DETERMINATION OF WATER QUALITY INDEX OF PUBLIC OPEN WELLS LOCATED IN DIFFERENT AREAS OF DHULE CITY (M.S.) INDIA

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ABSTRACT

The study assesses groundwater quality of some of the public open wells located in different areas of Dhule city (M.S) India. The water quality index of water samples of public open wells were determined on the basis of eight important physico-chemical parameters such as pH, total dissolved solids (TDS), total hardness (TH), calcium (Ca), magnesium (Mg), electronic conductivity (EC), dissolved oxygen (DO) and chloride (Cl). The objective of this study is to convert complex water quality data in to information that is easily understandable by the public and water management.

The water quality index (WQI) values for the selected open wells were found in the range of 32.9 to 78.12. These values showed that the status of the groundwater quality public open wells located in different areas of Dhule city was found good in one well, medium in five wells, bad in two wells, very bad in one well.

Key words: Open well, Physico-chemical parameters, Water quality index.

INTRODUCTION

Fresh water is essential for human existence. Understanding the quality of groundwater is as important as that of its quantity[1] as it is the main factor of determining its suitability for purposes. It is estimated that about 30% of global freshwater is present in the form of groundwater[2]. Water quality index is one of the most efficient tools for expressing the quality of water and for communicating information on the quality of water.

The objective of this study is to investigate the water quality index of public open wells located in different areas of Dhule city (M.S) India by using eight physico-chemical parameters namely, pH, total dissolved solids (TDS), total hardness (TH), calcium (Ca), magnesium (Mg), electronic conductivity (EC), dissolved oxygen (DO) and chloride (Cl).

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EXPERIMENTAL

Sampling and sampling sites

The water samples of public open wells located in different areas of the Dhule city, namely-Annasaheb Patil Nagar (C_1), Kumar Nagar Babalpuri (C_2), Deopur Church (C_3), Jamnagiri Bhilati (C_4), Mohadi Suburb (C_5), Mahajan high school (C_6), Nateshwar Society (C_7), Patole80 Ft. road (C_8), Sitaram Mali chawl (C_9), were collected at the end of March 2013 and analyzed for eight physico-chemical parameters.

Analysis methods

The parameters; pH, electronic conductivity (EC), total dissolved solids (TDS) and dissolved oxygen (DO) were analyzed immediately. Total hardness (TH), magnesium (Mg), calcium (Ca) and chloride were analyzed volumetrically. Standard procedures of APHA[3] were used. The results obtained are shown in Table 1.

The status of water quality was decided on the basis of water quality index. The quality of the water is categorized from very bad to excellent. The WQI ranges are presented in Table 2. The WQI calculations[4] involves following steps.

Weightage (Wi)

For water quality index, the weightage (Wi) of all the water quality factors must be known. Weightage of factor has an inverse relationship with its permissible limit (Vi).

Thus,   Wi α 1/Vi or Wi = K/Vi

K = Constant of proportionality, Wi = Unit weight of factor.

Vi = Maximum permissible limit[5,6] as recommended by ICMR and CPHEEO

The value of K was calculated as K = 1/∑1/Vi.

The value of ∑1/Vi was calculated as –

$$\sum_{i=1}^{8} 1/Vi = 1/Vi \text{ (pH)} + 1/Vi \text{ (TDS)} + 1/Vi \text{ (Hardness)} + 1/Vi \text{ (Ca)} +$$

$$1/Vi \text{ (Mg)} + 1/Vi \text{ (DO)} + 1/Vi \text{ (EC)} + 1/Vi \text{ (Cl) i} = 1$$

The weightages (Wi) obtained for selected parameters are presented in the Table 2.

Table 1

Parameter	Annasaheb Patil Nagar C₁	Kumar Nagar Babalpuri C₂	Deopur Charch C₃	Jammagiri Bhilati C₄	Mohadi Suburb C₅	Mahajan high school C₆	Nateshwar Society C₇	Patole 80 Ft. road C₈	Sitaram Mali chawl C₉
Sample collection date	31/3/13	30/3/13	30/3/13	31/3/13	31/3/13	31/3/13	31/3/13	31/3/13	31/3/13
Sample collection time	9.45 am	12.00 noon	12.40 pm	10.20 am	9.20 am	11.05 am	8.30 am	10.45 am	10.00 am
Air temp.	35	34.5	38	35.5	34	38	30	38	35
Water temp.	26	28.5	28.5	28	28.5	30.5	29	28	26
pH	7.58	7.45	7.81	7.67	7.21	7.76	8.0	7.58	7.31
TDS	1206	1266	764	2073	1104	983	1714	1600	1682
Total hardness	391	270	220	370	364	324	445	670	693
Calcium	94	31	75	75	153	85	30	90	270
Magnesium	297	238	145	295	211	238	415	580	423
D.O	2.5	3.5	4.0	2.9	6.0	4.3	3.1	2.0	4.8
EC	1915	2010	1212	3290	1753	1561	2800	2540	2670
Chloride	232	145	72	312	130	130	275	232	275

