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Investigation of Ground Water Quality of Ranchi District of Jharkhand, India using Water Quality Index Method

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Abstract

The present study showed analysis of the underground water quality index of Ranchi district of Jharkhand. Total of 33 samples were collected from 11 different locations. Physico-Chemical parameters like chloride, pH, fluoride, calcium, nitrate, sulphate, magnesium, sodium, total dissolved solids and total hardness were analysed. The results obtained were in between the range 137-42. The different water type percentage obtained were excellent type 27.27%, good type 54.54% and poor type 18.18%. It was observed that 81.81% of the total observed samples were suitable for human consumption while 18.18% falling under poor category needs to be treated before household consumptions. Water treatment plants need to be setup to counter the deteriorating quality of groundwater.

Keywords: *WQI, water management, BIS 2003, Groundwater, water type.*

1. Introduction

Water is absolutely essential for all living organisms. Most of the organisms are comprised of nearly 70% of water. With due increase in population and pollution water scarcity has increased over time. Our world has nearly 75% of its surface area surrounded by water. Out of which 97% is in oceans and 2% is locked as glaciers and ice and is not readily usable. Only 1% of the remaining water is available in lakes, rivers, ground water and other sources. Ocean and river water is constantly getting polluted by human activities like sewage disposal, waste water discharge, factory waste, microplastics etc. (RAZA & KHAN, 2018). A huge population is suffering from water crisis in India. Providing clean drinking water to people is a challenge for the government of India. Water quality index is a technique that provides the details of the overall quality of the water analysing multiple parameters. It is a single scoring number of water and can be calculated using different methods because of which it has become a key aspect for the analysis of the quality of water. The objective of this research is to assess the water quality at Ranchi District of Jharkhand. This study also discusses about the suitability of the water samples for drinking and household tasks.

2. Sampling method

The sampling was done in the post-monsoon in the Ranchi area. Water samples were collected from wells/tube wells/hand-pumps in a pre-washed polyethylene bottle of one litre capacity. The parameters like temperature and pH were calculated using laboratory thermometer and portable pH meter in the field. The other parameters were analysed in the laboratory. Total of the ten parameters were analysed for the assessment of WQI of the sample e.g., Fluoride, chloride, magnesium etc. The readings were noted in a well formatted tabular chart for maximum accuracy and the calculations were done according to BIS 2003 standard method. The calculated WQI is then used to classify the sample denoting its

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utility for the human consumption. The classification according to WQI value is done through the data described in Table 1.

Sampling locations were chosen randomly and from each location three samples were collected for the maximum precision. Total of 11 locations were selected from the Ranchi area. All the locations were having township with abundant human population.

Fig: Sampling locations in the Ranchi area. (https://goo.gl/maps/D1hmwUc3wwK2)

Table 1. Classification of WQI values for human consumption.

WQI Range	Water Type
>300.1	Unfit for drinking
200.1-300	Very poor water
100.1-200	Poor water
50.1-100	Good water
<50	Excellent water

(Ramakrishnaiah, C.R.,et al,2009)

3. Calculation of Water Quality Index

Water quality index (WQI) may be defined as a rating, reflecting the composite influence of different water quality parameters on the overall quality of water (Singh PK, et.al, 2013). The main objective of computing of water quality index (WQI) is to turn the complex water quality data into information which is easily understandable and usable.

The computation of WQI can be done by many methods for example APHA 2012 etc here this computation is done by the Indian Standard (BIS 2003) method which is computed in three steps which are as follows:

First step – Assigning of weight (wi) to the selected water parameters (e.g., pH, TDS, TH, H, Cl, SO4, NO3, Fe, ……) according to their relative importance in the overall quality of water for drinking purposes (weight may be from 1 to 5).

Second step – Computation of a relative weight (Wi) of the chemical parameter using the following equation: $Wi = wi / \sum wi \ (i = 1 \text{ to } n)$

where, Wi is the relative weight, wi is the weight of each parameter and 'n' is the number of parameters

Third step - Assigning of a quality rating scale (qi) for each parameter, as below:

$$qi = (Ci / Si) \times 100$$

where, qi is the quality rating, Ci is the concentration of each chemical parameter in each water sample in mg/l, and Si is the guide line value/desirable limit as given in Indian drinking water standard (BIS 2004).

