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Assessment of groundwater quality in parts of Bikaner District, Rajasthan

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***Abstract*---**Rajasthan's Bikaner District, part of the Thar Desert, is experiencing problems with falling groundwater levels, high salinity, fluoride and nitrate concentrations. Therefore, groundwater quality studies are underway to determine the suitability of groundwater for drinking purposes in the Bikaner district. Quality analysis is performed using parameters such as Conductivity (EC), Total Dissolved Solids (TDS), pH, Calcium, Potassium, Sodium, Nitrate, Sulfate, Chloride, Fluoride, magnesium, total hardness (TH) and Bicarbonate. Conductivity, TDS and TH increases were observed in the post-monsoon period. No such changes were observed in the sulphate, nitrate and fluoride concentrations after the rains. Most of the study areas have high salinity and are therefore unsuitable for consumption. However, all other chemical parameters are within the maximum allowable limits according to the BIS standard. Unconventional energy use desalination of groundwater is proposed to provide sustainable drinking water. Various industrial and mining man-made recharge structures (Pits with Borehole Technique) near the villages, resulting in higher groundwater levels and improved quality in neighboring areas. Success stories can be replicated in similar geographic environments. Large-scale artificial rainwater harvesting/storage/replenishment of potential aquifers is another management alternative, which can improve the chemical quality of groundwater.

***Keywords*---**Chemical parameters, Groundwater, Drinking, Bikaner Block, Bikaner.

1 Introduction

Rajasthan is the driest state in the country and Western Rajasthan is famous for its drought and deserts. The Thar Desert is located in Rajasthan and is facing a serious water crisis due to lack of rainfall, high evaporation, falling groundwater levels and most importantly, its poor chemical quality. Bikaner County, located in the center of the state, is not only experiencing scarcity of surface water, but also declining groundwater levels and poor quality due to high salinity, high concentrations of fluoride and nitrates. The famous Banka Patti (skein wrapped in bandages) with acute dental fluorosis & skeleton is also located in some areas of Bikaner county. Considering the groundwater deterioration scenario, studies of the chemical parameters of groundwater in the southwestern part of the Bikaner block in Bikaner district, Rajasthan, were performed specifically to assess its suitability. for domestic use plus other hydrogeological aspects. Bikaner District is located in the northwest of Rajasthan and covers from 2711` to 2903` north latitude and 7152` to 7415' east longitude covering a geographical area of 30247.90 square kilometers. It borders Ganganagar district to the north, Hanumangarh and Churu districts to the east, Nagaur and Jodhpur districts to the south, Jaisalmer district to the west and the international border with Pakistan. For management and development, the district is divided into eight subdivisions, namely Bikaner, Kolayat, Nokha, Loonkaransar, Khajuwala, Chhattargarh, Pugal and Dungargarh and eight tehsils, which are BIkaner, Kolayat, Nokgarha, Loonkaransar, Khajuwala, Chhattar Dungar , Pohogal and . The district development activities are supported by six Panchayat Cities, namely Bikaner, Kolayat, Nokha, Loonkaransar, Khajuwala and Dungargarh. There are 874 villages and 219 Gram panchayats. There is an independent SubTehsil Bajju located in Kolayat tehsil for better management. The district has a city council, 219 Gram Panchayats and 874 villages. According to the 20011 census, the total population of the district is 2,363,937 people, of which the rural population is 1,563,553 people and the urban population is 800,384. Modern civilization, industrialization, urbanization and population growth have led to over-exploitation and rapid deterioration of the chemical quality of groundwater in our country as well as in the Bikaner district of Rajasthan. Water resources, including groundwater, are the most important component of ecosystems in any region. The imbalance in the ecosystem is created in the form of a decrease in the quantity or quality of groundwater. Groundwater contains many different types of dissolved chemicals and pollutants, the concentrations of which are beneficial to the human body but within specific limits. For example, a limited concentration of fluoride is required for tooth growth, and its excess (more than 1.5 mg/l) in drinking water causes fluorosis in teeth, bones, and boneless. . Therefore, studies in parts of the Bikaner block in Bikaner district are being carried out by collecting groundwater samples from wells and pipes in six villages, and then conducting their chemical analysis.

