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Impact of agriculture on ground water quality of Batlagundu town, Tamil Nadu

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Abstract : The hydro chemical study was carried out in Batlagundu, Dindigul District, Tamilnadu, India, with an objective of understanding the suitability of local groundwater quality for domestic and irrigation purposes. Ground water samples have been collected from six different areas of Batlagundu town. The samples have been analyzed to determine 23physico chemical parameters. The parameters namely temperature, pH, sulphate, potassium, phosphate, DO, BOD and COD were within the permissible limits of BIS and WHO while other parameters were found to exceed the limit. From the analyzed data, water quality indices such as sodium absorption ratio, kelly's ratio, magnesium absorption ratio, residual sodium carbonate, residual sodium bicarbonate, permeability index and soluble sodium percentage have also been determined. SAR and MAR signified good quality while other indices indicated the ground water as moderately suitable for irrigation purposes. This study revealed that the ground water of the study area was not potable but had good irrigation quality.
Key words : Ground water, water quality parameters, Batlagundu, water quality indices.

Introduction

"No life without water" is a common saying depending upon the fact that water is the one of the naturally occurring essential requirement of all life supporting activities. Groundwater is the principal source of drinking water in our country and indispensible source of our life. They have excellent natural quality usually free from pathogens, colour and turbidity can be consumed directly without treatment. The healthy aquatic ecosystem is depended on physical, chemical and biological characteristics[1]. Good quality of water resources depends on a large number of physical, chemical and biological characteristics.

Water quality concepts have been evaluated in the last year owing to greater understanding of water mineralization process and greater concern about its origin. Various factors are responsible for water pollution, which makes it quite undesirable for portability .Such factors include sewage discharge which contribute to oxygen demand and nutrient loading to a destabilized aquatic ecosystem, agricultural practices and industrialization. Furhan[2]reported that the increase in anthropogenic activities as well as natural processes such as precipitation inputs, erosion, weathering of materials have rendered most water bodies unsuitable for their

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multipurpose usage. The water supply for human consumption is often directly sourced from groundwater without biochemical treatment and the level of pollution has become a cause for major concern.

Keeping this in focus, the quality aspects of ground water in Batlagundu area were analyzed for general water quality, pollution due to industrial discharges and pollution due to municipal sewage. According to our literature review, there has been no published report concerning possible contaminants in drinking water sources in the study area. The economy of the study area is mostly dependent on agriculture. So the present study is also analyzed the suitability of ground water quality for irrigation purpose using the water quality indices.

Study area

Batlagundu is situated in Dindigul district of Tamilnadu state, India. It is bounded by Longitude and Latitude is 77 ^{0} 45' 33.84" E and 10 ^{0} 9' 55.80"N.This area is located about 320meters above the sea level. The average temperature is 22^{0}C of the area under taken. The study area faces the water scarcity problems due to less rainfall. The area is one of the warmest, arid, dry and 86% humidity. The area is basically an agricultural area with paddy as the main crop. This study describes ground water quality of six sampling stations. The sampling stations are given in Table 1. The map of the study area is given in Fig.1.

Fig 1 Map of the study area

Table 1 Description of water quality sampling sites

Place	Site No	Description
Nilakottai	S_1	Near Pushpak Perfume Industry
Mallanampatti	S_2	Near Village Primary Health Centre
Usilampatti Road,	S_3	Near Land fill
AnnaNagar, Batlagundu	S_4	Near drainage
Middle Street, Batlagundu	S_5	Residential area
Periyakulam Road, Batlagundu	S_6	Near agriculture field

Materials and Methods

In order to determine the water quality of study area, the ground water samples collected from six sampling stations in triplicates. Samples were collected in polythene bottles and analyzed for various water quality parameters as per standard procedures APHA, AWWA, WPCF (1985)[3], Trivedi and Goel (1984)[4] and NEERI (1986)[5].

Irrigation water quality

Irrigation water quality is depending upon both the type and the quantity of the dissolved salts originates from natural and anthropogenic sources. Use of poor water quality can create four types of problems, namely toxicity, water infiltration and salinity[6].For current irrigation water quality assessment, the following indices were considered.

Sodium Absorption Ratio (SAR)

The Sodium Absorption Ratio (SAR) was calculated by the following equation given by Richards (1954)[7] as

$$SAR = \frac{Na^+}{\sqrt{\left(\frac{(Ca^{2+}+Mg^{2+})}{2}\right)}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Kelly's Ratio (KR)

The Kelly's ratio was calculated using the equation Kelly(1963)[8]

$$KR = \frac{Na^+}{Ca^{2+} + Mg^{2+}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Magnesium Absorption Ratio (MAR)

Magnesium Absorption Ratio was calculated by the equation Ragunath, (1987)[9]

$$MAR = \frac{Mg^{2+}}{Ca^{2+}+Mg^{2+}} \text{ X } 100 \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Residual Sodium carbonate (RSC)

Residual Sodium carbonate (RSC) was calculated according to Gupta and Gupta(1987)[10]

$$RSC = (CO_3^{2-} + HCO_3^-) - (Ca^{2+} + Mg^{2+}) \ldots\ldots\ldots (4)$$

Residual Sodium bi carbonate (RSBC)

