



## Estimation of groundwater quality for agriculture purpose in Meghnagar study region, Jhabua district, Madhya Pradesh, India

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### Abstract

The estimation of groundwater quality for agriculture purpose in Meghnagar study area, Jhabua district, Madhya Pradesh, India, has been conducted with main purpose to recognize the characteristics water quality of shallow groundwater resource for agriculture use. The quality assessment has been made by conducting chemical analysis of 25 dug well water samples. The suitability of groundwater samples for agriculture purpose is based on different chemical parameters. The Meghnagar study area chemical analysis of groundwater samples indicate suitability for irrigation has been determined on the basis of chemical parameters such as Kelley's ratio (0.105 to 0.263 epm), Sodium percentage (9.672 to 21.022 epm), Sodium adsorption ratio (0.708 to 1.266 epm), Residual sodium carbonate (-9.107 to -21.836 epm) and Mg-hazard (32.653 to 75.555 epm). In general, groundwater quality is suitable for agriculture purpose in the study area.

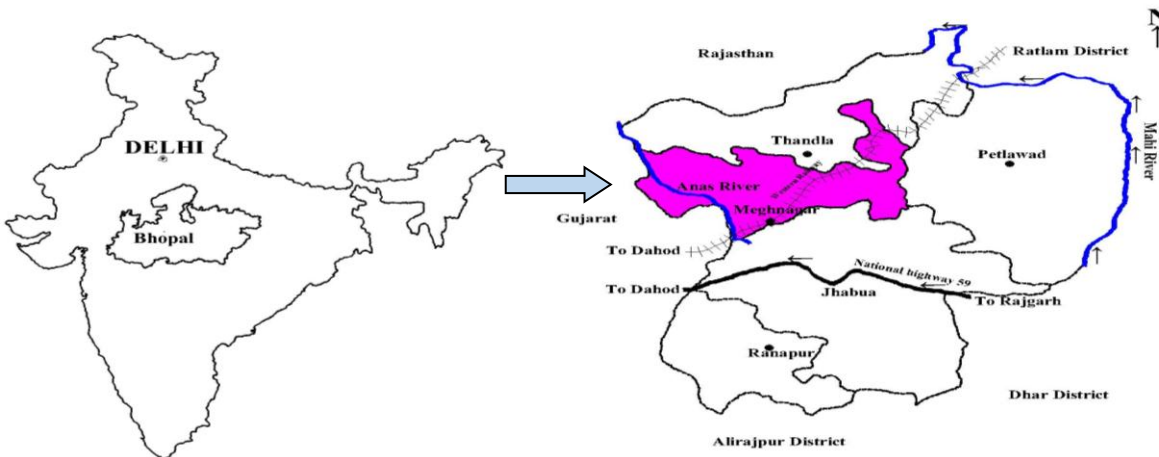
**Keywords:** estimation, groundwater, agriculture, Meghnagar study region, Jhabua district

### Introduction

The water quality analysis is to obtain information of groundwater quality from different wells and determination of different chemical parameters of groundwater samples collected from the Meghnagar study area. Determination of the physical and chemical quality of groundwater is essential for delineating the suitability of water for domestic and irrigation. Water, being an excellent solvent, acquires soluble products from the air and rocks; it comes into contact with. The amount of suspended materials carried in river water may be very large and varies in proportion to the discharge (Karanth, 1989, 2003) <sup>[5, 6]</sup>. The Groundwater-bearing rock formations (aquifers) range in age from the Archaean to Recent.

