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Comparative analysis of ground water in Jalore District in the year 2022 and 2023

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Abstract
In this paper seven ground water parameters for the villages of various tehsils of Jalore District has been studied and analyzed. An effort has been made to explore the various parameters of ground water i.e. Chloride, Fluoride, Total Hardness, Nitrate, pH and TDS. Ground water samples are collected in 2022 and 2023 from one town of each tehsil of Jalore district. In the next section of this paper analysis of experimental data has been discussed. In this section the experimental results are compared with previous data collected from National Rural Drinking Water Programme. Analysis of data shows that the water parameters are too far from the permissible limit. This paper concludes that Fluoride, Nitrate and TDS are surpassing as far as possible from the permissible limit. After analyzing the data it has been found that the ground water of study area is not suitable for domestic purpose and even it is not good for irrigation also. And some water treatment is recommended to save the life of gentry of Jalore district. The study area is full of limestone, Granite, building stone, rock and desert. The present experiments will help in the improvement of drinking water quality.

Keywords: National rural drinking water programme, ground water, total hardness, nitrate, pH and TDS

Introduction
Jalore district, located in the south-west of Rajasthan state, has a geographical area of 10,640 square kilometers. The distract derives its name from the Town of Jalore, which is the Headquarters of the district administration. The district is part of Jodhpur Division. The district is composed of Nine Tehsils - Ahore, Jalore, Bhinmal, Raniwara, Sayala, Bagoda, Jaswantpura, Sanchore and Chitalwana. Total number of Villages in the district is 850 and its also Four Urban Towns. Total population of the district as per census 2011 is 1828730 with Male and Female population of 936634 and 892096 respectively. Jalore city is known as the Granite City. The area of Jalore district is a mixture of Hills, Deserts and Plains, which is dependent on Rainwater for Water. Some areas of Jalore district are irrigated by the Narmada Canal project and some areas are irrigated by Wells and Tube wells. Jalore district is a rural district, so most of the Occupation here is agriculture work which is dependent on rain water due to low Ground water level. In Jalore district, the Ground water level has decreased in the year 2022-23 as compared to the year 2021-22. Groundwater is water located beneath the earth's surface in the pores of soil and rocks and in the joints and cracks of rock formations. Groundwater is the primary source of potable water supply in rural India. Deforestation and the resulting soil erosion hinder the recharge of groundwater, hence the groundwater level is declining almost all over India. The state of Rajasthan also has a serious problem of groundwater depletion. Hundreds of groundwater augmentation structures have been constructed in the last several years in Jalore district of Rajasthan by the state watershed department and other agencies. It is necessary to analyze the importance of water augmentation structures in relation to the change in groundwater level of different villages of Jalore district to understand how the groundwater level is falling due to increasing population, irregular water exploitation and excessive cutting of trees and how it can be prevented.

