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ASSESSMENT OF WATER QUALITY INDEX FOR GROUNDWATER OF VALSAD DISTRICT OF SOUTH GUJARAT (INDIA)

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ABSTRACT

The present study aims the assessment of the water quality index (WQI) for the groundwater of Valsad district of South Gujarat. Total fifteen sampling stations from five talukas of Valsad district were selected and groundwater samples were collected for two years (from August 2007 to July 2009). In this present study, WQI created by Canadian Council of Minister of the Environment (CCME) was used. For calculating the WQI, groundwater samples were analyzed for seventeen physico-chemical parameters like pH, Colour, Electrical Conductivity (EC), Total Hardness (TH), Calcium (Ca), Magnesium (Mg), Total Alkalinity (TA), Total Dissolved Solids (TDS), Silica, Chloride, Sulphate, Fluoride, Sodium, Chemical Oxygen Demand (COD) and metals like Copper (Cu), Lead (Pb) and Manganese (Mn). The WQI for Valsad district suggests that the groundwater quality is marginal.

Key Words: Ground Water, Water quality index, Valsad District, Gujarat

1. INTRODUCTION

Water is essential for the survival of any forms of life. Water accounts for about 70% of the weight of a human body.

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Even though 80% of the earth's surface is covered by water, but 97% of earth's water is saline to drink. 2.14% water is trapped in the giant glaciers and polar ice caps. Thus not even 1% quantity of water is available for drinking, agriculture, domestic and industrial consumption[1]. According to WHO, about 80% of all the diseases in human beings are caused by water [1].

Groundwater is the major source of water supply for domestic purpose in urban as well as rural parts of India. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source. It therefore becomes imperative to regularly monitor the quality of groundwater and to device ways and means to protect it. [2]

The physical and chemical parameters of groundwater play a significant role in classifying and assessing water quality. Water quality index is one of the most effective tools [3-6] to communicate information on the quality of water to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of groundwater. WQI is defined as a rating reflecting the composite influence of different water quality parameters. WQI is calculated from the point of view of the suitability of groundwater for human consumption.

The advantages of an index include its ability to represent measurements of a variety of variables in a single number, its ability to combine various measurements in a variety of different measurement units in a single metric and its effectiveness as a communication tool. In this present study, WQI created by Canadian Council of Minister of the Environment (CCME) was used.

In India, WQI of ground water was studied by Singh D.K. et al. [7] at Hasanpur, Uttar Pradesh, by Rajankar et al. [8] at Nagpur region, Maharastra, by Ramakrishnaiah C.R. et al. [9] at Tumkar Taluk, Karnataka and by Dhakad N.K. et al.[10] at Jhabua Town, Madhya Pradesh.The present study was carried out to study water quality index of at Valsad District of South Gujarat,India.

2. MATERIALS AND METHODS

Valsad district is laid between 20^0 8' to 21^0 9' N latitudes, and 62^0 39' to 73^0 30' E longitudes. The area is 2947.59 sq.km. It has main four rivers named Auranga, Par, Damanganga and kolak. Average rain fall in the area was 90 -110 inch. The district has five talukas namely Valsad, Pardi, Umargam, Kaprada and Dharampur. It would be useful to assess the groundwater quality of the district by deriving WQI. Three sampling stations from each taluka were selected on the basis of

the location demand. Total fifteen sampling stations were selected for assessment of WQI for groundwater of Valsad district. The sampling stations designated S1 to S15. The location of sampling stations is shown in **Fig. 1.**