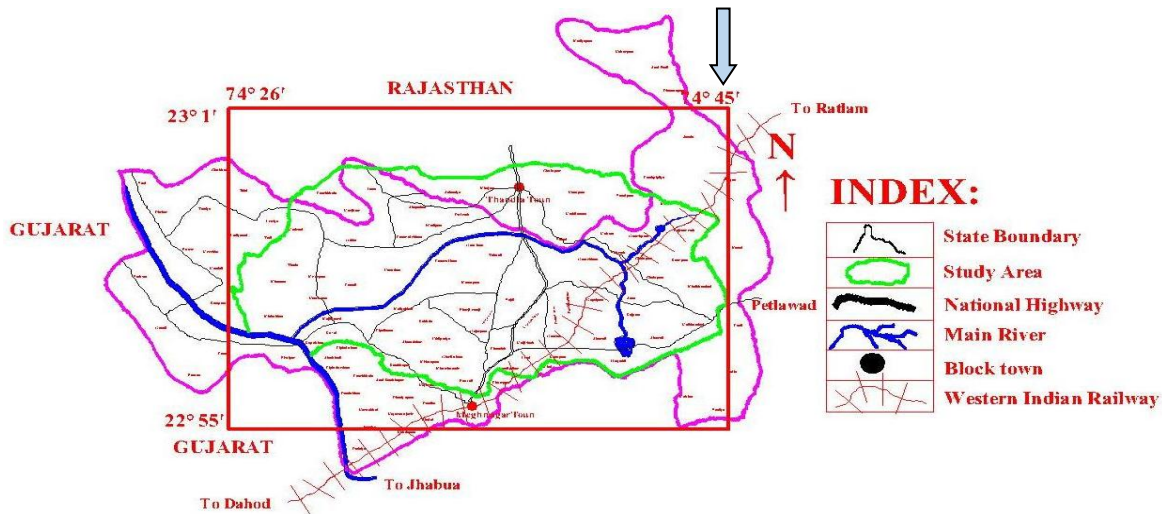
### Study Area

The Meghnagar study area lies within the latitude 22° 55' to 23° 1' N and longitude 74° 26' to 74° 40' E, covering an area of 328.9 km<sup>2</sup> (Survey of India Toposheet No. 46 J/9, 46 J/5, 46 I/8 and 46 I/12, Figure 1) on 1:50,000 scale. The landscape comprises of various lava plateau and dome shaped hillocks region. The temperature of study area is 3.5° C (minimum) and 43.5° C (maximum). The Meghnagar study area is generally dry. The relative humidity is the minimum 20 % (May) and maximum 50% (September). The average rainfall of the study area is 889.508 mm.



A. Map of India

B. Map of Jhabua District



C. Map of the Study Area

Fig 1: Showing location map of the Meghnagar study Region, Jhabua District, Madhya Pradesh.

**Hydrogeological conditions**

The Meghnagar study area belongs to Jhabua region of Madhya Pradesh, which is covered by Aravallis formations of Archaeans age and lava flows of Deccan Traps (Upper Cretaceous to Lower Eocene span). The geological setting of study area is essential for the optimum development of the water resources. Geologically, the study region is occupied by rocks such as the phyllite, quartzite, meta-conglomerate, limestone, sandstone and flows of the basalt. The region is characterized by the structural features such as the fold, fault, joint and foliation. The hydrogeological studies in the study region indicate the presence of groundwater under both unconfined and confined conditions.

**Methodology of chemical analysis**

Twenty-five groundwater samples have been collected from observation wells located in the Meghnagar study region and determine the chemical quality parameters for different applications. The samples were collected in the plastic bottles of one liter capacity, having a label pasted on bottles containing the details of location of well, date of collection and number of sample and observation well number. The collected groundwater samples were packed in plastic containers and brought to the laboratory, for the chemical analysis (Figure 2).

