RJC

RASĀYAN *J. Chem.*
Vol. 8 | No. 3 |339 - 345 | July - September | 2015
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

ASSESSING GROUND WATER QUALITY IN WINTERS OF INDUSTRIAL ZONE, KOTA, RAJASTHAN

Nupur Jain[1],*, Anurika Mehta[2], Rakesh Duggal[3]
[1]Department of Chemistry, Poornima University, Jaipur, India
[2]Department of Chemistry, Poornima Institute of Engineering and Technology, Jaipur, India
[3]Director, Poornima Group of Institutions, Jaipur, India
*E-mail : nupurjain.phd@gmail.com

ABSTRACT
A critical assessment of water quality of industrial zone Kota by chemical and statistical analysis has been carried out and data has been used for purposes of classification, correlation, etc. Graphical and numeral interpretation in the form of Stiff plot and scatter plot for hydro chemical studies has been applied for evaluating cations and anions in the industrial zone, Kota during winter season. The results of stiff plot indicate an irregular pattern i.e. values for cations are more in comparison to anions values during winter season. Scatter plot shows that calcium, sodium and chloride are not distributed evenly as they possess different compositions at different places.
Keywords: Quality, Stiff plot, Scatter plot, winter season.

INTRODUCTION

A sustainable monitoring of groundwater quality becomes essential for minimizing groundwater contamination and for having control over pollution causing materials. Usually groundwater quality is modified by the hydrological cycle that depends on natural and anthropogenic processes. Change in quality of natural waters may disturb the equilibrium in between different forms of life making it unfit for intended purposes.[1]The proper utilization of water resource to human's benefit is a primary factor in development of civilization. The gradual degradation of water quality in area of study is significant after declaration of Kota as one of the smart cities of Rajasthan. Kota is located along eastern bank of the Chambal River. The cartographic coordinates are 25°11′N 75°50′E/ 25.18°N 75.83°E. It covers an area of 318 km^2 (3.63 per cent of the Rajasthan State). The Chambal River separates these districts from Kota district, forming the natural boundary.[2]The increasing population of Kota district and surrounding areas is putting pressure on fresh water resources. In addition, rapid industrialization, urbanization and agricultural activities in its surroundings areas have degraded ground water quality considerably.[3] The study aims to report variations in groundwater quality of Industrial zone, Kota by assessing different physico-chemical parameters.[4] In this paper assessment and analysis of significant cations and anions of different water samples collected from the area during winter season have been kept as focus and Stiff plot and Scatter plot has been used for highlighting pollution concerns of study area.

EXPERIMENITAL

MATLAB R2008b was used for the preparation of the Stiff Diagram and Scatter plot and to analyze the data for the evaluation of groundwater quality. Stiff plot distinguishes between cations and anions. The results of Stiff plot helped in interpreting the data as by indicating patterns of cations and anions. Scatter plot represents the relationship between two ions and their relationships in curve form.

For analyzing the chemical aspects of groundwater in the study area, total 15 samples of groundwater used for drinking purpose were collected from different sources like hand pumps or open wells at different spots spread over DCM Industrial area during winter season in 2014.These spots were specifically identified on the basis of frequent use and probability of contamination and were mapped

(Figure-1). The season was selected because contamination often decreases rainy season (Table-1). The samples were analyzed using standard methods of analyses to assess various physicochemical parameters according to APHA & WHO norms.[5-6] Some parameters like temperature, color, and pH were measured on site. Water samples were analyzed by standard methods for cations like calcium, magnesium, sodium, potassium and anions like carbonate, hydrogen carbonate, chlorides, fluorides, nitrate, sulpahte, phosphate.

