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EVALUATION OF WATER QUALITY IN THE VICINITY OF SOME SALTPANS, VISAKHAPATNAM DISTRICT, ANDHRA PRADESH

Y. Avasn. Maruthi *et al.*

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Y. AVASN. MARUTHI*, S.RAMAKRISHNA RAO [1], D. APTA CHAITANYA, KAIZAR HOSSAIN, R. SANTHOSH KUMAR, M. SITARATNAM [2] AND R.TULASI RAO

Department of Environmental Studies, GITAM Institute of Science, GITAM University, Visakhapatnam-530 045, A. P., INDIA

[1]Department of Civil Engineering, Andhra University, Visakhapatnam - 530 003, A. P., INDIA

[2]Graduate student in Environmental Engineering, Centre For Environmental Systems, Stevens Institute of Technology, Castle Point on Hudson, Hoboken, New Jersy, USA - 07030

E mail: ymjournal03@yahoo.com

ABSTRACT

An attempt was made for the first time in the state of Andhra Pradesh to assess the impact of saltpan effluent on available water sources existing in and around saltpans. A total of seventy water samples from two sampling sites were collected along coastal line and analyzed for physico-chemical parameters. Water samples from Pudimadaka showed SAR content ranging from 8.43 to 44.60 which indicates medium hazard prone, where as Kommadi water samples showed a range of 13.21 to 84.07 showing more prone to high hazards of sodium. GWQI values of samples from Pudimadaka were in the range of 41.58 - 42.44 indicating their poor quality. Where as the GWQI values of the other site were with in the limits (89.60) indicating that they were good in quality and also potable. The result obtained conclusively suggests the detrimental impact of saline effluent on water quality in Pudimadaka area, rendering it unsuitable for the propagation of life and unfit for agricultural purpose. And this indicates a worse condition of salt pan vicinities, as the ground water is only source of drinking water in those places.

*Corresponding author

INTRODUCTION

Polluted water is responsible for many water-borne communicable diseases (Garg *et al.,* 2007). The diseases associated with contaminated water, however, remain as serious public health problems in India (Tamberkar and Charan, 2004). The common sources of water like wells (open / tube wells) in villages are getting contaminated by some sources such as effluents from different industries, discharge of drainage systems in natural water reservoirs, different human activities (washing & bathing) domestic and municipal waste, washing from salt pans etc. (Tamberkar *et al.,* 2007). Salinity is one of the most important problems of agricultural irrigation in arid and semi – arid zones. Both irrigation water and soil composition can increase salinity, which in turn decreases crop productivity and forces a shift to more resistant crops. Salinization of coastal fresh water aquifers by seawater intrusion, geomorphic changes, tidal waves, cyclonic storms and man-made hazards are major causes of the ground water pollution in the coastal areas of the State of Andhra Pradesh, India. Ground water quality/ quantity has been monitored from 1976 to 2003 through open dug wells, under water table conditions and purpose-built piezometers drilled through different aquifers under confined and artesian conditions. Water analysis data collected over 200 observation wells, both pre and post monsoon, for the last three decades has shown a significant changes in the saline/ fresh water interface, as revealed by specific conductance values and chloride Bi-carbonate ratios to the extent of maximum of 10.5 (Tambekar *et al.,* 2008). In the state of Andhra Pradesh, India, salinization of fresh water aquifers is mainly due to indiscriminate utility of ground water, cyclonic storms and man made pollution (through aquaculture, agricultural practices, industries and sewage). This study aimed at identifying the quality of water in the vicinity of saltpans and also assessing the rate of salinization of the same due to practicing of traditional salt making.

MATERIALS AND METHODS

Study area

Visakhapatnam is situated between 17°40' 30" and 17°40' 45" NL and 83°16' 15" and 83°21' 30" EL. Kommadi is a place, located 20 km away from Bheemli Beach and the water samples were collected from salt pans in and around the village (Fig. 1). Pudimadaka (Anakapalli Mandal) has around thirty salt pans. Ten water samples from each sampling site at each village were collected.

