Iron Fluorides and Alkalinity of the groundwater samples revels that the pH is the scale of intensity of acidity and alkalinity of water and measures the concentration of hydrogen ions (Annalakshmi & Amsath 2012) [10], pH is a term used universally to express the intensity of the acid or alkaline condition of a solution. Most of the waters are slightly alkaline due to presence of carbonates and bicarbonates. The pH values of water samples varied between 7.1 to 8.0 and were found within the limit prescribed by WHO. High values of pH may result due to waste discharge, microbial decomposition of organic matter in the water body (Patil *et al*., 2012) [21]. In the present study all the samples have pH below the prescribed values. (Table: 1& Fig: 2), the minimum and maximum values are 7.11 to 7.84

The total dissolved solids in water are due to the presence of sodium, potassium, calcium, magnesium, Manganese, Carbonates, bicarbonates, chlorides, phosphates, Organic matters and other particles (Bhattachary *et al*., 2012) [3].The minimum and maximum values are in the study area 1149.29 mg/l to 1643 mg/l, all the samples are exceeded the permissible limits 500 mg/l. very high concentration has been observed this indicates the ground water quality is changed by addition of dissolved particles and the increased value of TDS may be resulted from the solubility of lime and gypsum (Swarnalatha *et al*., 2017). (Table 2 and figure 3).Alkalinity of water is its capacity to neutralize a strong acid and it is normally due to the presence of bicarbonate, Carbonate and hydroxide compound of calcium, sodium and Potassium. The alkalinity values in the study area found to vary from 325 to 1039.43 mg/L. (table: 2 and fig.4), compared with the standards of BIS and WHO 600 mg/L, Sample 1 and Sample 3 are exceeded the Limit. Previous observations by (Leelavathi *et al*., 2016) [5] Alkalinity around 150 mg/L has been found conductive to higher productivity of water bodies.

High amount of potassium in the groundwater sample is due to the presence of silicate minerals from igneous and metamorphic rocks (Zahir and Abdul, 2011) [31], table: 2 and fig:2 indicated that the potassium minimum and maximum values are 11.14 mg/l and 18.85 mg/l, all the samples were in the permissible limits in the study area. The total hardness values shown rangefrom 410.85 mg/L to 668.28 mg/L. (table2 and fig.4) The Hardness is one of the most important properties of drinking water. High concentration may cause Urolithiasis (Chari &Lavanya, 1994) [7]. All samples were

beyond the permissible limit 300 mg/l. Among them calcium and magnesium cause by far the greatest portion of the hardness occurring in natural waters. Water is commonly classified in terms of the degree of hardness namely 0-75 mg/l, 75-150 mg/l, 150-300 mg/l and 300 mg/l above as soft, moderately hard, hard and very hard respectively (Makwe & Chup 2013) [12].

The Source of nitrate contamination is may be septic tanks and municipal sewage. (Mangukiya Rupal *et al*., 2012) [14], the leachate of crop nutrients and nitrate fertilizers from agricultural lands may be reason for this (Simeonov *et al*., 2003) [22], The presence of nitrate in groundwater may be due to leaching of nitrate with percolating powder (Mohamed Hanipha and Zahir Hussian, 2013) [15], the nitrates values are range from 0.018 mg/l to 35.28 mg/l (fig.2), The contamination of ground water may be due to sewage and other wastes rich in nitrates (Venkateswara Rao, 2011) [30].

Turbidity can be measured by turbidimetry. Turbidity of water affects other water quality parameters such as Color, when it is imparted by colloidal particles. It also affects the chemical quality of drinking water through the formation of complexes between the turbidity causing humid matter and heavy metals (Olumuyiwa *et al*., 2012) [19], (Nik *et al*., 2013) [18], the minimum and maximum values were observed in the study area are 0.292 mg/l and 0.622 mg/l, all the samples are in the permissible limits. Turbidity is an expression of certain light scattering and light absorbing properties of the water sample caused by the presence of clay, silt, suspended matter, colloidal particles, plankton and other microorganisms (WHO, 1984).

Magnesium generally occurs in lesser concentration than calcium because of dissolution of magnesium rich mineral is slow process and calcium is more abundant in earth crust (Varadarajan *et al*., 2012) [28]. The ground water samples in the study area magnesium concentrations were observed from 50.28 mg/l to 82.28 mg/l (table 1 & 2, fig.5), all the sampling stations were beyond the permissible limit of the WHO and BIS that is 30mg/l. Calcium is an essential nutrition element for human being and aids in maintaining the structure of plant cells and soils (Chari and Lavanya, 1994) [7], in the study area the groundwater samples calcium concentrations were observed (table1 and 2, fig 5) rangers from 79.28 mg/l to 147.51 mg/l according to the standards of WHO and BIS 75 mg/l, all the samples in the study area exceeded the permissible limits, It indicates that Sewage and industrial wastes were the important sources of calcium and more amount of calcium came from seawater, (Chung *et al*., 2015) [8].