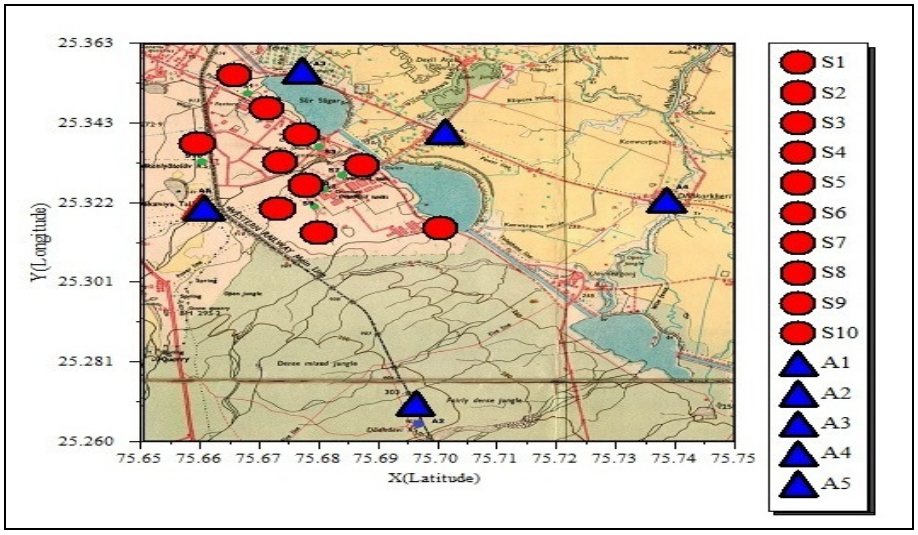


Fig.-1: Map of location with different sampling spots of study area with adjoining areas

Table 1: Description of spots and source type

S. No.	Spot No.	Name of the spot	Source type
1.	S1	Near Govt. Girls Senior Secondary School, Bombay Yogena, Kansua	Tube Well
2.	S2	Near Bombay Yogena Colony, Kansua	Hand Pump
3.	S3	Near Samudayik Bhawan, Near Maszid, Kansua	Hand Pump
4.	S4	Near Shiv Mandir, Kansua	Hand Pump
5.	S5	Near Govt. Senior Secondary , Ram Nagar	Hand Pump
6.	S6	Near Govt. Senior Secondary School, Indra Colony , DCM	Hand Pump
7.	S7	Shri Ram Fertilizer Gate , Near Fly Over, Prem Nagar	Hand Pump
8.	S8	Samudayik Bhawan Ke Paas Prem Nagar III	Tube Well
9.	S9	Papaji Ke Bhatte Ke Paas, Rayans Industry Boundary,Prem Nagar III	Tube Well
10.	S10	Industrial Area, Near Dakaniya Station, Sanjay Nagar	Hand Pump
11.	A1	Raipura	Dug Well
12.	A2	Daddevi	Dug Well
13.	A3	Soorsagar	Pizometer
14.	A4	Dhakerkhari	Dug Well
15.	A5	Dakniya talav	Hand pump

RESULTS AND DISCUSSION

All ions have been quantified by the analysis of physico-chemical parameters. Further discussion addresses quality assurance whereas Stiff plot and Scatter plot have been used to graphically demonstrate the similarities and differences in groundwater chemistry between the sites.

Calcium concentrations of samples range between 49.25 and 122.79 mg /L with a mean value of 87.70 mg/ L. Most of the samples are within permissible limits prescribed by WHO (as 100 mg/ L) with exception of sample numbers S-3, S-5, S-6, S-8 and S-9. Magnesium content ranged from 7.92 to 40.84

mg/ L with an average value of 23.53 mg/L. The observed magnesium concentrations are below the permissible limit prescribed by ICMR (as 200 mg/L). The sodium content in the ground water samples ranges from 36.45 to 99.93 mg /L with a mean value of 70.92 mg /L. Potassium content variations are from 1.35 to 9.45 mg/L with an average value of 4.39 mg /L(Table-2).

Carbonate and hydrogen carbonate contents varied from 176.67 to 360 and 0.00 to 291.33 mg/L with an average value of 251.44 and 99.71 mg/L respectively. Chloride content in the study area is between 66 to 168.67 mg/ L with an average value of 117.73 mg/ L. The chloride content in samples is in the permissible limit prescribed by WHO (as 250 mg/ L). Sulfate content varied from 31.98 to 118.33 mg/L with a mean value of 71.43 mg/L. The sulfate values of all ground water samples are under the permissible limits prescribed by ICMR (as 200 mg/L) and WHO (as 250 mg/L).

