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Mathematical Computation of Water Quality Index for the groundwater in Morena City, Madhya pradesh State, India

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Abstract

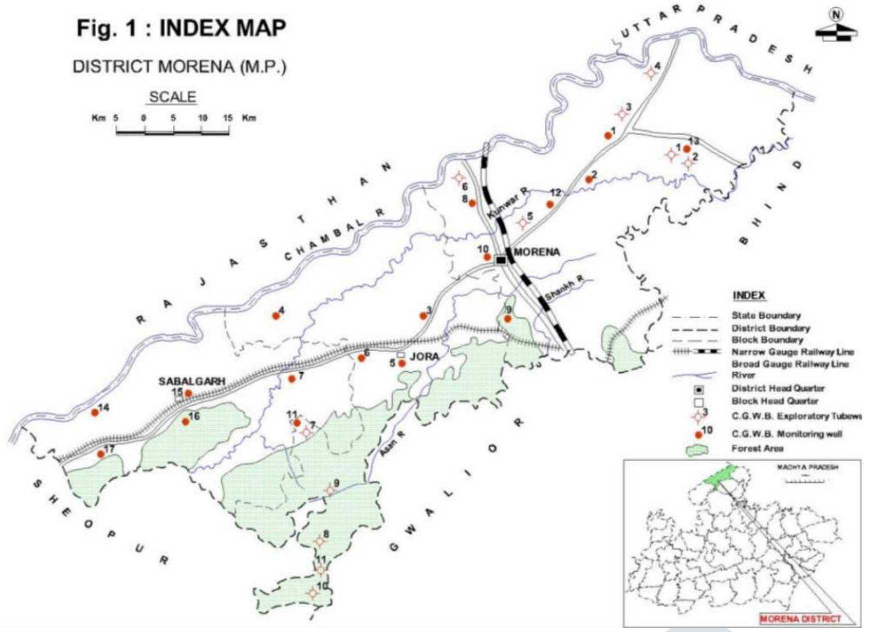
Water quality at MORENA is degrading due to various reason and bad management of water resources. Water quality of various places are assessed to check water characteristic and its usefulness. Water are sampled from site chosen. Analysis is done for these samples in lab. Various chemical parameter are then tested like ph, bod, hardness etc to evaluate wqi . weighted arithmetic index method used to calculate wqi.

WQI was evaluated for different sample sites be analyzed and in case of polluted water suitable treatment should be provided. strong suggestion is provided that resident area where water quality index is poor related diseases mustbe treated. The paper provides that the surface water of this area needs some treatment before used, and open-source water like reservoir river need high degree of treatment as it contains higher amount of organic matter causes high bod. Different quality method is used for comparative study and also some sample of vidisha are also taken for analysis.

Keywords: Groundwater, Water quality index, Weighted Arithmetic Index Method

Area of study

Morena district is placed with inside the northern a part of the State, bordered through Rajasthan on the West and Uttar Pradesh at the north. The adjoining districts are Gwalior and Bhind in the east and Sheopur in the South. The district is bounded through North Latitudes, 26˚ 05'—26˚ 42' and East Longitudes, 77˚ 05' 00"—78˚ 30' 00" and is overlaying an area of 4988 Sq.km Chambal is the main river which is flowing from southwest to northeast. Its tributaries Kunwari and Asan rivers drain the area. The overall drainage pattern in the district is dendritic.The net ground water availability in the district 64,244 hectare-m and ground water draft for all uses is 27,597 hectare-m



Introduction

Groundwater pollution occurs when man-made products such as gasoline, oil, road salts, and chemicals leak into the groundwater, making it unsafe and unsuitable for human use. Substances from the surface can travel through the soil and enter groundwater.Over time, pesticides and fertilizers can invade groundwater. Road salt, pollutants from mining operations, and used motor oil can also enter groundwater. In addition, untreated waste from septic tanks, toxic chemicals from underground storage tanks, and landfill leaks can contaminate groundwater.

A water quality index (WQI) is a single number that represents the overall water quality at a particular location and time, based on multiple water quality parameters. WQI's goal is to transform complex water quality data into information that is understandable and usable by the general public. Water is a compound with the chemical formula H2O. Covered water

It is 71% of the Earth's surface (CIA, 2014) and is essential for all known life forms.Water (Diersing and Nancy, 2009). It's a measure of water condition

In relation to one or more species and / or human requirements Necessity or purpose (Johnson et al., 1997). To keep everyone healthy Optimal level aquaculture system, specific water quality indicators or You need to monitor and control the parameters. Water quality index (WQI) Summarize a large amount of water quality data in simple terms (eg, excellent,

Good, bad, etc.) To consistently report to managers and the general public (Hulya, 2009). The water quality indicator provides a single number that represents the following:

METHODOLOGY

Find areas in morena where groundwater contamination is to be measured. Find the Water Quality Index (WQI). Compare the groundwater quality of industrial and residential areas. Determine the health risks of groundwater by assessing its suitability for drinking purposes. Comparison of groundwater samples by place of origin (hand pump, excavation, open, dug well).