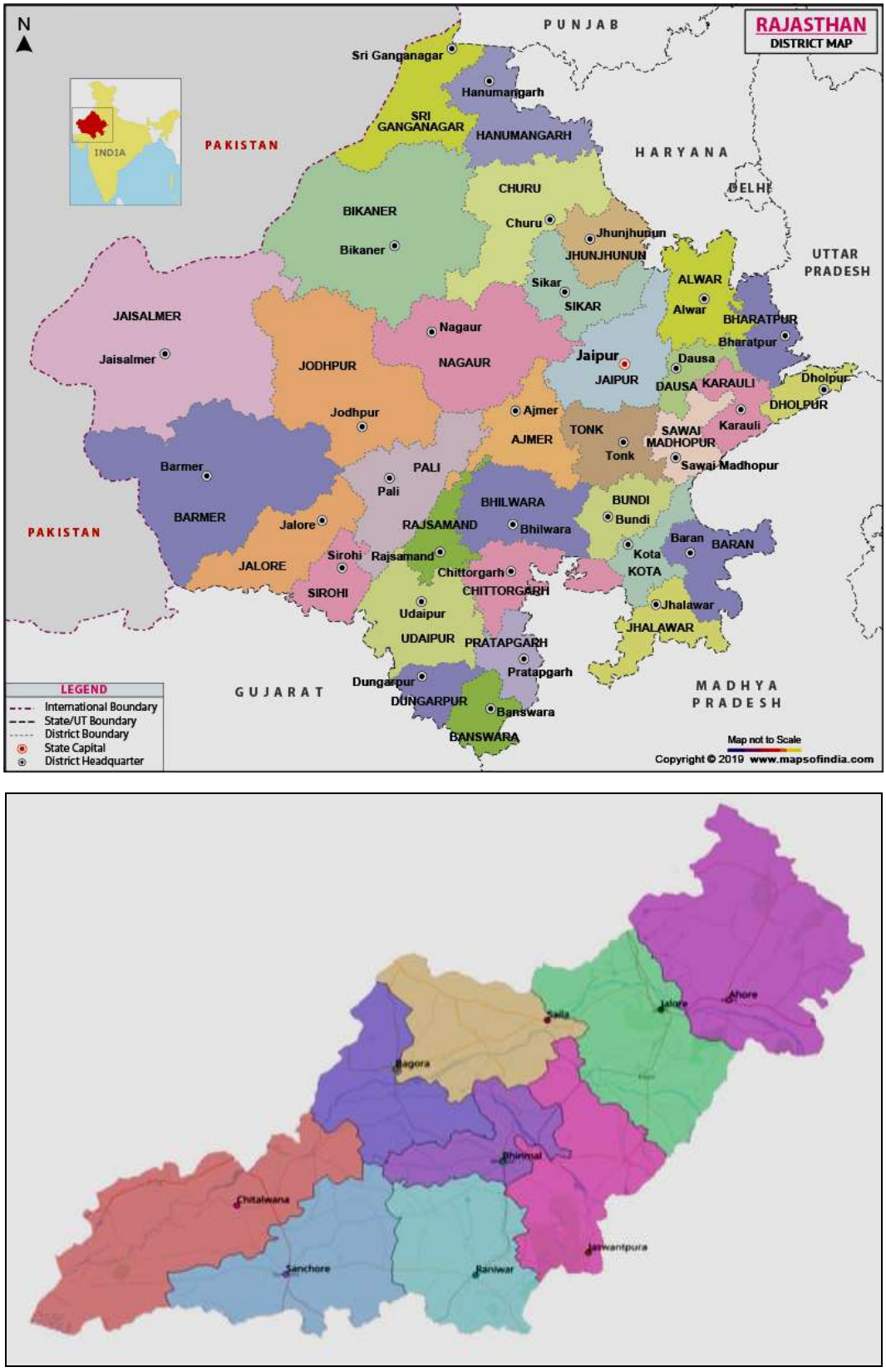

Fig 1: Jalore District

Rainfall and Climate

The average annual rainfall of the district is 626.4 mm in the year 2022 and 606.8 mm in the year 2023. However, the normal rainfall for the period 1901 to 1970 is 400.6 mm and Average annual rainfall 1071 to 2021 of the district is 445.4 mm. The annual rainfall gradually decreases from the south-eastern part towards the north-western part. Jalore district receives rainfall mainly from the south-west monsoon and also from the Mediterranean monsoon in winter. The climate of the district is dry except during the south-west monsoon season. Cold weather prevails from December to February followed by heat from March to June. The period from mid-September to the end of November constitutes the post monsoon season. The district experiences mild or normal drought once in two years. Jalore district recorded more droughts in 2023 than in 2022. The highest drought

has been recorded in Sanchore and Chitalwana blocks. This change in the environment is mainly found in Jalore district due to desertification. Due to increase in the number of trees in the district in the year 2023 as compared to the year 2022, a drop in temperature was recorded and there was also a change in rainfall.

Table 1: Average annual rainfall of the district, Jalore

Year	Annual Rainfall
1901-1970	400.6 mm
1971-2021	445.4 mm
2022	626.4 mm
2023	606.8 mm

Temperature

The summer season in Jalore district starts in the month of March and continues till June. Strong dust storms occur during the summer season which is known as Loo. The temperature drops when the monsoon arrives in July. In the month of May, the daily range of temperature increases further and the day becomes hot. The average maximum temperature during June reaches 47 °C. February is the coldest month. The normal minimum temperature in February is 18 °C. The normal minimum temperature range is 12 °C to 15 °C near and around the Aravalli mountain ranges. The lowest temperature in the district is around Jaswantpura and the highest temperature is around Chitalwana. There is a huge difference between daily and annual temperature difference in the district. An increase in temperature was recorded in the year 2023 as compared to the year 2022.

