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Correlation Study Among Water Quality Parameters of Ground water of Kota District of Rajasthan, India

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ABSTRACT

Kota district with an area of 5203.94 sq km is located between 24°32' & 25°50 N Longitude and 75°37' & 76°34' E Longitude in the southeast of the state of Rajasthan. It i s bounded on the north by Bundi and Sawai Madhopur districts, on the east by Baran district, on the south by Jhalawar district and on the west by Chittorgarh distict. In the northeast, the district is bounded by Madhya Pradesh. District is named after Kota town and is part of Kota Division. Administratively, the district is divided into five development blocks and five tehsils. Total numbers of villages in the district is 805 and it has 5 urban towns including 1 municipal corporation. The population of the district as per 2011 census is 1951014 persons including rural and urban population of 774410 and 1176604 respectively. In the present paper we discuss the correlation study among water quality parameters of groundwater of Kota district of Rajasthan, India.

Keywords: Kota, Rajasthan, groundwater, parameters, quality, correlation, population, district, division

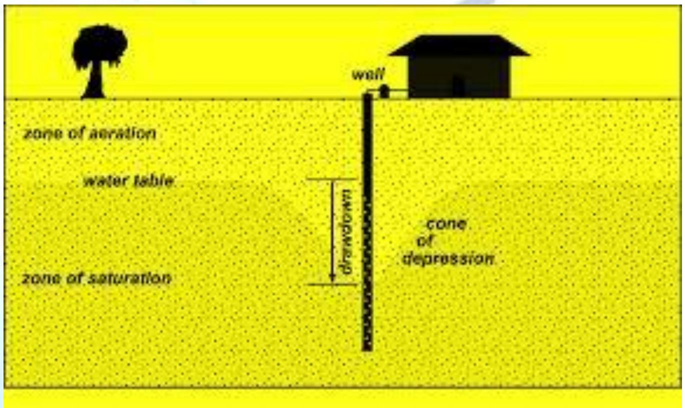
INTRODUCTION

The ground water investigation in the district was carried out by GSI. Systematic hydrogeological surveys in parts of the district were carried out by Central Ground Water Board. Detailed hydrogeological studies including exploratory drilling, testing, hydrological/ hydrometeorological studies and borehole geophysical logging etc. were carried out. Normal rainfall in the district is 807.9 mm. Climate of the district can be classified as semi arid type. The summers are hot and dry and winters are cold. The cold season prevails from December to February followed by hot season from March to mid of June.[1,2] After summers the rainy season starts with the onset of monsoon rains lasting till the end of September. The period September to November constitutes post monsoon period. January is the coldest month with mean daily maximum temperature at 24.3°C and a mean daily minimum temperature at 10.6°C. Mean daily maximum temperature during summers is 46.2°C and mean daily minimum temperature is 29.7°C. Physiographically, the district is characterized by undulating topography with gentle plains. The land slopes from south to north and is drained by the river Chambal and its tributaries. In the south there is 145 km long Mumundra range of Vindhyan hills. The physiography is rugged and the tributaries of Chambal river drain through undulating plains which slope from SSE to NNW. The maximum height of the hills in the district is 517 m amsl at village Borabas, block Ladpura and minimum height is 207mamsl at Khatoli in block

Itawa. Chambal is the principal perennial river in the district. Its tributaries are Kalisindh, Parvan and Parvati, which are all perennial in nature.[3,4] The soils of the district are alluvial in nature. Soils are generally deep to very deep with texture varying from clayey loam to clay and are generally non-calcareous. Colour of the soil varies from brown to dark brown. This type of soil generally occurs in plains. The principal means of irrigation in the district are canals and wells/ tube wells. Ground water is abstracted through tubewells, [5,6] dug wells and dug cum bore wells. Net irrigated area in the district is 226019 ha which is about 93% of the gross irrigated area (243313 ha). Agriculture activity is spread over both Kharif and Rabi cultivation. Kharif cultivation is rain fed and Rabi cultivation is mostly based on ground water. During the Kharif cultivation only 10.10 sq.km area is under irrigation, whereas during Rabi cultivation 1012.41 sq.km areas is under cultivation (including area under double crops). The main Kharif crops grown in the area are rice(13974 ha), oil seeds (224274ha), Jowar (6721ha), whereas principal Rabi crop is wheat (115280ha). The total cropped area in the district is 458857ha (including area sown more than once).[7,8]

KOTA DISTRICT

The rock formations exposed in Kota district are sedimentary in nature and belong to Vindhyan Super Group. These are overlain in most part of the district by the Quaternary alluvium. In Kota district, ground water occurs in mainly four hydrogeological formations. These hydrogeological formations are alluvium, sandstone, shale and limestone and among these formations alluvium is the most important formation as it covers the maximum area and also it is the most potential among different hydrogeological formations.[9,10] Occurrence of ground water depends upon topography, physiography and structural features of the geological formations. The movement of the ground water in hard rock areas is governed by size, openness, interconnection and continuity of structurally weak planes while in unconsolidated rocks, ground water movement takes place through pore spaces between grains. In the district, ground water occurs under water table condition both in unconsolidated and consolidated formations. The main hydrogeological units are alluvium, limestones, sandstones and shales. Shale also occurs as intercalations with both limestone and sandstone.[11,12] Limestone, sandstone and shale cover an area of 5123.17 sq.km out of which 2111.77 sq.km area falls under command area. Most of the command area is irrigated by Chambal Canal and comparatively small area by canals of Alniya, Sawan Bhadon and Harish Chandra Sagar Dams.