Sample collection

Samples were collected in triplicates for each season (January – December, 2009), at exact points on the mapped sites, with great care during collection and transportation. The samples were brought to the laboratory and analyzed for physico-chemical parameters by adopting known standard procedures (APHA, 1998). All the collected samples were analyzed for Sodium Absorption Ratio (SAR). SAR is a measure of the relative preponderance of dissolved sodium in water compared to the amount of dissolved calcium and magnesium. SAR was calculated as followed (Smitha *et al.,* 2007):

$$\text{SAR} = \frac{[Na^{+}]}{[Ca^{+2} + Mg^{+2}]^{1/2}} \quad \text{Units} = \text{mMol/L}$$

(The concentration of cations in the soil solution).

Groundwater quality index (GWQI): While chemical analysis yields the physical and chemical composition of water, the water quality index gives an estimate of the quality of drinking water. The GWQI (Brown *et al.,* 1970) was calculated using weighted arithmetic index method and the quality rating/sub index (Qi) corresponding to the ith parameter Pi is a number reflecting the relative value of this parameter. Qi is calculated by using the following expression.

Table 1: Physico-Chemical Characteristics of Water Samples Collected at Pudimadaka (from January to December 2009)

Parameter	W_1	W_2	W_3	W_4	W_5	W_6	W W_7	W_8	W_9	W_{10}	WHO
PH	9.00 - 9.24 (9.13)	8.18 - 8.56 (8.4)	7.93 -8.9 (8.2)	8.89-10.53 (8.5)	9.75-10.70 (10.3)	8.98-9.92 (9.5)	9.2-9.5 (9.3)	8.93-9.34 (9.2)	7.10-7.79 (7.5)	6.99-7.16 (7.07)	7.0-8.5
Conductivity (mmhos)	58.4 ± 20	4.85±5	3.68±5	85.1±10	87.4±3	104.5±10	61.05	122.3±4	2.2±2	2.53±3	—
Turbidity(NTU)	8.5 ±3	8.5±2	8.3±10	8.4±4	8.6. ±2	16.7±5	16.73	16.5±3	36.4±5	7.3-8.8	5
Alkalinity (mg/L)	15- 20	8.5-12.5	7.8-10	12.78-30	14-29	30-35	24-29	29-32	16.8-17.5	5-7	—
Total Hardness (mg/L)	280 ±100	520± 40	450±20	500±10	720±10	850±100	500±50	500±50	100±20	70-80	100
Calcium Hardness (mg/L)	500±50	300±50	420±10	500±10	600±20	900±30	300±10	2100±30	400±10	45-50	75
Magnesium Hardness (mg/L)	23±50	20±50	30±10	45±10	66±20	46±50	47±10	48±20	96±10	30±10	30
Total Solids (mg/L)	17.16±3	6.56±5	8.43±3	14.1±5	11.93±3	52.8±2	71.03±5	17.36±5	152 ±3	31.76±5	500
Total Dissolved Solids (mg/L)	51.6±20	7.6±15	2.83±10	34.56±10	21.63±5	115.43±6	37.23±5	91.6±4	511.1±5	15.7±2	—
Total Suspended Solids (mg/L)	34±10	1.04±3	5.6±5	20.46±20	9.7±5	62.63±10	33.8±3	7.76±4	359.1±3	16.06±5	—
Chlorides (mg/L)	197±100	524±50	389±30	249.9±10	197.30±100	349.9±50	299.9±20	369.8±10	149±10	249.9±4	200
Nitrates (mg/L)	0.2-0.4	2.7-3.54	3.89-5.13	0.1-0.3	0.1-0.2	0.25-0.36	2.6-3.3	1.2-1.73	2.2-3.73	0.6-0.9	45
Phosphates (mg/L)	0.53-0.76	0.02-0.14	0.34-0.26	0.16-0.3	0.45-0.63	0.5-0.66	0.7-0.74	0.6-0.75	0.2-0.3	0.2-0.3	—
Sulphates (mg/L)	20.4-22.2	21.87-25.56	19.21-22.43	20.31-22.43	23.76-24.92	20.45-23.46	20.3-23.56	20.2±21.66	16.3-20.5	20.4-23.86	200
Dissolved Oxygen (mg/L)	1.2-1.7	2.9-3.5	2.5-2.7	2.7-2.9	1.9-2.6	2.8-3.2	2.8-2..9	1.9-2.9	1.9-2.3	<0.2	—
Biochemical Oxygen Demand (mg/L)	0.9-1.1	1.0-1.2	0.12-0.15	1.00-1.2	0.7-1.4	0.9-1.2	0.8-1.2	0.7-1.1	0.9-1.1	<0.3	—
Chemical Oxygen Demand (mg/L)	1.5±0.3	1.6±0.2	3.2±1	4.2±0.6	4.6±2	6.8±1	5.2±0.5	4.4±2	4.8±1	<0.5	—
Sodium (mg/L)	148.2±100	238±40	189±30	188.6±10	185.3±20	248.9±30	144.7±50	216.0±20	315.4±10	Below detectable	—
Potassium (mg/L)	20.0±3	102±5	83.6±10	57±20	58.6±10	72.9±20	24±10	31.8±10	63.1±10	1.4±0.4	—
Boron (mg/L)	0.76±0.3	0.717±0.2	0.793±0.1	0.71±0.2	0.75±0.2	0.79±0.1	0.61±0.2	0.39±0.1	0.750.1	0.400	—
Sodium Absorption Ratio (mm1/L)	10.25-12.3	13.4-14.8	10.9-12.6	8.8-10.8	7.32-10.88	10.3-12.04	5.6-7.9	9.6-9.9	10.23-12.60	8.43-10.02	—