The ground water pollution in India is increasing due to nitrate concentration. The sources of nitrate pollution are mainly point sources (i.e. poultry farms, cattle shed and leakage from septic tanks etc.) and non point sources like nitrogenous fertilizers etc. In our findings, nitrate content varied from 14.34 to 72.96 mg/L with a mean value of 45.82 mg/L as NO_3^-. The sample numbers S-3, S-4, S-6, S-8, S-9, A-1, A-2 and A-3 crossed permissible limit prescribed by WHO (50 mg L-1 as NO_3^-) and is indicative of pollution in water quality (Table-3).

Table-2: Statistical values of Major Cations during winter season

Parameter	Major Cations (meq/L)			
	Ca^{2+}	Mg^{2+}	Na^+	K^+
Minimum	2.46	0.66	1.59	0.04
Maximum	6.14	3.40	4.35	0.24
Average	4.39	1.96	3.08	0.11
SD	1.21	0.93	0.89	0.06

Fluoride concentration less than 1 mg /L in drinking water has beneficial effect on human body but higher content causes serious dental and skeletal fluorosis. In area of study, the fluoride content is found between 0.25 and 1.57 mg/L with an average value of 0.54 mg/L and sample number A-3 has higher value than permissible limit of 1.5 mg/L prescribed by WHO and is an area of concern.[7]

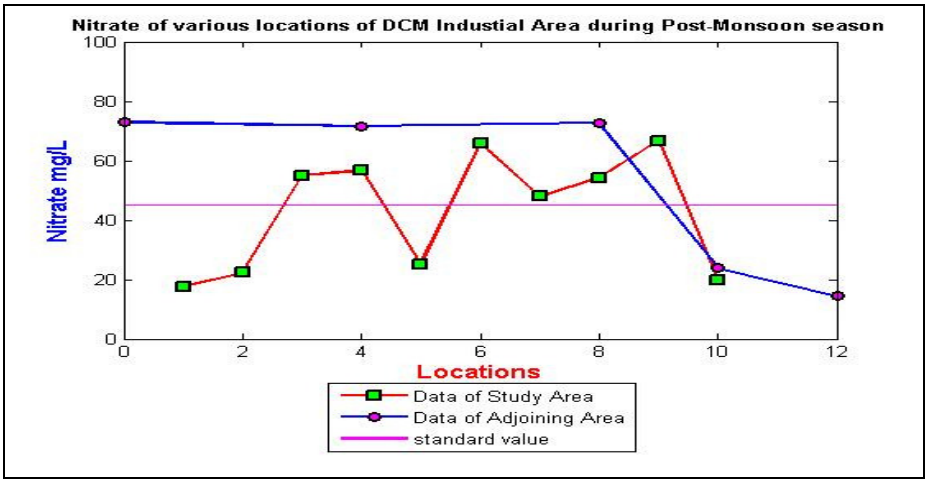


Fig.-2: Nitrate concentration of various location of DCM industrial area during winter season

Scatter plots

The two-dimensional scatter plot is one of the most familiar graphical methods for data analysis. It illustrates the relationship between two variables[8] indicating whether that relationship appears to be linear or curved, whether different groups of data lie in separate regions of the scatter plot, and whether the variability or spread is constant over the range of data. In each case, an enhancement called a "smooth" enables the viewer to resolve these issues with greater clarity than would be possible using the scatter plot alone. From the figure it easily observed that there is no demonstrated connection between calcium and chloride as it is having the positive correlation 0.703 during winter season (Figure -4).

Sodium with chloride shows a smooth relationship. They are having highly negative correlation which is -0.07 during winter season. It proves that the study area having calcium, sodium and chloride are not distributed evenly and are having different compositions at different places[8] (Figure- 5).

