International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 11, Issue 11 (November 2015), PP.25-32

Groundwater Quality Mapping Of Western Kota, India Utilizing Gis Modelling Technique

Jain Nupur[1], Mehta Anurika[2], Duggal Rakesh[3]
Department of Chemistry, Poornima University, Jaipur, India

Abstract:- The object of this study is to delineate groundwater potential area of western part Kota, Rajasthan using remote sensing and geographical information systems (GIS). Geo reference map along with other Analytical data sets have been used to extract information on groundwater storing controlling and quality features. Physico chemical parameters that influence groundwater quality were analyzed and integrated. GIS modeling technique of Interpolation and Contour formation was used to produce groundwater potential map. Finally, in produced maps darken area of map represent area having higher concentration of TDS, TH and Electrical conductivity as compared to the other parameters. So, groundwater of study area should only be used after prior treatment for domestic as well as other purposes.

Keywords:- Groundwater, Remote sensing, Geographical information systems (GIS), Quality mapping.

I. INTRODUCTION

Human beings depend on water for their survival. Water also is important for crop production. Obviously, an optimum agricultural production depends on water and soil quality [1].Groundwater is an important source of drinking water around the world. The resource in several places has been contaminated due to human activities. [2] So, the spatial distribution maps of water quality parameters were produced using Geographic Information System (GIS) [3]. The distribution maps serve to understand ecological status of the groundwater systems and for the identification of groundwater quality parameters with concentration above allowable limits of WHO and to find out potential areas where water treatment plants/technologies can be targeted. [4] Therefore, water quality data has been utilized in the present study to analyze the groundwater chemistry for year 2014 with regards to pre-monsoon, monsoon and post-monsoon seasons of Kota DCM industrial area. Various physico chemical parameters were analyzed by standard methods. Out of various parameters studied earlier [5]; especially concentration of Electrical Conductivity (EC), Total Dissolved Solids (TDS), and Total Hardness (TH) were considered appropriate for investigation by geographical information systems (GIS) software.

II. MATERIALS AND METHODS

Study Area

Kota is located along eastern bank of the Chambal River in the southern part of Rajasthan. 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). It has an average elevation of 271 meters (889 ft). The district is bound on the North and North West by Sawai Madhopur, Tonk and Bundi districts. The Chambal River separates these districts from Kota district, forming the natural boundary.DCM industrial area and its adjoining areas in western part of Kota have been chosen as area of study. Total covered area under study is 10 sq. Kms. The details of various spots selected for study are given in figure 1.

Data Used and Methodology

Survey of India (SOI) toposheet (45 O 16 KOTA) was used for the preparation of the base map. GIS software package QGIS 2.8.1 is used to map and analyze the data for the evaluation of groundwater quality. 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 Pre-monsoon Monsoon & Post-monsoon season in 2014.These spots were specifically identified on the basis of frequent use and probability of contamination and were mapped (Fig.1). The season was selected because contamination often increases due to starting of rain and tends to the accumulation of ions and decreases in the ending of rain.

The samples were analyzed using standard methods of analyses to assess various physicochemical parameters according to APHA & WHO norms. [6-7]Some parameters like temperature, color, and pH were measured on site. Water samples were analyzed by standard methods [8] for physicochemical parameters like water temperature(^{0}C), TDS, conductivity, turbidity, odor, nitrate, sulphate, phosphate, Dissolved Oxygen,

hardness, chlorides, fluorides, nitrate, sodium, potassium and Chemical Oxygen Demand(COD),Biological Oxygen Demand(BOD), alkalinity.