Table 2: Physico-Chemical Characteristics of Water Samples Collected at Kommadi (from January to December 2009)

Parameter	WW_1	WW_2	WW_3	WW_4	WW_5	WW_6	W WW_7	WW_8	WW_9	WW_{10}	WHO
pH	7.7-8.20 (7.95)	6.9- 7.65 (7.3)	7.2-7.60 (7.4)	6.8-7.30 (7.05)	7.2-7.70 (7.5)	7.3-7.87 (7.6)	6.6.23-6.94 (6.08)	7.0-7.61 (7.4)	6.9-7.79 (7.4)	6.8- 7.12 (6.96)	7.0-8.5
Conductivity (mmhos)	1.5±0.2	1.08±0.2	1.91±0.3	1.02±2	1.87±0.1	1.62±0.2	1.13±0.3	1.9±0.2	1.14±0.1	1.22±0.1	—
Turbidity(NTU)	5.1±0.8	5.2±1	5.0±0.3	5.0±1	9.9±1	9.2±1	16.2±1.4	14.5±1	10.5±1.2	4.2±2	5
Alkalinity (mg/L)	3.0±0.2	1.5±0.2	1.3±0.3	1.5±0.2	1.5±0.1	1.0±0.3	1.4±0.3	2.0±0.5	1.5±0.3	1.8±0.3	—
Total Hardness (mg/L)	170±10	160±10	270±10	140±20	200±10	100±10	109±20	85±10	200±20	198±10	100
Calcium Hardness (mg/L)	50±50	40±10	120±0.5	24±1	21±2	28±1	12±2	16±3	16±2	20±1	75
Magnesium Hardness (mg/L)	100±10	120±10	150±10	100±1	179±10	90±10	97±2	69±3	180±10	200±10	30
Total Solids (mg/L)	52.63±3	1.6±0.3	2.3	295.6	508.06	149.3	115.4	114	4.16	1.8	500
Total Dissolved Solids (mg/L)	29.23±2	4.2±1	3.43	214.6	506.26	140.7	86.96	61.06	7	4.2	—
Total Suspended Solids (mg/L)	23.4±5	2.6±0.2	1.13	81	1.8	8.6	28.44	52.94	2.84	2.4	—
Chlorides (mg/L)	63.98±100	69.97±30	49.98±10	59.7±20	19.7±10	29.9±20	55.97±10	47.27±10	46.9±20	44.96±20	200
Nitrates (mg/L)	<0.1	2.321-4.133	2.28-3.36	0.9-1.2	1.33-1.54	1.53-1.6	2.66-3.12	3.16-3.9	0.166>	0.533>	45
Phosphates (mg/L)	0.11-0.33	0.103-0.233	0.1	0.93	0.6-0.8	0.53-0.74	0.36-0.58	0.033-0.24	0.26-0.68	0.73-0.78	—
Sulphates (mg/L)	5.5-8.5	2.67-5.63	9.87-11.76	6.8-7.13	8.1-9.3	6.2-8.3	8.5-10.1	8.1-8.8	10.8-11.1	9.12-10.09	200
Dissolved Oxygen (mg/L)	1.2-1.5	2.8-3.5	1.7-2.4	1.8-2.8	1.9-3.1	2.1-2.5	2.7-3.5	2.4-3.4	1.2-1.9	0.2>	—
Biochemical Oxygen Demand (mg/L)	1.0-1.2	0.5-0.8	0.1-0.8	0.9-1.1	0.5-1.1	0.6-1.2	0.5-0.8	0.7-0.9	0.8-1.1	0.5	—
Chemical Oxygen Demand (mg/L)	1.2-1.4	1.2-1.9	2.6-2.9	2.2-2.8	2.8-3.2	1.-2.6	1.2-3.1	2.8-3.0	2.1-2.7	0.5>	—
Sodium (mg/L)	133.8±100	245.4±30	194.4-200.2	168.1-198.3	188-234	138.3-238	204.3-213.5	206.0-245.	100-150	2.4>	—
Potassium (mg/L)	85.6±50	90.5±10	91.2±20	39.0±30	95.4±10	96.6±10	37.6±20	39.23±	44.6±10	5.4>	—-
Boron (mg/L)	0.501>	0.429>	0.560	0.720	_	0.771	0.710	0.550	0.603	0.494	—
Sodium Absorption Ratio (mm1/L)	23.56-25.60	16.73-26.17	16.8-19.5	16.77-25.23	16.07-16.9	16.92-24.12	19.8-25.6	20.12-22.54	20.43-23.84	0.22>	—

