



WATER QUALITY INDEXING AND CORRELATION COEFFICIENT OF PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER IN AMRAVATI CITY

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ABSTRACT

The physico-chemical quality of drinking water is totally depend on the geological condition of the soil and ground water pollution of the area. In the present study water quality index of open well waters was 73.49 and for tube well waters 73.01 showing fair quality of ground water, indicating that the water quality was protected but occasionally threatened or impaired.

INTRODUCTION

The physico-chemical properties of ground waters clearly explain its geological profile, soil-water interstices, pollution states as well as human and animal health problems and other perspectives. The quality of the ground water is highly influenced with the local environment and geological condition. The quality of soil, rock and the water table determines the quality of ground water. The ground water table of a source changes with the regular withdrawal and hence the quality of ground water. Garg et al. (1990), Kaur et al. (1992), Rajmohan et al. (1997) and Singh et al. (2000) reported seasonal as well as yearly changes in the ground water quality. Ground water pollution causes irreparable damage to soil, plants, humans and animals, and spread epidemics and chronic diseases (Srinivas et al. 2002).

The water contains dissolved and suspended constituents in varying proportions and often has different chemical and physical properties (Paka & Narsing Rao 1997). In rural areas people often use unprotected water drawn from rivers, lakes and wells for drinking and domestic purposes (Indirabai & George 2002). Discharges of wastes from urban areas and industries, and agricultural wastes and farm wastes etc. also precipitate in the ground water pollution, hence waste water should be stopped or treated before discharge into bodies of water (Sangeeta et al. 2000).

The Purna river valley of Vidarbha, covering Amravati, Akola and Buldhana districts of Maharashtra state, is severely affected by salinity and poor quality of ground water. A total area of Purna valley is about 7500 sq.km out of which 4692 sq.km is severely affected by salinity. The salinity area of Purna valley in Amravati district is 1738 sq.km and people are mainly dependent on the ground water for drinking and domestic purposes (Tambekar et al. 2005). Hence, the present study was undertaken to analyze the physico-chemical quality of ground water and to evaluate the Water Quality Index (WQI) of Amravati city.

MATERIALS AND METHODS

A total of 250 ground water samples, 100 from Tube wells (TW) and 150 from open/dug wells (OW) were collected in the month of July to November 2005 from different localities of Amravati city in sterilized bottles and transported to the laboratory within 1 h of collection. The physico-chemical parameters such as colour, odour, turbidity, pH, TDS, conductivity, salinity, temperature, dissolved

oxygen, total hardness, calcium hardness, magnesium hardness, phosphate, sulphate, sodium, potassium, alkalinity and chloride etc. were analysed. Color, odor and turbidity of water was recorded at the site of collection. The physico-chemical properties such as pH, temperature, TDS, were analysis by soil/water kit (Century, Chandigarh, India). The sodium and potassium concentration were determined by flame-photometer and all other parameters of water were determined in the laboratory by chemical analysis using standards methods (APHA 1998).

The Water Quality Index (WQI) related to water quality (CCME 2001) is given below. The degree of correlation coefficient was calculated as per Surve et al. (2005).

Excellent = 95-100,

Good = 80-94

Fair = 65-79

Marginal = 45-64

Poor = 0.44

RESULTS AND DISCUSSION

The physico-chemical quality of drinking water totally depends on the geological condition of the soil and ground water pollution of the area. The permissible limit and values of various physico-chemical parameters of the ground water of different locations in Amravati city are shown in the Table 1. The pH of all OW and TW waters was within the normal range (WHO 1984), whereas maximum E.C. (9350 $\mu\text{mho/cm}$) was recorded in some places. Most of the water samples showed higher E.C. than permissible limit of 300 $\mu\text{mho/cm}$ by USPH (1974) as compare to TW. TDS of TW water was in higher ranges (25-600 mg/L) as compared to OW water (150-420 mg/L). The chloride

Table 1: Permissible limits and various physico-chemical parameters of open and tube well waters in Amravati city.

