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HYDROCHEMICAL CHARACTERISTICS OF LEKKUR BASIN, CUDDALORE DISTRICT, TAMIL NADU

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ABSTRACT

A detailed hydrogeochemical study was carried out in Lekkur sub basin which is part of Vellar basin. Groundwater is the major source of water supply for agricultural and domestic uses. The agricultural and urbanization activities have a lot of impact on the groundwater quality of the study area. In order to understand the water quality variations within the sub basin, groundwater samples were collected from dug wells and hand pumps during post monsoon season. These water samples were analysed for major cations and anions. The water analysis data was processed using a computer programme *HYCH*. In this programme, numerical steps are adopted for the hydrochemical facies classification using the criteria of Handa, Piper, Stuyfzand and USSL schemes. According to Stuyfzand classification, 50 % of waters are oligohaline to fresh type. Half of the water samples are coming under C2S1 and C3S1 types. When plotted in the USSL diagram for classification of irrigational waters, it indicates that the water is of moderate salinity and low sodium hazard and hence can be used for agriculture practices. Rest of the groundwater samples shows serious problems for domestic and agricultural uses during post monsoon season.

INTRODUCTION

Water means life and life means water. Groundwater is a most valuable natural resource among other natural resources. In the past few decades groundwater scarcity and contamination have become as one of the most serious problems in the world. The groundwater utilization has increased manifold due advancement in agrarian sector together with rapid industrialization (Umar et al. 2009). The extraction of groundwater is continuously on the rise which poses threats to the sustainability of groundwater resources. Water quality plays an important role in promoting agricultural production and standard of human health (Raju et al. 2009). The water quality may yield information about the environment through which the water has circulated. Each groundwater system in the area has a unique chemistry, acquired as a result of chemical alteration of meteoric water recharging the system (Back, 1966; Drever, 1982). The chemical alteration of the rainwater depends on several factors such as soil-water interaction, dissolution of mineral species and anthropogenic activities (Faure, 1998; Subba Rao, 2001; Umar and Ahmed, 2007).

In hard rock terrain availability of groundwater is limited and its occurrence is essentially confined to fractures and weathered zones (Javed et al. 2009). Water demand and quality deterioration are common in hard rock terrain. Hence, an assessment of groundwater quality in the sub basin is felt necessary to know its quality for further development. With this objective, an effort has been made to understand the spatial distribution of hydrogeochemical constituents and also to interpret chemical variations in groundwater.

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Study area

The present study area Lekkur sub basin is located between latitudes 11° 21' 55" to 11° 03' 59'' N and 78° 51' 40'' to 79° 03' 60'' E falling in toposheets No. 58I/2 & 58M/2. The area forms the southwestern part of Cuddalore district, Tamil Nadu. It covers an area of about 100 Sq.km. Physiographically the study area is almost flat and sloping gradually from west to east direction. The relief ranges from 62 to 121 m above MSL. The maximum and minimum temperature ranges between 20°C and 34°C in the month of January and May respectively. The average annual rainfall is 1100 mm and no perennial rivers and streams exist in the sub basin area. Seasonal River Vellar and Periya Odai flows in the area. Wellington reservoir is the major tank as well as major source of irrigation. The drainage is dendritic and sub dendritic. Geomorphologically the area consists of old flood plains, pediments, duri crusts, and pediments covered by forest land. A variety of soils occurs in the area like Paralithic Ustochrept, Paralithic Ustorthent, etc. Paddy, sugarcane, groundnut, chilies and cotton are grown as commercial crops in the basin.

Main objective of this study is to analyse various chemical parameters of groundwater in the basin to find out its usability for domestic, industrial and agricultural purposes. Study area location map is shown in Fig.1.

Geological setting

Geologically, the Lekkur basin is occupied by early to mid Precambrian rocks represented by charnockites and charnockite gneisses. The charnockites are intermediate to acid in composition, coarse to medium grained and form highland topography. The charnockite rocks are the oldest

and subjected to granulitic facies metamorphism. The gneisses occur as products of retrogression of charnockites indicating an event of retrogression in the metamorphic history of the area. The charnockitic rocks are massive to foliated and trending ENE – WSW with an average dip of 45° towards south. The charnockites show different depth of weathering. Generally the charnockites of the study area are highly massive and compact and devoid of joints and fractures making them impervious, which in turn results in poor groundwater potential (Senthilkumar, 2006).

