STUDY OF DIFFERENT PARAMETERS OF GROUNDWATER UTILIZING GIS TECHNIQUE IN SEMI-ARID REGION OF RAJASTHAN

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Abstract
The quality of water resources is a subject of concern. The health and happiness of the human beings are closely tied up with the quality of the water used for consumption where the per capita consumption of water is an index of quality of life of the people as well as their economic and social condition. Two major sources of drinking water are groundwater and surface water. In India groundwater is the major source of drinking water with 85% of the population dependent on the same. Due to various natural and anthropogenic factors, the groundwater is getting polluted becauseof deep percolation from intensively cultivated fields, disposal of hazardous wastes, liquidand solid wastes from industries, sewage disposal, and surface impoundments. The risk of drinking water is rising rapidly in the developing countries. Millions of people all over the world particularly in the developing countries are losing their lives every year from water borne diseases like cholera, typhoid, bacillary dysentery, infectious hepatitis, leptospirosis, giardiasis, and gastroenteritis. Similarly, the purpose of our study is to recognize the groundwater contaminate zone in Churu district the help of GIS.

Keywords: Water, Quality, Groundwater, GIS.

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Introduction

Water is a natural resource and plays a very important role in every living organism. It is essential for sustaining life, and adequate, safe and accessible supply of water must be available to all. Human and plant body consists of 60% and 90% water respectively. In this way, water resources have been considered as valuable reserves, and infrastructure developing countries have also tried to understand the capabilities of these resources. Groundwater is almost globally important for human consumption as well as for the support of habitat and for maintaining the river's base-flow. Being naturally filtered in their passage through the ground, they are usually clear, colorless and free from microbial contamination and require minimal treatment. About 71 percent of the Earth's surface is water-covered, and the oceans hold about 96.5% percent of all Earth's water. Water also exists in the air as water vapor, in rivers and lakes, in icecaps and glaciers, in the ground as soil moisture and in aquifers, and even in you and your dog. Water is never sitting still. Water supply is constantly moving from one place to another and from one form to another. The global water resources about 96.54% are saline water mainly in oceans, and remaining is available as fresh water. In fresh water 1.74% is as ice caps, glaciers & permanent snow, 1.69% is as groundwater, 0.022% is as ground ice and permafrost, 0.013% is as lakes and very less in atmosphere 0.001% and rivers 0.0002%.

1.1 Hydrologic Cycle

From the beginning of time when water first appeared, it has been constant in quantity and continuously in motion, little has been added or lost over the years. Water continually moves between the oceans, the atmosphere, the cryosphere, and the land. The movement of water among the reservoirs of ocean, atmosphere, and land is called the hydrologic cycle.

Figure 1, shows the hydrologic cycle in which water leaves the atmosphere and falls to earth as precipitation where it enters surface waters or percolates into the water table and groundwater and eventually is taken back into the atmosphere by transpiration and evaporation to begin the cycle again.

