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SEASONAL WATER QUALITY INDEX OF TUBE WELL WATER OF VILLAGES IN DARYAPUR TALUKA, AMRAVATI DISTRICT, MAHARASHTRA, INDIA

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ABSTRACT :- In present study water quality index is used to evaluate the seasonal water quality of tube wells from Daryapur Taluka of Amravati district. For calculation of Water Quality Index (WQI) assessment of seasonal water quality parameters such as pH, TDS (Total Dissolved Solids), DO (Dissolved Oxygen), Alkalinity, Total Hardness, Chloride, Sulphate and COD (Chemical Oxygen Demand) were considered and compared with ICMR and WHO standards. The calculated values of seasonal water quality index in both sampling sites reveals higher values during summer season (T1= 101.58 & T2=99.89) which indicates that the water is unsuitable for drinking purpose and very poor in respective sites.. During rainy seasons the reported values shows very poor status (T1= 82.89 & T2=82.75) in its rating where as in winter season the values (T1= 71.35 & T2=70.97) are lower as compared to summer and rainy seasons and rated with poor water quality. Seasonal monitoring of water quality and treatment of water prior supply is needed.

KEYWORDS: Water quality, WQI, tube wells, Daryapur,ICMR,WHO.

1. INTRODUCTION

Water is a natural resource required by all living organisms for betterment of their health. Now a days water pollution is the biggest problem faced by world population, characterized by poor water quality makes unfit for drinking and domestic purposes. Therefore there is a demand of supply of clean, safe and potable water. Ground water is of much importance than surface water due to certain characteristics (Goel, 2000) and it is main source of drinking (UNESCO), domestic and irrigational uses by urban as well as rural population. Ground water quality can be deteriorate as a result of unplanned urbanization and heavy industrialization (Singh et al., 2002), use of chemical and nitrogenous fertilizers (Shamruk et al. 2001) and mining activities (Lin et al., 2003) leading to the disturbed hydrological activities. Thus assessment of water quality is very important. Water Quality Index (WQI) is regarded as most effective tool for the communication of water quality. Several researchers (Gupta et al., 2011, Tambekar et al., 2008 and Rajankar et al. 2009) carried out studies on ground water quality of Amravati district before by using water quality index. In present study water quality index is used to evaluate the seasonal water quality of tube wells from Daryapur Taluka of Amravati district in order to communicate the status of ground water quality.

2. MATERIAL AND METHODS

2.1 Sampling site

Two villages namely Sasan and Shivar of Daryapur Taluka, Amravati District Maharashtra were selected for study. Tube wells in these villages were considered as sampling sites and represented as sampling site T1 for Sasan and T2 for Shivar village in present study.

2.2 Collection of Water Samples and Analysis

Water samples for physico-chemical analysis were collected monthly in each season during a year 2011. Water samples collected from sampling sites were analyzed on site and in laboratory as per the guidelines and standard methods prescribed by American Public Health Association (APHA 2005). For calculating the seasonal WQI parameters like pH, Total Dissolved Solids (TDS), Alkalinity, Total Hardness, Chloride, Dissolved Oxygen, Sulphate, and Chemical Oxygen Demand (COD) has been considered.

2.3 Calculation of WQI

For calculation of water quality rating (qn), seasonal mean values of water quality parameters were considered whereas calculation of subindex (qn.Wn), the drinking water standards (Sn) and unit weight (Wn) was taken as per recommended agencies ICMR and WHO (Table 1).The calculation of WQI was carried out using Weighted Arithmetic Index method (Brown et al. 1972) in the following steps.

Table 1: Water quality parameters with their std. values (Sn) and unit weight (Wn) values for Water Quality Index (WQI) calculation.

Parameters	Standards (Sn)	Unit Weights (Wn)
pH	7.0-8.5 (ICMR)	0.218176
TDS	500 mg/l (WHO)	0.003708
Alkalinity	120 mg/l (ICMR)	0.01545
Total Hardness	300 mg/l (ICMR)	0.0061816
Chloride	250 mg/l (ICMR)	0.0074179
DO	5.0 mg/l (ICMR)	0.37089
Sulphate	250 mg/l (WHO)	0.0074179
COD	20 mg/l (ICMR)	0.02507

2.3.1 Calculation of Sub index or Quality Rating (qn)

Let there be n water quality parameters and quality rating or subindex (qn) corresponding to n^{th} parameter is a number reflecting the relative value of this parameter in the polluted water with respect it's standard permissible value. The qn is calculated by using following expression.

$$q_n = 100 [(V_n – V_{io}) / (S_n – V_{io})]$$

Where,

q_n -Quality rating for the n^{th} water quality parameter.

V_n - (estimated value of n^{th} parameter at given sampling site

S_n - standard permissible value of n^{th} parameter.

V_{io} - Ideal value of n^{th} parameter in pure.