In Morena, where a large amount of groundwater is supplied, various regions are selected.All groundwater samples in this area are collected in bottles. All samples are tested for TDS, pH, alkalinity Calcium, Sodium, Sulfate, Chloride, and Fluoride levels in the sample water. The standard availability of these aspects of drinking water will be investigated according to the WHO (World Health Organization). The resulting values for all samples are compared to standard values in drinking water. All areas are classified as very bad, bad, good, excellent or inappropriate, depending on the water quality. Water quality index (WQI) is calculated. Proposals have been made to improve the water quality of poor quality areas.Water quality index (WQI)

Water samples were collected from different sources from morena in sterile bottles (1 liter Capacity) Under sterile conditions. Samples were placed in the ice chest containing them

After adding ice, it will be shipped to the laboratory for analysis. The sample was rated at 10 physio chemical parameters, namely pH, electrical conductivity (EC),

Total Dissolved Solids (TDS), Total Hardness (TH), Nitrate, Sulfates, Chlorides, Calcium, Dissolved Oxygen (DO), and Biochemical Oxygen Demand (BOD)

Follow the steps outlined in the standard method of testing Water and wastewater (APHA / AWWA / WEF, 1998). However, the pH was measured On the spot with a portable pH meter. WQI was calculated using weighted arithmetic water quality Index first proposed by Horton (1965) and developed by Brown et al (1972). Weighted Arithmetic Water Quality Index (WQIA) Next form: WQI is typically used to investigate the combined effects of all ions within a parameter. The purpose of determining WQI in this study is to identify the appropriate area of groundwater for drinking water supply. In WQI, the most important parameters are assigned high weights and the less important parameters are assigned low weights.

$$WQI_A = \sum_{i=1}^{n} w_i q_i / \sum_{i=1}^{n} w_i$$

wherein n is the range of variables or parameters, wi is the relative weight of the i th parameter and qi is the water exceptional score of the i th parameter. The unit weight (wi) of the diverse water exceptional parameters are inversely proportional to the endorsed requirements for the corresponding parameters. According to Brown et al (1972), the value of qi is calculated the usage of the subsequent equation:

$$q_i = 100\ [(V_i - V_{id}) / (S_i - V_{id})]$$

wherein Vi is the observed value of the ith parameter, Si is the standard permissible value of the ith parameter and Vid is the ideal value of the ith parameter in natural water. All the suitable values (Vid) are taken as 0 for water besides pH and dissolved oxygen (Tripaty and Sahu, 2005). For pH, the ideal permissible value is 7.0 (for natural water) and a standard permissible value is 8.5 (for polluted water). Therefore, the quality score for pH is calculated from the subsequent equation: $q_{pH} = 100\ [(V_{pH} - 7.0) / (8.5 - 7.0)]$

Here = the observed pH.

For dissolved oxygen, the ideal value is 14.6 mg / L is and standard permissible value is 5mg/l.

Therefore, quality grade is calculated from the following formula. Enter the number of parameters here. The quality of drinking water is 5 of excellent (<50), good (50-100), bad (100-200), very bad (200-300) and inappropriate (> 300) based on the IWQI value. It was divided into two classes.

Water quality index value (WQI)	Class	Water quality status
<50	I	Excellent Water
50-I00	II	Good Water
I00-200	III	Poor Water
200-300	Iv	Very Poor Water
>300	V	Unsuitable Water

Comparative Analysis by WQI calculated by ccme method.

In this method, we investigate and evaluate the wqi that was developed by the Canadian Council of Ministers of the Environment (CCME), as well as compare it to the wqi that we make use of in India. This strategy is a little improvement over the traditional aggregation method since it uses a more complex form of the wqi algorithm.

Therefore, the following is proposed to serve as the aggregate function for the basic water quality indicator, which is abbreviated as WQIB:

$$\mathrm{WQI}_B = \left[\frac{1}{5}\sum_{i=1}^{5} q_i \times \frac{1}{2}\sum_{j=1}^{2} q_j \times q_k\right]^{1/3}$$

where qi is the subindex value for the organic and trophic groups as determined by DO, BOD5, COD, NH4-N, and PO4-P and WQIB represents the groundwater quality index. qk is the subindex value for the bacterial group having just E. coli, whereas qj is the subindex value for the particle group including SS and turbidity. To create a worldwide water quality index, fundamental parameters as well as extra parameter groups were employed (WQIO). The first step was to calculate a sub-index using new water quality factors. Each subindex was then compared to WQIB, and if it was lower, it was only taken into account for further analysis. The coefficients for Tw and pH were obtained by deriving them directly from the subindices that are associated with them. To get the toxicity factor, we simply added up all of the scores for the toxicants (Tables 3 and 4). (The Third and Fourth Tables) Due to the fact that the WQIO values were anywhere from 1 to 100, the toxicity, pH, and Tw parameters were scaled anywhere from 0.01 to 1. As a result of this, the aggregate function for WQIO that has been suggested is as follows:

$$\mathrm{WQI}_O = \left(\prod_{1}^{n} C_i\right)^{1/n} \left[\frac{1}{5}\sum_{i=1}^{5} q_i \times \frac{1}{2}\sum_{j=1}^{2} q_j \times q_k\right]^{1/3}$$