Assessment of Groundwater quality of Kota district, Rajasthan

The statistical values of TDS, Conductivity and Total Hardness during pre-monsoon, monsoon and post -monsoon climates in average of different wells of Kota district (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 water quality ranged from freshwater, slightly saline, moderately saline, very saline to brine according to concentration basis during pre-monsoon, monsoon and post-monsoon times in Kota.

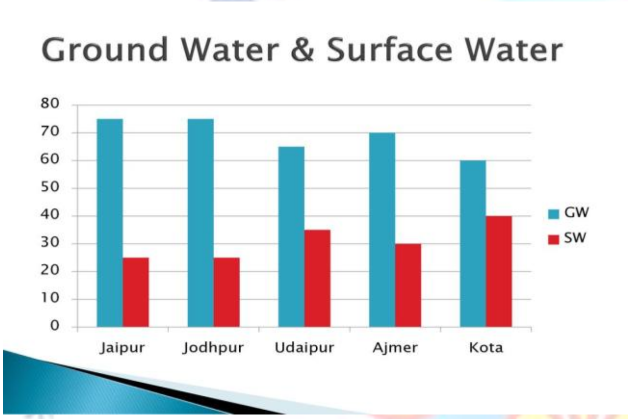
Table 2: Condition of Water Quality with Reference to Concentration

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

part, northern part and small area of central part of study

Analysis of groundwater quality of DCM industrial area, Kota by GIS was carried out (Table-2).

The regulation of urban water demand and non-revenue water in Kota can be seen by the following graph below (Graph-1):-



DISCUSSION

Shallow ground water of dug well zone is alkaline in nature with pH ranging from 7.4 to 8.5. Electrical Conductivity (EC) varies from 320 to 3650 µS/cm at 25°C. EC is within 3000 µS/cm at 25°C in majority of wells.[13,14] EC above 3000 µS/cm at 25°C has been observed in the southern part of the district along the adjoining borders of Sangod, Khairabad and Ladpura blocks. The fluoride content in ground water in the district is generally within 1.5 mg/l, the maximum permissible limit in drinking water as prescribed by the BIS. Excess fluoride has been reported from northwestern part of Sultanpur block. The concentration of Nitrate ranges from 9.0 mg/l to 125 mg/l. Nitrate values in major part of the district are within 45 mg/l, the maximum permissible limit in drinking water as prescribed by BIS. Higher concentration of nitrate in ground water has been reported from parts of Sultanpur and Itawa blocks. [15,16] The concentration of iron in ground water has been found to vary from 0.12 to 2.6 mg/l. High iron concentration (exceeding maximum permissible limit of 1 mg/l) in substantial part of the district covering entire Itawa block, major part of Ladpura block, northern part of Khairabad block and eastern part of Sultanpur block is a matter of concern. In the remaining parts of the district, iron content is well within the permissible limit. [17,18] Rainfall in the district is the main source of ground water recharge. Due to less rainfall and increased ground water withdrawals, ground water levels are declining in some parts of the district particularly in the northern part. Increasing urbanization and change in lifestyle have led to increased demand of water. Increasing urbanization also leads to reduced recharge. Further ground water is also an important source for irrigation in the district. The stage of ground water development for the district as a whole has reached 90%

Due to pressure of population and improvement in the standard of living, the demand of fresh water for both agriculture and domestic use has substantially increased. This has led to a sharp increase in ground water withdrawal. The top layer of fresh ground water is also reducing every year. Artificial recharge serves as a means for restoring the depleted ground water storage, slow down the quality deterioration and put back into operation many ground water abstraction structures.[19,20] Stage of ground water development in two out of five blocks in the district has exceeded 100%, which indicates that the scope of ground water development is already exhausted in these blocks and the blocks have been categorized as "Over-exploited". There is no scope for further development of ground water in these blocks for irrigation or industrial use. However, exploratory drilling can be taken up in unexplored area for estimation of aquifer parameters. There is need to control and regulate ground water development in over-exploited blocks in the district. In the semi-critical blocks, caution needs to be exercised so as not to further deplete the resource.

Precious ground water resources have to be conserved for sustainable availability. There is need to reduce/ avoid wastage of water in various uses. Ground water should be used judiciously taking into account modern agriculture water management techniques by cultivating crops needing less watering and use of sprinkler system & drip irrigation should be encouraged. Sandstone is the most important aquifer in the district. Extraction of ground water in this aquifer is through large diameter dug wells and dug cum bore wells and tube wells. The draft is mainly for agriculture in most of the area.

Over-exploitation of ground water resources has led to declining trend in ground water levels.