MATERIALS AND METHODS

Groundwater samples were collected in clean and sterile polythene bottles during post-monsoon period (January 2012). In order to cover the entire study area twenty representative groundwater samples were collected. GPS receiver was used to record the exact location. The electrical conductivity (EC) and p^H were measured immediately on collection in the field using portable consort C-425 digital p^H meter. The collected samples were chemically analysed by standard analytical method APHA (1985). The analytical results have been processed by using HYCH computer program (Balasubramanian et al. 1991). This program is capable of providing most of the needed output using the major ion chemistry data. It gives the interpretation of water quality based on water chemistry, facies, mechanisms of origin, type, suitability and usage factors like corrosivity and permeability. With the output result, GIS technique has been used for preparation of thematic maps and the following maps have been prepared.

i) Total Dissolved Solids ii) Total Hardness
iii) Water Classification iv) USSL Classification.

RESULT AND DISCUSSION

The results of chemical parameters of groundwater samples of Lekkur sub basin are presented in Table 1. The p^H value of post monsoon ground water samples varies from 6.9 to 7.8 with an average around 7.34 indicating alkaline nature as per ISI (1983) standards. Almost all samples fall within the recommended limits (6.5 to 8.5) for human consumption. The electrical conductivity values range from 575 to 3430 µ mhos/cm at 25°C (Table 1). A high salt content (high EC) in irrigation water leads to formation of saline soil. This affects the salt intake capacity of the plants through their roots. On the basis of electrical conductivity values, Richards (1954) classified irrigation water into four groups (Table 2). As per Richards's classification, no samples fall in good class, 17 samples are in medium and one sample is high in salinity. Groundwater samples falling in medium salinity hazard can be used, if a moderate amount of leaching occurs. High salinity waters cannot be used on soil with restricted drainage. Excess salinity reduces the osmotic activity of plants and thus interferes with the absorption of water and nutrients from the soil (Saleh et al. 1999).

TDS (Total Dissolved Solids)

TDS is one of the covering factors to determine the suitability of water for various uses, Carroll, 1962 proposed a classification based on Total Dissolved Solids present in ground water. According to his classification TDS up to 100 mg/l is fresh water, 1,000 - 10,000 is brackish water, >10,000 is saline water and above 1, 00,000 is brine water. The post monsoon period TDS special distribution map has been prepared (Fig. 2). The post monsoon aquifer of the study area shows different order of TDS values (below 1500 to above 2000 mg/l). The TDS values below 1500 mg/l fall in 16 locations out of 20, nearly 80% of water sample locations fall in almost fresh water conditions and the reaming 4 locations (locations 6,14,15 and 18) fall in brackish water according to Carroll's classification. During the slow movement of groundwater in the sub surface the TDS concentration is slowly enriched. Groundwater has low TDS in recharge areas than in discharge areas (Freeze and Cherry, 1972).

TH (Total Hardness)

Hardness of water is not a specific constituent but variable and is a complex mixture of cations and anions. The degree of hardness of drinking waters has been classified in terms of equivalent $CaCO_3$ concentration. Sawyer and McCarthy (1987) have made a classification of water based on total hardness present in groundwater. The study area hardness of groundwater is classified into soft water, moderate hard water, hard water and very hard water. Hard water occupied more areal extent in pre monsoon season (Fig.3). Locations 5 and 20 exhibit soft waters. Moderate hard water locations are 3, 4, 8, 9, 10, 13 and 17. Very hard water occurs in locations 1, 2, 6, 7, 14 and 18. Hardness has no known adverse effect on with but it present water from the formation of lather with detergent and increases the boiling point of the water.

