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Assessment of Water Quality Index for the Groundwater in and nearby Industrial Area

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ABSTRACT
The present work is aimed at assessing the water quality index (WQI) for the ground water of industrial area. The groundwater samples of all the 8-sampling location were collected and subjected for a comprehensive physicochemical analysis. For calculating the WQI, the following 14 parameters have been considered viz., pH, turbidity, total hardness, calcium, magnesium, chlorides, nitrates, sulphates, total dissolved solids, iron, fluoride, alkalinity, total solids, and total dissolved solids. The results analyzed by WQI method the results showed that the ground water quality was poor and unfit for drinking in some of the areas, scoring a water quality index greater than 100. And seasonal variation in quality of ground water was analysed. Based on the analysis and results (WQI values poor), for drinking purpose, it is recommended to use water only after boiling and filtering or by Reverse Osmosis treatment. Also, for the industrial use of water on large scale, as the TDS and hardness values are very high, it is suggested to install electrodialysis treatment plant in GIDC.
Keywords : UASB, Coagulation, Alum, PACL, Post treatment, Aeration.

I. INTRODUCTION

Groundwater quality depends on the quality of recharged water, atmospheric precipitation, inland surface water and sub-surface geochemical processes. Temporal changes in the origin and constitution of the recharged water, hydrologic and human factors may cause periodic changes in groundwater quality. Water pollution not only affects water quality but also threats human health, economic development and social prosperity.[35]

Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the sources. It therefore becomes imperative to regularly monitor the quality of groundwater and to device ways and means to protect it. WQI is defined as a rating reflecting the composite influence of different water quality parameters [30].

Industrial activities in groundwater recharge zones have significant potential to affect large areas of local or regional groundwater as a result of normal operations (e.g. waste disposal, materials storage) as well as short term adverse events (e.g. spills, leaks). Activities defined as "industrial" may include a wide variety of large scale or small-scale commercial, public governmental or military facilities that are engaged in manufacturing, chemical processing, power generation, or ancillary services.

The degree to which a facility poses risks to aquifers can be related to many factors, including:

- The specific industrial processes and chemicals in use;
- The age and size of the facility;
- Corporate "housekeeping" or environmental management practices; and,
- Local geological and hydrological characteristics.

In addition to contaminant release issues, industrial activities in drinking-water catchment areas may exert other non-chemical influences which change the vertical or horizontal flow regime of contaminants (e.g. changes in recharge inflow quantity or percolation rate), or which serve to reduce the overall capacity of the recharge area (e.g. groundwater withdrawal).

The water quality index (WQI) has been widely used to characterize the usability of water resources for domestic purposes. It provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters. It gives general idea of the possible problem with water in a particular region and is one of the most effective ways to know water quality [34].

In this study, bore wells frequently being used by the public were surveyed to analyze physical, chemical and bio-logical characteristics of water for the assessment of safe drinking water source, to study seasonal variations in water quality parameters with respect to locations, to evaluate seasonal variation for different bore wells, to develop model for WQI for computation of water quality for any season.

II. STUDY AREA

Surat city is located on the western part of India in the state of Gujarat. Geographical location of Surat city is 210°12´00.00´´N and 72°52´00.00´´E near the bank of river Tapi. Surat is one of the most dynamic cities of India with one of the fastest growth rates due to immigration from various parts of Gujarat and other states. Surat is now the tenth largest city of India having estimated population of 46 lakh plus. Surat is well, known as Diamond city as well as famous for silk and jari industries. Surat have many industrial area such as Sachin GIDC, Pandesara GIDC, katargam GIDC, Hazira, Palsana GIDC ,Olpad. Among these Pandesara GIDC, Sachin GIDC, Palsana GIDC were selected for this study.Two to four sampling location were chosen in each of the industrial areas.

III. MATERIALS AND METHODOLOGY

The water samples were collected from eight different open and tube wells during winter and summer season by following standard method. Sampling locations were selected on the basis of industrial unit and different land use pattern. The ground water samples were collected in acid washed plastic container to avoid unpredictable changes in characteristic as per standard procedures.14 parameters were analysed for WQI such as pH, Turbidity, Alkalinity, TDS, TS, TSS, Total Hardness, Cl, NO3, F, Fe, Mg and Ca, SO4 in the laboratory as per the standard procedures of APHA.

For computing water quality index three steps are followed as given in table no. In the first step, each of the 14 parameters has been assigned a weight (wi) according to its relative importance in the overall quality of water for drinking purposes. The maximum weight of 5 has been assigned to the parameter nitrate due to its major importance in water quality assessment. Magnesium which is given weight of 2 as magnesium by itself may not be that harmful.