Table 2: Average annual Temperature of the district, Jalore

Year	Max. Temp.	Min. Temp.	Aver. Temp.
2022	47 °C	17 °C	32 °C
2023	46 °C	16 °C	31 °C

Ground Water Scenario

Systematic and regular monitoring of ground water levels brings out the changes taking place in the groundwater regime. The maps so generated are of immense help for regional groundwater flow modelling which serves as a groundwater management tool to provide the necessary advance information to the user agencies to prepare contingency plans in case of unfavourable groundwater recharge situation. The data also has immense utility in deciding the legal issues arising out of conflicting interests of groundwater users. Water level data of the NHS collected during the year 2022 and 2023 has been utilized to prepare various maps showing depth to water level and fluctuation of water level. Depth to water level maps is useful in dealing with problems of water logging and artificial recharge, where the relative position of water level with reference to the ground surface is of critical importance. Water level fluctuation maps (rise or fall) are indispensable for estimation of change in storage in the aquifer.

Depth to Water Level

The depth of water table varies widely depending on topography, drainage, bedrock geology, etc. In Jalore district, during the year 2022, the depth of water table has been observed to vary from less than 10 meters to more than 50 meters. Water level is shallow mainly in hard rock aquifers in Bhinmal block. The depth of water table varies from 20 to 40 meters in most parts of the district. Deep water level has been observed to be less than 50 meters in some parts of Bhinmal, Raniwada, Sayla blocks. In Jalore district, the depth of groundwater level has increased in the year 2023 as compared to 2022. Groundwater level has increased due to Narmada Canal Project in Sanchore and Chitalwana blocks. Groundwater level was found to be high in those areas of Jalore district where there are more number of dams or ponds. The main reason for the deepening of groundwater level in Jalore district is less rainfall.

Table 3: Average depth to water level the district, Jalore

Year	Max. (M)	Min. (M)	Aver. (M)
1901-1970	35	5	20
1971-2021	40	8	24
2022	46	10	28
2023	47	11	27

Annual water level fluctuation

Jalore district Seasonal fluctuation based on pre and post-monsoon 2022 water level data in Jalore District shows that water level has increased over large parts of the district. Observation of fluctuation data shows that water level has increased up to 4.00 m over large parts of the district. Water level has declined up to 8.00 m in Sayla and Bagoda blocks. Seasonal Water Level Fluctuation (May 2022 - November 2022). To find out the trend of water level for pre monsoon, decadal mean (2011-2020) has been compared with 2022 water level data and is given in the table. Most of the monitoring stations have shown declining trend ranging from 0.2 m/year to 14.3604 m/year during pre-monsoon. Rising trend has been observed in small areas of Sanchore, Chitalwana, Raniwara and Jaswantpura tehsils. Groundwater level was found to be deeper in the year 2023 as compared to the year 2022.

Table 4: Average Water Level Fluctuation the district, Jalore

Year	Max. (M)	Min. (M)	Aver. (M)
2011-2020	4	2	3
2022	9	7	8
2023	11	6	8.5

Hydrochemistry

For the evaluate of hydro-chemical status and distribution of various chemical constituents in ground water of Jalore District, some water samples were collected during 2022 and 2023 from open wells and hand pumps which are fully or partially in use. Purity of water is essential for its beneficial use otherwise it may adversely affect human health. Quality of water depends on its physical and chemical properties. Physical properties include colour, odour and turbidity which can be determined by our senses. Chemical properties depend on the nature and quantity of various chemical constituents individually or combined. Chemical analysis was carried out for major cations (Ca, Mg, Na, K) and anions (CO_3^{-2}, HCO_3^-, Cl^-, SO_4^{-2}, NO_3^-, F^-) in addition to pH, EC, PO_4^{-3}, TH as $CaCO_3$ and were chemically analyzed in Regional Chemical Laboratory (NABL Accrediated).