2 Regional Geology and Hydrogeology

2.1 Rainfall & Climate

The district reports arid sort of weather within side the east to extraordinarily arid within side the west. Mean annual rainfall (1991-2010) of the district is 277.fifty

five mm while ordinary rainfall (1901-1971) is decrease than common rainfall and positioned at 257.eight mm. Almost 90% of the overall annual rainfall is acquired at some point of the southwest monsoon, which enters the district within side the first week of July and withdraws within side the mid of September. As the district lies within side the barren region location, extremes of warmth in summer time season and bloodless in iciness are the traits of the barren region. Both day and night time temperatures boom regularly and attain their most values in April, May and June. The temperature varies from forty eight diploma in summer time season to at least one diploma in iciness. Atmosphere is normally dry besides at some point of the monsoon period. The humidity is the very best in August with suggest day by day relative humidity of 71% within side the morning and 52% within side the evening. three. zero Geomorphology & Soil Types Geomorphologic ally, the district can widely be divided into ten devices viz. (1) flat aggraded older alluvial plains, (2) sandy undulating aggraded alluvial plains, (three) flat interdunal plains, (4) sandy undulating interdunal plains, (5) flood plains and aeolian complex, (6) stabilised sand dunes, (7) energetic sand dunes, (eight) gravelly aggraded alluvial plains, (9) eroded rocky floor and (10) saline depressions. The western, south-western, northern and north jap components of the district are in large part included with dunes of various sorts and magnitudes with flat to undulating interdunal plains. The primary jap and southern components of the district represent in large part flat and undulating aggraded alluvial plains. The fashionable fashion of the nearby slope with inside the location is from SSE (275 mamsl) to NNW (152 mamsl). There are only some small hill outcrops of approximately 1-2 mheight close to Kolayat with inside the district. The district has no primary river gadget besides for some quick intermittent and ephemeral channels close to Kolayat. A few herbal lakes or depressions are discovered close to Gajner, Kolayat, Nal and Lunkaransar. three The fundamental Rajasthan Canal enters the location someplace north of village Bhansar and leaves the district withinside the southern boundary close to village Gogliala. The fundamental canal has some of branches and distributaries like (1) Naushera Branch, (2) Dathar Branch, (three) Birsipur Branch, and (4) Charanwala branch. Besides the primary Rajasthan canal command location, there are different command regions of carry canals. The Indira Gandhi NaharPariyoajna gets water from barrage at HariKaPattan in Amritsar district of Punjab via 204 km. The IGNP canal command location is 591000 hectares withinside the district (Stage-I 179000 hectares and Stage-II 412000 hectares). The soils of Bikaner district are predominantly mild textured, weak – structured, sand to sandy loam with the clay content. Arid weather with low rainfall, excessive temperature and excessive evaporation losses has led to bodily and mechanical disintegration of the determine fabric giving upward thrust to predominance of coarse fraction withinside the soil. Very little chemical weathering has taken location and the improvement of soil is commonly indistinct Soils are generally of desertic type with poor fertility status and very low water retention capacity. Soil profile studied shows that the hydraulic conductivity in the soil profile reaches upto 10.9 cm/hr while the maximum available moisture in the soil profile remains to the extent of 1.13%. In general the soils have good porosity (40%) and good to very good permeability. Water Level Scenario is periodically monitors water levels through four times a year i.e. in January, May (Pre monsoon), August and November (Post monsoon). Block-wise details of depth to water level during pre-monsoon, post-monsoon and water level fluctuation

between the two periods are given in table 1. Depth to water level in the district ranges from 8.54 to 111.70 mbgl and 7.64 to 116.40 mbgl during pre monsoon and post monsoon, 2021 periods respectively.

Table 1: Block-wise details of depth to water level during various seasons

Block	Pre Monsoon		Post Monsoon		Water Levels Fluctuation (mbgl)			
	Water Level (mbgl)		Water Level (mbgl)		Rise		Fall	
	Min	Max	Min	Max	Min	Max	Min	Max
Bikaner	12.50	112.2	13.50	108.35	0.00	0.50	0.00	0.26
Kolayat	11.30	113.70	12.23	113.12	0.12	0.46	0.06	4.70
Nokha	8.34	68.35	8.64	65.35	0.03	1.78	0.00	0.43
Lunkaransar	71.33	105.7	78.50	108.6	0.01	2.99	0.28	7.30
Shri Dungargarh	52.5	71.2	35.30	72.30	0.01	4.22	0.12	0.25
Bikaner District	8.54	111.70	7.64	116.40	0.00	4.22	0.00	7.30

The natural effect because of advancement of water assets envelops the socio-social set up made by man to adjust to the requests, and difficulties of his normally happening conditions. The biological framework, once upset, may not be returned in the vast majority of the cases particularly the issues connected with ground water contamination. With the presentation of channel framework these have been recognizable changes in the ground bet system in its order region. There has been ascending in water levels in tubewells situated in the order region in the whole plot of Indira Gandhi Nahar Pariyojana of which locale Bikaner is a section. In the Bikaner Region ascend in water levels along the channel have been seen in the Public Hydrograph Stations at Amarpura, CharanwalaChattargarh, Khakhli, Kherbas, Lakhasar and so forth. There are no water logged regions at present in the Bikaner Locale. Notwithstanding, the regions around Kharbara, Dantor, Manaksar, Modayat, Charanwala Bhikampur and so forth.are more inclined to water logging.The fundamental danger in the improvement of ground water in the locale is its saltiness. The ground water of Bikaner locale has generally high mineral fixation,which fluctuates horizontally and in an upward direction.