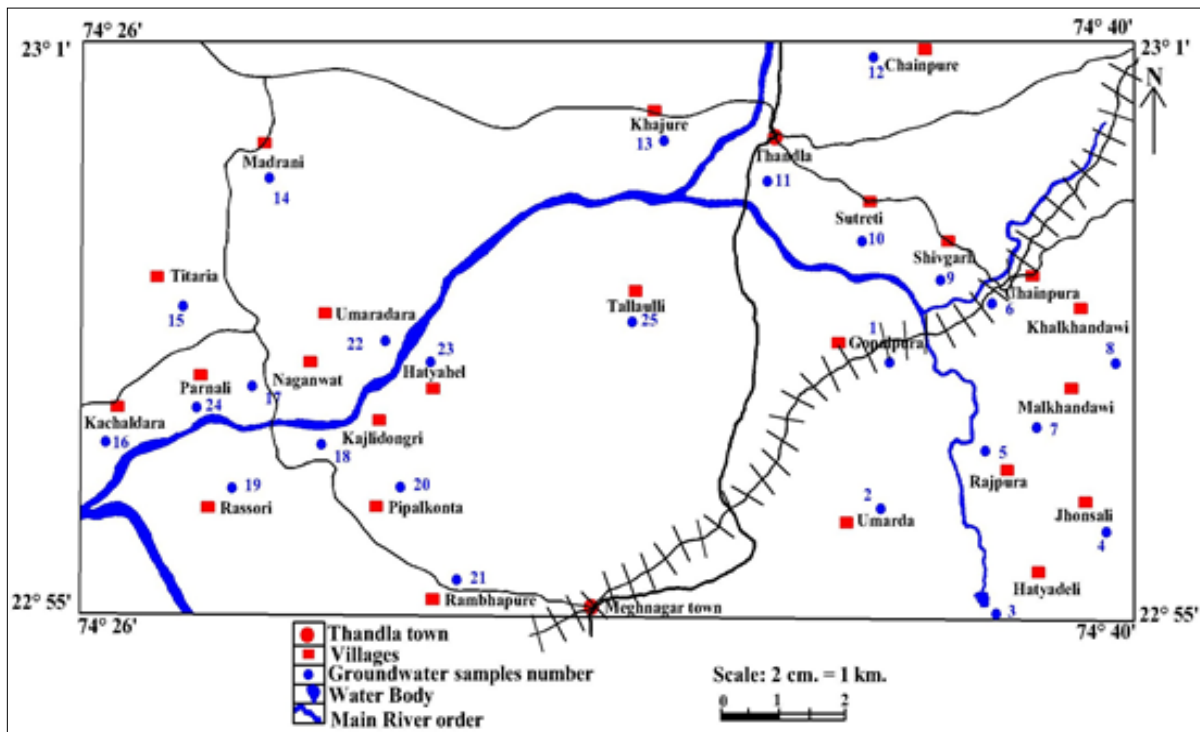


Fig 2: Displaying locations map of the collected groundwater samples in the study area

**Groundwater quality parameters for Agriculture use**

Physical properties indicate that all samples are colourless, odourless, tasteless, having turbidity range from 0.85 to 3.50, pH value range from 7.00 to 8.02, electrical conductivity range from 305 - 920  $\mu$  mohos /cm, total dissolved solids range from 250 - 468, total hardness range from 240 to 420 have been determined. The determination of chemical parameters include ionic concentrations (values expressed in ppm), Ca (75 - 200), Mg (50 - 180), Na (40 - 71), K (0.35 - 2.65), Cl<sup>-</sup> (67 - 250), SO<sub>4</sub><sup>-</sup> (62 - 220), CO<sub>3</sub><sup>-</sup> (--), HCO<sub>3</sub><sup>-</sup> (90 - 265), NO<sub>3</sub><sup>-</sup> (10 - 42), and F<sup>-</sup> (0.25 - 1.05).

In the Meghnagar study area chemical analysis of groundwater samples indicate suitability for irrigation has been determined on the basis of chemical parameters such as Kelley's ratio (0.105 to 0.263 epm), Sodium percentage

(9.672 to 21.022 epm), Sodium adsorption ratio (0.708 to 1.266 epm), Residual sodium carbonate (-9.107 to -21.836 epm) and Mg- hazard (32.653 to 75.555 epm). In general, groundwater is suitable for irrigation uses in the study area. These parameters are described in the following text:

- 1. Kelley's Ratio:** In the study area KR ranges from 0.105 to 0.263 epm (Table 2) indicating, that groundwater is suitable for irrigation purpose.
- 2. Sodium Percentage (Na %):** The Sodium percentage has been computed for all groundwater samples of the Meghnagar study area. In the study area Sodium percentage ranges from 9.672 to 21.022 epm (Table 1, 2). Except one all other groundwater samples are of excellent quality for irrigation.

**Table 1:** Classification of groundwater quality based on Na% values of Meghnagar study area (Modified after, Wilcox, 1955) <sup>[13]</sup>.