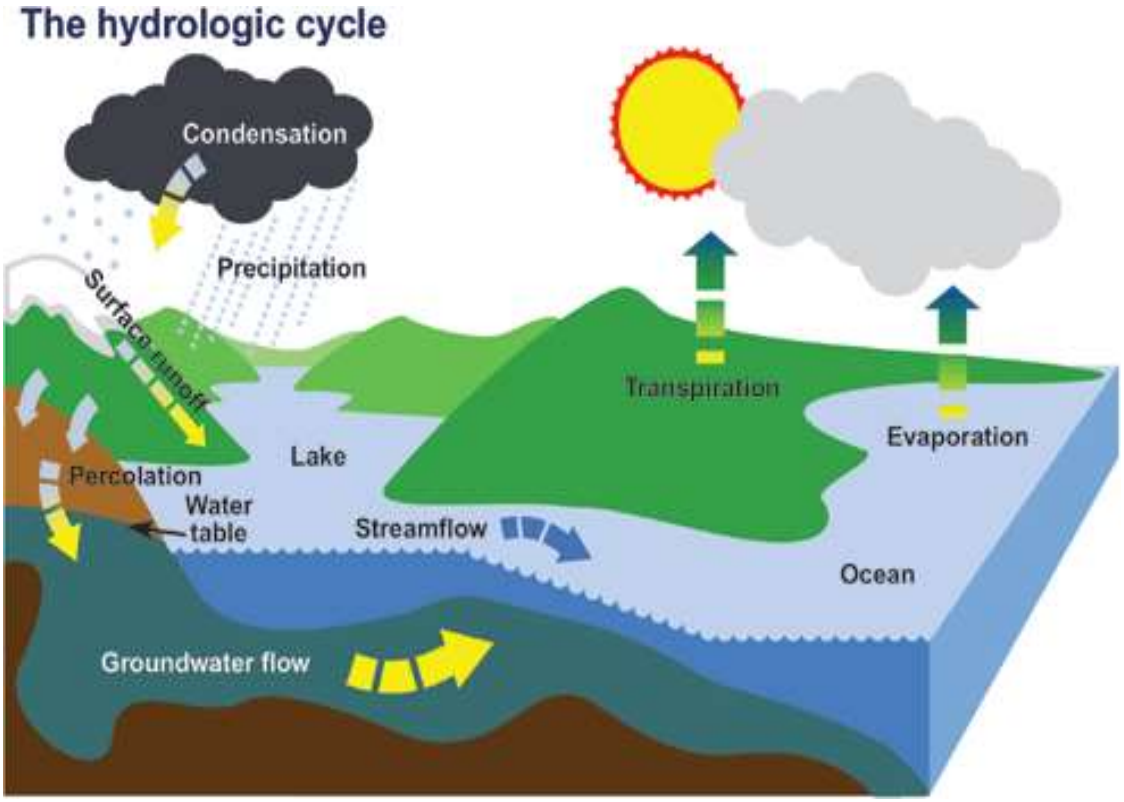


Figure 1: The Hydrologic Cycle (USGS, 2012)

Components of Hydrological Cycle

Evaporation:

As water is heated by the sun, surface molecules become sufficiently energized to break free of the attractive force binding them together, and then evaporate and rise as invisible vapor in the atmosphere.

Transpiration:

Water vapor is also release from plant leaves by a process called transpiration. Every day anactively growing plant transpires 5 to 10 times as much water as it can hold at once

Condensation:

As water vapor rises, it cools and eventually condenses, usually on tiny particles of dust inthe air. When it condenses, it becomes a liquid again or turns directly into a solid (ice, hail or snow). These water particles then collect and form clouds.

Precipitation:

Precipitation in the form of rain, snow, and hail comes from clouds. Clouds move around the world, propelled by air currents. For instance, when they rise over mountain ranges, they cool, becoming so saturated with water that water begins to fall as rain, snow or hail, depending on the temperature of the surrounding air.

Runoff:

Excessive rain or snowmelt can produce overland flow to creeks and ditches. Runoff is avisible flow of water in rivers, creeks, and lakes as the water stored in the basin drains out.

Ground water:

Subterranean water is held in cracks and pore spaces. Depending on the geology, the groundwater can flow to support streams. It can also be tapped by wells. Some groundwater is very old and may have been there for thousands of years.

Methodology:

Ground water data of Churu district is processed and geographical map created with the help of QGIS to analysis and recognize the pattern of tha ground water.

Data processing with QGIS:

QGIS (formerly Quantum GIS) is an open source geographic information system (GIS). This

software is a free alternative to proprietary GIS software such as ESRI's ArcGIS products which can be very expensive.

SHAPEFILE DATA

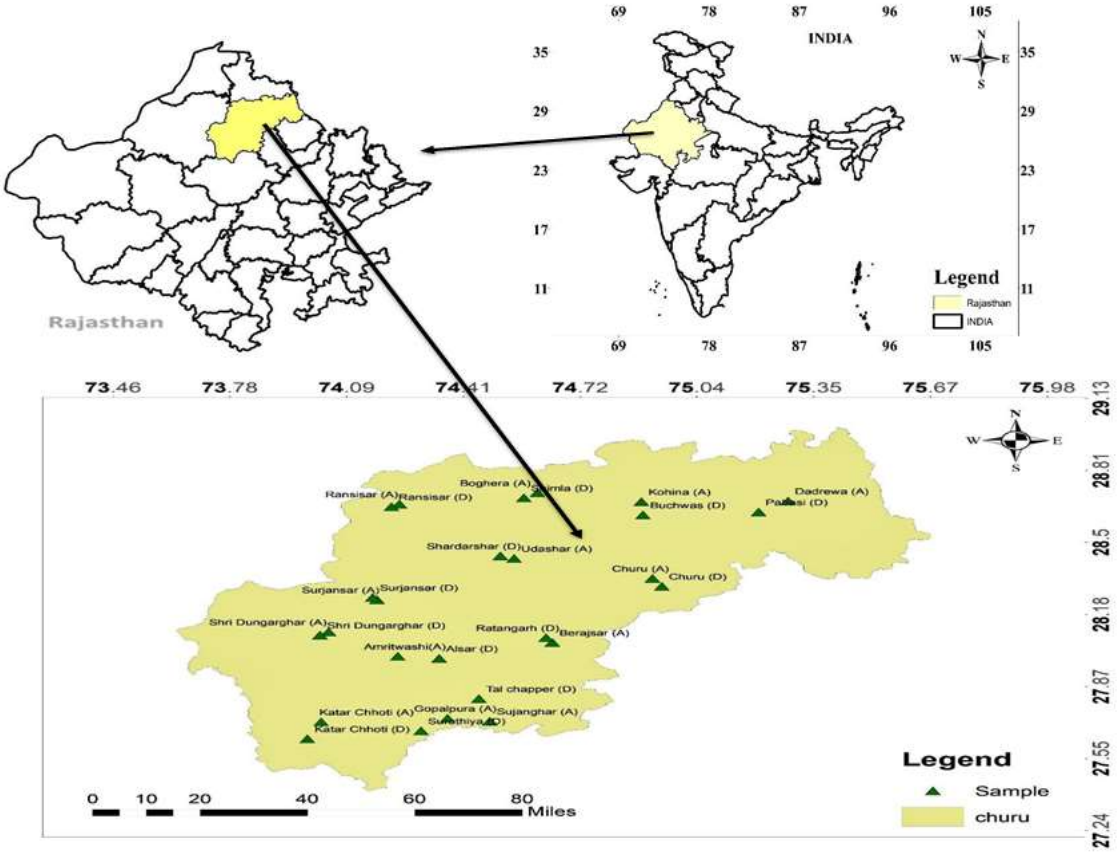
A shapefile is a simple, nontopological format for storing the geometric location and attribute information of geographic features. Geographic features in a shapefile can be represented by points, lines, or polygons (areas). The workspace containing shapefiles may also contain dBASE tables, which can store additional attributes that can be joined to a shapefile's features. To import a shape file, click on the 'Layer' tab in the upper left hand corner of the screen, and select the 'Add Vector Data' tab. A window will then prompt you to navigate to your saved shape file dataset on your hard drive. Afterwards click 'open' and you should see your point data on the main display.