Likewise such regions experience the ill effects of water quality issue and in a portion of the areas ground water is exceptionally saline. Towns situated in such regions have the fundamental issue of drinking water prerequisite and the circumstance turns out to be exceptionally basic in summers and in dry spell years.One more issue of worry in the locale is that the majority of the potential zones have enlisted weighty ground water improvement causing bringing down of water table and evaporating of huge number of shallow wells or decrease in their yields. Weighty decay of water level in the wells situated in Tertiary arrangement and Quaternary alluvium seen during most recent 15 years.

Geological Framework: Practically, the whole of the surface geology in the greater part of the district is concealed under a thick cover of windblown sand. However, rocks belonging to Palana Series of Eocene age are exposed around Kolayat, Mar and Bikaner. Sporadic outcrops of sandstone belonging to Lathi (Jurassic) and

Badhaura Series (Permo-carboniferous) occur in south-western corner of the district. Lathi and Badhaura sandstones are in small area. Palanas or the Quaternaries are directly underlain by rocks belonging to Marwar Super Group. Major Soils Area ('000 ha) Percent (%) of total Deep Yellowish brown sandy soils 3038 39.3 Deep Light yellowish brown loamy soils 2984 38.6 Medium Light yellowish brown loamy soils 1002 13.0 Others: Deep Pale brown loamy, medium yellowish brown sandy, shallow Pale brown gravelly sandy soils 686 08.9 2 Total 7710.0 100 4 Jodhpur sandstones and shales are encountered at very shallow depth just below the top Quaternaries in an elliptical area with its longer axis in east-west and shorter axis in north-south direction along Bamanwali-Dhirera and Dulmera line. Thickness of Quaternaries is less around Mahajan in the northern part of the district but increases both in the north towards Arjunsar and in south towards Lunkaransar. Again the Jodhpur sandstones are encountered at shallow depths just below the Quaternaries in the southern part of the district. The subsurface regional geological correlation has revealed the presence of a major longitudinal fault (further east of Bikaner District Boundary). It separates the Precambrian basement platform of the eastern upthrown block with the lower Tertiary of the western downthrown block falling in the Bikaner district. Some smaller parallel faults and a few cross faults are also noticed. One such fault passes in the east-west direction north of Nokha with its down throw in the north. Thus, practically whole of the Bikaner area forms a syncline separated from the southern Nagaur uplift. 4.2 Hydrogeology: The Palana sandstone member of the Palana series is the main aquifer in the district. Other aquifer formations are sandstone and limestone of Nagaur group of rocks. Jodhpur sandstone and Quaternary alluvium also form aquifer whenever they extend in the zone of saturation. Hydrogeological Conditions: The ground water conditions in different formations in the district are described below. Quaternary Aquifer: The unconsolidated Quaternary sediments attain the status of aquifer in the area north of latitude 28°03' except around Dhirera and Dhulmera, Mechanical analysis of the aquifer material collected during direct rotary drilling reveals the presence of 20% clay content in the aquifer with sorting coefficient varying from 1.3 to 3.34, the average being in the range of 1.5 to 2.5. The ground water occurs under water table conditions and the yield varies from 75 lpm to less than 950 lpm. Thickness of alluvium in the exploratory well at Godwala-II is found to be 187m and the yield of well is 947 lpm (Gadwala-II). The drilled depth of this borehole was 418.49 m whereas constructed depth was 187 m. The slim hole at Karmisar has been drilled to the depth of 510.27 m. The main potential area is the Central part, where Quaternaries form potential aquifers as and when they attain saturation. Palana Sandstone Aquifer: Palana sandstone belonging to lower Eocene to Palaeocene age forms the main and potential aquifer in the district. Palana Sandstone is overlain by Quaternary deposits and is underlain by rocks belonging to Nagaur Group of Marwar Super group. It mainly occupies eastern part of the area and extendsupto the south-western boundary of the district i.e. south of Kalasar. The exploratory drilling indicates that Palana sandstone comprises mainly sandstone fine to coarse grained, well sorted white to grey with some times pink tinge, poorly to moderately cemented, soft and friable. Locally it is more gravelly, poorly sorted and is intercalated with thin clay beds especially in the lower part, close to it's contact with the thick lower members of the Palana series. In accordance with the regional structural pattern, the saturated thickness of Palana sandstone aquifer increases towards north, except in the axial part of