Residual Sodium bi carbonate (RSBC) was calculated according to Gupta and Gupta(1987)[10]

$$RSBC = HCO_3^- - Ca^{2+} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Permeability Index (PI)

The permeability index (PI) was calculated according to Doneen (1964)[11] by the following equation.

$$PI = \frac{Na^+ + \sqrt{HCO_3^-}}{Ca^{2+}+Mg^{2+}+Na^+} \text{ X } 100 \ldots\ldots\ldots (6)$$

Soluble Sodium Percentage (SSP)

Soluble Sodium Percentage was calculated by the following equation (Todd, 1980)[12]

$$SSP = \frac{Na^+ + K^+}{Ca^{2+} + Mg^{2+} + Na^+ + K^+} \quad X\,100 \ldots\ldots\ldots (7)$$

All ionic concentrations are expressed in meq/l.

Results and Discussion

Suitability of water for drinking purpose

The temperature of the groundwater samples is generally room temperature and ranges between 16.7˚C and 24.5˚C. This means that groundwater in the study area has not been affected by geothermal heat which is insignificant at those depths. Turbidity of all sampling sites were found to be within the limits prescribed by WHO & BIS standards. The pH is a measure of the hydrogen ion concentration in water. In the study area, the concentration of hydrogen ion (pH) ranges between 6.87 to 8.03, all the water samples analyzed have concentration within the safe limit of 6.5 to 8.5 standard set by the WHO (2006)[13]. TDS content is usually the main factor, which limits or determines the use of groundwater for any purpose[14]. Nutrient enrichment due to fertilizers may enhance TDS and it, in turn, increases the EC since these two parameters are directly related to each other [15]. The higher values of EC in the study area may be due to semi-arid type climatic condition, high evaporation rate and incidence of inland salinity. The dissolution of salts and minerals present in soil and nearby agricultural fields due to the rise in water table and enhances total hardness concentration in groundwater[16].Total hardness of the study area ranged between 220-900mg/l. Most of the alkalinity of natural waters is caused by bicarbonates, carbonates and hydroxides. The concentration of alkalinity at all the sampling sites exceeds the limit of 200mg/l.

Table 2 Summary statistics of calculated indices for the sampling sites S_1 to S_6 in Batlagundu

Sampling sites	SAR	KR	PI	SSP	MAR	RSC	RSBC
S_1	2.86	0.90	72.99	50.89	44.29	6.33	3.16
S_2	6.06	1.55	72.52	64.55	47.56	2.21	1.15
S_3	2.88	0.48	43.16	33.29	44.19	-2.01	-2.02
S_4	6.08	1.61	73.85	64.91	46.14	2.68	1.30
S_5	5.71	1.11	61.44	56.14	48.29	-1.91	-0.89
S_6	6.15	1.81	77.69	67.57	47.15	3.02	1.56

Cation Chemistry

The concentration of Ca and Mg at all the sampling sites falls within the limit of BIS. The content of Mg is comparatively less than that of Ca. In many natural waters, the concentration of potassium is commonly less than one-tenth the concentration of sodium[17]. Water containing more than 200 mg/L sodium should not be used for drinking. According WHO the prescribed limit of potassium is 200 mg/L. The values of potassium for all sampling sites were found to be within the limits of WHO standard.

Anion Chemistry

The source of bicarbonate irons in ground water is from the dissolution of carbonate rocks. Chloride was higher at all sampling sites except S_1 indicating leaching from upper soil layers due to industrial and domestic activities and dry climates[18]. Nitrate in the study area is found to be comparatively very low in concentration and none of the samples exceeds the permissible limit. Nitrite and nitrate are inorganic ions produces during various stages of the nitrogen cycle. Nitrate is predominant ion in well-oxygenated water, because of the rapid oxidation of nitrite. Sulphate concentration at all the sampling sites showed within the limit of 200mg/l.The presence of small quantities of fluoride in drinking water may prevent tooth decay. Fluoride concentration at all the sampling sites were found to be within the prescribed limits of BIS and WHO, but the sample S_2 was found to be higher than the limits needs defluoridation for drinking.

Organic Chemistry

Phosphate level in study area ranged between 0.3-1.0mg/l. The concentration of Dissolved oxygen regulates the distribution of flora and fauna. The present investigation indicated that the concentration of dissolved oxygen fluctuated between 4.9 to 8.2 mg/L. Water without adequate dissolved oxygen may be considered as waste water. BOD is the measurement of the amount of biologically oxidizable organic matter present in the waste. The BOD Values obtained in the present study were within the WHO standards. The maximum prescribed limit of COD is 20 mg/L as per WHO standard. The minimum values of COD might be due to low organic matter while the maximum value might be due to high concentration pollutants and organic matter. In present study, values of COD for all sampling sites were found to be within WHO standards.