$$Q_i = \frac{(Mi - l)}{(Mi - l)} \times 100$$

The overall GWQI was calculated by aggregating the quality rating (Qi) with unit weight (Wi) linearly. Procedure adopted as suggested by Udayalakshmi *et al.,* (2010).

RESULTS AND DISCUSSION

Results of Physico-chemical parameter of water samples were presented in Table 1 and 2. pH is a measure of the intensity of acidity or alkalinity and is also a measure of the concentration of hydrogen ions in the water. It has no direct adverse effect on health, however, all values, below 4.0 will produce sour taste and value above 8.5 shows bitter taste (Karunakaran, 2008). The pH range of 6.5 to 8.5 is normally acceptable as per guidelines suggested by WHO (1984).

The pH values reveal that the water samples of Pudimadaka were alkaline, varying from 6.99 to 10.70 and were above permissible limit as prescribed by WHO (1984). Water samples collected near salt pans (W4, W5) showed high values of pH (10.53 and 10.70), which might be due to seepage of salt water from salt pans long back (Table 1). Water samples collected from Kommadi showed the pH ranging from 7.65 (W_2) to 7.60 (W_3) (Table 2).

The Electrical conductivity (EC) is an index to represent the concentration of soluble salts in water. EC values in all samples observed were in a range of 3.68 to 4.85, except water sample collected from Pudimadaka (Table 1). EC values of samples in the Kommadi region (WW_2, WW_3) were found to be between 1.08 to 1.99 mMohs. It was observed that water with high electrical values was rich in Sodium and Chloride ions and further it was noted that the electrical conductivity was higher

Figure 1: Map showing the study area

Table 3: Ground Water Quality Index (GWQI) of Water Samples

Taluka	Sample	GWQI	Grade
Pudimadaka	W_1	41.583	Poor
	W_2	41.583	Poor
	W_3	42.445	poor
	W4	41.583	poor
	W5	41.583	poor
	W6	41.583	Poor
	W7	41.583	Poor
	W8	41.583	Poor
	W9	38.254	Poor
	W10	42.736	Poor
	W W_1	88.105	Good
Kommadi	W W_2	89.601	Good
	W W3	84.601	Good
	WW_4	84.46	Good
	W W_5	79.797	Fair
	WW_6	84.46	Good
	WW_7	84.46	Good
	W W_8	84.46	Good
	WW_9	84.46	Good
	WW_{10}	89.601	Good