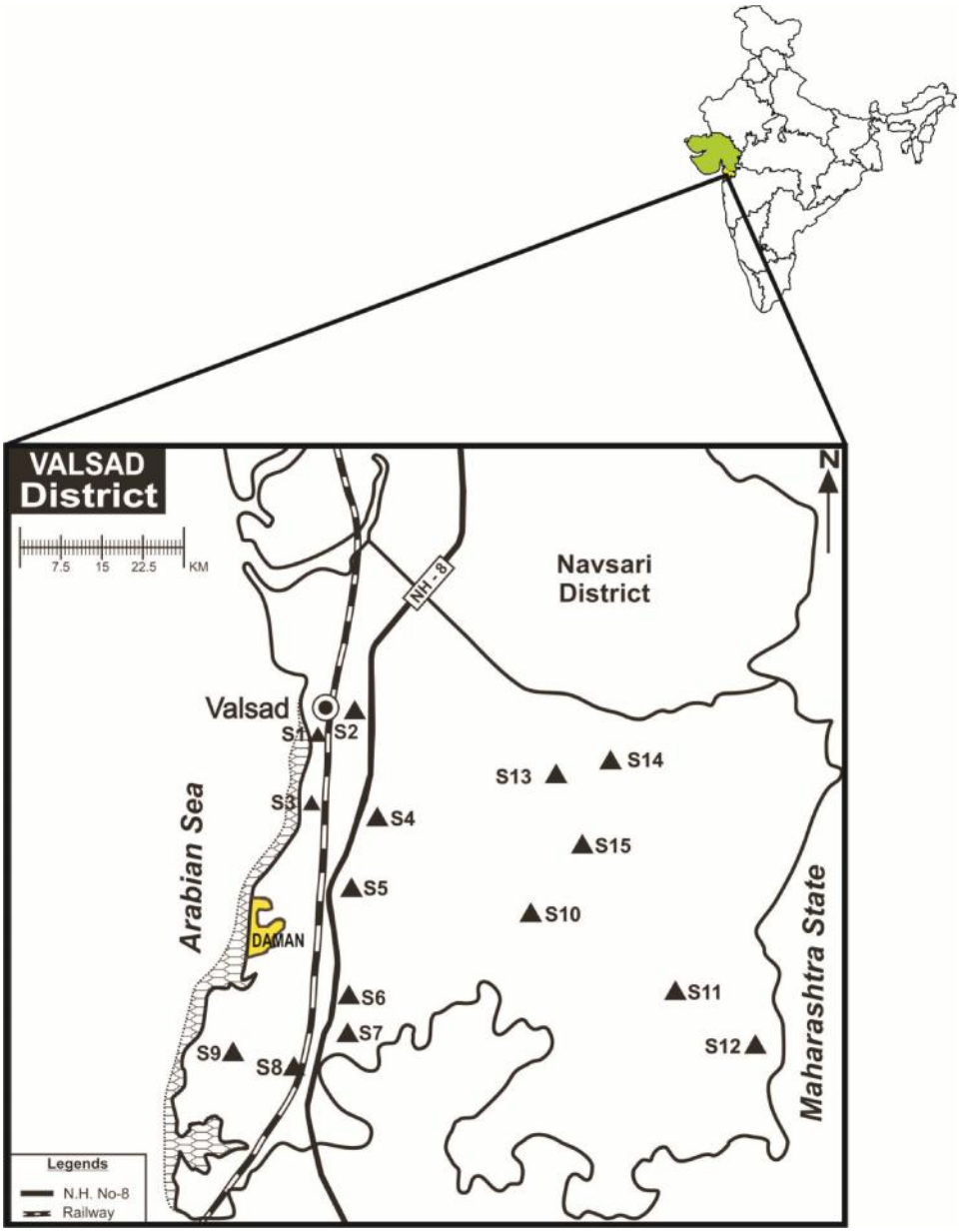

Fig.1. Location of sampling stations

The groundwater samples were collected in 2L polythene bottles which were thoroughly washed twice with the water to be analyzed. The physico-chemical parameters like pH, EC, color, Total

hardness, Calcium, Magnesium, Total Alkalinity, Total Dissolved Solids (TDS), Silica, Chloride, Sulphate, Fluoride, Sodium, COD and metals like Copper, Lead and Manganese were estimated as per APHA [11] .All the reagents and Standards were prepared freshly at the time of analysis.

The CCME water quality index has also been adopted by the UNEP for evaluating the quality of water in different countries around the globe [12]. The CCME Water Quality Index (CWQI) takes the form [13]

$WQI = 100 - \{[F_1^2 + F_2^2 + F_3^2]^{1/2} / 1.732\}$

Where;

Scope (F_1) is number of variables not met.

Frequency (F_2) is the number of times the objectives are not met.

Amplitude (F_3) is the extent to which objectives exceeded.

The computed CWQI values are classified meeting water quality objectives.

into five types, “excellent” to “Poor”, shown in **Table 1.**

Table 1. CWQI rating for Water quality [13]

WQI	**Rating**	**Significance**
95-100	Excellent	Water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels. These index values can only be obtained if all measurements are within objectives virtually all of the time
80-94	Good	Water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.
65-79	Fair	Water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.
45-64	Marginal	Water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.
0-44	Poor	Water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.

3. RESULTS AND DISCUSSION

The result of groundwater analysis for study period Aug 2007 – July 2009 was shown in **Table 2** with min., max. and average values. The IS standard [14] values are described in **Table 3**.

pH is a method of expressing hydrogen ion concentration. In present study, the pH of the water samples were found to be in range of 6.4 to 8.3 indicating the presence of very weak basic salts. Color in water may result from the presence of natural metallic ions (iron and manganese), humus and peat materials, plankton, weeds, and industrial wastes. Value of color ranges from BDL to 28 hazen. Electrical Conductivity (EC) value is an index to represent the total concentration of soluble salts in water.Results indicate,, EC was ranges from 0.169 to 3.63 mmho/cm.