S. No.	Na %	Classification	Sample numbers	Total no. of samples	%
1	< 20	Excellent	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25	24	96
2	20 - 40	Good	1	1	4
3	40 - 60	Permissible	-	-	-
4	60 - 80	Doubtful	-	-	-
5	> 80	Unsuitable	-	-	-

- 3. Sodium Adsorption Ratio (SAR):** U.S. Salinity laboratory (1954) <sup>[12]</sup> observed that the quantity to which the irrigation water tends to enter into cations exchange reaction in soil can be indicated by the Sodium Adsorption Ratio. Sodium Adsorption Ratio is also expressed as sodium content or alkali hazard is important for determining the quality of water for agriculture purpose.

Higher salinity reduces the osmotic activity of plants and prevents water from reaching the branches and leaves of plants resulting in lower production (Malpe *et al.*, 2010) <sup>[8]</sup>. It is denoted by SAR, and the concentrations of ions are recorded in epm. In the study area Sodium Adsorption Ratio ranges from 0.708 to 1.266.

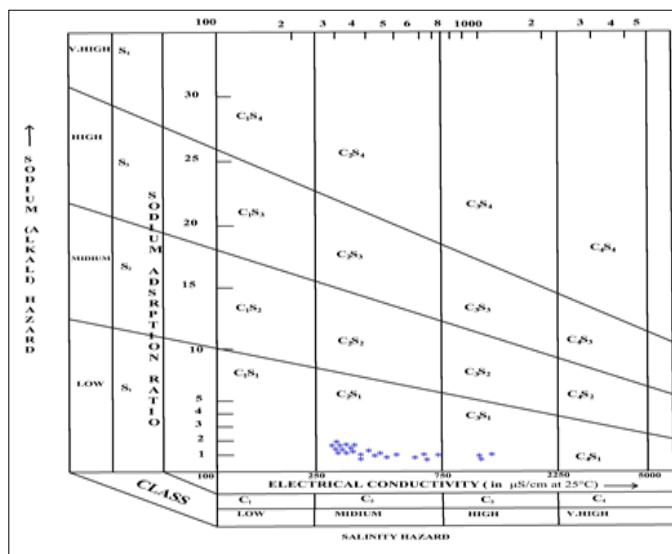
**Table 2:** Classification of chemical parameters derived groundwater quality for irrigation purposes.

S. No.	Kelley's ratio	Sodium percentage	Sodium adsorption ratio	Residual sodium carbonate	Mg hazard
1	0.263	21.022	1.266	-10.081	67.618
2	0.177	15.135	0.921	-11.513	51.873
3	0.143	12.59	0.865	-15.966	58.823
4	0.178	15.252	1.019	-13.873	75.555
5	0.208	17.42	1.086	-10.274	57.659
6	0.144	12.712	0.708	-9.107	51.165
7	0.163	14.145	0.8429	-10.858	49.414
8	0.232	19.053	1.172	-9.942	67.858
9	0.139	12.370	0.795	-13.947	60.902
10	0.231	18.87	1.143	-9.612	55.133
11	0.169	14.785	0.957	-13.578	54.416
12	0.105	9.672	0.741	-21.836	59.735
13	0.231	18.923	1.161	-10.138	32.653
14	0.146	13.038	0.874	-14.223	69.211
15	0.236	19.312	1.199	-11.406	65.135
16	0.191	16.274	1.074	-12.44	64.091
17	0.166	14.558	0.947	-12.289	61.860
18	0.145	12.936	0.872	-13.572	66.575
19	0.178	15.298	1.027	-13.309	61.493
20	0.170	14.768	0.960	-12.834	57.324
21	0.192	16.368	1.060	-11.508	63.680
22	0.220	18.157	1.168	-10.859	63.579
23	0.156	13.757	0.903	-13.821	59.638
24	0.193	16.409	1.045	-11.266	59.056
25	0.169	14.770	0.942	-11.755	64.244

4. **Residual Sodium Carbonate (RSC):** The RSC values of groundwater samples of the Meghnagar study area ranges from -9.107 to -21.836 epm, and hence the groundwater is marginally suitable for agriculture application.
5. **Mg- hazards:** The magnesium hazards ratio has been calculated for all groundwater samples of the Meghnagar study area, ranging from 32.653 to 75.555 epm (Table 2), indicate that groundwater is suitable for agriculture use.