Moreover, ground water storage capacity in this hard rock aquifer is very less hence during summer season, dug wells either go dry or yield is reduced. Therefore, it is recommended that deepening of dug wells should be carried out to have good storage during pumping so that these don't go dry during lean period. Alluvial aquifer is the next important aquifer in the district, which supports ground water extraction through dug wells, dug cum bore wells and tube wells. Stage of ground water development in this aquifer varies from 82.15 to 84.67. There is need to regulate ground water abstraction so as not to further deteriorate the ground water situation

It is recommended that increasing number of ground water structures should not be encouraged and artificial ground water recharge schemes like check dams, bunds, anicuts etc., should be constructed at appropriate hydrogeological locations. Surface water reservoirs like ponds/ tanks etc. should be constructed, which would serve dual purpose of supply of water during lean period and recharge to the ground water body. Also watershed development and soil conservation projects should be encouraged.[21]

RESULTS

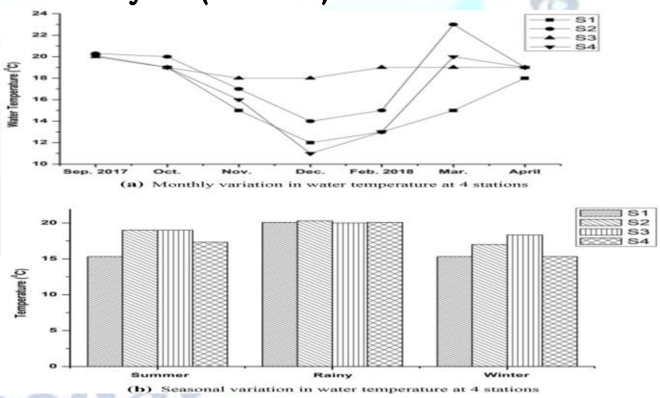
Surface Water in the Kota district (Fig.1)

The drilling at different blocks were done to obtain groundwater and borewell services were allotted (Fig.2) .

The borewell sites were sampled in different blocks of Kota district. (Fig.3)

S. No.	Characteristics	Tolerance limit
1.	Total suspended solids	Max. 100 mg/l
2.	pH	5.5 to 9.0
3.	Temperature	Temperature of wastewater should not exceed 40° C in any section of the river within 15 meters downstream from the effluent outlet
4.	BOD (5 day at 20°C)	Max. 30 mg/l
5.	Oil and grease	Max. 10 mg/l
6.	Sulphides (as S)	Max. 2.0 mg/l
7.	Total residual chlorine	1.0 mg/l
8.	COD	Max. 250 mg/l

The physico-chemical parameters at various surface and groundwaters in an average in different blocks of Kota district in Rajasthan were analysed (Table -3)



(Graph-2) Monthly and seasonal variations of water temperatures were also recorded in different sites/stations of different blocks of Kota district.

Sample Code	Parameters (in mg/l, except pH and temperature)					
	pH	Temperature	DO	BOD	COD	TDS
S-1	7.9	22.4	2.97	314	813.26	1500
S-2*	7.4	26.3	5.51	25	59	300
S-3	7.9	30.1	0.31	502	1340.34	1715
S-4	7.1	30.4	0.21	319	749.65	1500
S-5	8.2	32.5	2.37	328	1049.6	1610
S-6*	7.5	30.7	6.7	28	63	312
S-7	7.3	27.4	1.8	412	1054.7	1690
S-8	6.7	28.2	2.17	325	763.75	1611
S-9	8.3	22.4	2.9	110	262.9	590
S-10	6.9	30.9	3.7	150	363	612
S-11	8.0	31.4	3.42	146	421.94	530
S-12*	7.3	30.8	6.2	27	65	328
S-13*	7.8	32.2	3.7	80	191.2	523
S-14	7.4	30.7	3.1	105	327.6	711
S-15	7.9	31.1	2.97	110	285	810

(Table 4) Also at a single site in single block the physico-chemical parameters were noted down.

CONCLUSIONS

Large diameter (5-8 m) dug wells should be constructed in hard rock area with sufficient depth 30-40 mbgl so as to have good storage during pumping and also during the lean period. Horizontal drilling can be done to tap the lateral fractures for enhancing the yield of the wells in hard rock areas. Areas showing potential aquifer should be developed with careful monitoring of water levels by increasing the monitoring stations in blocks which have been categorized as semicritical. Ground water should be used judiciously taking into account modern agriculture water management techniques by cultivating crops that need less watering. Use of sprinkler system & drip irrigation should be encouraged. Small 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 beds should be constructed so that the ground water runoff can be arrested and impounded in the subsurface reservoir for meeting various sectoral demands. There is need for regulation of ground water development in overexploited areas. Awareness about the consequences in the near future caused by the impact of sharply declining water levels and need and ways of judicious use of water and rain water harvesting and artificial recharge needs to be created among the users. Lift irrigation projects and on-going construction of dams, anicuts should be speeded up particularly Chambal lift irrigation scheme and surface water reservoir projects, which will irrigate the large area reducing the ground water draft and increasing the ground water recharge.[21] The quality of ground water in most parts of the district is good for irrigation and domestic/ drinking purpose except at a few places where nitrate and iron problems need to be tackled by th e concerned state agencies by tapping alternate sources of water supply.

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