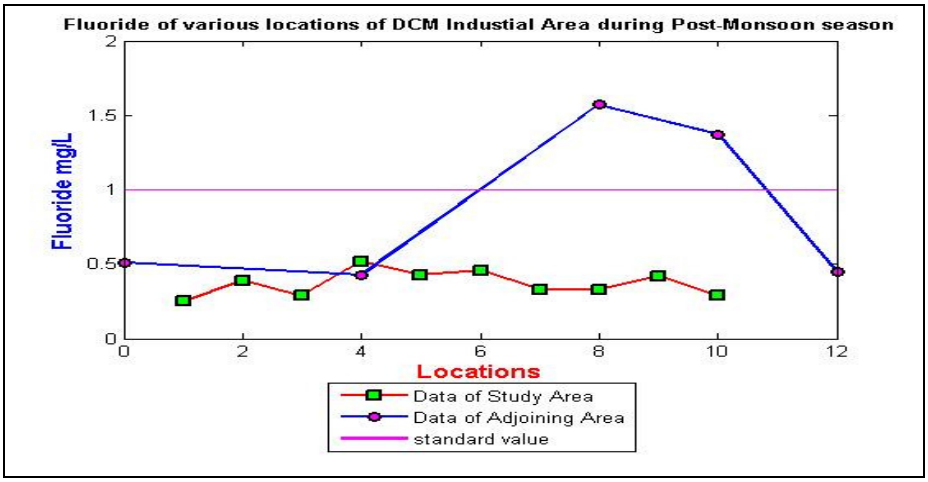


Fig.-3: Fluoride concentration of various location of DCM industrial area during winter season

Table-3: Statistical values of Major Anions during winter season

Parameter	Major Anions(meq/L)			Major Anions(mg/L)			
	CO_3^{2-}	HCO_3^-	Cl^-	F^-	SO_4^{2-}	NO_3^-	PO_4^{3-}
Minimum	2.46	0.66	1.59	0.25	31.98	14.34	0.56
Maximum	6.14	3.40	4.35	1.57	118.33	72.96	1.84
Average	4.39	1.96	3.08	0.54	71.43	45.82	0.97
Standard Deviation	1.21	0.93	0.89	0.39	24.03	22.62	0.43

Stiff Diagram

Stiff diagrams are graphical representation of water chemical analyses, first developed by H.A. Stiff in 1951.A polygonal shape is created from three or four parallel horizontal axes extending on either side of a vertical zero axes. Cations are plotted in mili equivalents per liter on the left side of the zero axes, one to each horizontal axis, and anions are plotted on the right side. Stiff patterns are useful in making a rapid visual comparison between water from different sources.

Stiff Diagram can help visualize ironically related waters from which a flow path can be determined or if the flow path is known, to show how the ionic composition of a water body changes over space and/or

time. Cations calcium magnesium and sodium and anions hydrogen carbonate, sulphate and chloride were used for analysis comparison.[9]

Results indicate irregular patterns that cations values are more in comparison to the anions values in winter season. Sample 5 shown in figure-6 reflects the same. Each different pattern represents a different type of water in study area as well as in adjoining area. The width of the pattern indicates an approximate of total ionic content. The Stiff system is a relatively distinctive method of showing differences or similarities in water and changes in water composition with depth. It is useful especially for illustrating chemical composition in hydrological cross section in the study area. It can be used also for classification purposes, and is useful as a symbol on a map.[10]

When comparison is done in between study area and adjoining area we found that cation-anion ratio is greater than that of study area in comparison to adjoining area (Figure-7).

