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Impact of agricultural practices on ground water quality of few villages of Sangod Tehsil in Kota District, Rajasthan

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Abstract

The present investigation was carried out to investigate the impact of agricultural practices on ground water quality at five villages in tehsil Sangod, Kota district. Examining various physicochemical parameters like pH, total dissolved solids, alkalinity, total hardness, sulphate, chloride, nitrate, phosphate through the water analysis and comparing results with water quality standards prescribed by WHO and BIS 10500 and calcuting various water quality indices indicated suitability of water for different purposes. Correlations among different parameters have also obtained by karl Pearson's method.

Key words : Ground water, Pearson's method for correlations, agricultural practices, water quality indices.

Introduction

Groundwater is an important source of water for agricultural, domestic and industrial purposes in Rajasthan state. High quality of ground water is essential for the health and welfare of the human beings. The disposal of large quantity of solid wastes and its open dumping to the soil affect the ground water quality[1]. The continuous addition of toxic materials in the land and water bodies reaches the ground water through seepage and contaminates the ground water[2]. Water pollution is an important aspect of environmental pollution and a large set of adverse effects upon water bodies caused by human activities[3-6]. Water pollution involves the release into lakes, streams, rivers and oceans, of substances that become dissolved or suspended in the water or get deposited upon the bottom and accumulate to the extent of damaging ecosystem[7]. Being an important component of ecosystem, any impurity added to water can create imbalance resulting harm to whole ecosystem. The development of agriculture lands and the increasing use of ground water for irrigation usually result in significant changes in water quality. The main source of income or occupation of most of the people in this area is agriculture/ farming. As the use of animal manures as fertilizer is

common in agricultural practices in this area, therefore probability of nitrogen contamination of ground water is relatively high. The present studies have been initiated to find out impact of agricultural practices on ground water quality of selected area.

Materials and Methods

Study Area: Kota city is centrally located in Hadoti Region. The district Kota lies between 24°25' and 25°51' North latitudes and 75°31' and 77°26' East longitudes with total area of 5217sq Kms. "Kota City" is located at extreme South of it at 25°11' North latitude and 75°51' East longitude occupying total area of 238.59 sq Kms with average height of 253.30 meters from mean sea level. The only perennial river "Chambal" originating from the hills of Western Madhya Pradesh passes through the district. According to 2011 census, total population of district is 1,950,491. Total male population of Kota district is 1,023,153 and female population is 927,338. Total geographical area of Sangod tehsil is 106889 hectare in which agricultural land is recorded 66077, 65835, 66710 hectare and recorded nonagricultural land is 35961, 36435, 35962 hectare in year 2008, 2009 and 2010 respectively. In years 2008, 2009 and 2010 the irrigated agricultural land area in record was 63496, 62347 and 59172 hectares respectively. In agricultural practices, various types of agro-chemicals are used by farmers. In selected location the total number of tube wells was recorded as 144, 165 and 184 in years 2008, 2009 and 2010 respectively and it was recorded that 06 open wells were used in irrigation during these years. In Sangod tehsil, agrochemicals which were used during 2008-2010 are; sulphur, urea, D.A.P., potash (as fertilizer) and endosulphan (as pesticides). In the study area main source of irrigation is open well/ tube well. (Source—Milan Khasara, Land Record Office Tehsil Sangod, Kota (Rajasthan) V.S.2064).

Sampling Locations and Techniques: To find out ground water quality status in Sangod tehsil, five villages Deoli, Nagra Kheri, Theemli, Barna, Gardana were selected for study. Water samples were collected from twenty different selected sites in winter, spring, pre monsoon and, post monsoon, period of years 2008, 2009, and 2010. The open wells /tube wells located in agricultural area were selected for sampling. The samples were collected as composite samples; at every site, samples were collected from four different points and then mixed together *i.e.* from five village locations, samples were collected from twenty different sites. Samples were collected in pre-cleaned good quality narrow mouth screw-capped polypropylene bottles of two-liter capacity and rinsed thrice with the water to be collected and then filled completely to avoid encroachment of any air bubble. Sample bottles were then screw-caped tightly and brought to the laboratory. The samples were procured with traditional methods and preserved in a refrigerator at 4°C. Samples were protected from any outside contamination. The coding of sampling locations is given in table 1.

