



Evaluation of Ground Water Quality in and Around Mining Area of Umrer, Nagpur City, Maharashtra

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Abstract:

The present work describes various hydrologic parameters indices used for deciding the ground water quality and pollution levels of ground water. Further these indices will be used to decide the suitability of ground water for drinking, irrigation and industrial purpose. This study is also relevant for nearby community and farmers. Compressive water quality investigation need to characterise large water sample area and also significant to describe the water quality.

Key Words: Hydrologic parameter, Quality indices, Makardhokda, Ground water, Nitrate

Introduction:

Water is our lifeline that batches us and feed us. It is recognized that water is prime necessity and precious natural asset. In ancient culture water is to be represented as very essence of life. The planning, development and management of resources need to be governed by national perceptiveness. The use of water resources over the last fifty years has to be declined per capita availability of water, falling ground water quality, ground water tables and inefficient use of water. While pressures have built up on water resource from wide range of economic and developmental activities, present policy and institutional framework has also failed to ensure equity and sustainability in the use of water, (Murugesan *et al.*, 2005). Hence it is important to divert attention towards the protection and conservation of ground water for its best designated use.

It is hour need that the quality of mining area (Makardhokda, Umrer) ground water should be checked at regular time intervals because due to discharge of industrial waste water and mining discharge in ground and surface. So the nearby population suffers from variety of water born disease. Without clean water neither human being nor environment sustain on earth surface. With this strong background the present study focus on the quality of ground water collected from Umrer and mining areas.

Materials and methods:

Umrer and makardhokda mine area were selected for the assessment of ground water quality samples were analysed for physical, chemical characteristics as per the procedure described in APHA (2005) and manual of water and waste water analysis NEERI (1986) while some important indices were calculated as given below.

Calculation of Langelier Saturation Index:

$I(\text{sat}) = \text{pH} - \text{pH}_S$

Where, $\text{pH}_S = (9.3 + A + B) - (C + D)$

Where, A = Total solids

B = Temperature

C = Alkalinity

D = Hardness (Calcium)

Where, pH is the actual pH that is observed and pH_S is the theoretical pH value. If saturation index is zero, the water is chemically balanced. If it is in positive quantity, scale forming tendency are indicated. If it is negative, corrosive tendency is indicated.

Calculation of WQI:

WQI is calculated from the following equation:

$$\text{WQI} = \sum q_n W_n / \sum W_n$$

Calculation of index quality rating (q_n):

Let there be, "n" water quality parameters and quality rating or sub index (q_n) corresponding to nth parameters is a number reflecting the relative value of this parameters in the polluted water with respect to standard permissible value. The q_n is calculated using the following expression,

$$q_n = 100 \{ (V_n - V_{io}) / [(S_n - V_{io})] \}$$

Where, q_n = quality rating for the nth water quality parameters

V_n = estimated value of the nth parameters

S_n = standard permissible value of the nth parameters

V_{io} = ideal value of the nth parameter in pure water

All the ideal values (V_{io}) are taken as zero for the drinking water except for pH = 7.0

Calculation of unit weight (W_n):

The unit weight (W_n) for various water quality parameters are inversely proportional to the recommended standards for the corresponding parameters.

$$W_n = K / S_n$$

Where, W_n = unit parameter for nth parameter

S_n = standard value for nth parameter

K = constant for proportionality

Sodicity:

Sodicity of an irrigation water is the extent to which can possibly influence the exchangeable sodium content of the soil and cause infiltration and permeability problems affecting the plant growth, the criteria often use to evaluate irrigation waters from sodicity point of view are percent sodium, sodium adsorption ratio (SAR). These are defined as:

$$\text{SAR} = \text{Na}^{++} / \frac{1}{2} (\text{Ca}^{++} + \text{Mg}^{++})$$

$$\text{Percent sodium} = \{ \text{Na}^{++} / (\text{Na}^{++} + \text{K}^{+} + \text{Ca}^{++} + \text{Mg}^{++}) \} \times 100$$

Where, all ionic concentrations are expressed in milliequivalent per litre.

WQI:

Water quality index (WQI) indicates the quality of water in terms of index number which represents overall quality of water for any representative

intended use. It is defined as a reflecting the composite influences at different water quality parameters on the overall quality of water.

For calculation of WQI, six physical-chemical parameters such as pH, Chloride, Alkalinity, Nitrate, Fluoride, Hardness were used.

WQI of Umrer Site- I and Site- II were founded to be 1411.3, 6612.46 respectively.

WQI of Umrer (Makardhokda) Site- III was found to be 6897.3 (Table – 2). According to status of water. Qualities based on WQI. The studied water falls under the unsuitability for drinking purpose (Table- 3). According to Mishra and Patel (2001) it is cleared that the water quality of Umrer Area is highly polluted because of discharge of untreated effluent, mining discharge, such ground water cannot be use for drinking purposes without proper treatment.