Groundwater classification (Styufzand classification)

Based on Styufzand classification (1989) of groundwater, a thematic map has been prepared for the study area groundwater types (Fig.4). She classified groundwater and identified main types based on chloride content. The water samples of the study area fall under four types and the details are given below:

Sl. No	*Main types*	*Cl in mg/l*	*Location No.*
1	Oligohaline	5-30	03
2	Fresh	30-150	07
3	Fresh - Brackish	150-300	06
4	Brackish	$300\text{-}10^3$	04

As per Styufzand classification 50% of the study area water samples show fresh water nature and the remaining samples fall in saline water category; this due to uniform dilution of minerals in water.

USSL classification

The United States Salinity Laboratory (USSL) has proposed a classification for rating irrigation water with reference to salinity and sodium hazard (Richards, 1954). In USSL classification, the classes C1, C2, C3 and C4 are based on salinity and sodium hazard. Another hazard mentioned is sodium hazard and these are classified as S1, S2, S3 and S4 water having SAR values less than 10, 10-18, 18-26 and greater than 26 respectively. Water used for irrigation can be rated as C2S1 (medium salinity – low sodium water), C3S1 (high salinity - low sodium water), C3S2 (high salinity – medium sodium water), C3S3 (high salinity – high sodium

Chemical analysis of groundwater samples collected from Lekkur sub basin

S.No	Habitation	EC (µmhos)	TDS in mg/l	pH	Ca	Mg	Na+K	HCO3 in mg/l	CO3 in mg/l	Cl	NO3 in mg/l	So4 in mg/l	SAR	CR
1	Orangur	1955	1369	7.4	122	40	275	547	0	313	4	174	5.521208	1.1373
3	M.Podaiyur	815	571	7.1	16	9	73	228	0	26	8	9	3.618196	0.2017
4	Kallur	710	497	7	34	9	68	244	0	35	12	13	2.67825	0.2575
7	Alambadi	1410	987	7.3	119	19	199	494	0	251	12	42	4.467491	0.8042
10	Venganur	1060	742	7.1	25	10	99	304	0	35	5	20	4.230556	0.2307
11	Vaidhyanadhapuram	1340	938	7.4	14	4	177	469	0	22	7	22	10.73535	0.1149
13	Near Korukkai	950	665	7.2	31	15	87	266	0	56	11	25	3.207664	0.3944
14	Alathur	3430	2401	7.8	87	105	742	1176	0	864	3	78	12.66277	1.1039
16	Vagaiyur	1130	791	7.1	51	23	141	316	0	173	9	20	4.115627	0.837
17	Akkanur	950	665	7.5	14	13	99	266	0	56	0	13	4.577618	0.3474
19	Labbaikudikadu	970	679	7.2	35	9	115	272	0	78	10	36	4.483724	0.5418
20	Nathamedu	1100	770	7.3	32	2	120	308	0	52	5	24	5.559577	0.319

Table 2 Classification of irrigation water (Richards, 1954)

Water class	Salinity hazard **Electrical conductivity**		Alkali hazard **Sodium adsorption**	
Excellent	Up to 250	-	Up to 10	17
Good	250 – 750	02	10 – 18	03
Poor / Bad	>2250	01	>26	-

water) and C4S4 (very high salinity – very high sodium water).

From the HYCH program output, the USSL classification of water has been prepared for the post monsoon season (Fig.5). According to USSL classification the study area reveals five classes of water during post monsoon period. They are C2S1, C3S1, C3S2, C3S3 and C4S4. The C2S1 class falls in two locations. This class of water could be used if a moderate amount of leaching occurs with low risk of developing harmful levels of sodium. C3S1 falls in eight locations; this class of irrigation water cannot be used on soils with restricted drainage otherwise harmful levels of sodium may be developed. C3S2 falls in seven locations; this type of water may be used on coarse texture or organic soils with good permeability (Karanth, 1989). C3S3 falls in two locations; however, water falling under class C3S3 is likely to cause both sodium and salinity hazards and C4S4 falls in only one location which is not at all suitable for irrigation under ordinary condition but it may be used occasionally under very special circumstances.