during post monsoon season. Hardness in water is due to cations that are the divalent ions like calcium and magnesium. The hardness in water is derived largely from contact with the soil and rock formations. Calcium and Magnesium hardness is caused by greatest portion of the hardness occurring in natural waters. Hardness of water is objectionable from the view point of water used for laundry and domestic purposes, since the processes consume a large quantity of soap. Total Hardness was reported for Pudimadaka water samples as 520 (W_2) – 450 (W_3) mg/L, calcium-hardness was reported as 300 (W_2) and 420 (W_3) mg/L and magnesium-hardness 220 (W_2) and 30 (W_3) mg/L respectively (Table 1) and remaining water samples from Pudimadaka were found to exceed the permissible limits of hardness. This was mainly due to presence of high calcium content in these places (Foppen, 2002; Karunakaran, 2008). The water samples of Kommadi showed total hardness 170 (WW_2) and 270 (WW_3) mg/L, calcium hardness 40 (WW_2) and 120 (WW_3) mg/L and magnesium hardness 130 (WW_2) and 150 (WW_3) mg/L (Table 2). All these values were above the prescribed standards respectively indicating the deterioration of ground water quality. Alkalinity of water is a measure of its capacity to neutralize acids. Alkaline values provide guidance in applying proper doses of chemicals to water and in waste water treatment processes particularly in coagulation, softening and operational control of anaerobic digestion. There is no standard value for total alkalinity. The total alkalinity value indicates poor water quality. The high value of alkalinity is probably either due to intrusion of seawater or percolation of washings from salt pans. Water collected from Pudimadaka showed maximum value of 35mg/L (W_2). The alkalinity of Kommadi water samples ranged from 1.5 mg/L (W_2) to 3 mg/L (W_3) (Table 2). Chlorides are important in assessing the quality of ground water. In general, high evapotranspiration tends to increase the concentration of chloride and salinity at the root zone of irrigated plants. This makes it difficult for crops to take up water due to osmotic pressure differences between the water outside the plants and within the plant cells (Hariharan, 2007). For this reason, chlorides and total salinity concentration below the drinking water standards are normally specified for waters used to irrigate salt sensitive crops (Alagamuthu and Rajan 2008). All water samples collected from Pudimadaka showed maximum values of, 524 mg/L (W_2), 389 mg/L (W_3) (Table 1), while the prescribed standard limit of chlorides is being 200 mg/L for domestic purposes. The concentration of chlorides in water samples of Kommadi was reported below permissible limits (69.97 – 49.98 mg/L) (Table 2). All water samples are found to be free from sulphate pollution. The results reveal sulphate concentrations ranging from 25.56 mg/L (W_2) to 22.43 mg/L (W_3), which are within permissible limits according to WHO (1984) (Table 5). Similar results were observed with water samples from Kommadi (5.63 mg/L to 11.76 mg/L) (Table 2).The maximum allowable limit for nitrates in drinking water is 45 mg/L. It was found that all water samples of Pudimadaka were free from nitrate pollution as the amounts of nitrates vary from 3.5 mg/L (W_2) to 5.1 mg/

L (W_3) (Table 1). Phosphates are of great importance in drinking water and the quantity of phosphates in water indicates the degree of pollution of water body. The phosphate concentration in water samples of Kommadi village were within the range (0.1 mg/L to 0.8 mg/L) (Table 2). As per WHO (1984 & 2004) guidelines there is no specific permissible limit for phosphates. All the water samples collected at Pudimadaka were found to have low D.O content ranging from 2.7 mg/L to 3.5 mg/L and similar results were observed in Kommadi samples (Table 1 and 2). BOD (Bio-chemical Oxygen Demand) is a measure of organic pollution. All water samples showed BOD values within the range of 0.15 mg/L to 1.2 mg/L. However these values are well below the prescribed limit. There is no permissible limit of COD for drinking water. All water samples found to have low COD values, ranging from 1.6 mg/L to 3.2 mg/L (Table 1 and 2).One of the water samples from Pudimadaka (W2) and one from Kommadi (WW3) showed maximum sodium concentrations (238 mg/L and 245mg/L) (Table 1and 2). All the water samples showed values of potassium ranging from 83.6 mg/L to 102.9 mg/L. (Table 1 and 2).Calculation of SAR for water provides a useful index of Sodium hazard in water for soils and crops. Low SAR (2 to 10) indicates little danger from sodium, medium hazards between 7 and 18, high hazards between 11 and 26 and very high hazards indicate that the lower the ionic strength of the solution, the greater the sodium hazards for given SAR (Smitha *et al.,* 2007). Pudimadaka water samples showed SAR content ranging from 12.61 mMol/L to 14.809 mMol/L indicating medium hazard prone (Cardona *et al.,* 2004), whereas water samples from Kommadi showed a range of 16.73 mMo1/L to 26.17 mMo1/L showing more prone to high hazards of sodium (Table 1 and 2). All the samples analyzed for boron concentration were reported as 0.3 mg/L to 0.793 mg/L (W_3).