N.B: All units are in mg/L except for EC which is in µS/Cm; Temperature °C; and pH has no unit

Table 2: WQI ranges and status of water quality

S. No.	WQI Ranges	Water quality status
1	90-100	Excellent
2	70-90	Good
3	50-70	Medium
4	25-50	Bad
5	0-25	Very Bad

Rating scale

The scale as shown in Table 3 was prepared for range of values of each selected physico-chemical parameter. This scale is as per the guide lines of Kumar and Dua[4]. The rating varies from 0 to 100 and is divided in to five ranges. The rating $V_r = 0$ implies that the parameter present in water exceeds the standard maximum permissible limit and water is severely polluted. On the other hand $V_r = 100$ implies that parameter present in water has the most desirable value. The other ratings fall between these two extremes and are $V_r = 40$, $V_r = 60$, $V_r = 80$ standing for excessively polluted, moderately polluted and slightly less polluted.

Table 3: Drinking water standard, recommended agency and calculated unit weights

S. No.	Physico-chemical parameters	Standard max. permissible limit (Vi)	Recommended agency	Unit weight (Wi)
1	pH	7.0-8.5	CPHEEQ	0.3247
2	TDS	< 1500	CPHEEQ	0.0055
3	TH	< 600	CPHEEQ	0.0138
4	Ca	< 75	ICMR	0.0368
5	Mg	< 50	ICMR	0.0920
6	DO	> 5	ICMR	0.5520
7	EC	< 300	ICMR	0.0092
8	Cl	< 250	ICMR	0.0110

Water quality index calculation

The water Quality Index (WQI) is equal to the sum of product of rating (Vr) and unit weight (Wi) of all the factors. It is given as –

$$WQI = \sum_{i=1}^{8} Wi \times Vi = Wi_{(pH)} \times Vi_{(pH)} + Wi_{(TDS)} \times Vi_{(TDS)} + Wi_{(Hardness)} \times Vi_{(Hardness)} +$$

$$Wi_{(Ca)} \times Vi_{(Ca)} + Wi_{(Mg)} \times Vi_{(Mg)} + Wi_{(DO)} \times Vi_{(DO)} + Wi_{(EC)} \times Vi_{(EC)} + Wi_{(Cl)} \times Vi_{(Cl)}$$

The values of Vi, Wi and Vr are given in Table 3 and 4.

RESULTS AND DISCUSSION

The values of physico-chemical parameters of water samples of public open wells located in different areas of Dhule City (M.S.) obtained are presented in the Table 1.

Table 4: Rating scale for calculating WQI (All units are in mg/L except for EC, which is in µS/Cm and pH has no units)

Physico-chemical parameters	Ranges				
	Range-1	**Range-2**	**Range-3**	**Range-4**	**Range-5**
pH	7.0-8.5	8.6-8.7	8.8-8.9	9.0-9.2	> 9.2
TDS	0-375	375.1-750	750.1-1125	1125.1-1500	> 1500
Total Hardness	0-150	150.1-300	300.1-450	450.1-600	> 600
Ca Hardness	0-20	20.1-40.0	40.1-60.0	60.1-75.0	> 75
Mg Hardness	0-12.5	12.6-25.0	25.1-37.5	37.6-50	> 50
DO	> 7.0	5.1-7.0	4.1-5.0	3.1-4.0	< 3.0
EC	0-75	75.1-150	150.1-225	225.1-300	> 300
Cl	0-62.5	62.6-125	125.1-187.5	187.6-250	> 250
Vr	100	80	60	40	0
Extent of pollution	Clean	Slight pollution	Moderate pollution	Excess pollution	Severe pollution

The WQI values of open public wells are presented in the Table 5. From these values the water quality of open public well were found in the order of

$$C_8 < C_1 < C_4 < C_9 < C7 < C_3 < C_2 < C_6 < C_5$$

Table 5: The water quality index and status of the public open well water samples

City area	Annasaheb Patil Nagar	Kumar Nagar Babalpuri	Deopur Charch	Jamnagiri Bhilati	Mohadi Suburb
Code	C_1	C_2	C_3	C_4	C_5
Water quality index	33.30	59.53	58.34	34.77	78.12
Water quality status	Poor	Medium	Medium	Poor	Good

City area	Mahajan High School	Nateshwar Society	Patole 80 Ft. road	Sitaram Mali chawl
Code	C6	C7	C8	C9
Water quality index	67.50	58.32	32.9	54.55
Water quality status	Medium	medium	Very Bad	Medium

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