Chloride is the most abundant anion in the human body. It is present in natural waters due to the dissolution of salt deposits, its concentration is high in ground waters. Soil porosity and permeability also play an important role in building up the chloride value (Jain *et al*., 2005) [11], in the study area the chloride concentrations were observed that ranges from 186.85 mg/l to 288 mg/l, compared with the standards sample 4 and sample 5 were beyond the limits 250mg/l WHO and BIS. Similarly study of Chemical characteristics of groundwater depicts that the chloride content is beyond the permissible limit (Neeraj and Patel 2010) [17], these two elements are directly added into the ground water from industrial and domestic wastes and contribute salinity of water (Chari and Lavanya, 1994) [7], and high chloride concentration indicates organic pollutants in the water. The sodium concentrations in the study area ranges from 96.57 mg/l to 167.28 mg/l, all samples were exceeded the standard limit60mg/l according to WHO and BIS, High concentration of sodium ion in drinking water may cause heart problems and high sodium in irrigating water may cause salinity problems (Chadrik & Arabinda, 2011) [6].

Fluorine, a naturally occurring element never exists in its elemental state in nature because it is the most reactive non-metal. So it occurs in environment in combination with other elements, except oxygen and noble gases, including fluorspar, rock phosphate, cryolite, apatite, mica, hornblende and others (Leelavathi *et al*., 2016) [5], the fluoride concentrations were observed from 0.51 mg/l to 1.47 mg/l, all the samples in the study are within the permissible limits indicate in table 1 &2. The high concentration of the fluoride is due to fertilizer usage in agricultural activities for killing the insects. Skeletal fluorosis is an important disease due to presence of high fluoride content in ground water (Mangale Sapana *et al*., 2012) [13], the Iron concentration in the study area was observed that 0.001 mg/l to 0.035 mg/l indicated in table 1& 2, the similar results of Iron in groundwater in the study area showed wide variations. (Abdul Jameel *et al*., 2012) [1].

4. Conclusions

It is necessary that drinking water should be pure. However the absolute pure water is not found in nature. It is essential to assess the quality of water available from various sources whether the water is potable or not. To reveal this aspect we require various physic-chemical parameters like Turbidity, pH, Total Dissolved Solids, Total Hardness, Alkalinity, Calcium Hardness, magnesium, Iron, Fluorides, Chlorides, Nitrates and potassium. All the sampling regions of Magalagiri Mandal should be treat the ground water, Hence in all sampling stations water required some degree of treatment before consumption and it also need protection against contamination.