EXCEL SHEET DATA

Spreadsheets are composed of columns and rows that create a grid of cells. Typically, each cell holds a single item of data. Here's an explanation of the three types of data most commonly used in spreadsheet programs:

1. Text data, also called labels, is used for worksheet headings and names that identify columns of data.
2. Number data, also called values, is used in calculations. By default, numbers are right-aligned in a cell. In addition to actual numbers, Excel also stores dates and times as numbers
3. Formulas are mathematical equations that work in combination with data from other cells on the spreadsheet. Simple formulas are used to add or subtract numbers. Advanced formulas perform algebraic equations.

Creating the IDW Interpolated Raster Surfaces Interpolation in QGIS
Creating Clipping Polygon and Clipping Interpolation Surface Exporting the Final Maps
Study area
Location and extent of the Churu district:



Map of Churu District (in legend sample should be written as sample site)

Churu district is located in the northern part of Rajasthan. It is bounded on the north by Hanumangarh district, in the east by the state of Haryana and Jhunjhunu district, south by Sikar and Nagaur districts and by Bikaner district in the west. It stretches between 27^0 24' 31.50" to 29^0 00' 01.74" North latitudes and 73^0 50' 39.45'' to 75^0 40' 31.85'' East longitudes. It has six tehsils

including Churu, Rajgarh, Ratangarh, Shardarshar, Sujangarh, and Taranagar. The district does not have a properly evolved drainage system, except for a negligible part in the east which is part of Shekhawati River Basin, almost whole of the district is part of an 'Outside' Basin. Churu district is administratively divided into six blocks but few year back it will be divided into seven blocks and in this study, Churu divided into seven blocks.

Table 4.1: Sample location

S. No.	Sample Site	Source of Water	Latitude	Longitude
1	Dadrewa (A)	Bore-well	28.68	75.28
2	Pabasi (D)	Bore-well	28.63	75.20
3	Kohina (A)	Bore-well	28.68	74.89
4	Buchwas (D)	Bore-well	28.62	74.89
5	Boghera (A)	Well	28.72	74.61
6	Shimla (D)	Bore-well	28.69	74.57
7	Ransisar (A)	Well	28.67	74.23
8	Ransisar (D)	Bore-well	28.65	74.21
9	Surjansar (A)	Well	28.25	74.17
10	Surjansar (D)	Well	28.26	74.16
11	Udashar (A)	Well	28.43	74.54
12	Shardarshar (D)	Well	28.44	74.51
13	Churu (A)	Well	28.34	74.92
14	Churu (D)	Bore-well	28.31	74.94
15	Berajsar (A)	Well	28.06	74.65
16	Ratangarh (D)	Hand-pump	28.08	74.63
17	Amritwashi(A)	Well	28.00	74.23
18	Alsar (D)	Hand-pump	27.99	74.34
19	Shri Dungarghar (A)	Well	28.11	74.04
20	Shri Dungarghar (D)	Hand-pump	28.09	74.02
21	Katar Chhoti (A)	Bore-well	27.71	74.02
22	Katar Chhoti (D)	Hand-pump	27.64	73.99
23	Gopalpura (A)	Bore-well	27.73	74.36
24	Surothiya (D)	Hand-pump	27.68	74.29
25	Sujanghar (A)	Well	27.72	74.48
26	Tal chapper (D)	Hand-pump	27.82	74.45

A = Agricultural Land & D= Populated Area.