WQI CALCULATION for arithmetic aggregation method

The following table is based on sample collected from various ganj tap water source on 11 Jan 2022 morena and various parameter are calculated and tested in environment lab of SATI, using these parameter water quality indices is measured, The water quality index (WQI) was then calculated using the weighted arithmetic index formula as follows-

Parameter	**Observed values (v)**	**Standard values(s)**	**Unit weights (w)**	**Quality rating (q)**	**W.q**
pH	7.6	6.5 - 8.5	0.2201	47.58	11.211
alkalinity	46.08mg /l	120 mg/l	0.0155	39.74	1.4485
Total Dissolved Solids TDS	45.41 mg/L	500 mg/L	0.00366	9.11	0.0365
Total Hardness TH	31.1 mg/L	300 mg/L	0.00618	11.01	0.0678
Calcium (Ca)	11.4 mg/L	75 mg/L	0.0249	14.58	0.3518
Chlorides (Cl)	3.22 mg/L	250 mg/L	0.3775	1.27	0.0095
Nitrates	1.83 mg/L	45 mg/L	0.0421	3.49	0.1524
Sulphate	8.1 mg/L	200 mg/L	0.0129	4.78	0.0482
Dissolved Oxygen DO	2.23 mg/L	5 mg/L	0.3692	119.54	54.474 1
BOD	1.1 mg/L	5 mg/L	0.3723	22.00	13.210 6
			Σw= **1.438**		Σw.q=**79.563**

Σw.q / Σw =79.563/1.438

=55.0608 (GOOD WATER)

Result of Water quality index for different sample collected

Table: Result of wqi values by different method.

S.NO.	Location (morena)	W.Q.I. for aggregation method	W.Q.I using CCME Method
1	Ganj source tap water filtered	55.06	85.33
2	Ganj source tap water	85.33	77.33
3	Gopalpura borewell	110.36	35.66
4	Maharajpura village handpump	129.46	39.45
5	Kotwal reservoir	163.54	48.76
6	Kotwal reserviour reading 2	156.89	52.33
7	Near Khandoli chambal river	212.66	19.37
8	Near devari chambal river	220.98	17.76
9	Banmore source borewell	192.59	42.15
10	Old housing board borewell	91.23	79.39
11	SATI vidisha	65.33	87.37
12	Vidisha railway station beripura borewell	85.36	81.97
13	Vidisha bus stand Indira nagar Borewell	112.35	58.37

WQI graph for aggregation method

Analysis

- Source 1 which is filtered water give wqi which is close to excellent and good means simple filter is effective with borewell water in ganj area for drinking purposes.
- Source 2 and 10 which comes in the range of 50 to 100 are also good can be used in drinking purposes directly. This source has slightly higher total dissolved solid then required.
- Sources 3,4 came in range of poor wqi ground water these places are slightly less developed their drainage facility is not very good contaminating the ground water and making it unsuitable for drinking. High quantity of TDS and organic matter is found.
- Sources 5 and 6 which is also reservoir has also poor quality of wqi. Very high quantity of bod is found which is somewhat due to open nature is not suitable for drinking should be avoided.
- Sources 7 and 8 which are taken from chambal river has very poor wqi. Has high amount of bod, TDS and sulphate and nitrate concentration which kind of due to pollution in river should be avoided for drinking purposes and other activity.
- Source 9 wqi is touching very poor which is industrial area of morena as environment regulation are not regulated by industries while disposing the waste as compare to sources 2,3, and 10.
- Source 2 which is supply line tap water has better wqi then borewell water due to treatment of water before supply.
- In vidisha source water quality is relatively good except for source 13.
- Comparative analysis both wqi gives similar results but wqi by ccme gives value which are more on lower side means more poor and relatively accurate result because it is not simple aggregation so if one factor dominates it will show on index which average out in our method also using this method, we can calculate value and effect of toxic chemicals on wqi which is generally not done in India hence slightly more accurate result.

Conclusion

The objective of these project was to calculate the Water Quality Index (WQI) of morena region of madhya pradesh in order to assess its suitability and safety for drinking purposes. The water quality index obtained is a clear indication that surface water from the morena is of varying quality varies from good water to very poor and most of them are of poor and very poor quality and must therefore be treated as per the sources and different degree of treatment is required. Based on the result we can say that we can choose better sources for water consumption. suitable treatment of water are recommended before consumption in areas where water quality is poor and result of this projects can be used to determine specific treatment process for the sites.

Similar studies can be done to other part of India for calculating water quality of that place and make healthy water accessible to that region which can fulfil the most necessary condition of providing good quality drinking water and choosing better source available at that place

Future scope

This topic has a huge scope in future. A new area of study is prepared based on the need to find out wqi at that area and to measure water pollution of surface water in other areas.

The same model can be used to calculate wqi or other model developed by different countries or organization can be used to classify water quality and find out best sources available for water consumption.

Comparative work between different model can also be done in this field to calculate error in different model. And find out which model is more significant.

Different quality parameter calculated in this model can be used to know which parameter is causing more pollution and based on that specialized site-based water treatment can be done which is beneficial both economically and resource wise.

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