Physico-chemical Parameter	Permissible Limit	Below Permissible Limit		Within Permissible Limit		Above Permissible Limit	
		OW	TW	OW	TW	OW	TW
pH	6.5-9.2	0	0	150	100	0	0
Temp. (°C)	-	-	-	-	-	-	-
TDS	500-1500	53	30	91	70	06	0
Conductivity	300 ($\mu\text{mho/cm}$)	-	-	14	22	136	78
Salinity	200-600	19	20	105	60	26	20
D O	4-6	9	10	70	60	71	30
Total Hardness	100-500	18	20	121	45	11	35
Ca-Hardness	75-200	32	24	82	63	36	13
Mg-Hardness	30-150	24	15	98	72	28	13
Alkalinity	200	-	-	83	86	57	14
Chloride	200-600	39	25	102	75	09	0
Phosphate	25 (mg/L)	-	-	149	100	01	0
Sulphate	400	-	-	150	100	-	-
Sodium	50-60	17	8	30	24	103	68
Potassium	20	-	-	122	80	28	20
Colour	5 pt. Unit	-	-	150	100	-	-
Odour	5 pt. Unit	-	-	150	100	-	-
Turbidity	5 NTU	-	-	150	100	-	-

Note: All the values are given in mg/L, otherwise as stated.

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Table 2: Water Quality Index (WQI) of OW and TW waters from various areas of Amravati city.

Areas under study	No. of water samples tested		Mean WQI		Water Quality	
	OW	TW	OW	TW	OW	TW
Chaman Shahwali	11	08	76.66	75.50	Fair	Fair
Vrundavan Colony	05	05	75.82	70.20	Fair	Fair
Jijau Nagar	08	04	64.60	74.50	Fair	Fair
Shivneri Layout	10	10	75.25	72.25	Fair	Fair
Inkayyapura	16	10	78.12	73.50	Fair	Fair
J.G. Nagar	20	-	69.50	-	Fair	-
Tapovan	10	-	67.50	-	Fair	-
University	04	04	74.62	51.68	Fair	Marginal
Gurukrupa Colony	20	10	60.06	64.25	Marginal	Fair
Suraksha Colony	06	-	73.47	-	Fair	-
Chaprasipura	04	11	76.20	69.96	Fair	Fair
Congress Nagar	04	03	79.00	81.52	Fair	Good
Frezarpara	04	06	75.61	79.69	Fair	Fair
Yashoda Nagar	04	10	70.88	80.70	Fair	Good
Rajapeth	04	07	70.07	70.09	Fair	Fair
Ganesh Colony	04	-	77.15	-	Fair	-
Masanganj	04	-	77.51	-	Fair	-
Pathanpura	04	-	79.00	-	Fair	-
Laxminagar	04	-	72.76	-	Fair	-
Shivaji Nagar	04	-	76.02	-	Fair	-
Sanket colony	-	10	0	75.25	-	Fair
Rukhamani Nagar	-	05	0	83.06	-	Good
Total	150	100	73.49	73.01	Fair	Fair

concentration in OW water was between 28 mg/L and 2085mg/L, which produces a salty taste above 200 mg/L. The salty taste of some of the well waters is due to high concentration of chlorides (Trivedy & Goel 1986).

Alkalinity of OW water was found to be higher than the permissible limit (200 mg/L) as compared to TW water. Calcium and magnesium hardness was in the range of 20 to 750 in OW water and 10-240 mg/L in TW water. Total hardness of OW water was found to be higher than TW water. Sodium and potassium was in high concentration (850 mg/L) in OW waters as compared to TW. Sodium content of most of the OW (102 out of 150) waters was observed to be more than the permissible limit of 50-60 mg/L (USPH 1974). Only one OW water sample contained phosphate greater than permissible limit (26 µg/L). Results showed that concentration of sulphate in all the well and TW waters were within the permissible limit. Dissolved oxygen (DO) is a highly fluctuating factor in water and it was varied between 3.4 and 26 mg/L in OW and 3 and 17 mg/L in TW. Maximum (3723 mg/L) salinity was recorded in OW as compared to TW water samples.

Water quality index is commonly used for the detection and evaluation of water pollution and may be defined as a rating reflecting the composite influence on the overall quality of a number of quality parameters. In the present study CCME (2001) water quality index WQI of OW water was 73.49 and for TW 73.01 indicating fair quality of ground water (Table 2). The water quality index (WQI) of 19 study areas indicated the fair quality, showing that the water quality was protected but occasionally