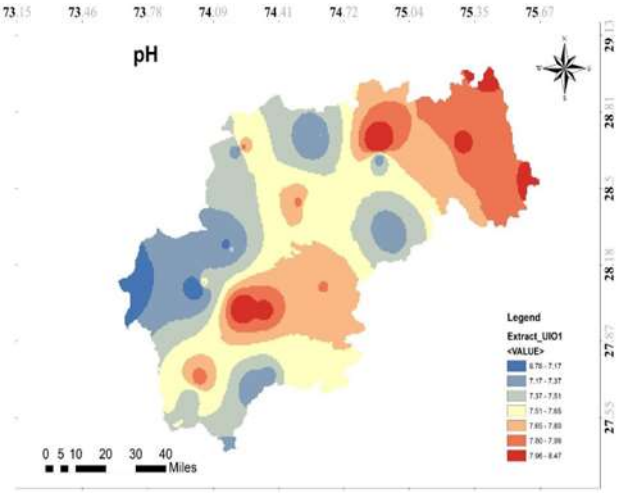
5. Results and Discussion

Table 5.1 Hydrochemical Properties:

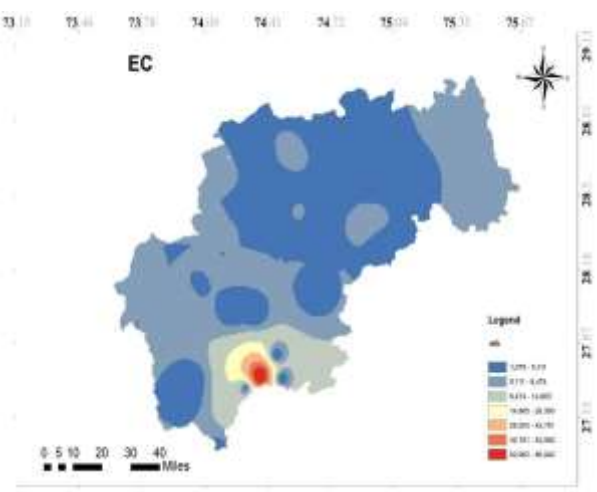
Sample	pH	EC µS	TDS mg/L	Alkalinity mg/L	T. H. mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	Cl^{-} mg/L	SO_4^{2-} mg/L	F^{-} mg/L
G 1	8.03	8230	3510	900	266.67	46.53	36.53	131	0.16	1712.8	663	13
G 2	7.69	2740	1260	640	173.33	42.53	16.28	49.1	0.17	259.92	339	2
G 3	8.48	1370	570	420	153.33	33.2	17.09	28.3	0.02	36.66	97	12
G 4	7.24	4740	2280	496.67	493.33	114.53	50.3	77.7	0.06	573.16	222	16
G 5	7.38	2030	740	486.67	666.67	118.53	89.99	12.7	8.77	76.64	180	1.6
G 6	7.18	7660	3330	360	746.67	127.87	103.76	282	0.69	1586.18	1150	1.5
G 7	7.9	952	215	133.33	123.33	31.87	10.61	8.6	0.25	53.32	48.5	4
G 8	7.16	9150	3900	323.33	1363.33	238.53	186.38	122	1.01	2156	1320	16
G 9	7.47	4630	1920	766.67	156.67	29.2	20.33	82.9	0.44	756.43	422	5
G 10	7.01	7110	2930	326.67	620	122.53	76.22	99.1	1.18	2051.03	418	0.9
G 11	7.54	5560	2290	276.67	980	171.87	133.73	61.4	0.88	1372.91	1000	13
G 12	7.86	4070	1780	853.33	103.33	19.87	13.04	72.7	0.28	521.5	451	8
G 13	7.31	8490	3630	266.67	1353.33	213	199.34	112	0.75	2264.3	1690	1
G 14	7.3	2360	1030	250	476.67	78.53	68.12	23.2	0.88	566.49	114.5	6
G 15	7.73	3170	1310	743.33	100	29.2	6.56	58.3	0.19	166.62	389	4
G 16	7.84	3110	1250	470	310	55.87	41.39	47.2	0.75	596.48	139	9
G 17	8.23	1360	550	286.67	170	37.2	18.71	20.6	0.22	168.28	109	2
G 18	8.04	1390	590	326.67	220	35.87	31.67	17.8	0.31	189.94	111	0.6
G 19	7.68	2530	1090	703.33	210	46.53	22.76	39	0.28	138.29	243	0.7
G 20	6.76	7730	3220	366.67	1456.67	349.2	141.83	78.8	0.63	411.54	239	2
G 21	7.89	2460	1060	173.33	323.33	50.53	47.87	26.6	0.34	2237.64	147.5	2
G 22	7.45	1150	487	280	230	42.53	30.05	10.1	0.31	156.62	63.5	3
G 23	7.33	87200	32500	300	7733.33	1318.53	1078.19	1590	94.87	1161.31	9010	18
G 24	7.18	4060	1730	170	1436.67	294.53	170.18	15.5	1.18	1216.29	230.5	1
G 25	7.58	2150	910	270	343.33	75.87	37.34	32.8	0.28	1657.82	104.5	11
G 26	7.63	2570	1090	646.67	203.33	49.2	19.52	157	2.87	401.54	167	9

pH:

pH in the groundwater of study area is caused by bicarbonate and carbonates. The pH of the North-West area and in some particular area concentration is very high. North, middle and southern are showing high concentration while only western region show medium to normal concentration in the area. If we go north weat from the south side we see increase in the pH value.