Table 5: The overview of the table shows the water quality standards for drinking use

S. N.	Constituents	Acceptable limit (ppm)	Permissible limit (ppm)	Probable effects
1	TDS	500	2000	Beyond limit water bitter in taste and can cause stomach disorder.
2	Chloride	250	1000	Indigestion, bitter taste
3	Sulphate	200	400	Causes stomach disorder.
4	Nitrate	45	No relaxation	Methemoglobinemia in bottle fed infants and Gastro-intestinal problems.
5	Fluoride	1	1.5	Above permissible limit causes skeletal and dental fluorosis and non-skeletal fluorosis
6	Total Hardness	200	600	Calcification of arteries, urinary concretions, diseases of kidney or bladder, stomach disorder.
7	Calcium	75	200	Insufficiency causes rickets, excess cause's stones in kidney or bladder, essential for human health.
8	Magnesium	30	100	Its salts are cathartic & diuretic, excess is laxative.
9	Iron	1	No relaxation	Bitter sweet taste, staining of laundry, trace is essential for nutrition.

The range of chemical constituents of groundwater in Jalore district is sown in table

Table 6: Ranges of various chemical constituents in ground water

S. N.	Chemical constituent	Range
1.	PH	7.3 to 8.15
2	Chloride	99 - 1633 ppm
3.	Fluoride	0.09 - 2.40 mg/lit
4.	Nitrate	15 - 155 ppm
5.	Calcium	16 - 92 ppm
6.	Total hardness as CaCo3	110 - 700 ppm
7.	Iron	0.05 - 0.66ppm
8.	Magnesium	09 - 120 ppm

1. Chloride (Cl^-)

In Jalore district, chloride content was recorded ranging from 99 to 1633 PPM, which was found to be varying at different places. It is one of the most common constituent present in natural water and remains soluble in water unaffected by biological processes therefore reducible by dilution. Natural mineral origin can also be a cause of high chloride content. Industrial effluents (galvanizing plants, water softening plants, oil wells, refineries and paper works) may also leach into ground water. Sewage effluents contain a larger concentration of Chlorides. Chloride ions have some functions in the body. The tolerance limits of chloride vary with climate and excretion. Cation associated with chloride is usually has harmful effects on human body. Individual affected by heart and kidney disease should restrict water consumption with a high chloride concentration.

2. Fluoride (F^-)

In Jalore district, Fluoride (F^-) content was recorded ranging from 0.09 to 2.40 mg/lit, which was found to be varying at different places. Fluoride is as inherent component of igneous rocks. The main sources of fluoride in natural water are Fluorite (CaF_2), Cryolite (Na_2AlF_2), Fluorapatite. In minerals like mica, amphiboles and topaz etc, the fluoride ions are bound on the mineral surfaces. Food in the diet is the major source of fluoride. Tea contains high fluoride concentration. Fluoride reduces dental carries, very high concentration may cause crippling skeletal fluorosis in human body. Less than 1.0 mg/l is essential. Fluoride (F) values higher than the BIS permissible limit (>1.5 mg/l) for drinking water, have been observed in central areas and a few places lying in areas of the jalore district, thus, making the ground water non-potable.

Occurrence of high fluoride in the ground water is a great concern as 19.62% of 210 ground water samples contain fluoride value beyond Permissible limits i.e. 1.5 mg/l, whereas. The worst affected districts are Jalore (80.00%), and Minimum value of fluoride has been observed 0.01 mg/l in Rajsamand District.

3. Nitrate (NO_3^-)

In Jalore district, Nitrate (NO_3^-) content was recorded ranging from 15 to 150 PPM, which was found to be varying at different places. Sources of Nitrate are mineral deposits (sodium and potassium nitrates), soils, sea water and atmosphere. Nitrate is used as a fertilizer, as a food preservative and as an oxidizing agent in the chemical industries. Higher concentrations are expected where fertilizers are used, in decayed animals and vegetable matter, in leachates from sludge and refuge disposal and in industrial discharges. Higher concentration of nitrate causes methemoglobinemia disease in bottle fed infants (4 months old). In parts of the Jalore district high nitrate values (>50 mg/l) have been observed thus making the ground water non potable. Gastrointestinal disorders are also founds. It may also have adverse effect on central nervous and cardio vascular system. High nitrate concentrations have been observed in ground water at several places.