Table 3: Correlation co-efficient of various physico-chemical parameters of open-well waters of Amravati city.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
pH	1														
Temperature	-0.02	1													
TDS	0.3	0.17	1												
Conductivity	0.16	0.36	0.81	1											
Phosphate	-0.09	0.23	-0.1	0.01	1										
Sulphate	-0.3	0.13	-0.01	0.04	-0.04	1									
Sodium	0.18	0.01	0.54	0.53	-0.15	-0.09	1								
Potassium	-0.09	0.06	-0.12	-0.06	0.28	0.09	-0.05	1							
DO	-0.04	-0.2	-0.11	-0.12	0.04	-0.12	-0.01	0.01	1						
Total hardness	0.13	0.12	0.29	0.36	-0.06	-0.01	0.5	0.12	-0.08	1					
Ca.Hardness	0.12	0.16	0.24	0.33	-0.13	0.05	0.48	0.17	-0.04	0.83	1				
Mg.Hardness	0.08	0.02	0.21	0.22	0.06	-0.07	0.3	0.01	-0.1	0.74	0.24	1			
Alkalinity	0.32	0.12	0.63	0.6	-0.07	-0.1	0.74	-0.19	-0.09	0.31	0.24	0.26	1		
Chloride	0.17	0.11	0.39	0.43	-0.14	-0.14	0.71	0.06	-0.07	0.71	0.61	0.49	0.53	1	
Salinity	0.15	0.1	0.4	0.45	-0.4	-0.09	0.73	0.09	-0.06	0.74	0.62	0.54	0.57	0.96	1

1-pH; 2-Temperature; 3-TDS; 4-Conductivity; 5-Phosphate; 6-Sulphate; 7-Sodium; 8-Potassium; 9-DO; 10-Total hardness; 11-Calcium hardness; 12-Magnesium hardness; 13-Alkalinity; 14-Chloride; 15-Salinity

Table 4: Correlation co-efficient of various physico-chemical parameters of tube-well waters of Amravati city.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
pH	1														
Temperature	0.14	1													
TDS	0.22	0.21	1												
Conductivity	0.22	0.2	0.61	1											
Phosphate	-0.21	0.47	0.1	0.07	1										
Sulphate	0.19	0.06	0.05	0.03	0.01	1									
Sodium	0.26	0.2	-0.09	0	0.01	-0.02	1								
Potassium	0.08	0.17	0.08	0.23	0.31	0.02	0.21	1							
DO	0.17	-0.24	-0.04	0.16	-0.38	-0.07	0.09	-0.05	1						
Total hardness	0.11	0.02	0.3	0.07	0.13	-0.02	0.07	0.08	-0.08	1					
Ca-hardness	0.15	0.12	0.27	0.14	0.07	0.03	0.14	0.17	0.09	0.76	1				
Mg-hardness	0.04	-0.6	0.22	0.02	0.15	-0.03	-0.01	-0.02	-0.21	0.76	0.17	1			
Alkalinity	0.37	0.01	0.41	0.38	-0.06	0.12	-0.05	-0.03	0.09	0.2	0.24	0.07	1		
Chloride	0.08	0.14	0.13	0.26	-0.11	-0.13	0.29	-0.1	0.12	0.14	0.06	0.17	0.01	1	
Salinity	0.04	0.15	0.13	0.27	-0.02	-0.23	0.27	-0.01	0.12	0.22	0.15	0.19	0.09	0.71	1

1-pH; 2-Temperature; 3-TDS; 4-Conductivity; 5-Phosphate; 6-Sulphate; 7-Sodium; 8-Potassium; 9-DO; 10-Total hardness; 11-Calcium hardness; 12-Magnesium hardness; 13-Alkalinity; 14-Chloride; 15-Salinity

threatened or impaired.

The correlation co-efficient among the various physico-chemical parameters for TW water showed highest positive correlation between chloride and salinity and highest negative correlation between phosphate and DO. pH, temperature, conductivity, sodium, total hardness and calcium hardness showed positive, and phosphate, sulphate, TDS and DO negative correlation with all other parameters (Table 3). OW water showed maximum positive correlation between chloride and salinity, and negative correlation between pH and sulphate. TDS was negatively correlated with temperature, phosphate, potassium and dissolved oxygen (DO). Temperature was negatively correlated with DO; conductivity

with potassium and DO; and phosphate with chloride, alkalinity and salinity, and positively correlated with total hardness, calcium hardness, sulphate and sodium. Sulphate was negatively correlated with sodium, DO, total hardness, magnesium hardness, chloride, alkalinity and salinity (Table 4). The negative correlation between dissolved oxygen and water temperature was also observed by Singh et al. (2000). Surve et al. (2005) recorded the highest positive correlation between air temperature and water temperature, while highest negative correlation between water temperature and dissolved oxygen.

The quantity of some physico-chemical parameter was above or higher than permissible limits, which may have adverse effect on the quality of ground water and health of human beings. Hence, these sources are to be protected from pollution and proper treatment should be applied before using the water for drinking purposes. The CCME water quality index indicated that ground water quality of Amravati city was fair in year 2005.

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