pH Concentration of Churu District



EC Concentration of Churu District

Electric conductivity:

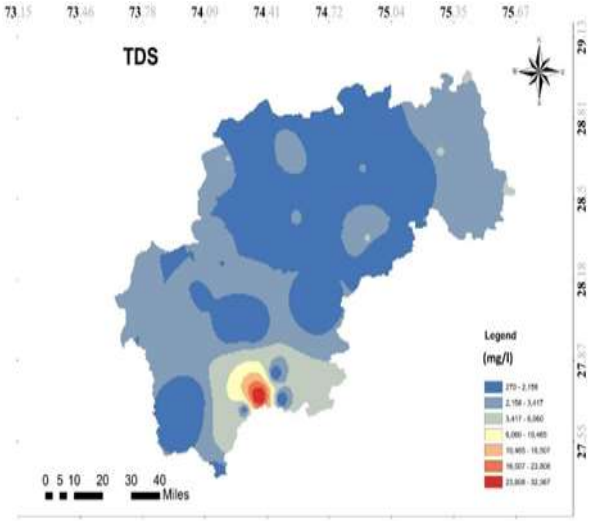
Conductivity is directly related to the total dissolved solids. The electric conductivity of the groundwater from study area is very high in southern side of the particular area. Mostly all other areas of the district are too shows high electric conductivity.

TOTAL DISSOLVED SOLIDS:

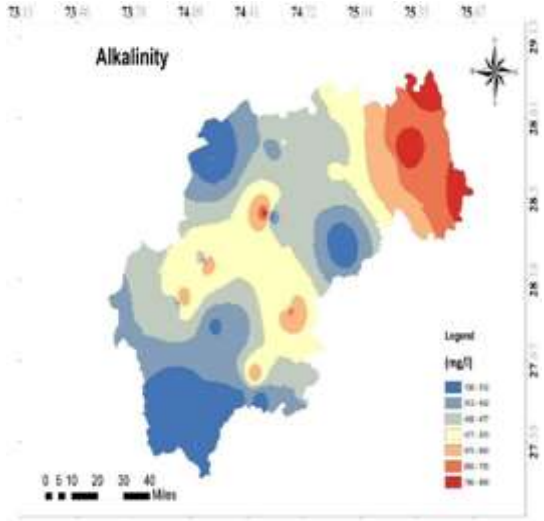
The map of total dissolved solids also show similar pattern like Electric conductivity and the total dissolved solids of the groundwater from study area is very high in southern side of the particular area. Mostly all other areas of the district are too shows high total dissolved solids.

ALKALINITY:

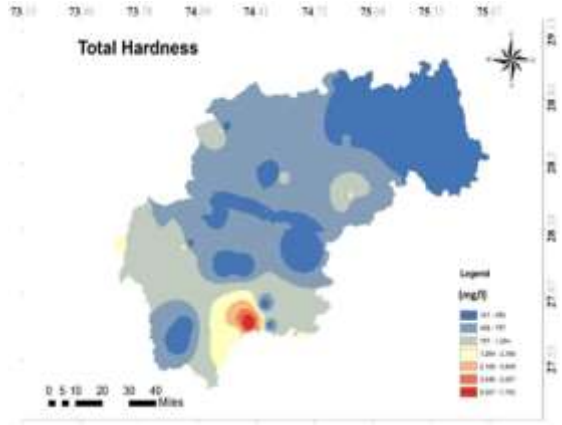
The alkalinity of water may be defined as its capacity to neutralize the acid. Alkalinity in the groundwater of study area is caused by bicarbonate and carbonates. The alkalinity of the groundwater from study area show concentrations in north eastern side of district and some ares of central area. North wester and south western areas of the district.



