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## Assessing the agricultural suitability of groundwater using SAR values in Nasrullaganj area, district Sehore, Madhya Pradesh

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### Abstract

The classification of irrigation waters with respect to SAR is based primarily on the effect of exchangeable sodium on the physical condition of the soil. Sodium-sensitive plants may, however, suffer injury as a result of sodium accumulation in plant tissue, when exchangeable sodium values are lower than those effective in causing deterioration of the physical condition of the soil. In the present study the SAR values for groundwater samples have been calculated to understand the suitability of groundwater in the study area. The highest value of SAR is reported to be 4.4 and the lowest value is 0.5 at two locations, the average value is 1.9. The values fall in the excellent category of Richards (1954) [4] classification, and is very suitable for the agricultural purposes.

**Keywords:** Groundwater, sodium adsorption ration (SAR), agricultural suitability, Nasrullaganj, Sehore

### Introduction

India is a country, which has agriculture as its prime occupation. The country's economy is based on agriculture, hence it becomes important to understand the various factors effecting the agriculture produce like rainfall, soil types, groundwater conditions and the quality of groundwater. The quality of groundwater is a very important factor as mentioned with the other factors, various anions and cations present in the groundwater decide its quality and play important role in increasing or decreasing the agricultural produce in any area. The study of these ions and their combination, their relationship at a particular area effects the soil, groundwater and ultimately the agriculture, as a lot of areas today use groundwater as an important source of water for irrigation.

As discussed about the quality of groundwater, SAR (sodium adsorption ratio) is one of the important factors that effects the agriculture of an area for sodium sensitive plants. The presence of this ion in the groundwater and its effects on the plants have been studied to understand for a long time now.

Sodium adsorption ratio (SAR) is a measure of the suitability of water for use in agricultural irrigation, because sodium concentration can reduce the soil permeability and soil structure (Todd & Mays, 2005) [5]. Salinity indicates leaching of salts into groundwater. This creates a lot of problems, especially in dry climatic regions, where clayey soils occur. As the water salinity develops saline soils, this in turn affects the salt intake capacity of plants through the roots. Excess concentration of salts in agricultural fields due to loss of water through evaporation causes poor drainage conditions. These conditions decline groundwater levels up to the root zone of plants, which accumulates the salts in soil solution through capillary rise, following the water evaporation (Hem, 1985) [2], the SAR measures the relative proportion of sodium ions in a water sample to those of calcium and magnesium (Kalra & Maynard, 1991) [3] and is calculated using the following equation:

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

Where the metal ions are expressed as milliequivalents per litre (meq/L)

The above formula can be expressed as below, when the metal ions are expressed as mg/L.

