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Studies on Groundwater Quality in Slums of Visakhapatnam, Andhra Pradesh

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Commensurate with the growth of industrial and allied activities in and around Visakhapatnam city, its area grew from 30 km^2 in 1960 to over 80 km^2 to date. The city's population according to 2001 census is about 1.33 million. Water supply has always been inadequate in this city with the crisis growing along with the cities progress. Today's water requirement is 360 million gallons per day. The existing Thatipudi, Gossthani, Meghadrigadda and Mudasarlova can hardly meet 50 % of the need. Raiwada water scheme can add a little more, therefore the supply capacity needs to be augmented. The only viable solution is to transport water from Godhavari. Apart from the municipal supply the population also depends upon the ground water reservoirs.

Key Words: pH, Electrical conductivity, Water quality index.

INTRODUCTION

Lack of reasonable access to adequate supplies of safe drinking water is a big problem in sub-urban and rural communities in developing countries. Most of the water related problems are compounded when methods and techniques used for abstraction do not take into consideration the unique local conditions.

Storage improves the microbiological and physical qualities of water[1]. However, storage is not usually used as a separate independent water purification method, since more rapid sedimentation and removal of colloidal matter can be achieved with chemical coagulation and filtration[2]. Chemical treatment for springwater in slums is practically inapplicable on a significant and sustainable scale. Hence, storage can be an appropriate springwater quality improvement technique.

Groundwater quality of southern India is strongly dependent on bedrock geology and climate but may also be impacted in parts by pollution, particularly from agricultural and industrial sources. The most important agricultural pollutants are nitrate and pesticides, though it is recognised that fertiliser and pesticide applications are not as intensive as in many western nations[3]. No data could be found for pesticide occurrences in southern Indian groundwater. Phosphate and potassium fertilisers are also used though the mobility of these beyond the soil zone is much less than that of nitrate. Another impact of pollution is likely to be increased values of total dissolved solids (TDS).

Some groundwaters from the sedimentary aquifers in the southern states have been identified by radiocarbon analysis as very old. Groundwater from the deep confined part of the Cuddalore Sandstone (screen depth up to 470 m) has been dated at up to 26,000 years[4]. The quality of such old groundwater is determined by natural water-rock reaction processes with little likelihood of inputs from modern pollution.

In the present study, the ground water quality in the slum areas Vishakapatnam Old Post Office, Ramakrishna Street, Spring Road, Poorna Market and Lakshmi Talkies Area of Vishakapatnam has been surveyed. The samples have been collected from dug wells and bore wells for physico-chemical analysis, which has been carried out, in the Environmental Monitoring Laboratory, GITAM Institute of Sciences, GITAM University, Visakhapatnam, India.

The objective of the present study is to assess the ground water quality status in the study area and its potability.

EXPERIMENTAL

The water samples are collected from both dug wells and bore wells in residential areas of Visakhapatnam. The collected samples are properly labeled indicating the source of the sample, time and date of collection. The samples are brought to the laboratory in ice containers and analyzed for the parameters within 48 h of collection. In case of dissolved oxygen the samples are fixed in the site itself and analyzed in the laboratory within 6 h. Standard methods are employed to analyse the following physico-chemical parameters of water[5-15].

Water quality index: Out of 18 parameters studied 7 parameters were taken for calculating water quality index[16,17]. Water quality index is defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water. The water quality index was calculated from the point of view of the suitability of bore water of human consumption. The weights for various water quality parameters are assumed to be inversely proportional to the standards for the corresponding parameters.

$$Wi = k/Si$$

where Wi is unit weight for the ith parameter, Si (I = 1, 2…12) refer to water quality parameters and k is constant of proportionality. For the sake of simplicity we assume K = 1. The unit weight Wi obtained from the equation with K = 1. Calculation of water quality index involves two fundamental steps

Calculation of the quality rating for each of the water quality parameters used in the index

Aggregation of these sub indices into the overall index.

Let there be N water quality parameters and Pi (i = 1, 2, 3…..N) are to be taken into account for calculating the water quality index. Then the quality rating qi corresponding to the ith parameter of Pi is a number reflecting the relative values of these parameters in the polluted water with respect to its standard or its permissible value (Si). One of the simplest relations to calculate

$$qi = 100 (Vi - V10)$$

where, Vi is measured value of the I the parameter in polluted water, V10 is the ideal value of this parameter in pure water and Si is the standard or permissible value of the i th value.

Since in general, the ideal value, V10 = 0 for the drinking water for most parameters. Equation qi = 100(Vi-V10)/ (Si-V10) assumes that simple from for these parameters

$$qi = 100(Vi/Si).$$

The above two equations ensure that qi = 0 if the ith parameter is totally absent in the polluted water and qi = 100, if amount of this parameter is just equal to its permissible value Si for the drinking water. But there are two following exceptions.