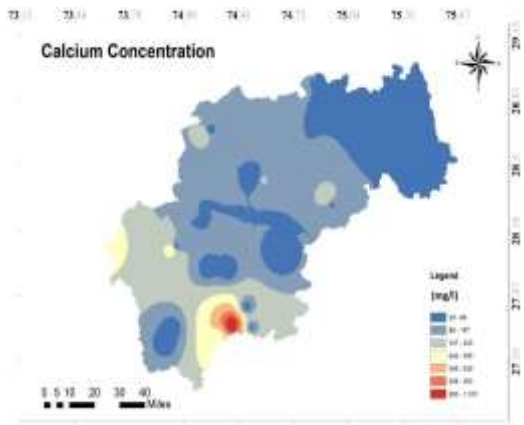
TDS Concentration of Churu District



Alkalinity Concentration of Churu District



Total Hardness Concentration of Churu



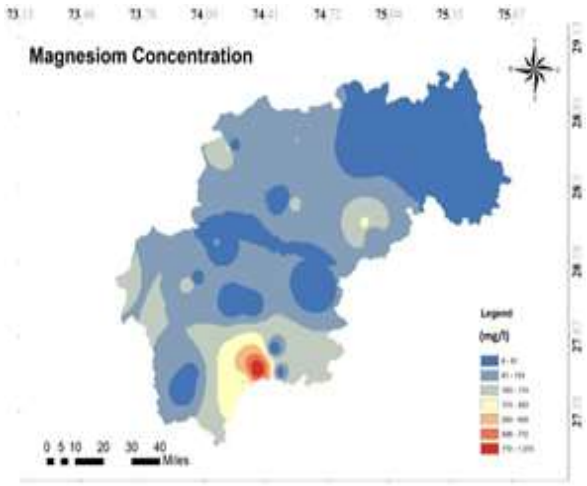
District Calcium Concentration of Churu District

TOTAL HARDNESS:

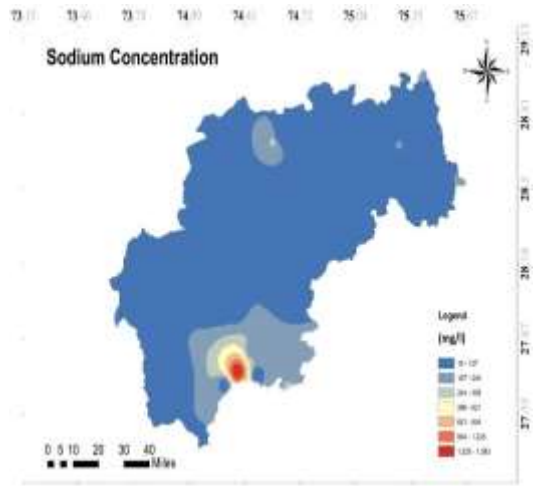
Total Hardness concentration in south western region is very high and in other all region of the district are varying from medium to normal.

Variation in ions concentration:

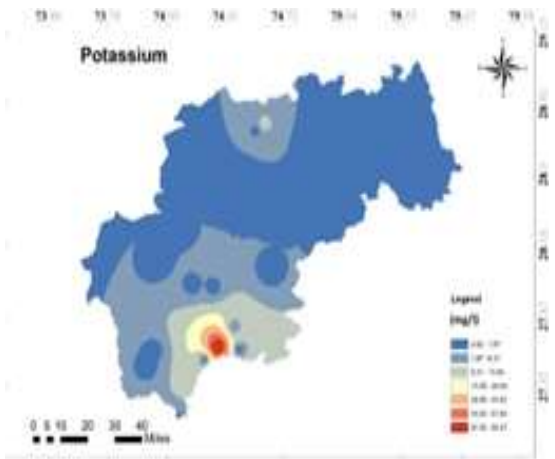
In the study area, calcium concentration ranges between 19.87 to 1318.53 mg/L. GIS map shows north eastern regions show normal concentration and south western region show medium to high concentration. Magnesium in the sampling area range between 6.56 mg/L to 1078.19 mg/L. Magnesium concentration is also show smiler map like calcium concentration. In this region also, GIS map shows north eastern regions normal concentration and south western region medium to high concentration.



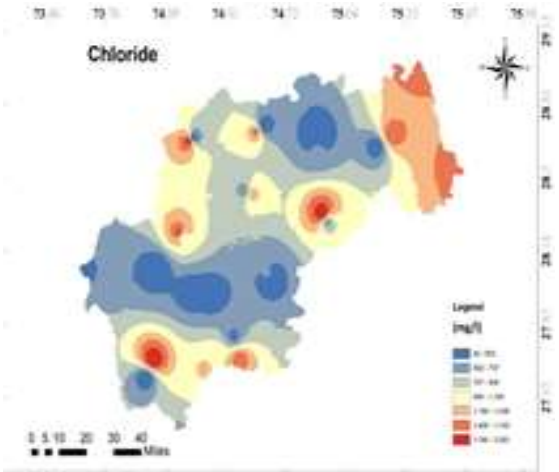
Magnesium Concentration of Churu District