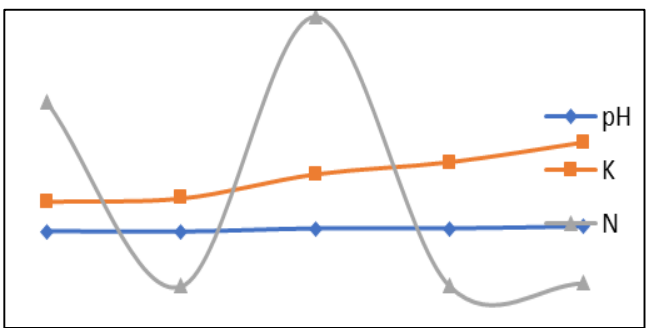

Fig 2: Groundwater quality parameters in the study area pH, K, Nitrates

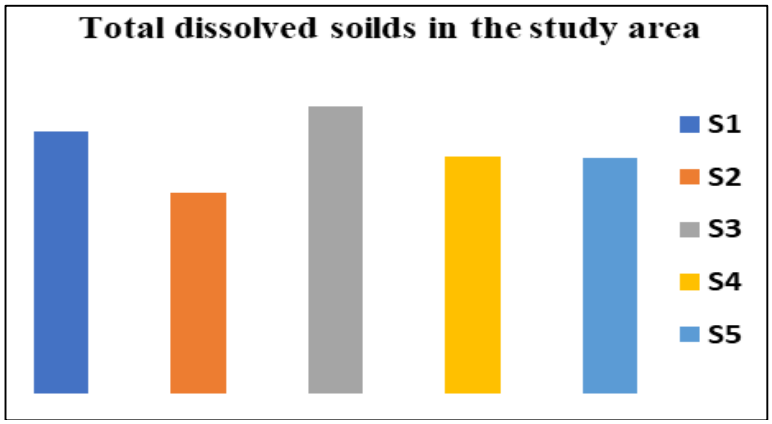

Fig 3: Total dissolved solids in the study area groundwater

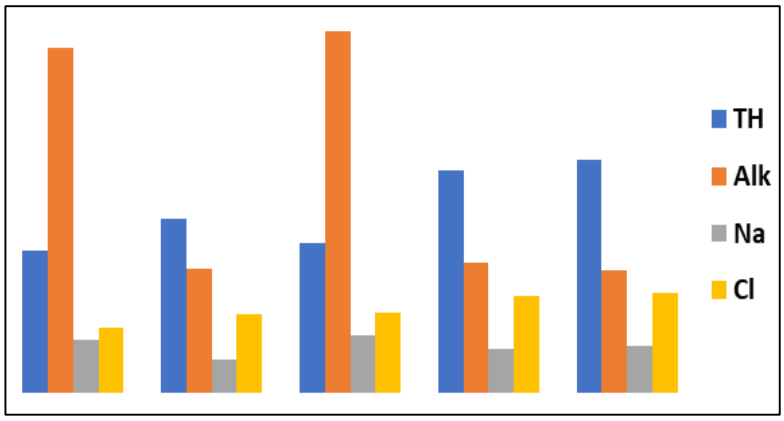

Fig 4: Ground water parameters concentrations TH, Alkalinity, Na and Cl in the study area

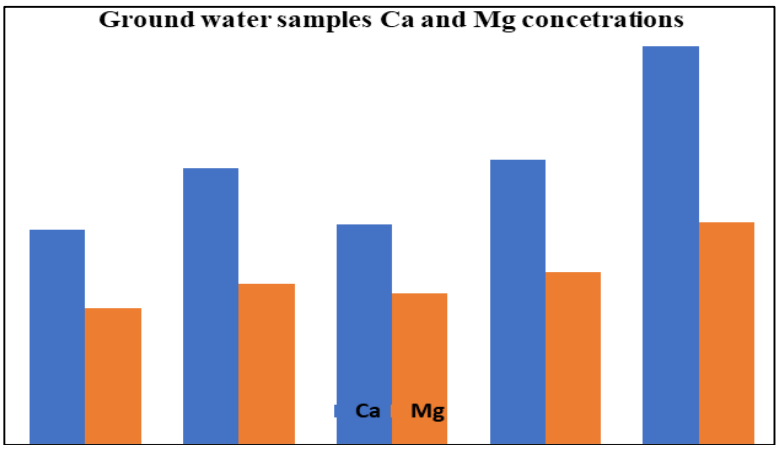

Fig 5: Calcium and Magnesium concentrations in the study area

Table 1: Average values of Groundwater quality in the study area

S. No	Parameter	S1	S2	S3	S4	S5
1	pH	7.19143	7.11714	7.56286	7.55429	7.84833
2	Tr	0.34286	0.29286	0.47857	0.35429	0.62286
3	TDS	1504.29	1149.29	1643	1355	1349.57
4	TH	410.857	499.429	433	639.429	668.286
5	Ca	79.2857	102.429	81.4286	105.571	147.571
6	Mg	50.2857	59.4286	56	63.7143	82.2857
7	Na	154.571	96.5714	167.286	126.429	137.143
8	K	11.1429	11.5714	14.7143	16.2857	18.8571
9	N	24.1429	0.018	35.2857	0.11429	0.44
10	Cl	186.857	227.429	230.571	279.714	288
11	F	0.84286	1.15714	0.51571	1.30286	1.47143
12	Fe	0.03571	0.03443	0.03443	0.001	0.001
13	Alk	992.714	357.714	1039.43	374.286	352.429

Table 2: Minimum and Maximum values of the Groundwater quality

S. No.	Parameter	Min	Max	Permissible
1	pH	7.11714	7.84833	6.5-7.5
2	Tr	0.29286	0.62286	10
3	TDS	1149.29	1643	500
4	TH	410.857	668.286	300
5	Ca	79.2857	147.571	75
6	Mg	50.2857	82.2857	30
7	Na	96.5714	167.286	60
8	K	11.1429	18.8571	20
9	N	0.018	35.2857	45
10	Cl	186.857	288	250
11	F	0.51571	1.47143	1.5
12	Fe	0.001	0.03571	0.3
13	Alk	352.429	1039.43	600

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