Table 1. Sampling Locations

S. No.	Sampling Locations	Source
1.	Deoli	S_1 Open well/ Tube well
2.	Nagra Kheri	S_2 Open well/ Tube well
3.	Theemli	S_3 Open well/ Tube well
4.	Barna	S_4 Open well /Tube well
5.	Gardana	S_5 Open well /Tube well

The physicochemical parameters like pH, Total Hardness (TH), chloride (Cl^-), nitrate (NO_3^-), Total Dissolved Solids (TDS), total alkalinity, phosphate, sodium(Na), potassium (K), calcium (Ca) and magnesium(Mg) were analyzed using standard methods[8-10]. The methods used for estimation of various physicochemical parameters are tabulated in table 2.

Table 2. Methods used for estimation of physicochemical parameters

S. No.	Parameters	Methods
1.	pH	pH metry
2.	Conductivity	Conductometric method
3.	Total dissolved solids	Calculation method
4.	Total alkalinity	Titration method
5.	Total Hardness, calcium and magnesium	EDTA titration
6.	Sodium and Potassium	Flame photometric method
7.	Chloride	Silver nitrate titration method
8.	Nitrate	Ion-Selective Electrode method
9.	Phosphate	Spectrophotometric method

Some important indices calculated adopting following methods:

Aggressive Index (AI): AI is calculated from the pH, total hardness in mg/L as $CaCO_3$ (TH) and the total alkalinity in mg/L as $CaCO_3$ (TA) of the water.

$$AI = pH + \log (TA \times TH)$$

Where pH = Measured water pH , TA = Total alkalinity in mg/L, TH=Total hardness in mg/L

Langlier Saturation Index (LSI): It simply indicates the driving force for scale formation and growth in terms of pH is a master variable. LSI is defined as:

$$LSI = pH - pHs$$

pHs is the pH at saturation in calcite or calcium carbonate and is defined as:

$$pHs = (9.3+A+B) - (C+D)$$

Where $A= (\log10 (TDS)-1) / 10$; $B = -13.72 \times \log_{10} (C + 273) + 34.55$

$C = \log_{10}$ (TH as Ca CO_3) – 0.4; $D= \log_{10}$ (A as Ca CO_3))

Ryzner Index (RI): The Ryzner Stability index is an empirical method for predicting scaling tendencies of water based on a study of operating results with water of various saturation indices.

$$RI = 2pHs - pH$$

Percentage Sodium (%Na): The proportion of sodium among all the cations present in water is usually expressed in terms of percent sodium. It is also called as Soluble Sodium percentage (SSP). It is estimated with following equation[11]:

$$\% Na = \left\{ \frac{Na^+}{(Ca^{+2} + Mg^{+2} + K^+ + Na^+)} \right\} \times 100$$

Sodium Adsorption Ratio (SAR): A ratio of soil extract and irrigated water used to express the relative activity of sodium ions in exchange reaction with soil. It is estimated with the help of the following equation[12]:

$$SAR = \left\{ \frac{Na^+}{\sqrt{(Ca^{+2} + Mg^{+2})/2}} \right\}$$

Exchangeable Sodium Percentage (ESP):

It is a degree of saturation of the soil exchange complex with sodium. It is calculated with the help of the following relationship[13]:

$$ESP = \left\{ \frac{100(-0.0126+0.01475\ SAR)}{1+ (-0.0126 + 0.01475\ SAR)} \right\}$$

Residual Sodium Carbonate (RSC) :

It is also an index for evaluation of water quality for irrigational purpose and calculated as[14]:

$$RSC = (CO_3^{-2} + HCO_3^{-}) - (Ca^{+2} + Mg^{+2})$$

Permeability Index (PI) :

Permeability index is used to evaluate the sodium hazards of irrigation water. It is calculated by the following method[15]:

$$PI = \left\{ \frac{(Na^{+} + HCO_3^{-})}{(Ca^{+2} + Mg^{+2} + Na^{+})} \right\} X\ 100$$

Results and Discussion

The average results of the sampling locations (S_1, S_2, S_3, S_4, S_5) of physicochemical parameters for water samples are presented in table 3.

pH: The lower values of pH may cause corrosion in containers and pipeline, while the higher values may produce sediment, deposit and difficulties in chlorination for disinfection of water[16]**.** In the present studies the pH values in all ground water samples varied from 7.7 to 8.5. The pH ranges showed that water samples were alkaline in nature.

