Assessment of Water Quality Index of Groundwater of Panchkula & Derabassi Region

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Abstract: Water quality of groundwater is getting deteriorated due to the percolation of polluted water in to the soils from the wastewater drains, polluted rivers and ponds making it unsuitable for drinking and other purposes. Evaluation of the groundwater quality is gaining attention now days. In the present study, groundwater quality of the Derabassi and Panchkula region along Ghaggar is being studied. Water quality index was calculated for the sample and it was observed that out of the twenty samples collected, three samples collected adjacent to the river have poor water quality and as the distance increase between the river and sampling sites the quality of water improves. Around six of the samples sites water qualities were on the verge of poor quality of WQI.

Keywords: Water quality Index, water quality, groundwater, drinking water

I. INTRODUCTION

Water is the most important natural resource of any country. Water plays a vital role in the living organism and is essential for survival of all the living organisms. In India, maximum population depends on groundwater for drinking purpose. Groundwater term is for the subsurface water beneath water table in soils and geologic formation that are fully saturated. Ground water plays a vital role in the development of arid and semi-arid zones. It is believed to be comparatively much clean and free from pollution than surface water.

The average level of groundwater development in India is 32%, although some states have exploited their resources to a much greater extent (94% in Punjab, 84% in Haryana, 60% in Tamil Nadu, 64% in Lakshadweep, 51% in Rajasthan). 85% of ground water extracted is used for irrigation purposes and 15% for Industrial and domestic purposes. Reciprocally, as much as 70 to 80% of India's agricultural output may be groundwater dependent The groundwater quality depends on large number of things like recharge water composition, water and soil interaction, and residence time and reactions that occur within the aquifer (Freeze and Cherry, 1979; Appelo and Postma, 2005). It is estimated that 80% of domestic needs in rural areas and 50% in urban areas is met by groundwater. Quality of groundwater is affected by various natural and anthropogenic activities. Undesirable groundwater quality restrains the in living conditions of rural people. Therefore, it has become essential for organized assessment and monitoring of groundwater quality to examine its appropriateness for drinking and to adopt suitable measures for protection. Water quality index (WQI) plays one of the most useful approaches to correspond quality of any water.

The WQI is a mathematical equation used to transform large numbers of water quality data into a single number (Stambuk, 1999). It helps in understanding of water quality issues by integrating complex data and generating a score that better describes water quality status to policy makers (Reza and Singh, 2010).

WQI is a dimensionless number that combines multiple water-quality factors into a single number by normalizing values to subjective rating curves. The area under investigation is a rural where residents depend on groundwater for drinking and domestic purposes. The objective of this paper is to consider the suitability of groundwater for human consumption based on compliance of physicochemical data with reference to drinking water standards and computed WQI values. (Miller et al., 1986)

A. Study Area

The present study had been conducted on groundwater of area along the river Ghaggar. River originates in the outer Himalayas & flows through state of Haryana, Punjab and Rajasthan. Its water is used for multiple purposes. During its course of flow it receives discharge from various cities and runoff from agricultural lands. In the study water samples were collected from groundwater along the river from Derabassi, Punjab and Panchkula Haryana for studying the physicochemical parameters. The discharge in the river varies i.e. quite low during the dry weather and very high during the rainy seasons. The dry period discharge is contributed by waste drains discharging into the river.
Thus, polluting water of the river and renders it unsuitable for it various uses. Groundwater along the River gets recharged by the rainfall or by seepage from the river. In the study, total twenty sampling points were isolated, out of which twelve were from Derabassi region and six from the Panchkula region.

The groundwater samples were taken and their physico-chemical parameter analysis was done. All the samples were analyzed as per the specification given in Standard Methods for the Examination of Water and Wastewater (18th edition). Some of the physicochemical parameters were analyzed at the site like pH and temperature, colour. The samplings were done in both pre monsoon & post monsoon season and compared with the ISO 10500-2012 (Standard for Drinking Water in India).