Sodium Concentration of Churu District

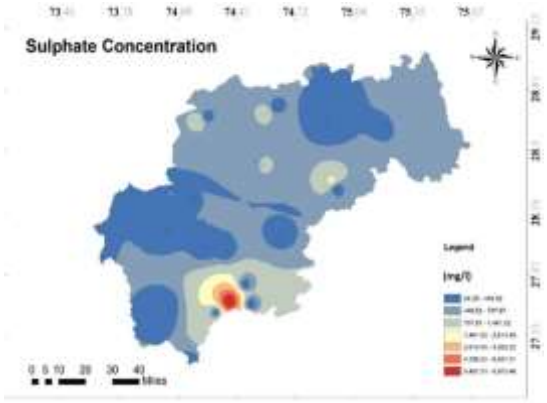


Potassium Concentration of Churu District

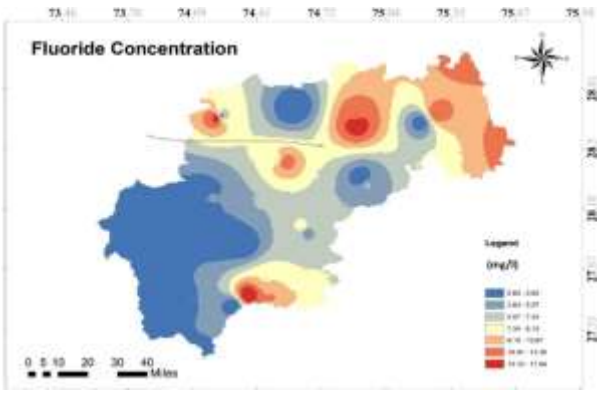


Chloride Concentration of Churu District

Sodium in the groundwater varies between 8.6 to 1590 mg/L and potassium varies in between 0.02 to 94.87 mg/L. Sodium and Potassium concentration map both are show similar characteristics or patterns that are normal in all the district and high in the south western regions and very high in south side in a particular area of the district.The chlorides value was between 36.66 to 2237.64 mg/L in the groundwater. In chloride concentration, chlorides concentrations in the district are moderate to high in manly all region but in some particular areas the concentration of the chlorides is normal and these areas are very limited. The sulphate ion is one of the major anions occurring in natural water. Sulphate in the groundwater ranged between 48.5 to 9010 mg/L. In the study area, most samples are with a high concentration of sulphate. Southern regions show high concentrations of sulphate and other all regions also show moderate to high concentration.



Sulphate Concentration of Churu District



Fluoride Concentration of Churu District

Fluoride, the most commonly occurring form of fluorine, is the natural contaminant of water. The presence of fluorine in groundwater is mainly a natural phenomenon and mainly influenced by local and regional geological conditions, as the fluoride minerals are nearly insoluble in water. Hence fluorine is present in groundwater only when the conditions favour their solution. Fluoride concentration in the sampling area ranges from 0.06 mg/L to 18 mg/L and approximately 68% sample will found with the excessive amount of fluorides.

GIS map shows high concentrations of fluoride in the all regions of the district but in southern side of the district fluoride concentrations is normal to moderate.

6. Conclusions

1. In the present study, some regions show average concentration or adequate concentration of all parameters and some region show high concentration of all parameters.
2. Sujangarh region shows very high concentration of all the parameters in all the areas.
3. The spatial representation of groundwater quality in the study area of Churu district indicates variable groundwater quality in the study area so that it is very necessary to watwer treatment before consumption needs treatment before consumption.
4. High fluoride concentration more than permissible value region recognized and water of thoese are can not be used as drinking water.

7. References

1. K. Sinha and Y. Musturia (2004): High fluoride Groundwater in Chaksu Tehsil, Jaipur, Rajasthan: Indian Journal of Environmental Science: 8(2): Page 103-107.
2. APHA, Standard Methods for Analysis of Water and Wastewater.18th Edition. American Public Health Association, Inc., Washington D C. (1992).
3. Arnal J. M. A., M. S. Fernandez, G. M. Verdu and J. L. Garcia (2001): Design of a membrane facility for water potabilization and its application to third world countries. Desalination, 137, p.63-69
4. Atikeh Afzali et all (2014): Groundwater Quality Assessment in Haraz Alluvial Fan, Iran: International Journal of Scientific Research in Environmental Sciences: ISSN: 2322- 4983: Page 46-360
5. Bahruddin Saad et all (1998): Analysis of Anions and Cations in Drinking Water Samples by Capillary Ion Analysis: Food Chemistry: Vol. 61: Page 249-254
6. Beibei Niu et all (2014): Twenty years of