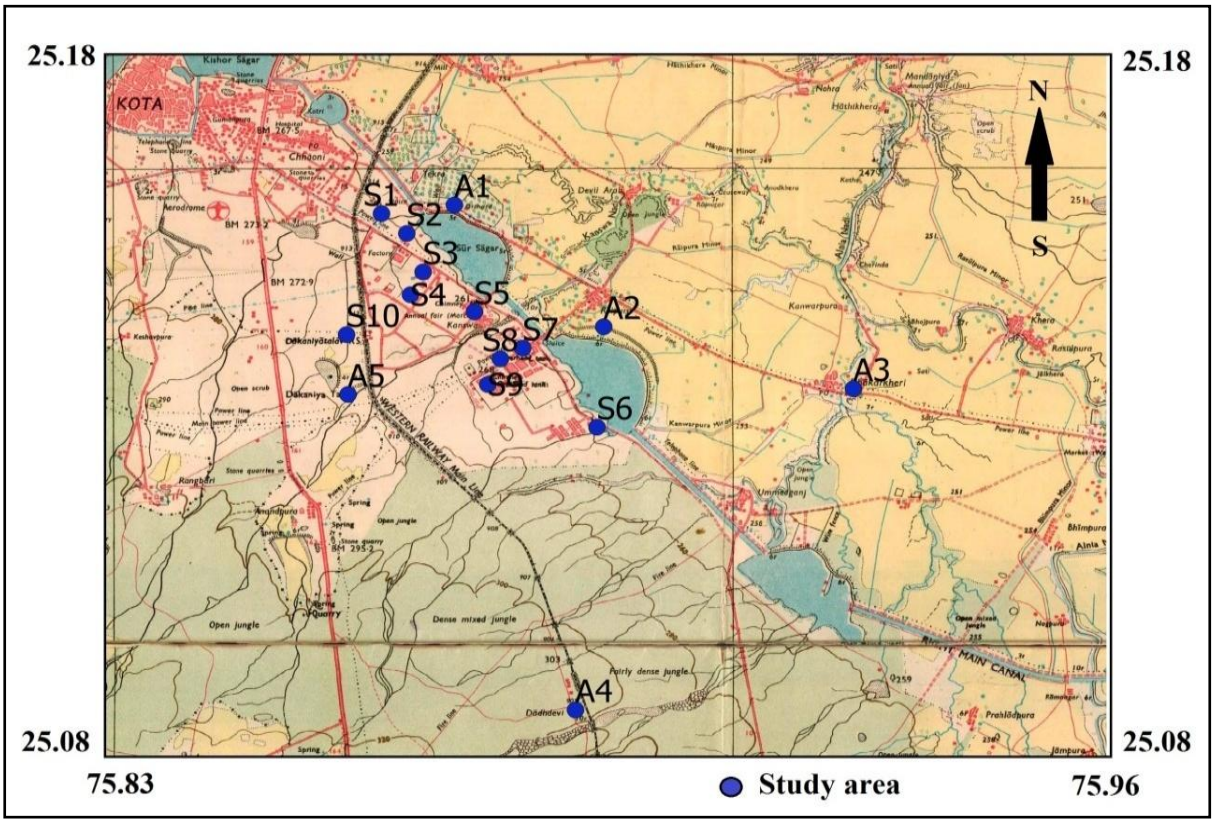

Fig. 1: Location map of Study area, Kota.

III. RESULT AND DISCUSSION

Geo reference map along with other analytical data sets have been utilized to extract information on the groundwater storing controlling and quality features of this study area. GIS modeling technique of Interpolation and Contour formation was used to produce groundwater potential map. [9-10]

Most of the parameters studied were found in the permissible limit according to the WHO but EC, TDS and TH was found higher in the range and their statistical values of seasonal variation are presented in Table (1).

Table 1: Statistical value of TDS, Conductivity & TH

Parameter	TDS (mg/L)			Conductivity(µmhos/cm)			TH (mg/L)		
	Pre	Monsoon	Post	Pre	Monsoon	Post	Pre	Monsoon	Post
Mini	327.63	356.00	390.00	307.47	418.70	121.67	118.00	159.33	178.67
Max	905.82	841.70	826.67	794.62	819.33	813.33	492.00	460.00	453.33
Average	568.67	585.80	612.98	499.45	622.62	517.53	289.91	295.20	315.71
S.D.	194.33	152.032	127.72	137.72	116.66	166.74	113.35	91.4017	90.54

The electrical conductivity of water depends upon the concentration of ions and its nutrient status. Based on electrical conductivity values the water quality can be classified as poor, medium or good [11]. In the present investigation maximum conductivity was observed at S2 (Near Bombay yogena colony, Kansua) in post monsoon period and minimum at S5 (Near govt. school, Ramnagar) in monsoon period. The electrical conductivity (EC) of ground water samples in pre-monsoon period ranged from 307.47(S1-Near govt. school, Bombay yogena) to 794.62 (A3-Soorsagar) and monsoon period ranged from 418.70 (S1- Near govt. school, Bombay yogena) to 819.33 µS/cm (A3- Soorsagar) whereas in post-monsoon period it ranged from 121.67 (S1-Near govt. school, Bombay yogena)) to 813.33 µS/cm (A3- Soorsagar). The EC in the study area was found above the permissible limits of WHO and BIS [9] (300 µS/cm) except some samples of S1 & S2. (Table 1)

Table 2: Classification of Irrigation Water Based on Electrical Conductivity

Classification Pattern	Categories	Ranges	Number of Samples		
			PRE	MONSOON	POST
EC (Salinity Hazard class) (Wilcox 1955)	Excellent (C1)	100-250	0	0	1
	Good(C2)	250-750	14	13	13
	Doubtful(C3)	750-2250	1	2	1
	Unsuitable(C4 & C5)	>2250	0	0	0