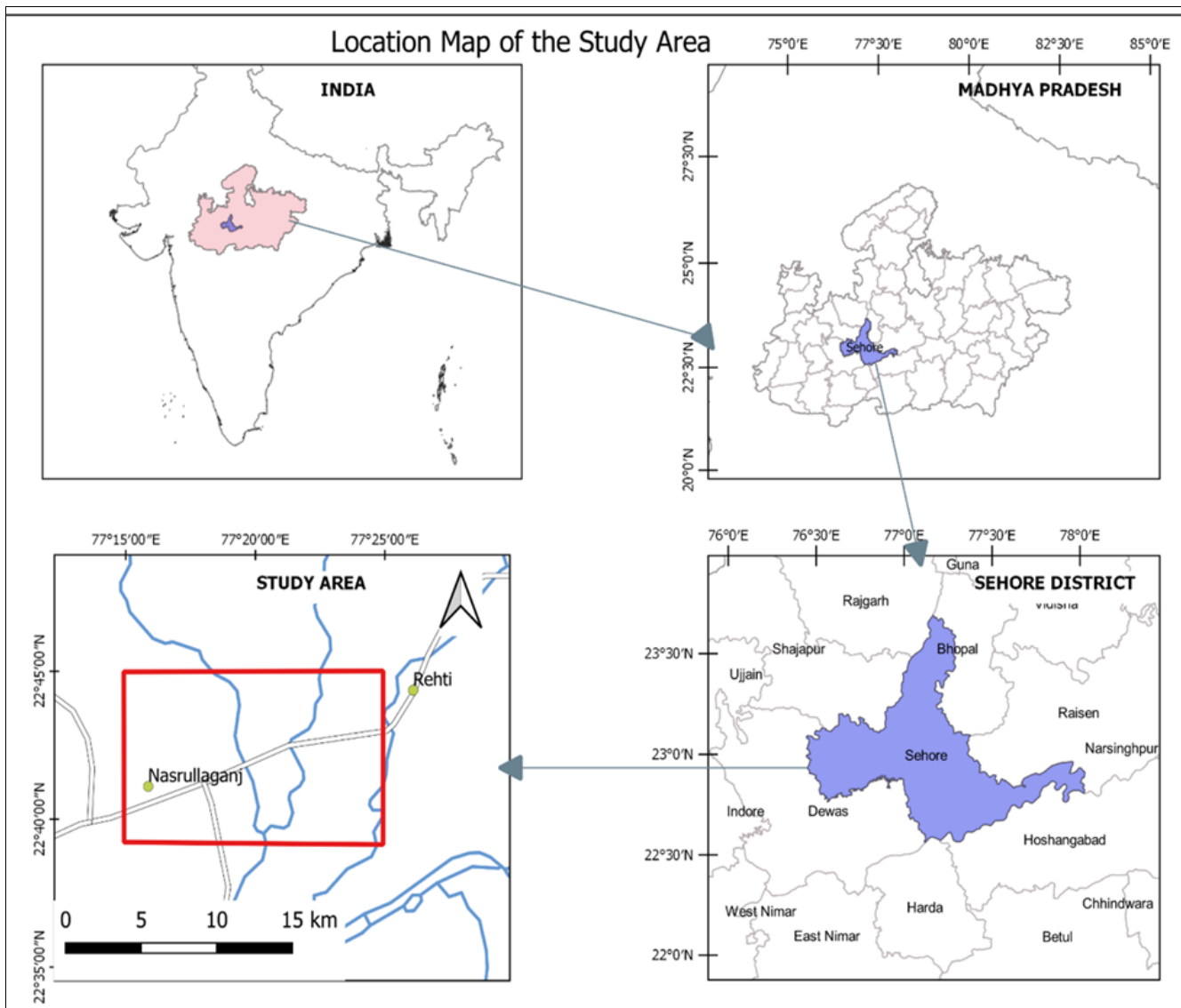
$$SAR = \frac{(Na^+)}{\sqrt{\frac{(Ca^{2+} + Mg^{2+})}{20.04 + 12.15}}}$$

The study area is a part of Nasrullaganj in Sehore district, and falls on Survey of India Toposheet No. 55 F/6 and

bounded by latitudes 22°40'00'' to 22°45'00'' N and longitudes 77°15'00'' to 77° 25'00''E and covers about a total of 158 km<sup>2</sup> area.

Sehore is the nearest railway station and Bhopal the state capital of Madhya Pradesh is the nearest airport. The entire area can be accessed through all-weather and fair weather roads.

The area of present study lies to the north of Nasrullaganj in Sehore district of Madhya Pradesh. The Location map of the study area is given in the Figure 1.



**Fig 1:** Location Map of the Study Area

The major settlement on the western side of the area is Joglan, whereas Rehti stands on the eastern boundary. Barodiya is the northern and Nasrullaganj is the southernmost settlement of the area covered. The study area consists of nearly 18 villages. Most of the population is dependent on agriculture and agricultural products. Geologically Granites, are the oldest rocks, overlain by Vindhyan and Deccan basalts followed by laterites and

alluvial deposits in the area. The recent formations can be encountered randomly in the area. Major structure in the area is the Narmada-Son Lineament running NNE-SSW. The regional geological map of the study area is given in Figure 2.