II. METHODOLOGY & CALCULATION

To get the complete depiction of the groundwater quality overall, WQI was being used. WQI is defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water. The Indian standard specified for drinking water (ISO 10500-2012) was used for the calculation of WQI. The WQI was computed through following steps. First of all, parameters to be studied were identified and were assigned weight (wi) according to its relative importance in the overall quality of water for drinking purposes. The weights were assigned from the range of 1 to 5. The maximum weight 5 was assigned to a parameter because of its major importance in water quality assessment; minimum weight 1 was assigned to another parameter because of its insignificant role. Similarly other parameters were assigned weights between 1 and 5 based on their relative significance in the water quality evaluation.

### Table 1: Weights assigned to physic-chemical parameters

| Parameters | pH | TDS | Alkalinity | Chloride | Sulphates | Nitrate | F | Na⁺ | Ca²⁺ | Mg²⁺ | Hardness | Iron | Zinc |
|------------|----|-----|------------|----------|-----------|---------|---|-----|------|------|----------|------|------|
| Weight (wᵢ) | 4  | 4   | 2          | 3        | 4         | 5       | 4 | 2   | 2    | 2    | 3        | 4    | 1    |

Second, the relative weight (Wᵢ) of the chemical parameter was computed using the following equation

\[ Wᵢ = \frac{wᵢ}{\sum_{i=1}^{n} wᵢ} \]

where \( Wᵢ \) is the relative weight, \( wᵢ \) is the weight of each parameter and \( n \) is the number of parameters.

Next, a quality rating scale (qᵢ) for each parameter is calculated by dividing measured concentration of each water sample with parameter standard and is multiplied by 100.

\[ qᵢ = \frac{Cᵢ}{Sᵢ} \times 100 \]

Where \( Cᵢ \) is the concentration of chemical parameter in each water sample in mg/L and \( Sᵢ \) is the Indian drinking water standard for each chemical parameter in mg/L.