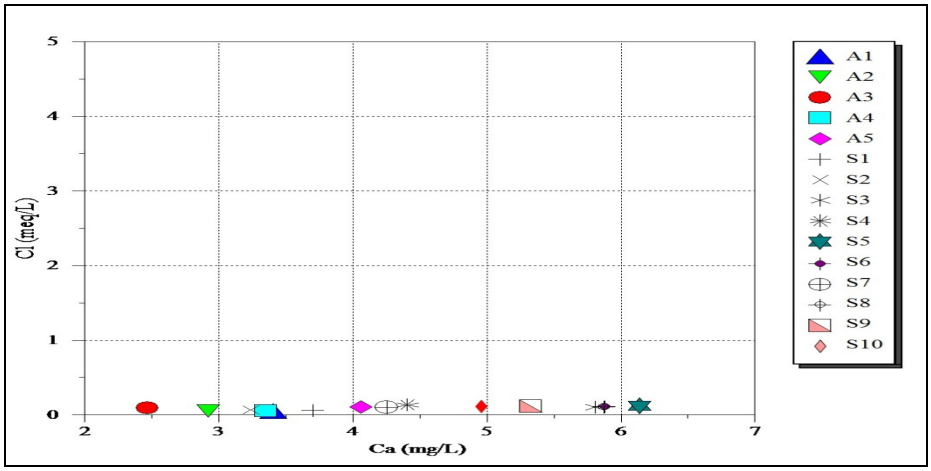


Fig.-4: Scatter Plot for $CaCl_2$ in DCM Industrial Area, Kota during winter season

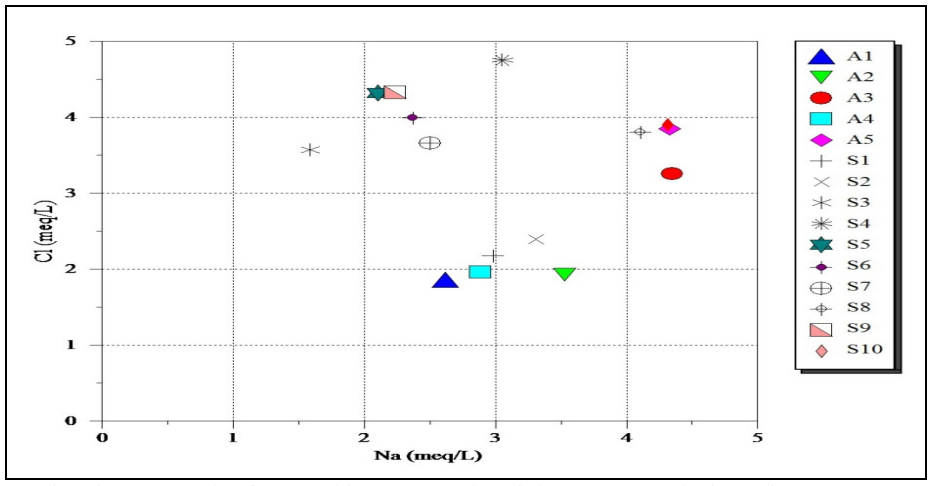


Fig.-5: Scatter Plot for NaCl in DCM Industrial Area, Kota during winter season

CONCLUSIONS

The groundwater sources in the DCM Industrial area have been evaluated for chemical and quality analysis. Graphical and numeral method by Matlab software is used for interpretations of cations and anions values in ground water sample of industrial zone during winter season. The results indicate that cations values are more in comparison to the anions values in winter season. Stiff plot indicates irregular patterns of cations and anions and each different pattern represents a different type of water in study area as well as in adjoining area. Scatter plot also indicates that ions are not evenly distributed in the study area

and are having different compositions at different places. The higher value of fluoride in A-3 sample in adjoining area requires attention from the point of view of awareness of people as an initial step for better health prospects. The study indicates that pollution levels though not alarming at present are going to affect human health in future soon.