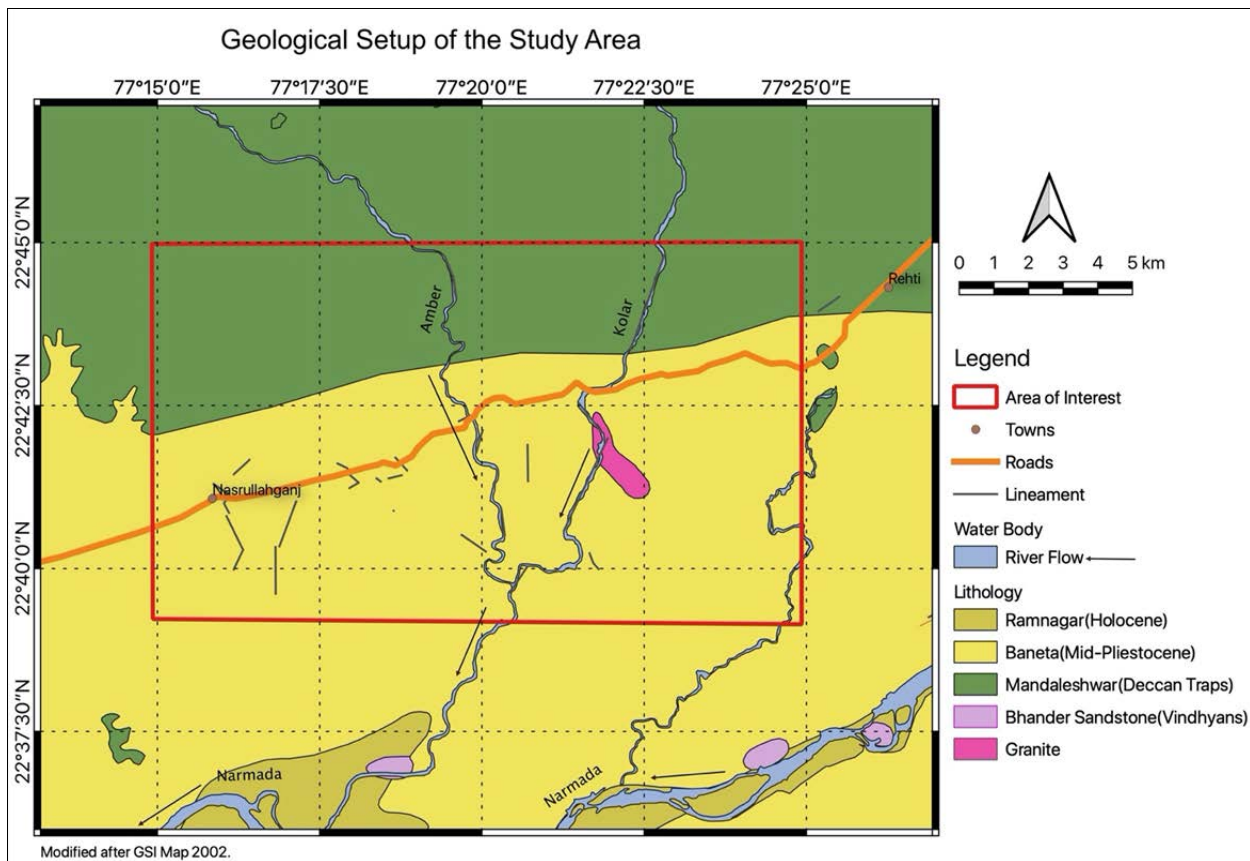
A detailed stratigraphic succession of Sehore district can be seen in the Table 1 below.