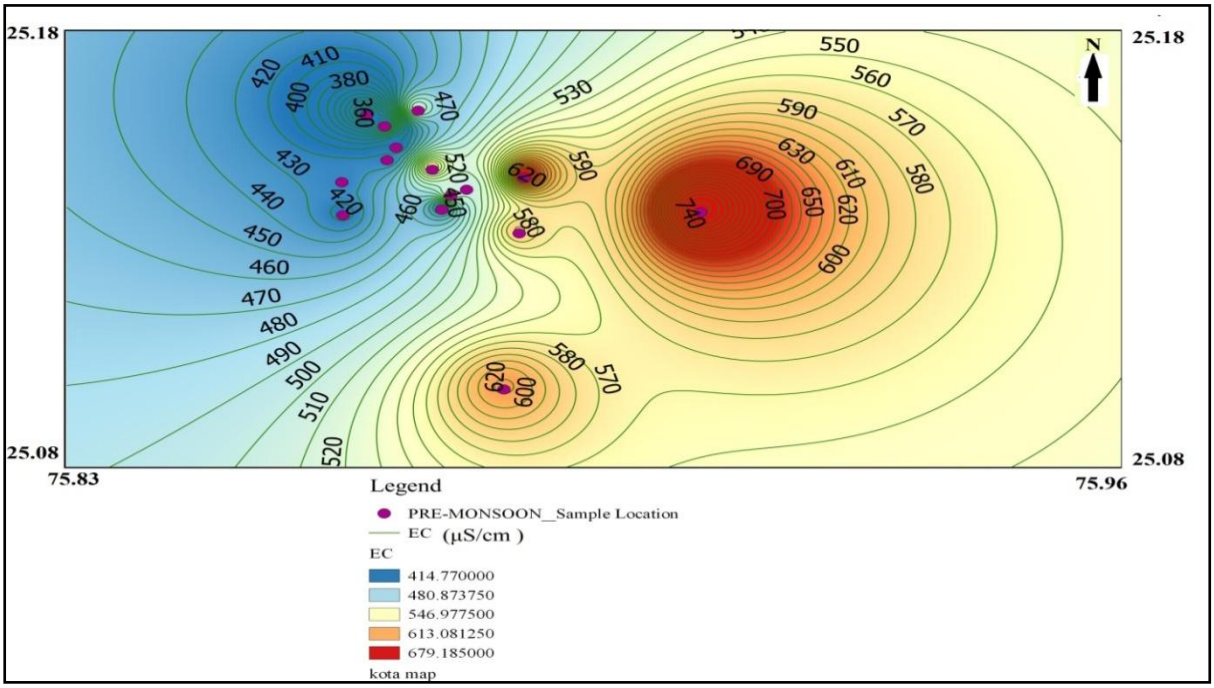

Fig.2: Spatial distribution of Electrical conductivity during Pre-monsoon

According to irrigation water based classification of EC of water 93.33 % samples are in good category while only 6.66% samples are in doubtful category during pre-monsoon period. During monsoon period 86.66% samples are good category, 13.33% samples in doubtful category. During post-monsoon period only one sample (6.66%) was found in excellent category. (Table 2)These findings are indicative of monsoon and afterword effects on EC.

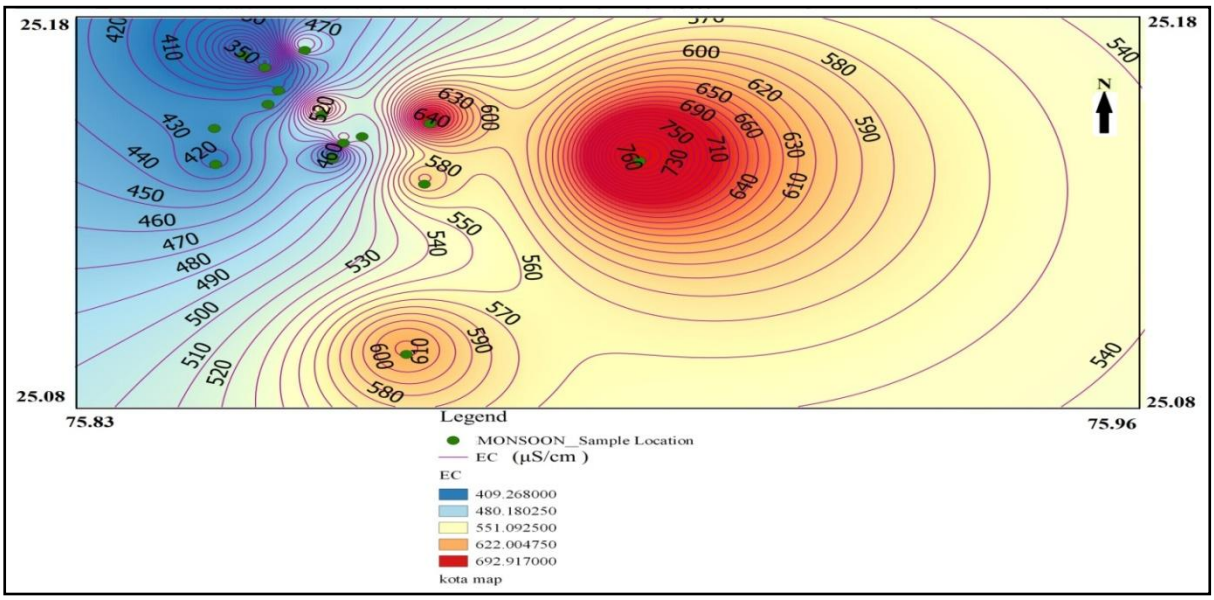

Fig.3: Spatial distribution of Electrical conductivity during Monsoon

In 2014 pre monsoon period, the EC results shows higher concentration of (> 710) salts in northeast part of the study area. The lowest concentration of (< 403) salts was observed in south, precisely southwest part of the study area. During Monsoon period, higher concentration of (> 751) salts was observed in northeast part and small area of central part of the study area. During post monsoon period, higher concentration of (> 708) salts was observed in northeast part, northern part and small area of central part of the study area. (Fig.2-4)