Conductivity: Conductance generally varies according to the season. In pre-monsoon period when water gets concentrated the conductance goes on higher side. The values of conductivity varied between 615 to 1060 µS.

Total Dissolved Solids (TDS): Normally ground water has a higher Total Dissolved Solids load compared to surface water. Water with TDS less than 450 mg/L is considered good, and that with greater than 2000 mg/L is unsuitable for irrigation[17]. The values of TDS varied between 600 to 900 mg/L.

Alkalinity: The presence of carbonates, bicarbonates and hydroxide are the main source of alkalinity in natural water[18]. The Average value of alkalinity for water samples varied from 400 to 850 mg/L.

Hardness: Hardness in water is due to the natural accumulation of contents of Ca^{+2} or Mg^{+2} salt or both. They may be present in form of carbonate, bicarbonate, sulphate and chloride[19]. Hardness was found in the range of 200 to 500 mg/L.

Calcium and Magnesium (Ca^{+2}, Mg^{2+}): Calcium is one of the most abundant elements found in the natural water. It is important ion in imparting the hardness to the water. In the present investigation, calcium concentration ranged from 110 to 225 mg/L.

Magnesium also occurs in all kind of natural waters, but its, concentration remains generally lower than the calcium hardness.

Table-3. Average Values of Physicochemical Parameters of Sangod Tehsil

S. No.	Year / Parameters	2008				2009				2010			
		Season				Season				Season			
		Pre-monsoon	Post-monsoon	Winter	Spring	Pre-monsoon	Post-monsoon	Winter	Spring	Pre-monsoon	Post-monsoon	Winter	Spring
1	pH	8.22	7.78	7.98	8.1	8.38	7.9	8.12	8.22	8.3	7.84	8.04	8.2
2	Conductivity	1285	958.2	1064	1172	1319	976.2	1091	1180	1252	932	1052	1124
3	TDS	822.4	613.2	680.9	750	844.2	624.7	698.2	755.2	801.3	596.4	673.3	719.4
4	Total alkalinity	669.2	464	543.4	617.8	782.6	577	665	725.4	798.4	581.6	658.6	730.8
5	Carbonate alkalinity	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
6	Bicarbonate alkalinity	669.2	464	543.4	617.8	782.6	577	665	725.4	798.4	581.6	658.6	730.8
7	Total hardness	482	330.4	392	441.8	532.4	367	436.6	485.2	536	367.4	429.8	483.6
8	Calcium hardness	198.2	129.8	156	176.4	220.8	152.4	177.6	199.6	217.2	151	175	196.4
9	Magnesium hardness	283.8	200.6	236	265.4	311.6	214.6	259	285.6	318.8	216.4	254.8	287.2
10	Sodium	165.4	106.4	129.8	146.6	193.4	137.6	158.8	175.8	208.6	147.2	167.6	188.2
11	Potassium	16	12	13.8	14.6	17.6	13	15.2	16.4	17.4	11.8	14	16
12	Chloride	61.8	35.8	44.8	52	61.6	34.2	45.2	52.6	66.8	40.4	45.6	58
13	Sulphate	76.6	45.4	61.6	64.4	70.4	36	47.4	58.6	81.6	43.8	63.2	68.8
14	Nitrate	34.4	19.4	28.2	27.4	42.6	26.6	29.8	35.8	45.4	26	32.2	39.8

Table 4. Showing correlations analysis between various physicochemical parameters

	pH	TDS	TA	TH	Ca	Mg	Na	K	Cl	SO4	NO3
pH	1	0.9426	0.9304	0.9872	0.9853	0.9836	0.8826	0.9895	0.9201	0.7947	0.9131
TDS		1	0.7864	0.9210	0.9121	0.9228	0.7294	0.9298	0.9236	0.8443	0.7926
TA			1	0.9584	0.9691	0.9455	0.9869	0.9178	0.8513	0.6883	0.9613
TH				1	0.9960	0.9978	0.9313	0.9771	0.9488	0.8304	0.9483
Ca					1	0.9878	0.9404	0.9711	0.9305	0.7952	0.9516
Mg						1	0.9197	0.9765	0.9573	0.8521	0.9410
Na							1	0.8682	0.8483	0.7085	0.9694
K								1	0.9084	0.7823	0.9147
Cl									1	0.9340	0.8894
SO4										1	0.7795
NO3											1