**Table 1:** Stratigraphic Succession of the Study Area Nasrullaganj District Sehore Madhya Pradesh, Source: District Resource Map 2002

Lithology	Stratigraphic Status	Group	Age
Non-Calcareous silt, sand and Gravel	Ramnagar Formation	Recent	Middle Pliestocene to Holocene (Quaternary)
Calcified silt, sand and Gravel	Bauras Formation		
Calcareous Sand, silt, clay, gravel and Conglomerate	Baneta Formation		
Laterite			Cainozoic
Aa' & Basaltic lava flows (2 flows)	Bargonda Formation	Malwa Group. (Deccan Traps)	Cretaceous to Palaeogene
Aa' & compound Basaltic lava flows (7 flows)	Indore Formation		
Aa' & compound Basaltic lava flows (5 flows)	Kankariya Pirukhedi		
Compound to Simple and 'Aa' basaltic lava flows (2 flows)	Kalisindh Formation		
Granite			Palaeoproterozoic

A brief geomorphology states that the area is a part of Malwa plateau. Major rivers draining the area are Kolar and Amber. These are tributaries to the Narmada River and join about 30 km south of Nasrullaganj near village Neelkanth. Isolated hills form the major water divide towards the

northern part. The general slope of the area is towards south west. The elevation ranges from 280 m to 570m. Dominant soil type observed is black cotton soil and alluvial at places. Area exhibits the older flood plain of fluvial origin.



