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CHARACTERIZATION OF GROUNDWATER OF DIFFERENT ACTIVITY REGIONS OF AN URBAN SETTLEMENT

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ABSTRACT

Rapid expansion with industrialization along with residential and other built-up areas in cities is affecting the groundwater resources in terms of quality and quantity. The present study is aimed at characterizing the present groundwater quality of an urban settlement. 10 groundwater samples were collected from bore wells at different zones of the study area and were analyzed for pH, Electrical Conductivity, Total Hardness, Total Dissolved Solids, Calcium, Magnesium, Chloride, Sulphate, and Phosphate,. The results revealed that concentration of most of the ions exceed the prescribed permissible limits making the water unsuitable for drinking purpose.

Keywords: Characterization; Groundwater; Physico-chemical parameters

INTRODUCTION

Water is a valuable resource on which all life is dependent. Water is a basic necessity of life, not only for people but for every type of plant and animal as well. Water is essential not only for survival but also contributes immeasurably to the quality of our lives. Groundwater accumulates chiefly from the precipitation that percolates through the soil strata. It collects water that seeps into the ground from lakes and ponds. The water settles into the pores and cracks of underground rocks and into the spaces between grains of sand and pieces of gravel. The quality of groundwater is the resultant of all the processes and reactions that act on the water from the moment it condensed in the atmosphere to the time it is discharged by a spring.

Increasing living standards, growing population, rapid industrialization and wide sphere of human activities have brought greater stress on land and water, which in turn results in steady increase in the demand for water resources. Pollution of groundwater resources has become a major problem today. The pollution of air, water and land has an affect on the pollution and contamination of groundwater. According to the World Health Organization, about 80% of all the diseases of human beings are caused by water. It is therefore important to monitor the quality of groundwater of various parts of our country[1]. Keeping this in view, the present study aims to investigate the groundwater quality status in order to assess the suitability of water for human use in different activity zones of Visakhapatnam. Some of the recent works in the area of research are[2,3,4,5].

EXPERIMENTAL

Study Area

Visakhapatnam is coastal station situated on the east coast of India. Geographically lies between 17^0 32'N to 17^0 51'N latitudes and 83^0 07'E to 83^0 21'E longitude.

Sampling

For the present study water samples were taken from 10 different zones of Visakhapatnam city. Each zone has been selected on the basis of different activities as for eg: BHPV (S-1), Industrial areas (S-2), pendurthi (S-3) and aarilova (S-4) were selected as old settlements, Bheemili (S-4), yendada (S-5), Chinagadili (S-6), Ravindranagar (S-7), as new coming up settlements, Adavivaram (S-8) Aanandapuram

(S-9), Tarakavalasa (S-10) and Adarshnagar (S-11) as fringe zones where agricultural activity is dominant. Each zone is having individual tube well source. Water samples either from public stand post or an individual household bore well were collected in clean plastic bottles. These samples were analyzed for estimation of pH, total hardness, calcium hardness, magnesium hardness, chlorides, sulphate, nitrate, phosphate and TDS as per standard methods[6].

Quality Assurance Procedures

Sampling is a pre requisite for accurate results of various analyses. In the present study much care was taken in sampling, which was done in a step wise procedure. As the first step the sampling sites were identified and then the samples were collected from bore wells after allowing some amount of water to flow out. The samples were collected in clean bottles, which were soap cleaned, dried in dust free environment and sterilized. Chemicals used for analysis were of analytical grade. Data is immediately recorded and stored for further calculations to avoid errors and confusion. All the samples were analyzed in triplet to get accuracy.