For dissolved oxygen the ideal value may be taken as 14.6 mg/L (the solubility of oxygen in pure water at 0 °C). Since the standard for drinking water is 5.0 mg/L. The equation

qi = 100(Vi - V10)/ (Si - V10) v reduce s to qdo = 100 (Vdo - 14.6)/ (14.6-5.0)

where V do is observed value of dissolved oxygen.

For pH the ideal values is 7.0 (for neutral water) and the permissible value is 8.5. So the equation qi = 100(Vi - V10)/(Si - V10) can be written as

$$qpH = 100(VpH - 7.0)/ (8.5 - 7.0)$$

$$Wqi = \left(\sum_{i=1}^{N} qi\, W_i\right) / \sum_{i=1}^{N} W_i$$

RESULTS AND DISCUSSION

The physico-chemical characteristics and water quality index of open well and bore well water collected in and around slum areas of Visakhapatnam and the results are given in Tables 1 and 2, respectively.

TABLE-1
PHYSICO-CHEMICAL CHARACTERISTICS OF OPEN WELL AND BORE WELL WATERS COLLECTED IN AND AROUND SLUM AREAS OF VISAKHAPATNAM

Parameter	S1	S2	S3	S4	S5	S6	S7
pH	7.10	7.12	7.19	7.02	7.15	7.09	7.21
Chlorides	899.72	933.70	1039.67	839.73	699.00	499.00	349.00
Total dissolved solids	580.00	1220.00	5580.00	700.00	720.00	680.00	560.00
Total hardness	600.00	1360.00	3700.00	420.00	500.00	560.00	500.00
Calcium	420.00	640.00	1020.00	320.00	360.00	380.00	200.00
Nitrate	1.76	6.14	0.22	0.44	1.78	4.62	3.20
Sulphate	70.00	120.00	180.00	62.00	68.00	158.00	52.00
Iron	0.10	0.21	0.22	0.20	0.25	0.21	0.09
DO	4.20	4.50	2.50	4.30	3.80	4.80	5.10

All values are expressed in mg/L except pH; All values are average of triplicate; S1 = Closed well (Ramakrishna street); S2 = Bore well (spring road); S3 = Open well (Near Laxmi Talkies); S4 = Closed well (Ramakrishna street); S5 = Closed well (Ramakrishna street); S6 = Bore well (Near one town police station Old post office); S7 = Bore well (Poorna Market).

TABLE-2
WATER QUALITY INDEX (WQI) OF OPEN WELL AND BORE WELL WATERS COLLECTED IN AND AROUND SLUM AREAS IN VISAKHAPATNAM

Parameter	WHO standard	Unit Wt (Wi)	S1	S2	S3	S4	S5	S6	S7
			qiwi	qiwi	qiwi	qiwi	qiwi	qiwi	qiwi
pH	8.5	0.117	0.77	0.93	1.38	0.005	1.1	0.66	1.63
Chlorides	250	0.004	1.0	0.005	1.663	1.34	1.118	0.798	0.55
TDS	500	0.002	1.439	0.488	0.0044	0.28	0.288	0.272	0.224
Total hardness	300	0.003	0.6	1.359	3.699	0.42	0.49	0.559	0.499
Calcium	75	0.013	7.28	11.09	17.68	5.54	6.24	6.585	3.465
Nitrates	45	0.022	0.00001	1.32	0.009	0.021	0.079	0.004	0.142
Sulphates	200	0.005	0.0008	0.3	0.45	0.155	0.017	0.395	0.13
Iron	0.3	3.33	199.8	233.1	166.5	266.4	277.4	233.1	99.9
DO	5.0	0.20	25.33	23.32	36.60	23.32	5.60	21.32	19.32
ΣWi		3.686							
Σqiwi			236.78	271.89	227.98	297.66	292.33	263.6	125.86
	Σqiwi / ΣWi		64.179	73.88	61.95	80.88	79.43	71.63	34.20

All the values are average of triplicate.

The water quality index (WQI) for the slum areas Ramakrishna street (S1), spring road (S2), Near Laxmi Talkies (S3), Ramakrishna street (S4), Ramakrishna street (S5), Near one town police station Old post office (S6), Poorna Market (S7) are 64.17, 73.88, 61.95, 80.88, 79.43, 34.20, respectively, indicating that the water in the study area is fit for human consumption with respect to the physico-chemical parameters that have been analyzed (Bacteriological quality testing is also carried out).

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