All ideal values (V_{io}) are taken as zero for the drinking water except for pH=7.0 and Dissolved Oxygen = 14.6 mg/l

2.3.2 Calculation of Unit Weight (Wn)

The unit weights (Wn) for various water quality· parameters are inversely proportional to the recommended standards for the corresponding parameters.

$$W_n = \frac{K}{S_n}$$

Where, W_n - Unit weight for n^{th} parameter.

S_n - Standard value for nth parameter.

K - Constant for proportionality.

2.3.3 Calculation of WQI

WQI is calculated from the following equation.

$$WQI = \sum_{n=1}^{n} q_n w_n \; / \; \sum_{n=1}^{n} w_n$$

The suitability of WQI values for human consumption were rated according to Mishra and Patel (2001) as given in table 2.

Table 2.: Water quality rating values for determination of Water Quality Index (WQI), according to Mishra and Patel (2001).

WQI values	Status
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
100 & Above	Unsuitable for drinking

2.4 Statistical analysis

The data obtained in triplicate were analyzed by SPSS statistical package (Window version 17) and Microsoft software Excel 2007 and represented as mean values with standard deviation in figures and tables.

3. RESULTS AND DISCUSSION

3.1Seasonal water quality parameters

Seasonal observations on water quality parameters of sampling sites are represented in table 3.

pH - Seasonal mean values of pH during different seasons show acidic nature of water. However it remains below the prescribed limit value 7.0 – 8.5 of ICMR for drinking water during winter (6.99) in both T1and T2 sampling sites.

TDS- A seasonal variation of TDS values in both sampling sites shows higher concentration during all seasons exceeding the desirable limit 500 mg/l of WHO and ranges between 819.75 – 856.25 mg/l in sampling site T1 whereas 823 – 878 mg/l in sampling site T2.

DO - Seasonal mean values of DO in both sampling sites were increased from summer (T1= 2.57 mg/l, T2= 2.65 mg/l) followed by rainy (T1= 3.97 mg/l, T2= 4.07 mg/l) and higher in winter (T1= 4.2 mg/l, T2= 4.27 mg/l) season. Seasonal values in both sampling sites for DO were below the desirable range 5.0 mg/l of ICMR.

Alkalinity-Seasonal variations in the mean values of Alkalinity were remains under desirable limit 120 mg/l of ICMR and exceeds in summer (T1= 134.75 mg/l, T2= 133 mg/l) season in both the sampling sites.

Total hardness-Seasonal mean value of Total hardness exceeds the desirable range 300 mg/l of ICMR during all seasons (T1= 398.25 – 484.5 mg/l, T2= 398.5 – 468.75 mg/l) in both the sampling sites which is unsuitable for drinking purpose.

Chloride - Seasonal mean value of Chloride do not exceeds the desirable range 250 mg/l of ICMR during rainy and winter seasons except summer season (T1= 261.54 mg/l, T2= 250.44 mg/l) in both the sampling sites.

Sulphate-Seasonal mean values of Sulphate remains in the desirable range 250 mg/l of WHO during all seasons (T1= 136.75 – 231.25 mg/l, T2= 142 – 218.25 mg/l) indicating suitability of water for drinking purpose.

COD-Seasonal mean variation in values of COD in both sampling sites (T1= 18.125 – 19.75 mg/l, T2= 18.62 – 20.12 mg/l) favors the desirable range 20 mg/l of ICMR indicating the suitability of water for drinking purpose.

Overall seasonal water quality reveals that it is mainly affected during summer followed by rainy season whereas winter season water quality suppose to be the good one up to certain extent. However some of the parameters like pH, DO, TDS, Alkalinity and Total hardness which exceeds the desirable limit during summer season where as during rainy and winter only pH, TDS, DO and Total hardness seems to affect water quality which might be due to the geology and hydrology of the region (Tiwary et al. 1995; Tiwary and Dhar1994), climatological factors (Kant and Kachroo 1971) as well as anthropogenic activities (Singh, 1992). Similar observations were reported on ground water quality of dug wells by Tambekar and Neware (2012) while assessing the ground water quality of Amravati District, Warhate et al. (2006) on assessment of ground water quality of mining affected areas of Yavatmal District.

3.2 Seasonal Water Quality Index (WQI)

The seasonal water quality rating (qn) values, subindex values (qn Wn) values and calculated seasonal water quality index values are represented in table 4, table 5 and table 6 respectively.

The calculated values of seasonal water quality index (Table 6 & Fig1) in both sampling sites reveals higher values during summer season (T1= 101.58 & T2=99.89) which indicates that the water is unsuitable for drinking purpose and very poor in respective sites.. During rainy seasons the reported values shows very poor status (T1= 82.89 & T2=82.75) in its rating where as in winter season the values (T1= 71.35 & T2=70.97) are lower as compared to summer and rainy seasons and rated with poor water quality. Similar observations were recorded by Gupta et al. (2011) on poor water quality of Daryapur. Also the findings on water quality index of adjacent district Akola (Tambekar et al., 2008) and Nagpur (Rajankar et al., 2009) by using CCME and NSF water quality index respectively could be correlate with present study.