RESULTS AND DISCUSSION

The pH of water is very important indication of its quality and provides information in many types of geochemical equilibrium or solubility calculations[7]. The pH of the groundwater in the study area is varying between 6.5 and 7.5. The limit of pH is 6.5 to 8.5[8]. The pH of the groundwater is within the permissible limits. The EC measurement provides an indication of ionic concentrations. It depends upon temperature, concentration and types of ions present[7]. The conductivity of groundwater is varying between 350 and 730 at 25^0C. The maximum limit of EC in drinking water is prescribed as 1500µs/cm at 25^0C[7]. High conductivity is attributed to high chloride concentrations in groundwater. TDS of the groundwater varies from 100 to 700mg/L with a mean of 400mg/L. The desirable limit of TDS in drinking water is 500mg/L[8]. It was observed that 38.46% of groundwater of area exceeds the permissible limits. Hardness is an important criterion for determining the usability of water for domestic, drinking and many industrial supplies. TH of the groundwater in the study area varies from 110 to 560mg/L, with a mean of 335mg/L. The acceptable limit of TH for drinking water is specified as 300 mg/L. Water hardness is primarily due to the result of interaction between water and the geological formations[9]. The hardness of water is due to the presence of alkaline earths such as calcium and magnesium. However, iron, strontium, barium, manganese and aluminum also contribute to hardness[10]. Ca^{2+} concentration of the groundwater is varying between 30 and 260 mg/L with a mean of 145mg/L. The limit of Ca for drinking water is specified as 75mg/L[8]. It is observed that nearly 92.3% of groundwater exceeds the permissible limit. Ca^{2+} is derived mainly by weathering of silicate minerals like feldspar, pyroxene and amphiboles. Mg^{2+} concentration were varying from 40 to 260 mg/L with a mean of 200mg/L. The limit of Mg^{2+} concentration for drinking water is specified as 30 mg/l[8]. It was observed that 100%samples of the ground water exceed the permissible limits. The concentration of Mg^{2+} in groundwater is due to weathering of pyroxene present in the gravities of the study area. Chloride concentrations are varying from 30 to 700 mg/l with a mean of 365mg/l. The limit of Cl^- concentration for drinking water is specified as 250 mg/l[8]. It is observed that 38.46% of the groundwater exceeds the desirable limits. The source of Cl^- in the groundwater is due to weathering of phosphate mineral apatite present in gravities. The other sources of Cl^- in groundwater are domestic sewage and industrial effluents[11]. Sulphates concentration is varying from 85 to 340mg/l with a mean of 212.5mg/l. The limit for sulphate concentration in drinking water is specified as 150mg/l[8]. Nitrates concentration is varying from 1.7 to 42.4mg/l with a mean of 22.05mg/l. the limit of nitrate concentration in drinking water is specified as 45mg/l[8].

Classification based on TDS concentration

Water can be classified based on the concentration of TDS[12] as given below:

Upto 500mg/L – Desirable for drinking
500 to 1000mg/L – Permissible for drinking
Upto 3000mg/L – Useful for irrigation.
Above 3000mg/L – Unfit for drinking and irrigation

From the above classification, 25% samples are within the permissible limit for drinking and 100% samples are suitable for irrigation.

Table-1: Physico-chemical characteristics of groundwater samples from different Zones

Sampling Sites	pH	EC	TDS	Cl	TH	Ca	Mg	NO_3	SO_4
S-1	6.85	420	500	50	150	90	60	7.9	292
S-2	6.33	350	300	30	140	100	40	6.2	260
S-3	6.83	410	500	70	260	150	110	6.6	300
S-4	6.5	730	200	65	180	100	80	7	340
S-5	6.92	520	100	20	120	60	60	4.8	168
S-6	6.7	580	200	200	110	30	80	1.7	85
S-7	7.54	350	300	300	350	180	170	42.4	112
S-8	6.86	420	700	700	330	200	130	29.1	96
S-9	7.35	650	400	400	390	260	130	9.6	120
S-10	6.95	520	600	600	560	200	360	11.9	165
S-11	7.5	680	700	700	490	220	270	24.7	134

Table-2: % of Samples exceeding the ISI limits

Parameter	Min	Max	Mean	SD	ISI limits	% of Samples exceeding
pH	6.5	7.5	7	0.38628	6.5-8.5	0
EC	350	730	540	133.927	1500	0
TDS	100	700	400	207.145	500	38.46
Cl	30	700	365	273.761	250	38.46
TH	110	560	335	156.013	300	38.46
Mg	40	360	200	98.5255	30	100
Ca	30	260	145	73.2617	75	92.3
NO_3	1.7	42.4	22.05	12.6892	45	0
SO_4	85	340	212.5	92.1762	150	46.15

Table-3: % Standards for Drinking Water

Parameter	ICMR		ISI		WHO	
	P	E	P	E	P	E
Colour	5	25	10	50	5	25
Taste & Odour	UO	UO	UO	UO	UO	UO
pH value	7 – 8.5	6.5 – 9.2	6.5-8.5	6.5-9.2	7 – 8.5	6.5 – 9.2
Total Dissolved Solids	-	-	-	-	500	1500
Total Hardness mg/lit	300	600	300	600	-	-
Calcium	75	200	75	200	75	200
Magnesium	50	150	30	100	50	150
Chlorides	250	1000	250	1000	200	600
Sulfate	200	400	150	400	200	400
Nitrate	20	50	45	-	-	100

P = Permissible Limit; E = Excessive Limit; UO = Un Objectionable;
Note – All Units except pH are in mg/L, otherwise stated.

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