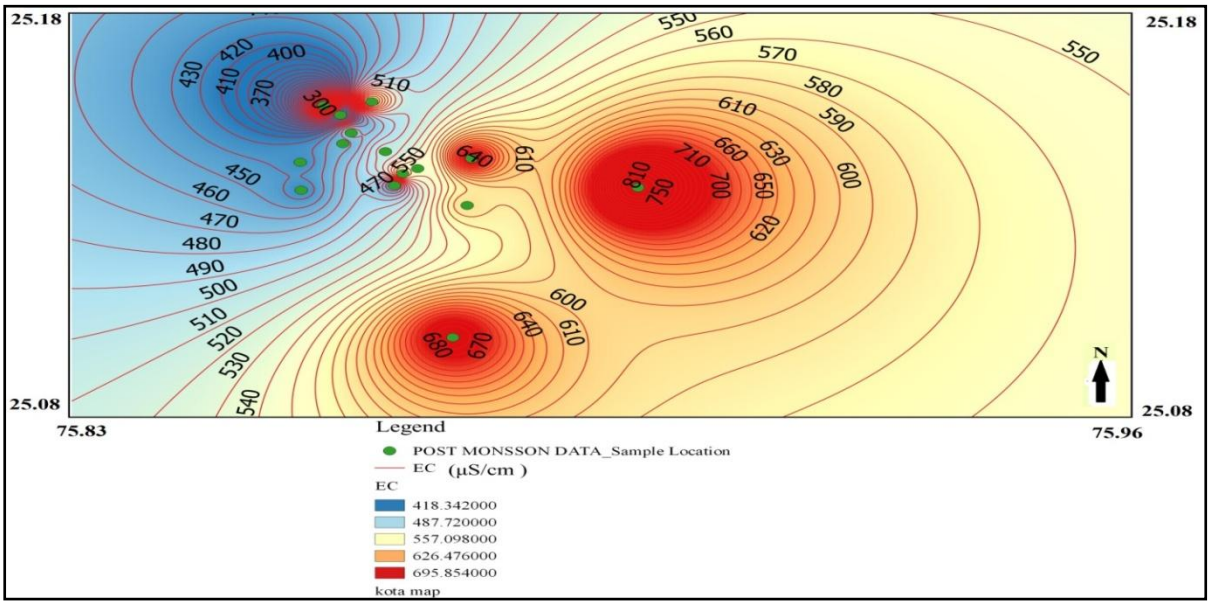

Fig.4: Spatial distribution of Electrical conductivity during Post-monsoon

Total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and Nitrates of Calcium, Magnesium, Sodium, Potassium, Manganese, organic matter salt and other particles.[12] When present in excessive quantities, they reduce the osmotic activities of the plants and may prevent adequate aeration. The Total dissolved solids (TDS) in water samples in pre-monsoon period ranged from 327.63(A1) to 905.82 (S6) ppm and in post-monsoon ranged from 390(A1) to 826.67 ppm(S6). The TDS in the water samples of the study area are much above the permissible limit of WHO and BIS (<500 ppm) that is for S3, S4, S5, S6, S7, S8, S9, S10, A4, A5 samples. They are generally found in excess of 200 mg/L and can be classified as unsuitable irrigation water. (Table 1)