Result and Discussion:

Table-1, The physico-chemical parameters of ground water from three different areas:

Sr. No.	Parameters	Umrer Site-I	Umrer Site-II	Makardhokda Site-III
1.	pH	8.1	8.4	8.4
2.	Temperature	33.0°C	30.0°C	38.0°C
3.	Total dissolved solids	950	3050	2000
4.	Conductivity	516	2120	2160
5.	Alkalinity	1000	920	1300
6.	Chloride	43.98	5649.2	1749.4
7.	Hardness	179	701	300
8.	Sulphate	1300	1820	1880
9.	Fluoride	78	61	14
10.	Nitrate	943	630	530
11.	Sodium	11.0	10.0	15.0
12.	Potassium	6.0	6.0	7.0

(All values are expressed in mg/lit, except pH and conductivity are expressed in $\mu\text{S}/\text{cm}$.)

Table-2, Water quality index for ground water.

Sr. No.	Sample Taken	$q_n W_n$						$\Sigma q_n W_n$	ΣW_n	$\text{WQI} = \frac{\Sigma q_n W_n}{\Sigma W_n}$
		pH	Alkalinity	Chloride	Hardness	Nitrate	Fluoride			
1.	Umrer Area Site- I	24.08	6.91	0.07	1.24	46.10	1728.1	1806.5	1.28	1411.3
2.	Umrer Area Site-II	18.92	5.67	9.03	4.84	31.28	8394.2	8463.9	1.28	6612.4
3.	Makardhokda Site- III	24.08	9.68	2.79	2.07	25.42	8764.5	8828.5	1.28	6897.3

Table-3, Status of water qualities based on WQI (Mishra & Patel)

Sr. No.	Samples Location	Index Value
1.	Umrer Area Site- I	1.2
2.	Umrer Area Site-II	1.4
3.	Makardhokda Site- III	1.5

Table-4, Langeier calcium carbonate saturation index.

Sr. No.	Samples Location	Index Value
1.	Umrer Area Site- I	1.2
2.	Umrer Area Site-II	1.4
3.	Makardhokda Site- III	1.5

Langelier calcium carbonate saturation index:

Langelier calcium carbonate saturation index is useful to measure the characteristics of water particularly to decide the corrosivity and scale forming tendency of ground water. These tendencies are useful to evaluate corrosive control properties in industrial equipment. The value of Langelier index is given in (Table-4.). 1.2 & 1.4 are the index value of Site-I and Site-II of Umrer Area and 1.5 is the index value of Makardhokda Mine Area.

From the calculated index, it can be concluded that the theoretical pH is greater than actual pH (Langelier, 1946). The scale forming tendencies of ground water under study may be due to high concentration of total solids, calcium hardness, total alkalinity, nitrate, fluoride. Temperature of

water also play crucial role while calculating this index.

The total salt concentration of soluble salt in irrigation water can be expressed for the purpose of classification of irrigation water (Table-5). The total salt concentration (salinity), sodium absorption ratio (SAR), Present sodium (PS) and total cations are parameters which are important for plant growth and nutrition point of view. In this present investigation, the study area water sources have low salt concentration. This low salt concentration in water lead to the formation of saline soil. TDS in ground water from all three studied site were greater than 1500 mg/ lit hence not suitable for irrigation. Conductivity values indicate that all three studied site comes in high salinity zone.

Table-5, Classification of irrigation water (Jain & Kumar, 1996)

Sr.No.	Zone	TDS (mg/lit)	Conductivity ($\mu\text{S/cm}$)
1.	Low salinity zone	< 200	<250
2.	Medium salinity zone	200-500	250-750
3.	High salinity zone	500-1500	750-2250
4.	Very high salinity zone	1500-3000	2250-5000

Table-6, Values of sodium adsorption ratio and sodium percent

Sr.No.	Sample Location	SAR	Na %
1.	Umrer Area Site- I	0.084	0.87
2.	Umrer Area Site-II	0.073	0.91
3.	Makardhokda Site- III	0.103	1.07

Sodium adsorption ratio (SAR):

A salt concentration in water leads to formation of saline soil, high sodium leads to development of hazard in the use of water for irrigation is determined by the absolute and relative concentration of cations and express in terms of sodium adsorption ratio.

During the growth of crop or plant, the irrigation water undergoes and depending upon evapotranspiration of the soil type. The extent of maximum concentration of dissolved in soil may be 3 to 10 times of the concentration in the original irrigation water (Kale & Bal, 1994). Calculation of SAR for given water provides a useful index of the sodium hazard of that water for soil and crops. A low SAR (2 – 10) indicate little danger from sodium, medium hazard are between 7 – 18, high hazard between 11 – 26 and very high hazards above that. The lower the ionic strength of the sample, The greater the sodium hazard for a given SAR. The values of SAR in the ground water samples of the study area were found to be 0.084, 0.073, 0.103 at Site-I, Site-II, at Site-III respectively (Table-6).

Present sodium:

The concentration of sodium is important in classifying irrigation water because it react with soil affecting permeability (Hirekhan, Patil, 2003). The sodium percentage in the study area was found to be 0.87, 0.91, and 1.07 respectively (Table-6). the ground water of the study area falls under the category of low sodium hazard (Table-5). According to (Jain et.al., 1996), low sodium can be used for irrigation on almost all soil with little danger of the development of harmful levels of exchangeable sodium.

Conclusion:

From the above data it can be concluded that, ground water quality of Umrer and Makardhokda mine area is highly contaminated and that water cannot be use for drinking irrigation and industrial utility, that water requires pre treatment before its use.

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