global groundwater research: A Review Bijendra Kumar et all (2016): Spatial Variability of Fluorine in Agricultural Soils around Sidhi District, Central India: Journal Geological Society of India: Vol.87: Page 227- 235
7. Sadashivaiah et all (2008): Hydrochemical Analysis and Evaluation of Groundwater Quality in Tumkur Taluk, Karnataka State, India: Environmental Research and Public Health: ISSN 1661-7827: Page 158-164
8. W. Fetter (1988) Applied Hydrology 2nd Edition Merril Publishing company, London: Page 592.
9. Chebbah Mohamed and Allia Zineb (2015): Geochemistry and Hydrogeochemical Process of Groundwater in the Souf Valley of Low Septentrional Sahara, Algeria: African Journal of Environmental Science and Technology: Vol. 9(3): Page 261-273
10. D S. Rajendra Prasad et all (2009): Hydrochemical Characteristics and Evaluation of Groundwater Quality of Tumkur Amanikere Lake Watershed, Karnataka, India: E- Journal of Chemistry: ISSN: 0973-4945
11. Allen and M. Suchy (2001): Geochemical Evolution of Groundwater on Saturna Island, British Columbia: Can. Jour. Earth Science
12. Laura et al, (1997): Sampling Procedures for Groundwater Monitoring Wells.
13. D. Murlidharan, A. P. Nair and U. Sathyanarayana (2002): Fluoride in Shallow Aquifers in Rajgarh Tehsil of Churu district, Rajasthan: an Arid Environment Current Science: 83(6): Page 699-702.
14. Dipankar Chakraborti et all (2011): Examining India's Groundwater Quality Management: Environmental Science & Technology Feature: Page 27-33
15. Dohare Devendra (2014): Analysis of groundwater quality parameters: Research journal of engineering sciences: ISSN 2278-9472: Vol. 3(5)
16. Taiana et all (2015): Bulk Atmospheric Deposition of Major Ions and Dissolved Organic Nitrogen in the Lower Course of a Tropical River Basin, Southern Bahia, Brazil: Chemistry Society: Vol. 26
17. Geology And Mineral Resources of Rajasthan, Geological Survey Of India: No. 30, Part 12, 3rd Reviewed Edition, (2011)
18. Groundwater Year Book (Rajasthan State): Central Groundwater Board (2014 – 2015) Groundwater Quality and Groundwater Pollution, Publication 8084.
19. Groundwater Quality in Shallow Aquifers Of India, Central Groundwater Board: Ministry Of Water Resources, Government Of India (2010)
20. Groundwater Sampling and Analysis – A Field Guide: Geoscience Australia: AustralianGovernment (2009)
21. Handa, B.K., (1975): Geochemistry and Genesis of Fluoride Containing Groundwater in India, Groundwater: 13: 278281
22. Hydrogeological Atlas of Rajasthan, Churu District: Groundwater Department, Rajasthan(2013)
23. Indian Standard for Drinking Water: Bureau of Indian Standards, New Delhi (Second Revision, 2012)
24. J Hussain, K. C. Sharma (2004): Fluoride in Drinking Water in Rajasthan and its Ill Effects on Human Health: Journal of Tissue Research: Vol. 4 (2): Page 263-273
25. K. Akhalesh, G. Seth and M. K. Samota (2005): Geochemical Studies of Fluoride in Groundwater of Rajasthan: Chemistry: an Indian Journal: 2 (6): Page 191-193.
26. Keshar Dev et all (2014): Estimation of the Physico-Chemical Properties of Water in the Churu Tehsil, of Arid Region of Rajasthan (India): Asian Resonance VOL.-III, ISSUE-III
27. Kulshreshtha S N (1998): A Global Outlook for Water Resources to the Year 2025, Water Resources Management, 12 (3), p.167–184
28. Patel S. V., D. R. Fudani and K. P. Patel (2007): Physico-chemical characterization of under groundwater used in Modasa and other villages of Modasa Taluka District Sabar Kantha (Gujarat), International Journal of Chemical Sciences, 5(1), p.276-280
29. M Jayaprakash et all (2013): Groundwater Geochemistry of Neyveli Lignite Mine-Industrial Complex, Tamil Nadu, India and Its Suitability for Irrigation: International Journal of Advanced Earth Science and Engineering: Volume 1: Issue 1
30. M. S. Rathod (2005): Groundwater Exploration and Augmentation Efforts in Rajasthan: A review.
31. N. Singh (2014): Physico-chemical Analysis of Selected Drinking Water Resources of Rajgarh- Sadulpur tehsil of Churu Rajasthan: Grip: Page 29-34
32. Rajdeep Kaur and Ravi Singh, (2011): Assessment for different groundwater quality parameters for irrigation purposes in Bikaner city, Rajasthan: journal of applied science in environmental sanitation: 6(3):365-392.
33. Rakesh Kumar Tatawat and C. P. Singh

Chandel(2008):A Hydrochemical Profile for Assessing the Groundwater Quality of Jaipur City: Enviro. Moni Assess- 143: Page 337-343.
34. Reviews, S. (2015): Indian Mineral Yearbook 2013, part -1: Yearbook 2013, 2013(0712).
35. S. Earle and E. Krogh (2004): Groundwater Geochemistry of Gabriola: Shale No. 7: Page 37-44.
36. S. Swati and S. Umesh (2015): Nemerow's Pollution Index: for Groundwater Quality Assessment: Journal of Environmental Science and pollution Research: 1(1), 23-31.
37. Science Citation Index Expanded-based Bibliometric Survey (1993–2012): Journal ofHydrology: Page 966-975
38. SI Babiker, AA Mohamed, TH Mohamed (2007): Assessing Groundwater Quality using GIS.Water Resour Manag 21:699–715.
39. Watershed Function, publication 8064.
40. WHO Health Criteria and other Supporting Information: Guidelines for Drinking Water Quality: 2: CBS Publishers and Distributors (1985).
41. World Health Organization-WHO. Guidelines for Drinking Water Quality. 2nd Edition Surveillance and Control of Community Supplies. Geneva, Switzerland. 3 (1997).