4. Calcium (Ca^{+2})

In Jalore district, Calcium (Ca^{+2}) content was recorded ranging from 16 to 92 PPM, which was found to be varying at different places. It is always found in combination in limestone, marble and chalk. Its most common compounds are limestone, gypsum, fluorite; also calcium carbide, chloride, hypochlorite. Calcium is essential for human body. Its low content in soft water has been linked with rickets & defective teeth. Its excess may cause stones in kidney or bladder. Gout, Rheumatism etc. are also linked with its high concentration. There is no cause of concern about the calcium hazard as only 4.73% samples are beyond the permissible limit of 200 mg/l, 30.64% samples are within permissible limit and 64.63% samples are within acceptable limit of BIS.

5. Sulphate (SO_4^{-2})

In Jalore district, Sulphate (SO_4^{-2}) content was recorded ranging from 150 to 450 PPM, which was found to be varying at different places. Sulphates are found in natural water in the final oxidized state of sulphides, sulphites and

thiosulphates or in the oxidized stage of organic matter in the sulphur cycle; in all cases as a product of pollution sources related to mining or industrial waste. Detergents add Sulphate to sewage. Tanneries, steel mills, textile plants may contaminate water. Sulphate ions associated with high concentration of Magnesium and sodium ions, acts as laxative and may cause gastric disorders.

6. Total Hardness (TH)

In Jalore district, Total Hardness (TH) content was recorded ranging from 110 to 700 ppm, which was found to be varying at different places. It is primarily determined by sum of calcium and magnesium ions expressed as calcium carbonate. Other substances such as iron, manganese, aluminum, strontium, zinc may also contribute to a very small extent due to low solubility. An inverse correlation between hardness of water & cardiovascular diseases (Heart, hypertension and stroke) has been shown. High values may cause calcification of arteries, urinary concretions and stomach disorder.

7. Magnesium (Mg)

In Jalore district, Magnesium (Mg) content was recorded ranging from 09 to 120 ppm, which was found to be varying at different places. It is never found as a free element. It constitutes a large deposit as magnesite & common rock forming dolomite. Presence of magnesium is beneficial for heart & nervous system. However higher concentrations have laxative and diuretic effect.

Conclusions and Recommendations

As mentioned above, both primary and secondary data have been collected and ground water level data of the area is continuously being analysed. Conclusively, the wells near the rocky terrain are analysed for adequate recharge and higher agricultural productivity. Reference From the above discussion, it is quite clear that the ground water augmentation structures constructed in the rocky terrain by the state watershed department and other NGOs in the last one decade in Jalore district have proved to be beneficial for the local population as such structures recharge the ground water considerably. The wells dug in the rocky terrain have adequate water even during the leap period of the year. Hence, it can be concluded that ground water augmentation structures should be constructed in Jalore district.

- Groundwater should be used judiciously taking into account modern agriculture water management techniques by cultivating crops needing less watering such as wheat, barley, Makka- Mahi kanchan, Jowar, Bajara, Moong, Soyabeen, Til, Ground nuts, Mustard and use of sprinkler & drip irrigation systems should be encouraged.
- The small-scale farmers in the area should be encouraged to use common ground water structures for optimum use of ground water resources for irrigation purposes.
- Cultivators should also be made aware and encouraged to adopt suitable cropping pattern using modern techniques by extension services for getting maximum agriculture production through minimum withdrawal.
- Suitable artificial recharge structures like subsurface barriers across the river bed should be constructed to arrest and impound the ground water run off for meeting various sectoral needs.
- Mass awareness programmes should be taken up in almost all the areas of the district to educate public in adopting water saving practices & conservation of water.

A provision for surplus water of Narmada Canal project for artificially recharge in the district may be taken into consideration. Emphasis should be laid on preparation of regional water supply scheme from Narmada canal water & irrigation should also be facilitated by surface water available through Narmada Canal project so as to reduce the stress on ground water resources

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