Second step, relative weight (Wi) is computed from the following equation:

$$W_i = \frac{w_i}{\sum_{i=1}^{n} w_i}$$

Where (Wi) is the relative weight, (wi) is the weight of each parameter and ‘n’ is the number of parameters. Calculated relative weight (wi) values of each parameter are also given in (Table 1).

In the third step, a quality rating scale (qi) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the guidelines laid down in the IS-10500,2012 and the result is multiplied by 100:

$$q_i = (C_i / S_i) \times 100$$

Where qi is the quality rating, C_i is the concentration of each chemical parameter in each water sample in mg/l, and S_i is the BIS (Bureau of Indian standards) water standard for each chemical parameter in mg/l according to the guidelines of the IS-10500,2012.

For computing the WQI, the SI_i is first determined for each chemical parameter, which is then used to determine the WQI as per the following equation

$$SI_i = W_i \times q_i$$

$$WQI = \sum S_i$$

SI_i is the sub index of Ith parameter, qi is the rating based on concentration of ith parameter and n is the number of parameters. The computed WQI values are classified into five types

"excellent water", "good water", "poor water" "very poor water" and "water unsuitable for drinking" as shown in table no. 1

TABLE I. Water quality classification based on WQI value [32]

Water quality classification based on WQI value		
WQI value	Class	Water quality
<50	I	Excellent
50-100	II	good water
100-200	III	poor water
200-300	IV	very poor water
>300	V	Water unsuitable for drinking

IV. RESULT AND DISCUSSION

WQI is a useful tool used to obtain a comprehensive picture of ground water quality and to identify the suitable location of ground water resources in a particular region. In the present study WQI has been calculated by weighted arithmetic index method given of eight different Sampling points. The samples were taken from three industrial zones. In this study some of the sampling points were in the industrial zone and some of them are nearby (1.5 to 2 KM) industrial area. S2, S4, S5 and S7 are the sampling points located in industrial zone and the remaining are from within a range of 1 to 2.5 km from industrial zone.

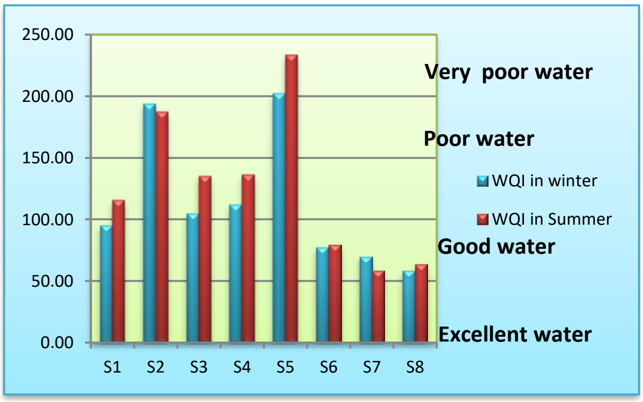

Fig. 1. Bar chart showing comparison of WQI between summer and winter season

Red bars are indicating WQI of samples which were taken from industrial zone and blue bar is indicating WQI of samples which were taken from nearby industrial area. From fig. 1. .it is clear that the water quality index of samples which have been taken from industrial zone is slightly higher camper to samples which have been taken from nearby industrial area and higher value of WQI indicating poor water quality, so there is a significant influence of industries or industrialization on groundwater quality.

V. CONCLUSIONS

In this study samples were analyzed from 8 different locations of three industrial areas. From the results, it is observed that parameters such as TDS, Total Hardness, Chlorides, and Alkalinity show very high concentration and are not within the permissible limits of BIS standards (BIS-10500). Also, water quality index of these industrial area(s) indicate poor water quality (WQI ranging from 108 to 222), except Palsana GIDC.

In this study, it is observed that WQI is slightly higher in summer season than value of WQI in winter season for almost all sampling points. It means that at higher temperature, quality of water gets deteriorated, But to determine the relationship between seasonal change and water quality more no of sampling is required. WQI of samples which have been taken from industrial zone is slightly higher compared to samples which have been taken from nearby industrial area. This higher value of WQI of industrial areas, indicates poor water quality and hence there is a significant influence of land use pattern on WQI i.e. groundwater quality.

Based on the analysis and results (WQI values poor), for drinking purpose, it is recommended to use water only after boiling and filtering or by Reverse Osmosis treatment. Also, for the industrial use of water on large scale, as the TDS and hardness values are very high, it is suggested to install electrodialysis treatment plant in GIDC.

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