The term 'hardness' is one of the oldest terms used to describe characteristics of water. Total hardness (TH) was varied from 70 to 1060 mg/l at various locations. Calcium concentrations at various sampling locations ranges between 18 to 269 mg/l, while magnesium concentration ranged between 3.7 to 132.4 mg/l.

Alkalinity is a measure of capacity of water to neutralize acids. In present study, total alkalinity is varied from 65 to 570 mg/l, which is within the limit.Total dissolved solids (TDS) in water varied from 149 to 3200 mg/l at various locations, indicating the variation is very high.

Degradation of silica containing rocks results in the presence of silica in natural waters as suspended particles, in a colloidal or polymeric state, and as silisic acids or silicate ions [11]. Silica was found between 5 to 50 mg/l.

Chloride ion is one of the major inorganic anions in water. The concentration of chloride ranged from 7.1 to 1180 mg./l. Sulfate is widely distributed in nature and may be present in natural waters in concentrations ranging from a few to several thousand milligrams per liter [11]. In present study, the sulphate concentration is also found within limit. Accurate determination of fluoride has increased in importance with the growth of practice of fluoridation of water supplies as a public health measures. Fluoride is more common in groundwater than surface water. The main sources of fluoride in groundwater are the fluorine bearing minerals in igneous and metamorphic rocks [15]. Result indicate the fluoride concentration was found within limit.

The Chemical Oxygen Demand (COD) is used as a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant [11]. In present study, the COD value was ranges from ND to 28 mg/l. Metals with specific

gravity greater than 5 or often more are termed as heavy metals. The term simply used to denote metals that are toxic [15]. Overall the concentration of Copper, Lead and Manganese was found within limit.

Sodium is the dominant cation in most mineralized groundwater with the exception of gypsiferous and many Ca-HCO_3 waters [16] . In the present study, sodium concentration ranges from 7.8 to 837 mg/l.

Based on these values the CWQI was calculated for Valsad district. The obtained value is 59.07. The WQI for Valsad district suggests that the groundwater quality is marginal.

Table 2. Results of groundwater analysis of Valsad district

Parameters	**Min.**	**Max.**	**Avg.**
pH	6.4	8.3	7.4
Colour	BDL	28	3
EC	0.169	3.63	0.847
Total Hardness as $CaCO_3$	70	1060	368
Calcium as Ca	18	269	88
Magnesium as Mg	3.7	132.4	36
Total Alkalinity as $CaCO_3$	65	570	265
TDS	149	3200	764
Silica	5	50	24
Chloride as Cl^-	7.1	1180	183
Sulphate as SO_4^{-2}	4.9	113	25
Fluoride	0.14	0.48	0.32
COD	ND	28	3.4
Copper	BDL	0.03	0.0005
Lead	BDL	BDL	BDL
Manganese	BDL	0.61	0.04
Sodium	7.8	837	125.5

(Results are expressed in mg/l except for pH, Colour in Hazen and EC in mmho/cm) (ND : Not Detected; BDL : Below Detectable Limit)

Table 3. Standards for Drinking Water[9].

Parameter	Standards for Drinking Water	
	Desirable Limit	**Permissible limit**
pH	6.5-8.5	No relaxation
Colour	5	25
EC	-	-
Total Hardness	300	600
Calcium	75	200
Magnesium	30	90
Total Alkalinity	200	600
TDS	500	2000
Silica	-	-
Chloride	250	1000
Sulphate	200	400
Fluoride	1.0	1.5
COD	-	10 [17]
Copper	0.05	0.15
Lead	0.05	No relaxation
Manganese	0.1	0.3
Sodium	-	-

(All parameters are expressed in mg/l except for pH, Colour in Hazen and EC in mmho/cm).

4. CONCLUSIONS

The overall WQI of Valsad District for the study period was 59.67,Which was lie under marginal category of CCME(WQI).WQI of S_1(Tithal),S_2(Dhamadehi) lie under fair category while S_{12}(sutharpada) under excellent category,while rest of the stations falls under good category. The low value of CWQI has been found to be mainly for TDS, Total Hardness, Calcium, Chloride and Sodium in groundwater. The groundwater quality may improve by recharging during monsoon season. The analysis reveals that the groundwater of Valsad district needs some degree of treatment before consumption.

5. ACKNOWLEDGEMENTS

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