4. CONCLUSION

It can be concluded on the basis of seasonal water quality index that the water of both the sampling sites is unsuitable for drinking in summer, rainy and winter seasons. However it can be use during winter season for drinking purpose only after treatment and proper monitoring of physico-chemical characteristics of water.

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Table 3: Seasonal mean variation in water quality parameters of sampling site T1 and T2

	Sampling site T1			Sampling site T2			
WQP	**Summer**	**Rainy**	**Winter**	**Summer**	**Rainy**	**Winter**	**Water Std.**
pH	6.125±0.22	6.52±0.15	6.99±0.25	6.175±0.19	6.5±0.24	6.99±0.27	**7-8.5(ICMR)**
TDS	819.75±38.9	843.25±22.2	856.25±13.5	823±21.5	827.75±24.8	878±15.6	**500 (WHO)**
DO	2.57±0.23	3.97±0.26	4.2±0.44	2.65±0.21	4.07±0.24	4.27±0.43	**5.00 (ICMR)**
Alk.	134.75±4.8	100.75±4.5	115.75±8.6	133±5.61	105.75±4.4	118.75±10.0	**120 (ICMR)**
TH	484.5±48.3	481.75±37.9	398.25±71.6	468.75±22.9	451±51.4	398.5±63.9	**300 (ICMR)**
Chl.	261.54±10.4	198.72±9.7	195.265±29.3	250.44±9.7	188.95±11.3	192.14±27.7	**250 (ICMR)**
Sul.	231.25±14.4	136.75±28.0	196±21.94	218.25±18.8	142±28.2	164.5±25.1	**250 (WHO)**
COD	19.75±1.09	18.25±0.90	18.125±0.54	20.12±1.29	18.5±0.94	18.62±0.65	**20 (ICMR)**

*All values are in mg/l except pH, ±SD n=4 ,

WQP= Water Quality Parameters, TDS= Total Dissolved Solids, DO= Dissolved Oxygen, Alk.=Alkalinity, TH=Total Hardness, Chl.=Chloride, Sul.=Sulphate, COD=Chemical Oxygen Demand

Table 4: Seasonal Water Quality Rating (q_n) values of water quality parameters of sampling sites.

	Sampling site T1			Sampling site T2		
Parameters	**Summer**	**Rainy**	**Winter**	**Summer**	**Rainy**	**Winter**
pH	58.33	32.00	0.66	55.00	33.33	0.66
DO	125.31	110.72	108.33	124.47	109.68	107.60
TDS	163.95	168.85	171.25	164.60	165.55	175.60
Alkalinity	112.29	83.95	96.45	110.83	88.12	98.95
Total Hardness	161.50	160.58	132.75	156.25	150.33	132.66
Chloride	104.61	79.48	78.10	100.17	75.58	76.85
Sulphate	92.50	54.70	78.40	87.30	56.80	65.80
COD	98.75	91.25	90.62	100.60	92.50	93.10

Table 5: Seasonal calculated Subindex ($q_n W_n$) values of water quality parameters of sampling sites.

	Sampling site T1			Sampling site T2		
Parameters	**Summer**	**Rainy**	**Winter**	**Summer**	**Rainy**	**Winter**
pH	12.726	6.981	0.143	11.999	7.271	0.143
DO	46.476	41.064	40.178	46.164	40.679	39.907
TDS	0.607	0.626	0.634	0.610	0.613	0.651
Alkalinity	1.734	1.297	1.490	1.712	1.361	1.528
Total Hardness	0.998	0.992	0.820	0.965	0.929	0.820
Chloride	0.775	0.589	0.579	0.743	0.560	0.570
Sulphate	0.686	0.405	0.581	0.647	0.421	0.488
COD	2.475	2.287	2.271	2.522	2.318	2.334

Table 6: Calculated values for Water Quality Index (WQI) determination (Seasonal)

*Sampling sites	Seasons	$\sum_{n=1}^{n} q_n w_n$	$\sum_{n=1}^{n} w_n$	$\sum_{n=1}^{n} q_n w_n \ / \ \sum_{n=1}^{n} w_n$	Status of Water Quality based on WQI (Mishra & Patel, 2001)
T1	**Summer**	66.47	0.6543114	101.58	Unsuitable for drinking (100 & Above)
	Rainy	54.24		82.89	Very poor (76 - 100)
	Winter	46.69		71.35	Poor (51 - 75)
T2	**Summer**	65.36	0.6543114	99.89	Very poor (76 - 100)
	Rainy	54.15		82.75	Very poor (76 - 100)
	Winter	46.44		70.97	Poor (51 - 75)

Fig.1. Seasonal WQI of sampling sites T1&T2