SUMMARY AND CONCLUSION

On the basis of the present study, analysis of post moon groundwater of Lekkur sub basin in Tamil Nadu shows that physico-chemical properties are well within the permissible limits except carbonate ion. According to Stuyfzand classification, 50 % of waters are oligohaline to fresh type. Based on USSL classification, half of the water samples are coming under C2S1 and C3S1 categories of irrigational waters. It indicates that the water is of moderate salinity and low sodium hazard and hence can be used for agriculture practices. Rest of the groundwater samples show serious problems for domestic and agricultural uses during post monsoon season.

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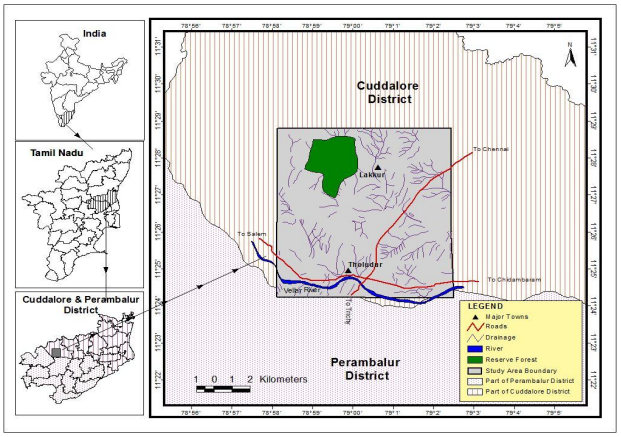

Fig. 1 Location map of the study area

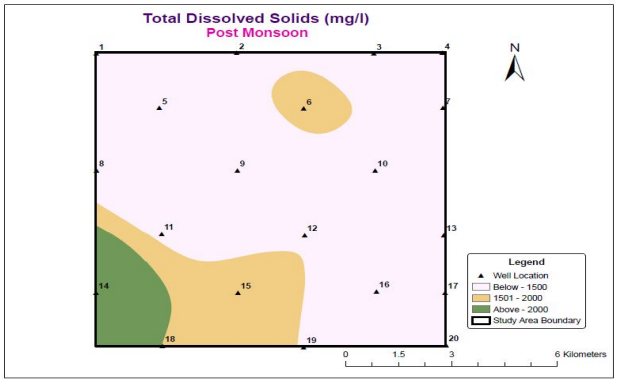

Fig. 2 TDS map

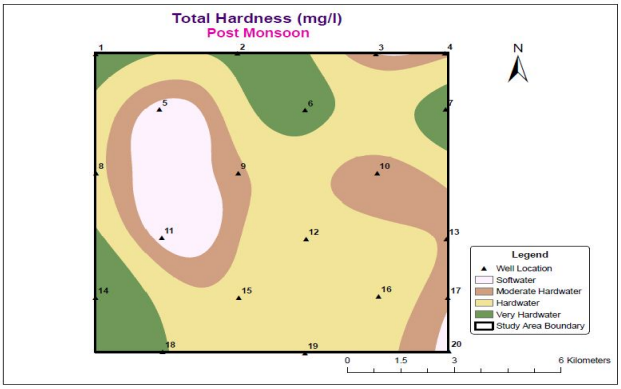

Fig. 3 Total Hardness map

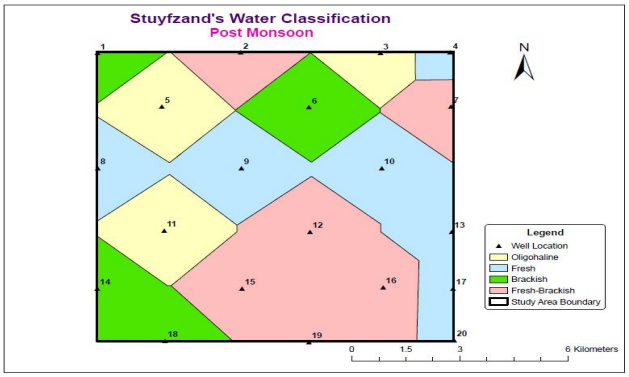

Fig.4 Water classification (Stuyfzand)