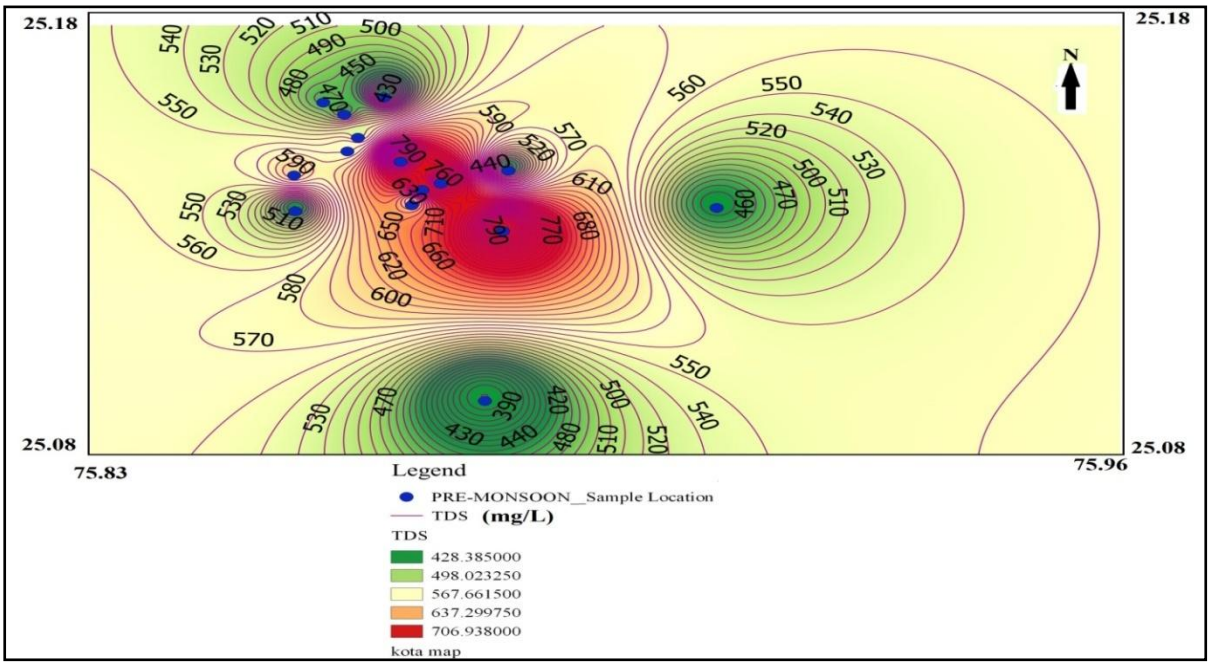

Fig.5: Spatial distribution of TDS during Pre-monsoon

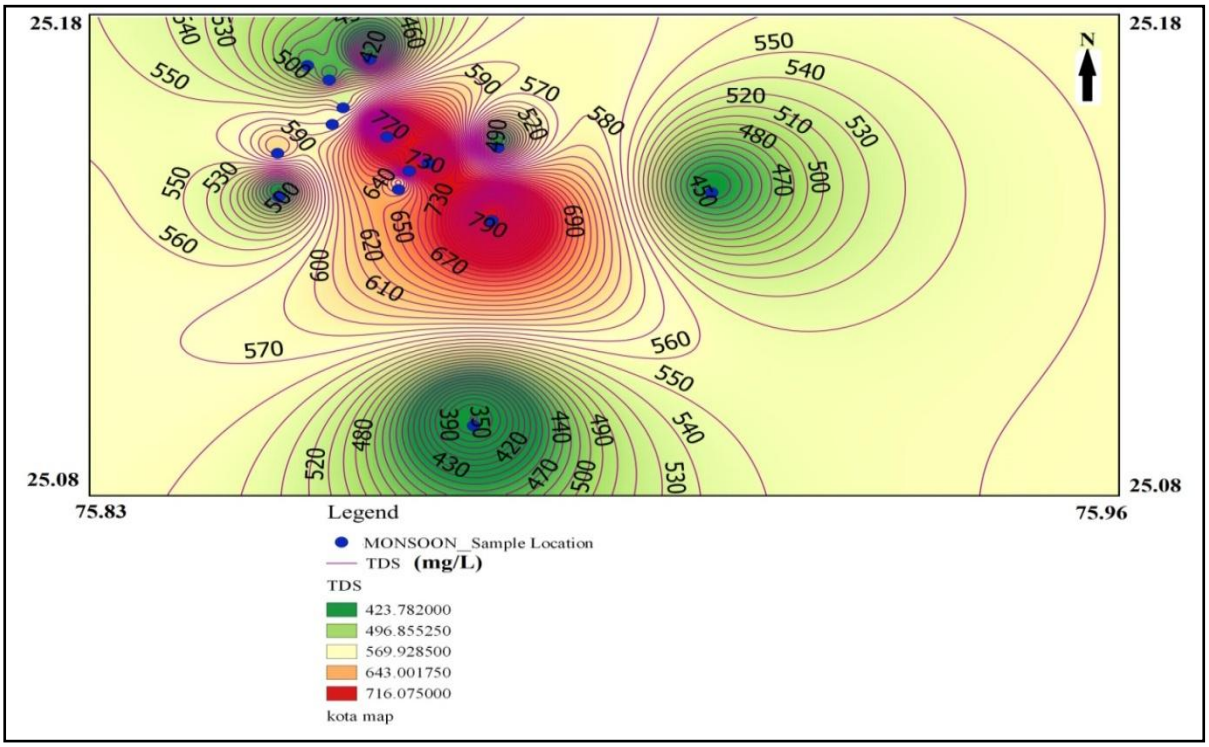

Fig.6: Spatial distribution of TDS during Pre-monsoon

Table 3: Condition of Water Quality with Reference to Concentration

Classification Pattern	Categories	Ranges (Mg/L)	Number of Samples		
			PRE	MONSOON	POST
TDS	Fresh Water	< 1000	15	15	15
	Slightly Saline	1000-3000	0	0	0
	Moderately Saline	3000-10000	0	0	0
	Very Saline	10000-35000	0	0	0
	Brine	>35000	0	0	0

According to the salinity classification of Davis and De Wiest, [13] the results of pre monsoon, monsoon and post monsoon periods show that 100 per cent of samples fall under fresh water category.