**Fig 2:** Regional Geology around the area around Nasrullaganj

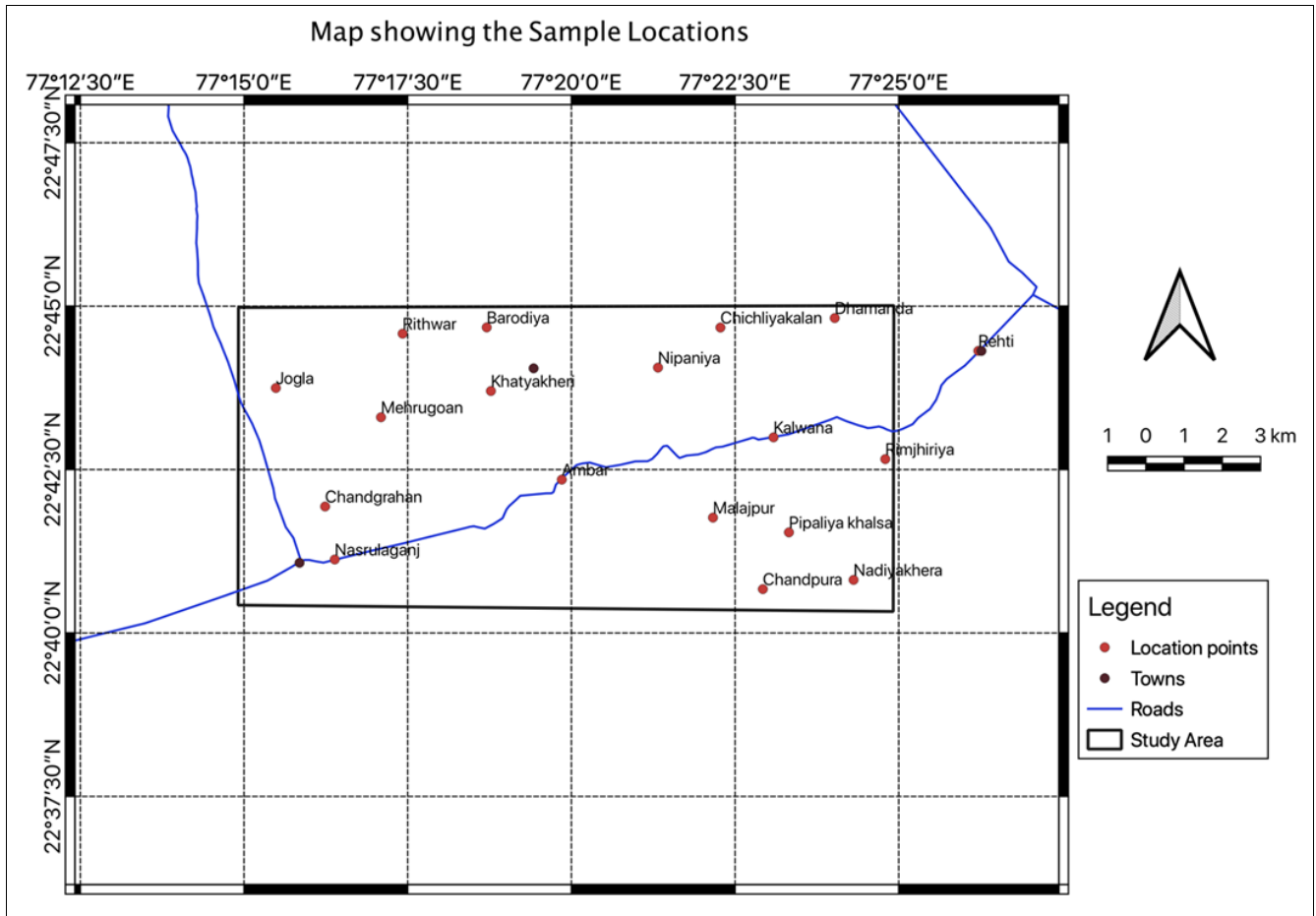
**Materials and Methods**

A total of 18 ground water samples were collected and analysed from 18 different locations spread across 158 km<sup>2</sup> area between Nasrullaganj and Rehti. The samples locations are given in Figure 3.

Samples were collected in airtight polypropylene bottles of

one- and two-liter capacity, and for chemical analysis of the water samples, the standard procedure of (APHA, 2017) was followed.

The samples were analysed at the State Regional Laboratory of Public Health Department Analytical Facility at Bhopal.



**Fig 3:** Map showing the Sample Locations in the Study Area

**Results**

In the present study SAR (sodium adsorption ratio) values for 18 samples have been calculated to understand the