Table 5. Average result of calculated indices of sampling locations

Year	2008				2009				2010			
Calculated	Season				Season				Season			
Indices	Pre-monsoon	Post-monsoon	Winter	Spring	Pre-monsoon	Post-monsoon	Winter	Spring	Pre-monsoon	Post-monsoon	Winter	Spring
% Na	41.71	40.08	40.78	40.90	43.10	43.81	43.08	43.02	44.82	45.55	44.87	44.80
SAR	3.28	2.55	2.85	3.03	3.64	3.12	3.30	3.47	3.92	3.34	3.51	3.72
ESP	5.74	4.77	5.18	5.42	6.22	5.54	5.78	6.00	6.58	5.82	6.05	6.32
RSC	3.74	2.67	3.03	3.52	5.00	4.20	4.57	4.80	5.25	4.28	4.58	4.94
PI	196.42	232.92	214.74	205.32	190.92	225.21	209.08	199.32	188.61	221.97	207.46	197.24
AI	13.73	12.97	13.31	13.54	14.00	13.23	13.58	13.77	13.93	13.17	13.49	13.75
LSI	1.75	1.00	1.34	1.56	2.02	1.26	1.61	1.79	1.95	1.20	1.52	1.77
RI	4.72	5.78	5.31	4.98	4.34	5.38	4.90	4.64	4.39	5.43	5.00	4.65

Magnesium content in the investigated water samples was varied from 150 to 340 mg/L.

Sodium (Na^+): Sodium concentration in the present analysis was found from 100 to 215 mg/l. Excessive amount of sodium in drinking water is harmful to person suffering from cardiac, renal and circulatory diseases.

Potassium (K^+): Potassium content in the water samples varied from 10 to 18 mg/ L. Potassium is an essential nutrition element but in excessive amounts, it act as cathartic.

Chloride (Cl^-): Chloride is one of the major inorganic anions of water and wastewater. High concentration of chloride is considered to be an indicator of pollution due to organic waste of animal origin (for example animal excreta) which has high quantity chloride along with nitrogenous wastes[20]. Chloride contents varied from 29 to 85 mg/L in all the samples.

Sulphate (SO_4^{-2}): The sulphate ion produces cathartic effect upon human beings when it is present in excess. Sulphate values ranged in ground water samples from 35 to 110 mg/L.

Nitrate (NO_3^-): The toxicity of nitrate to humans is due to the body's reduction of nitrate to nitrite[21]. Nitrate Forms nitrosamine in stomach which causes gastric cancer. Nitrate (NO3-) is the highest oxidized from nitrogen. The nitrate concentration in the samples varied from 20 to 45 mg/L.

Phosphate (PO_4^{-3}): The phosphate concentration in ground water samples varied from 0.08 to 0.15 mg/l which all were within

the limit. Occurrence of Phosphate in groundwater is due to domestic sewage, detergents, agricultural effluents with fertilizers and industrial waste water.

Seasonal Trends: Usual seasonal trends in values of different parameters *i. e.* dilution effect from pre monsoon to post-monsoon period and concentrating effect from post-monsoon to winter, spring are observed within study period.

Correlation Analysis: Existing strong correlation among different water quality parameters and a systematic calculation and interpretation of correlation coefficient gives an idea of rapid water quality monitoring methods[22-23]. The average result of correlation analysis of sampling locations (S_1, S_2, S_3, S_4, S_5) between various physicochemical parameters is tabulated in table4. Correlation is a mutual relationship between two variables.

Calculated Indices :

The average result of calculated indices of sampling locations (S_1, S_2, S_3, S_4, S_5) tabulated in table5. In the study Exchangeable Sodium Percentage (ESP), Residual Sodium Carbonate (RSC), Aggressive Index (AI), Millie equivalents (Cation-Anion), Percentage Sodium (%Na), Sodium Adsorption Ratio (SAR), Langlier Saturation Index (LSI), and Ryzner Index (RI) were calculated. Except RSC, the values indicated that there is no specific impact of agricultural practices on ground water quality of study area during study period. In the samples, value of RSC is more than 2.5; therefore water is not suitable for irrigation.

Conclusion

In all ground water samples, the values of physicochemical parameters except total alkalinity show that the ground water quality is appropriate for agricultural use. The average value of total alkalinity in Sangod tehsil is not so high but out of 20 analyzed samples 3 samples were of higher values than the permissible limit of drinking water standard IS10050.

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