In 2014 pre monsoon period, the TDS results show higher concentration of (> 718) salts in central part of the study area. The lowest concentration of (< 416) salts was observed in southeast, southwest, northern part of the study area. During Monsoon period, higher concentration of (> 687) salts was observed in central part of the study area and in east and west part range was observed [near to high] same as in during post monsoon period. (Fig. 5-7)

Hardness is the property of water which prevents lather formation with soap and increases the boiling point of water. Hardness of water mainly depends upon amount of calcium or magnesium salt or both. In our findings hardness value varied from 118 ppm to 492 ppm, these values are above the permissible limit in maximum samples (S3,S4,S5,S6,S7,S8,S9,S10) with regards to values prescribed by WHO. [Figure 8-10, (Table 1)]

According to Durfor and Becker's (1964) classification of total hardness, hardness ranges describe hardness of water. Total hardness was found to be in the category of "Hard to very hard" for the samples of at all the locations (Table 4). [14]

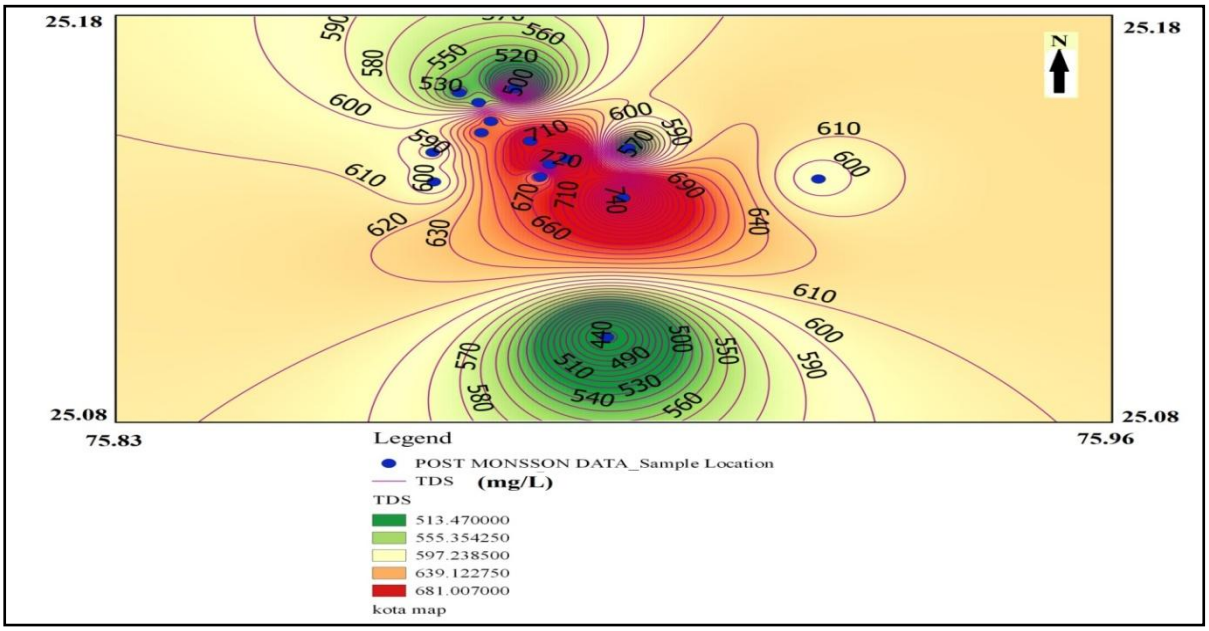

Fig.7: Spatial distribution of TDS during Post-monsoon

Table 4: Durfor and Becker's Classification of the water samples based on Total hardness

S. No.	Description	Hardness (mg/L)	Range (No. of Samples) (Total-15)		
			PRE	MONSOON	POST
1	Soft	0 – 60	-	-	-
2	Moderately Hard	61 – 120	-	-	-
3	Hard	121 – 180	118-173.67 (3/15)	159.33-174.67 (2/15)	178.67 (1/15)
4	Very Hard	>180	201-460.00 (12/15)	205.33-460.00 (13/15)	185.33-453.33 (14/15)

In pre monsoon period 80% of samples have been found under very hard category while only 20% samples were under hard category. During monsoon period about 86.6 per cent of samples fell under very hard category while only 13.33 per cent of samples under hard category whereas during post monsoon season about 93.33 per cent of samples were observed under very hard category while only 6.66 per cent of samples under hard category. We also find that Ram Nagar, Indra Colony, Prem Nagar area samples have exhibited maximum hardness as compared to other areas and thus water quality is questionable for human use.