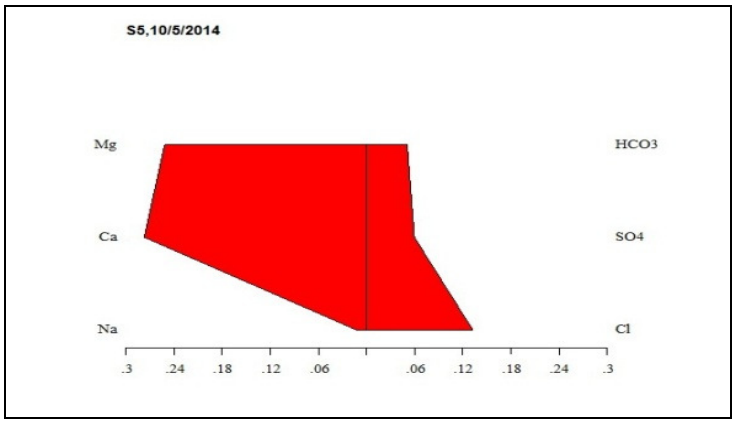
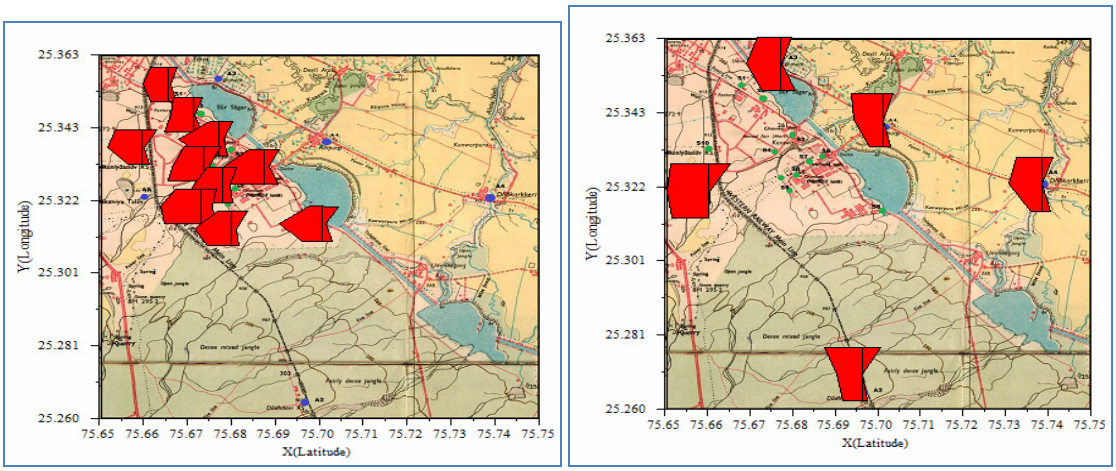


Fig.-6: Stiff diagram of sample no. 5 Ram Nagar in DCM Industrial area



(a) (b)

Fig.-7: Stiff Plot for ground water parameters in DCM Industrial Area (a) study area (b) Adjoining area (winter season)

ACKNOWLEDGEMENTS

The authors are thankful to Dr. Susmita Sharma, Professor, Poornima College of Engineering, Jaipur and Dr. R. C. Mishra, Principal, Gurukul Institute of Engineering & Technology, Kota for their valuable suggestions and support.

REFERENCES

1. K.M.Sharma *et.al*, *Rasayan Journal of Chemistry*, **8(1)**, 42(2015).
2. Meena Manju *et.al.*, *Iranica Journal of Energy & Environment*, **5(2)**, 160(2014).
3. Nupur Jain *et.al*, *Chem Sci Rev Lett*., **4(14)**, 447(2015).
4. Nupur Jain *et.al*, *International Research Journal of Environmental Science*, **4(8)**, 26(2015).
5. WHO, Guidelines for drinking water quality, Recommendations, World Health Organization, Geneva, **1**, pp 188, (1996).

6. APHA, Standard methods for the examination of water and waste water, [17th] Ed. American public Health Association, American Water Works Association, Water Pollution Control Federation, Washington D.C. (1989).
7. V. Veeraputhiran, G. Alagumuthu, *International Journal of Environmental Sciences*, **1(4)**, (2010).
8. C. Morgan, J. Wang, Brad and Bushman, *Psychological Methods,* **3(1)***,* pp 46(1998).
9. Zaporozec Alexander, "Graphical interpretation of water quality data" , **10(2)**, pp.32(1972).
10. S.K. Srivastava and A.L. Ramanathan, *Environ Geology*, **53**, 1509 (2008).

[RJC-1316/2015]