The water quality Index (GWQI) of water samples were calculated and are shown in Table 3. Water samples from Pudimadaka showed the WQI values in the range of 38.25 to 42.73 indicating a poor quality of the water (Tambekar *et al.,* 2008). Water samples from Kommadi showed WQI values within the limits (89.60) indicating good quality of the water, which could be potable.

CONCLUSION

The analysis of all the water samples collected from sampling sites revealed that the high load of hardness, chloride, calcium, magnesium and sodium of the saltpan effluent caused remarkable increase in all the parameter values. The results clearly indicated that the water resources have been salinized. Water quality has deteriorated due to gross alteration values of pH, hardness, chloride and sodium. Experimental results strongly suggest the need of proper treatment of effluents from saltpan prior to the release into the neighboring water bodies, to protect aquatic environment and depending life forms.

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REFERENCES

Alagamuthu, G. and Rajan, M. 2008. Monitoring of fluoride concentration in Ground water of kadayam Block of Tirunelveli District, India: correlation with physico –chemical parameters. *Rasayan J. Chem.* **1(4):** 757 – 765.

APHA. 1998. Standard methods for the examination of water and waste water, 20th Edn. American public health association, Washington DC., USA.

Brown, P. M., McClelland, N. I., Deninger, R. A. and Tozer, R. G. 1970. A water quality Index – de we dare? *Water and Sewage works.* **117(10):** 339-343

Cardona, A., Rivera, J. J. C., Alvarez, R. H. and Castro, E. G. 2004. Salinization in coastal aquifers of arid Zones: An example from Santo Domingo. Baja California sur. Mexico. *Environ. Geol.* **45:** 350-366.

Foppen, J. W. A. 2002. Impact of high-strength waste water infiltration on ground water quality and drinking water supply. The case of Sanaa. *Yemen. J. Hydrol.* **263:**198-216.

Hariharan, A. V. L. N. S. H. 2007. Some studies on the water quality parameters of Shiramnagar (Garividi), Vizanagaram district, Andhra Pradesh. *J. Curr. Sci.* **10:** 9-96.

Karunakaran, V. 2008. Study of Water Quality in and Around Vriddhachalam in Cuddalore District, Tamil Nadu. *Nature Environment and Pollution Technology*. **7(4):** 635-638.

Smitha, P. G., Byrappa, K. and Ramaswamy, S. N. 2007. Physico-chemical characteristics of water samples of Bantwal Taluk,south-western Karnataka. *J. Environ. Biology*. **28(3):** 591-595.

Tambekar, D. H., Waghode, S. M., Ingole, S. G. and Gulhane, S. R. 2008. Water Quality Index (WQI), Analysis of the Salinity- Affected Villages from Purna River Basin of Vidarbha Region. *Nature Environment and Pollution Technology*. **7(4):** 707-711

Tambekar, D. H., Bochare, V. G., Gole, B. B. and Banginwar, Y. S. 2007. Bacteriological quality of groundwater in Amravati, India. *Poll. Res.* **26(3):** 473-475.

Tamberkar, D. H. and Charan, A. B. 2004. Antibiotic sensitivity indexing of E.Coli to identify source of faecal contamination of drinking water in Pirna vally of Vidarbha. *Nature Environment and Pollution Technology*. **3:** 413-418.

Udayalaxmi, G., Himabindu, D. and Ramadass, G. 2010. Geochemial evaluation of ground water quality in selelcted areas of Hyderabad,A.P., India. *Inian J. Sci. Technology*. **3(5):** 546-553.

WHO, 1984. Guidelines for Drinking Water Quality, Recommendations, World Health Organization

WHO, 2004. Revised drinking water guidelines to help prevent water related outbreaks and disease, Public Health News, World Health Organization.