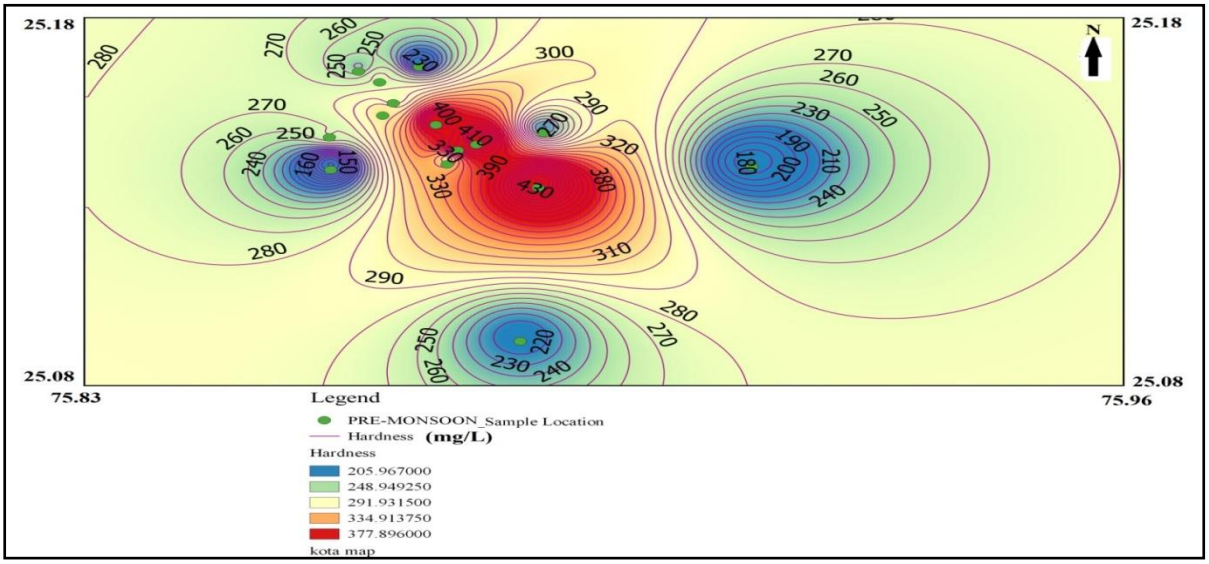

Fig.8: Spatial distribution of Total Hardness during Pre-monsoon

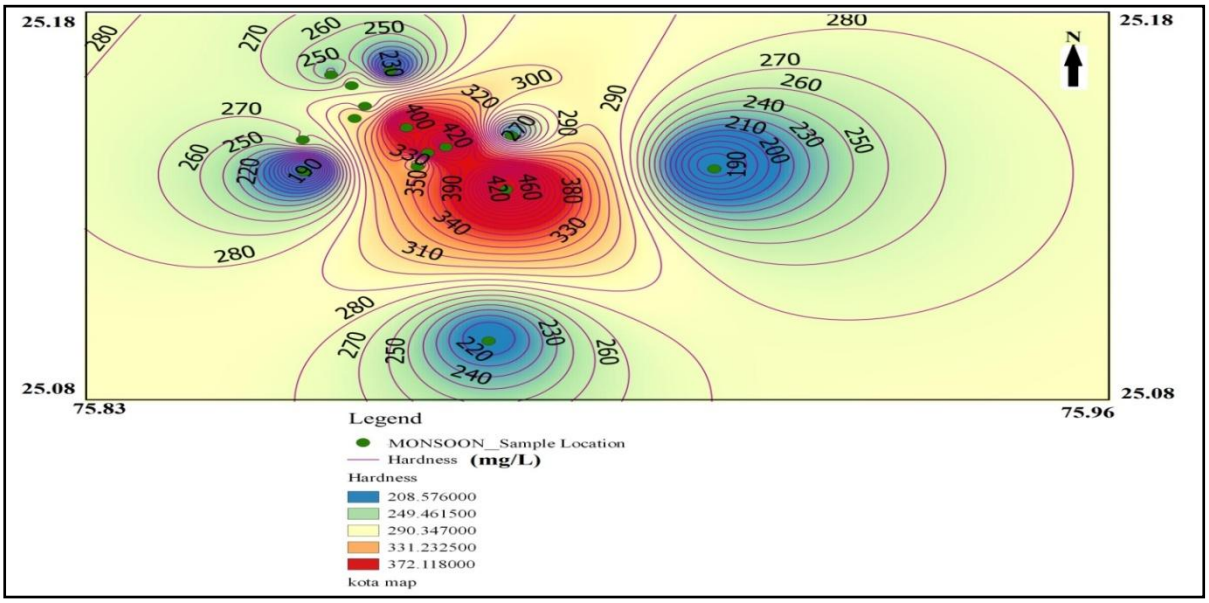

Fig.9: Spatial distribution of Total Hardness during Monsoon

However, GIS indicates no appreciable variation between the pre, during and post monsoon periods in water quality for TH. Almost all areas of study during pre monsoon, monsoon and post monsoon periods fall under the low ion concentration of < 500 mg/l category. But central part alone falls under the highest ion concentration of > 372 category.