### Table 2: Calculated a quality rating scale (qᵢ) for each parameter of sampling points

| Parameter | pH | TDS | Alkalinity | Chloride | Sulphates | Nitrate | F | Na⁺ | Ca²⁺ | Mg²⁺ | Hardness | Iron | Zinc |
|-----------|----|-----|------------|----------|-----------|---------|---|-----|------|------|----------|------|------|
| G1        | 116.923 | 105.2 | 96         | 30       | 13.96     | 2.711111111 | 35 | 80  | 28   | 86.66667 | 175.5  | 30  | 2   |
| G2        | 118.4615 | 102 | 102         | 32       | 5.935     | 2.4       | 53 | 98.35 | 38.66667 | 120.3333 | 204.5   | 366.667 | 2   |
| G3        | 112.3077 | 115 | 38.2        | 32.84    | 13.155    | 3.822222222 | 41 | 90  | 41.46667 | 88.66667 | 153     | 33.3333 | 0   |
| G4        | 93.8415  | 146 | 99          | 55.6     | 31.55     | 12.666666667 | 46 | 142.5 | 33.6  | 123   | 179.9    | 200  | 10  |
| G5        | 98.4154  | 121 | 107.5       | 53.68    | 24.55     | 10.888888889 | 37 | 177 | 37.33333 | 122    | 175.3    | 100  | 6   |
| G6        | 112.3077 | 103 | 100.3       | 46.4     | 20.93     | 4.666666667  | 38 | 145.5 | 77.33333 | 133.2  | 70       | 4    |
| G7        | 115.3846 | 98.2 | 100         | 56.8     | 25.75     | 4         | 19 | 78.5 | 29.33333 | 90.66667 | 80.3     | 66.6667 | 3.6 |
| G8        | 116.9231 | 102 | 94          | 51.6     | 18.155    | 2.822222222 | 22 | 89.5 | 28   | 90.33333 | 60.35   | 66.6667 | 0   |
| G9        | 89.23077 | 151 | 73          | 70.8     | 37.25     | 4.422222222 | 34 | 177 | 149.6 | 409.6667 | 162.4    | 333.3333 | 22 |
| G10       | 95.38464 | 144 | 58          | 60.8     | 34.05     | 4         | 32 | 168 | 136.3333 | 369.6667 | 187.1    | 266.6667 | 34 |
| G11       | 106.1538 | 82.4 | 96          | 58.56    | 20.25     | 3.777777777 | 88 | 126 | 93.33333 | 124     | 84.8     | 100  | 0   |
| G12       | 107.6923 | 100 | 74.6        | 62.8     | 22.9      | 4.4       | 36 | 117 | 86.66667 | 131.3333 | 62.2     | 66.6667 | 0   |
| G13       | 115.3846 | 104 | 32.1        | 26.56    | 11.045    | 17.533333333 | 41 | 95  | 46.66667 | 113.6667 | 142.5    | 333.3333 | 8  |
| G14       | 107.6923 | 99  | 52.6        | 25.16    | 8.8       | 6.644444444 | 35 | 91.05 | 97.33333 | 79.66667 | 131     | 366.6667 | 4.8 |
| G15       | 83.07692 | 111 | 49          | 46.48    | 29.5      | 7.088888889 | 46 | 135 | 192.667 | 132     | 149      | 125.3333 | 2.4 |
| G16       | 104.6154 | 66  | 66.2        | 37.67    | 17.9      | 2.8       | 53 | 86  | 169.4667 | 173.3333 | 137     | 333.3333 | 4 |
| G17       | 107.6923 | 49  | 62          | 29.6     | 10.25     | 2.953553556 | 32 | 75  | 105.3333 | 220     | 105.5    | 400  | 0   |
| G18       | 110.7692 | 64  | 68.2        | 32.8     | 14.8      | 0.333333333 | 25 | 85  | 85.33333 | 163.3333 | 137.5    | 98.66667 | 4   |
| G19       | 116.9231 | 82.4 | 51.2        | 18.56    | 13.5      | 1.488888889 | 34 | 60  | 78.66667 | 190     | 132.5    | 400  | 0   |
| G20       | 120     | 84  | 52.2        | 24.96    | 14.65     | 1.733333333 | 52 | 95  | 61.33333 | 176.6667 | 137     | 366.6667 | 0   |
Finally aggregation function is applied in order to compile the sub-indices into a single index called as water quality index as per the equation below:

\[ SI_i = W_i \times q_i \]

where, \( SI_i \) is the sub index of \( i^{th} \) parameter

\[ WQI = \sum_{i=0}^{n} SI_i \]

Table 3: Calculated WQI at sampling points

| Sampling Point | \( WQI \) |
|----------------|----------|
| G1             | 87.44303 |
| G2             | 100.6613 |
| G3             | 58.81205 |
| G4             | 91.14045 |
| G5             | 79.03743 |
| G6             | 66.55244 |
| G7             | 58.29763 |
| G8             | 56.69517 |
| G9             | 123.6175 |
| G10            | 113.7826 |
| G11            | 72.87127 |
| G12            | 63.8109  |
| G13            | 59.91913 |
| G14            | 90.41095 |
| G15            | 80.33147 |
| G16            | 97.69187 |
| G17            | 93.51284 |
| G18            | 64.13109 |
| G19            | 95.19125 |
| G20            | 95.35533 |

On the calculation of the WQI, water quality is classified into five categories as shown in the table:

Table 4: Range of water quality index (WQI) as specified for drinking purpose

| WQI    | Water quality |
|--------|---------------|
| < 50   | Excellent     |
| 50-100 | Good          |
| 100-200| Poor          |
| 200-300| Very poor     |
| >300   | Unsuitable    |

(Ramakrishnaiah et al. 2009)

III. CONCLUSION

By using the weighted arithmetic index method, “3” water samples fell in the category of “poor water quality” and only “17” samples fell into the category of “good water quality”. This comes out that only 10% of water samples falling into the category of “poor” drinking water. The water quality index (weighted index method) of around six points out of seventeen is very close to the margin of poor water quality.

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