Suitability of water for Irrigation purpose

Sodium Absorption Ratio

Sodium concentration is very essential parameter for irrigation water quality because high level of sodium concentration in irrigation water produces an alkaline soil. Todd (1980)[12]describes that SAR is an important parameter for the determination of the suitability of irrigation water because it is responsible for the Sodium hazard.From the Table 3 ,it is inferred that , all the samples of the study area have been classified as excellent for irrigation.

Table 3.Classification of ground water on the basis of ratios

Water quality indies	**Range**	**Water class**	**Sampling sites of Batlagundu**
SAR (Richards, 1954)	<10	Excellent	All samples
	10-18	Good	Nil
	19-26	Doubtful	Nil
	>26	Unsuitable	Nil
KR (Kelly, 1963)	<1	Suitable	S_1,S_3
	1-2	Marginal	S_2,S_4,S_5,S_6
	>2	Unsuitable	Nil
Permeability Index (Doneen,1964)	>75%	Excellent	S_6
	25-75%	Good	S_1,S_2, S_3,S_4,S_5
	<25%	Unsuitable	Nil
SSP (Todd, 1980)	<20	Excellent	Nil
	20-40	Good	S_3
	40-60	Permissible	S_1,S_2,S_4,S_5
	60-80	Doubtful	S_6
	>80	Unsuitable	Nil
MAR (Raghunath, 1987)	<50	Suitable	All samples
	50-60	Marginal	Nil
	>65	Unsuitable	Nil
RSC (Gupta 1987)	<1.25	Safe	Nil
	1.25-2.5	Marginal	S_2,S_3,S_5
	>2.5	Unsuitable	S_1,S_4,S_6
RSBC (Gupta,1987)	<5	Satisfactory	All samples
	5-10	Marginal	Nil
	>10	Un Satisfactory	Nil

Kelly's ratio

A Kelly's ratio of more than one indicates an excess level of sodium in water. Water with a Kelly's ratio less than one are suitable for irrigation, while those with a ratio more than one are unsuitable, From the

Table 3 ,it is inferred that , Kelly's ratio using equation 2,for the sampling sites S_1 and S_3 suitable for irrigation and other sampling sitesS_2,S_4,S_5 and S_6 were found to be between 1 and 2 indicates the water quality of these samples are marginal for irrigation.

Magnesium Absorption Ratio

Excess magnesium present in water would adversely affect the soil quality rendering it unfit for cultivation. If magnesium hazard was less than 50, then the water was safe and suitable for irrigation[19]. The values of MAR of the sampling sites is calculated using the equation 3, as S_1(44.29), S_2(47.56), S_3(44.19), S_4(46.14), S_5(48.29) and S_6(47.15). From the Table 3 , it is analyzed that MAR of the water samples in study area showed less than 50 and can be classified as suitable for irrigation.

Residual Sodium Carbonate

The RSC is a valuable parameter that has a great influence on the suitability of irrigation water. From the Table 3, it is analyzed that the results of these sampling sites possess the water quality between marginal and unsuitable category. The sampling sites S_3 and S_5 showed negative values which indicates that dissolved Ca and Mg contents were higher than Carbonate and bicarbonate contents.

Residual Sodium Bi Carbonate

The RSBC significantly influence pH, EC and SAR of the irrigation water. From the equation 5 and Table 2, it is reported that RSBC of the all sampling sites are calculated less than 5 indicates the water samples are classified as satisfactory for the irrigation purpose.

Permeability Index

Doneen (1964) [11] evolved a criterion for assessing the suitability of water for irrigation based on Permeability Index. Accordingly, water can be classified as Class I, Class II and Class III orders. Class I and Class II water are categorized as good for irrigation with 75% or more of maximum permeability. Class III water are unsuitable with 25% of maximum permeability. In the present study, PI is calculated from the equation 6, for the sampling sites S_1(72.99), S_2(72.52), S_3(43.16), S_4(73.85), S_5(61.44) and S_6(77.69). On the basis of Table 3, it is reported that the groundwater in the study area falls under Class II and hence the water is considered suitable for irrigation.

Soluble Sodium Percentage

In all natural water, Sodium percentage is the most important parameter in determining the suitability of water for irrigation use[20]. As per Indian standards BIS(1991)[21] a Sodium Percentage of 60 is the maximum recommended limit for irrigation water. The water with greater than 60% can cause break down in the soil physical properties.SSP is calculated using the equation 7 for all six the sampling sites S_1(50.89), S_2(64.55), S_3(33.29), S_4(64.91), S_5(56.14) and S_6(67.57) . From the Table 3, it is inferred that 50% of water sample is suitable for irrigation and remaining 50% of water sample is unsuitable for irrigation in the study area. Summary statistics of calculated indices for the sampling sites is given in Table 2.Classification of groundwater is shown in Table 3.

Conclusion

This study has thrown light on quality and suitability of ground water in Batlagundu. There was neither salinity nor toxicity problem in irrigation water in the study area. In respect of all evaluating criteria, the ground water for the samples was suitable for irrigation purpose but not potable and need to be treated before consumption. For effective ground water management and sustainability, this assessment should be adopted on regular basis to monitor the ground water system of the area apart from health education hygiene related issues to reduce indiscriminate waste dump in the study area.

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