For computation of WQI, the sub index (SI) is first determined for each chemical parameter, as given below: $SIi = Wi \times qi$

$$WQI = \sum SIi \ 1 - n$$

Where, SIi is the subindex of ith parameter; Wi is relative weight of ith parameter; qi is the rating based on concentration of ith parameter and 'n' is the number of chemical parameters.

Table 2. Relative weight of chemical parameters

Chemical parameter	Standard (BIS 2003)	Weight (wi)	Relative weight (Wi)
Total hardness	300	2	0.05
pH	8.5	4	0.11
Total dissolved solids	500	5	0.13
Fluoride	1	5	0.13
Chloride	250	5	0.13
Nitrate	45	5	0.13

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Sulphate	200	5	0.13
Calcium	75	3	0.08
Sodium	200	1	0.03
Magnesium	30	3	0.08
		∑wi= 38	∑Wi=1.00

Except pH every concentration is in mg/l.

The maximum weight 5 is given to the parameters which have major importance in the assessment of WQI like TDS, fluoride, chloride, nitrate, sulphate etc. Minimum 1 is given to sodium and calcium, magnesium etc have values assigned according to their relative importance (value ranging between 1 to 5) in the WQI assessment.

4. Results and discussion

Out of the 33 water samples collected from 11 different locations from the Ranchi area the assessment result was recorded in Table 3. The results obtained ranges from 137-42 having a major proportion of good water with very locations having poor quality of water.

Table 3. WQI of groundwater of different locations of Ranchi, Jharkhand area.

S no.	Location	WQI value	Water Type
1	Bariatu	57	Good
2	Morabadi	94	Good
3	Bargain	42	Excellent
4	Rani bagan	65	Good
5	Ratu road	51	Good
6	Doranda	45	Excellent
7	Kanke	63	Good
8	Mecon	50	Excellent
9	Kadru	102	Poor
10	Harmu	137	Poor
11	Hinoo	56	Good

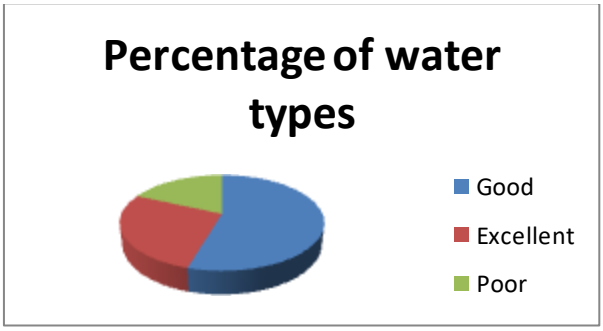

Fig 1: Graphical data representation of WQI classifications at Ranchi District of Jharkhand.

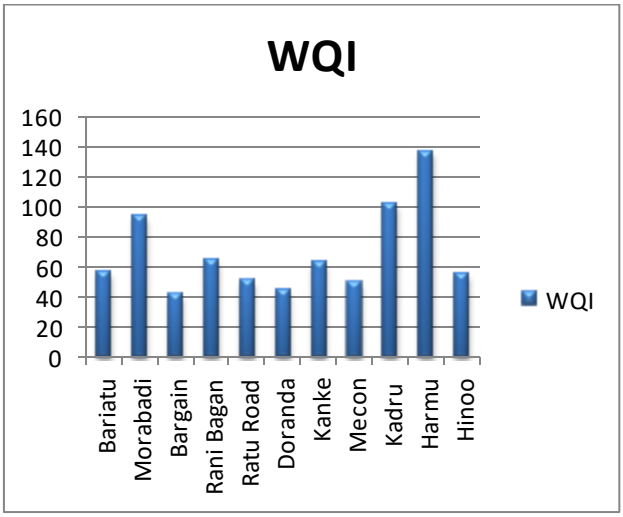

Fig. 2: WQI for different locations at Ranchi, Jharkhand.

5. Conclusion:

The research is to estimate the water quality index of different locations of the Ranchi district of Jharkhand. WQI of the 33 samples studied from the 11 different locations came out to be ranging in between 137-42 i.e., from excellent water type to poor water type. The percentage of excellent, good, poor, very poor and unfit for drinking type was 27.27%, 54.54%, 18.18%, 0% and 0% respectively. The water underlying under excellent category can be used for drinking purpose while those underlying under poor category need to be treated before usage and also required to be protected from contamination.

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