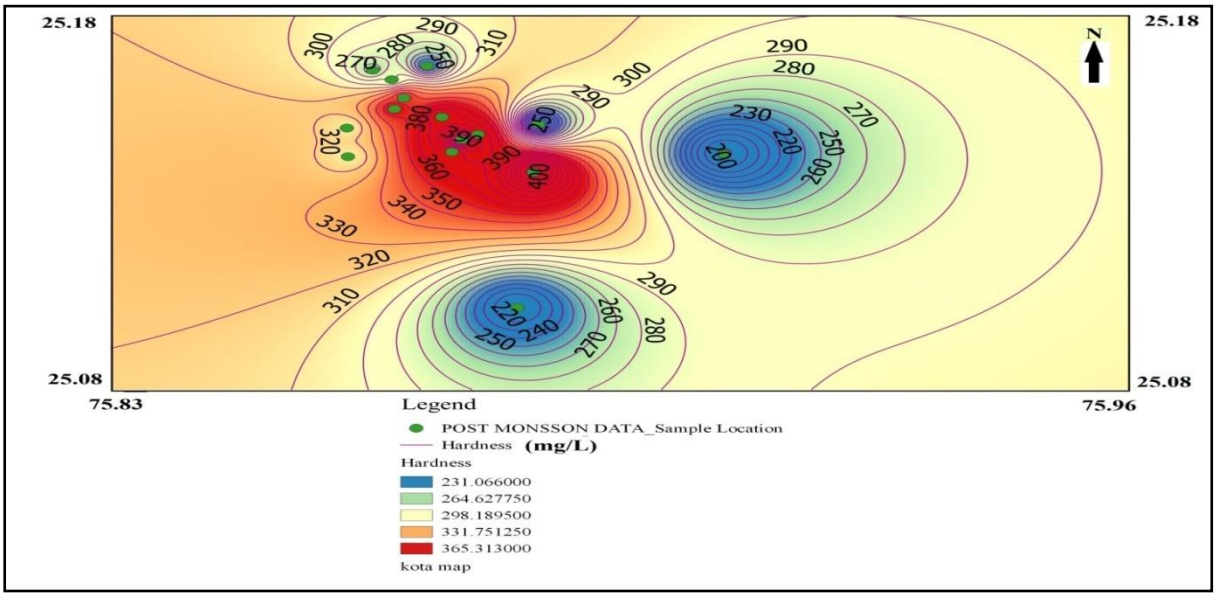

Fig.10: Spatial distribution of Total Hardness during Post-monsoon

IV. CONCLUSIONS

The evaluations of groundwater quality of western part of Kota Industrial area are based on WHO international standards (1971). Electrical conductivity is high in all seasons in most of areas while some of them lie in doubtful category. Only one sample was found in excellent category and is of Bombay yogena (S1) during Post-monsoon. During pre monsoon period TDS content is above desirable limits and during Monsoon & post monsoon period TDS content is low in some locations. It can be assumed to be due to addition of rainwater into the groundwater regime through infiltration. The locations Bombay yogena(S1), Raipura (A1),Daddavi (A2),Soorsagar (A3), Dhakerkhari (A4) with low TDS point out that water is potable in these areas. In other locations TDS exceeds the desirable limit and water is non-potable. Total Hardness values define that quality of water comes either in hard or very hard water class. It can be concluded that ground water of study area should be used after prior treatment of water.

REFERENCES

[1]. Collet, C., Consuegra, D. and Joerin, F. "GIS Needs and GIS Software", Kluwer Academic Publishers. Pp.115-142, 1996.

[2]. Balachander D., et.al., "An Investigation of Groundwater Quality and Its Suitability to Irrigated Agriculture in Coimbatore District, Tamil Nadu, India – A GIS Approach" International Journal of Environmental Sciences, Volume 1, No 2 ,176-190, 2010.

[3]. M. Venkateshwarlu, et.al., "Assessment of Ground Water Quality in and Around Miryalaguda Area, Nalgonda District of Andhra Pradesh", International journal of plant animal and science, Vol. 4,issue 2, 259-266, April-June 2014.

[4]. Rizwan Ullah, et.al, "Assessment of groundwater contamination in an industrial city, Sialkot, Pakistan" African Journal of Environmental Science and Technology Vol. 3 (12), pp. 429-446, December, 2009.

[5]. Nupur Jain, Rakesh Duggal et.al.,"Evaluating Geochemistry by Multivariate Analysis of Groundwater in DCM Industrial Area Kota, Rajasthan (India)" Chem Sci Rev Lett, 4(14), 447-458,2015.

[6]. APHA, Standard methods for the examination of water and waste water, 1^{7th} Ed. American public Health Association, American Water Works Association, Water Pollution Control Federation, Washington D.C. (1989).

[7]. WHO, Guidelines for drinking water quality, Recommendations, World Health Organization, Geneva, 1, pp 188 (1996).

[8]. Standard methods for the examination of water & waste water, 11^{th}& 17^{th} edition, APHA-AWWA-WPCF, 2007.

[9]. A. Ponniah Raju, et.al. "Spatial Analysis of Groundwater Quality Investigation in North Chennai, Tamilnadu, India" International journal of water research, 1(1), 1-6, 2013.

[10]. Golekar R. B., Patil S. N., et.al., "Human health risk due to trace element contamination in groundwater from the Anjani and Jhiri river catchment area in northern Maharashtra, India", Earth Sci. Res. SJ. Vol. 17, No. 1 17 – 23, (June, 2013).

[11]. Siebert S. et al. Groundwater use for irrigation-a global inventory. Hydrology and Earth System Sciences, 14, 1863-1880, (2010).

[12]. Rao N. S., Nitrate pollution and its distribution in the ground water of Srikakulam district, Andhra Pradesh, India, *Environ Geology*, Vol. 51, and pp 631-645 (2006).

[13]. Davis, S.N., and De Wiest "Hydrogeology", John Wiley & Sons, New York, P. 463(1996).

[14]. Durfor, C.N. and E. Becker. Public water supplies of the 100 largest cities in the United States, US Geog. Sur. Water Supply, Paper 1812, pp 364, 1964.