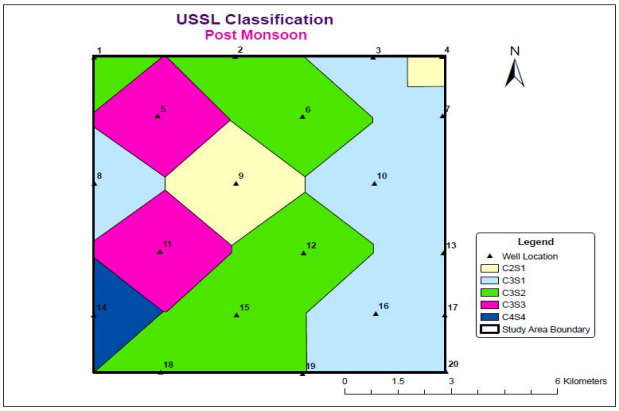

Fig.5. USSL classification

References

APHA. AWWA and WPCF. 1985. Standard methods for the examination of waste and wastewater, 16 th edition. *American Public Health Association*, Washington, D.C.

Back, W. 1966. Hydrogeochemical facies and groundwater flow patterns in the northern part of the Atlantic Coastal Plain, USGS Prof. Paper 478-A.

Balasubramanian, A., Subramanian, S., and Sastri , J.C.V., 1991b, HYCH - Basic computer program for hydrogeochemical studies, Proc. Vol. Nat. Sem. on water. Govt. of Kerala, Trivandrum.

Carroll, D. 1962. Rainwater as a chemical agent of geologic processes-A review, US Geological Survey water supply paper 520-f, pp.97-104.

Drever, J.I. 1982. The geochemistry of natural waters. Prentice-Hall, Englewood Cliffs, NJ.

Faure, G. 1998. Principles and applications of geochemistry, 2nd edn. Prentice Hall, Englewood Cliffs, New Jersey.

Freeze, R.A., and Cherry, J.A. 1979. Groundwater. 2nd ed. New Jersey, Prentice Hall, Eaglewood, Cliff, 87p.

Javed. A. and Wani. M.H. 2009. Delineation of groundwater potential zones in Kakund watershed, Eastern Rajasthan, Using remote sensing and GIS techniques, Jour. Geol. Soc. India, v.73, pp. 229-236.

Karanth. K. R. 1989. Hydrogeology, Tata McGraw-Hill Publishing Company Limited, New Delhi

Raju, N.J., Ram, P. and Dey, S. 2009. Groundwater quality in the Lower Varuna River Basin, Varanasi District, Uttar Pradesh, Jour. Geol. Soc. India, v.73, pp. 178-192.

Richards. 1954. Diagnosis and improvement of saline and alkali soils, U.S.Dept. Agri hand book, no.60, U.S. Govt. printing office, Washington D.C.

Saleh, A., Al-Ruwaih, F. and Shehate, M. 1999. Hydrogeochemical processes operating within the main aquifers of Kuwait. Jour. Arid Environ, v.42, pp.195-209.

Sawyer, C. N. and McCarty, D. L. 1967. Chemistry of sanitary engineers (2nd ed., p.518). New York: McGraw-Hill.

Senthil Kumar, G.R. 2006. Hdrogeochemical investigations in Tittagudi taluk, Cuddalore District, Tamil Nadu, S.India, Ph.D thesis, Annamalai university, Annamalai Nagar, 22p.

Stuyfzand, P.J. 1989. A new hydrochemical classification of water types, Proc, IAHS 3 Science Association, Baltimore, U.S.A, pp.33-42.

Subba Rao, N. 2001. Geochemistry of ground waters in parts of Guntur district, Andhra Pradesh, India. Environ. Geol., v.41, pp.552-562.

Umar, R. and Ahmed, I. 2007. Hydrogeochemical characteristics of groundwater in parts of Krishni-Yamuna Basin, Muzaffarnagar district, UP. Jour. Geol. Soc. India, v.69, pp.989-995.

Umar, R., Ahmed, I. and Alam, F. 2009. Mapping groundwater vulnerable zone using modified DRASTIC approach of an alluvial aquifer in parts of Central Ganga Plain, Western Uttar Pradesh, Jour. Geol. Soc. India, v.73, pp.193-201.

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