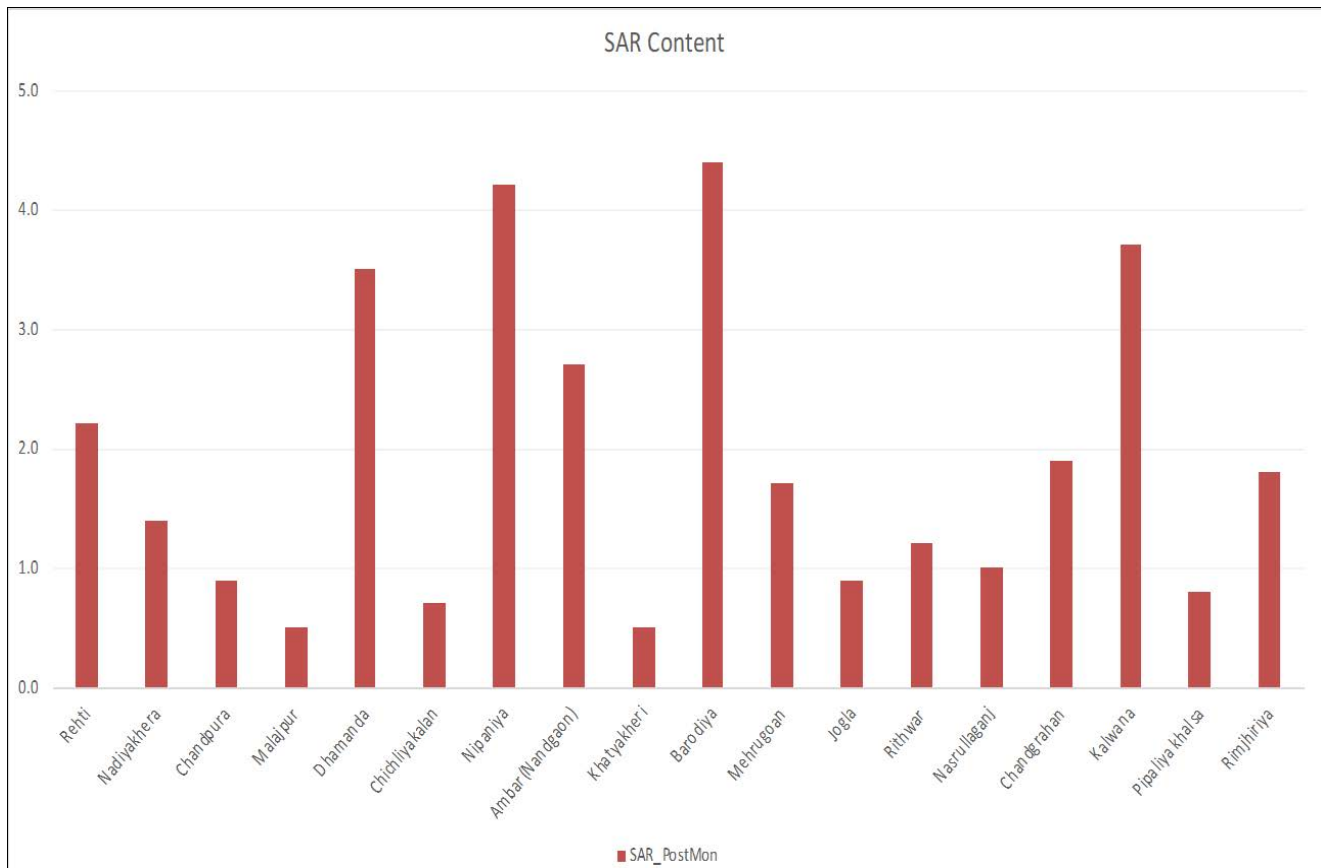
suitability of groundwater in the study area. The calculated values of Sodium Adsorption Ratio in the samples of the study area are tabulated in the Table 2 below.

**Table 2:** Sodium Absorption Ratio in the water samples in the study area

S. No.	Location	Sodium Adsorption Ratio
1	Rehti	2.2
2	Nadiyakhera	1.4
3	Chandpura	0.9
4	Malajpur	0.5
5	Dhamanda	3.5
6	Chichliyakalan	0.7
7	Nipaniya	4.2
8	Ambar(Nandgaon)	2.7
9	Khatyakheri	0.5
10	Barodiya	4.4
11	Mehrugoan	1.7
12	Jogla	0.9
13	Rithwar	1.2
14	Nasrulaganj	1.0
15	Chandgrahan	1.9
16	Kalwana	3.7
17	Pipaliya khalsa	0.8
18	Rimjhiriya	1.8

The values are plotted graphically with help of a bar graph in the Figure 4. It can be interpreted from the bar graph, the minimum value of SAR is 0.5 at two locations i.e.

Khatyakheri and Malajpur, and the maximum is 4.4 at Barodiya. The average SAR value in the study area is 1.9.



**Fig 4:** Bar graph representing SAR content in the study area

**Conclusions**

High sodium concentration effects the permeability of soil and also hardens the soil, which in turn increases the compaction, this eventually leads to the low permeability in soil. However, there are other factors as well such as soil texture, drainage conditions, soil type responsible for the permeability but this aspect of SAR is actually taken into account for sodium sensitive plants.

The classification of irrigation waters with respect to SAR is based primarily on the effect of exchangeable sodium on the physical condition of the soil. This classification, as given by (Richards, 1954) [4] is listed in the Table 3 below.

**Table 3:** Table showing the Classification of SAR values by (Richards, 1954) [4].

Sodium Absorption Ratio	Class
<10	Excellent
10-18	Good
18-26	Fair
>26	Poor

The entire area falls under the excellent category of Richards classifications and the water quality in the study area is excellent for the agricultural purposes.

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