**U.S. Salinity Diagram Application**

U.S. Salinity Laboratory (1948, 1954) proposed a diagram for assessment of water suitability for irrigation use. The plots of Meghnagar water of the Sodium Adsorption Ratio and Electrical Conductivity values on the salinity diagram (Figure 3), indicate that the quality evaluation of groundwater for the agriculture use.

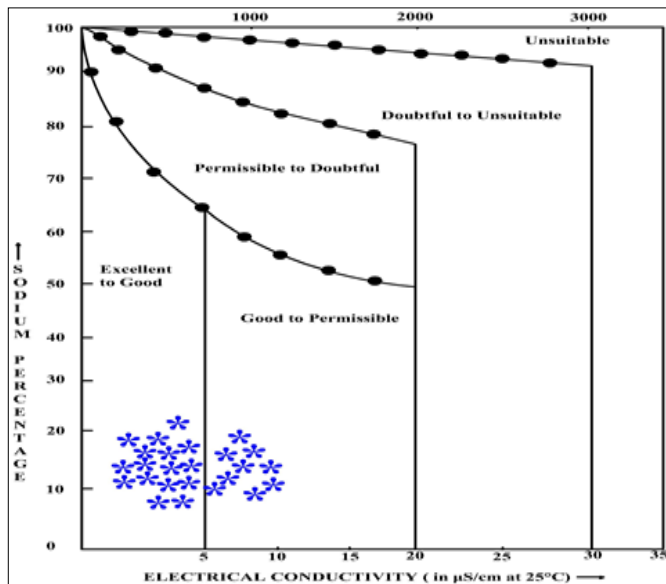


**Fig 3:** U.S. Salinity Diagram of the Meghnagar study area (After Richards, 1954).

In the present study area, diagram (Figure 3) indicates that 22 samples belong to class C<sub>2</sub>S<sub>1</sub> (Medium salinity to low sodium) and 3 samples represent, class C<sub>3</sub>S<sub>1</sub> (High salinity to low sodium), hence suitable for irrigation and indicate that most of the groundwater samples of the study area are medium to high saline and low sodium hazard.

**Wilcox diagram Application**

Wilcox (1955)<sup>[13]</sup> evaluated the suitability of groundwater for irrigation application. The values of sodium percentage and electrical conductivity are plotted on the Wilcox Diagram. The diagram is divided into five categories- Excellent to Good, Good to Permissible, Permissible to Doubtful, Doubtful to Unsuitable and Unsuitable. In the Meghnagar study area, computed values of the sodium percentage and electrical conductivity on the Wilcox diagram have been plotted (Figure 4).



**Fig 4:** Wilcox diagram of the Meghnagar study area (After Wilcox, 1955)<sup>[13]</sup>.

The plots indicate that 16 groundwater samples (Gopalpura, Jhonsali, Rajpura, Khalkhandawi, Sutreti, Thandla town, Chainpure, Khajure, Madrani, Titaria Kachaldara, Kajlidongri, Rassori, Rambhapur, Umaradra and Parnali Villages) represent the categories of Excellent to Good quality and 9 samples (Umarda, Hatyadeli, Chainpura, Malkhandawi, Shivgarh, Naganwat, Pipalkonta, Hatyahel and Talavalli Villages) represent the Good to Permissible categories. In general, the groundwater is suitable for agriculture /irrigation applications.

**Conclusion**

The chemical evolution of Meghnagar study area, groundwater samples indicate suitability for irrigation has been determined on the basis of chemical parameters such as Kelley’s ratio (0.105 to 0. 263 epm), Sodium percentage (9.672 to 21.022 epm), Sodium adsorption ratio (0.708 to 1.266 epm), Residual sodium carbonate (-9.107 to -21.836 epm) and Mg- hazard (32.653 to 75.555 epm). The evaluation of chemical quality indicates that the groundwater of Meghnagar study area is Ca, Mg, CO<sub>3</sub>, HCO<sub>3</sub> and SO<sub>4</sub>, type. The computed values of the sodium percentage and electrical conductivity on the Wilcox diagram have also been plots groundwater samples of the study area suggested that best part of samples represent the categories of Excellent to Good quality. In general, groundwater is suitable for agriculture/irrigation uses in the Meghnagar study area.

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