the Bikaner syncline around Sital where it is greatly reduced to 15 meters only. North of Bikaner, the saturated thickness of 5 Palana sandstone aquifer is about 80 meters. In Gajner, Akasar and Soa, the saturated thickness negligible but it again attains thickness of about 100 m at Kolayat and Baneri. The drilled depth in Palana sandstone varies from 105 mbgl to 505 mbgl. Palana aquifer is found to be under phreatic conditions. Specific capacity of wells ranges from 3.6 to 28.1 m3 /hr/m and transmissivity ranges up to 720 m2 /day, and permeability from 1.65 to 13.5 m/day. The values of transmissivity remain much below 100m2 /day in the axial zone of the Bikaner syncline and relatively high values are expected in the north-eastern part around Bikaner-Sujandesar and around Raneri in the west. Average specific yield of the aquifer is estimated at 7%. Aquifers of Nagaur Group: Only the upper part of Nagaur Group of rocks comprising mainly sandstones has been encountered just below Palana series in most of Kolayat-Bikaner-Sital-Surpura area. Ground water in Nagaur Sandstone occurs under confined conditions mostly. In the explored part its saturated thickness varies from 40 to 310 m. However, Nagaur sandstone aquifer occurs under water table conditions in Nokha area. In this area its saturated thickness varies from a few m to little over 50 m at Nokha. Yield of wells varies from 200 to 750 lpm. Transmissivity is low and ranges from 2.5 to 50 m2 /day. Permeability is correspondingly low. Specific capacity of wells varies from 0.17 to 1.20 m2 / hr/ m. The specific yield of Nagaur Sandstone is estimated at 1% only. In the southernmost part of the district, the lower members of the Nagaur group comprising limestone - evaporite sequence also form an aquifer of insignificant potential in a localized patch. Aquifers of Jodhpur Group: Jodhpur sandstone is compact, fine to coarse grained, micaceous and purple to reddish brown in colour. In most of the Bikaner area, it lies below the evaporite sequence and it contains saline ground water. Ground water occurs under phreatic conditions in Palana sandstone and Quaternary sediments whereas it occurs mostly under confined conditions in Nagaur sandstone and Jodhpur sandstone in the district. Both in Tertiaries and Quaternaries, perched water bodies are formed by arresting of downward movement of rainfall percolation by shales and clay lenses in the zone of aeration. Depth to water level in such bodies varies from 5 to 30 mbgl, the shallower being in Pipal area and deeper in Lunkaransar Kutuwas area.

3. Methodology

Every one of the examples was broke down for different physico-synthetic boundaries eg. pH, Total Dissolved Solids (TDS), Electrical Conductance (EC), Total Alkalinity (TA), Total Hardness (TH), Chloride (Cl), Nitrate (NO3-), Fluoride (F-), Sodium (Na+), Potassium (K+), Sulfate (SO42-) and so on keeping guideline techniques. Investigation of water tests for assurance water quality isn't just unwieldy however tedious too. Anyway the undertaking of occasional observing of the nature of water might be significantly worked with on the off chance that we can discover a few connections among the various water quality boundaries. This becomes conceivable from the way that, when such connections do exist, the assurance of a couple of significant boundaries would do the trick to give an unpleasant thought of the general nature of water since different boundaries can be anticipated from the relations determined by utilizing relationships.

3.1 Testing techniques: - Thirty water tests from various destinations were gathered from various areas of Barmer district. The water tests were widely utilized for drinking and other home-grown reason. . The examples were gathered in high grade plastic jugs of one litre limit subsequent to flushing with Distilled water. The procedures and techniques followed for assortment, protection, investigation and understanding.

3.2 Examination Methods: - The physicochemical qualities of the ground water not entirely set in stone by standard strategies .The pH and Electrical conductivity were estimated by utilizing convenient meters. The groupings of Magnesium, Calcium hardness, all out hardness, nitrate, were assessed by volumetric techniques and the outcomes are contrast and Water guidelines

3.4 Location of sampling sites: The samples were collected from villages of different regions namely Nokha Mandi(1), Dasalsar(2),Palana(3),Gajner(4),Shri Kolayat(5), Jajhu(6), Nokhra(7), Pubasar(8), Dantour(9), Pugal(10), Karmisar(11),Motigarh(12)Kumbhana(13)Lunkaransar(14), Kapurisar(15), Kalu(16), Mundsar(17), Ghatu(18), Jamsar(19), Sobhasar (20)

4. Results of Studies

Perusal of results of chemical analysis shows that the Electrical conductivity in groundwater is ranging from 1840 to 6550µm/cm and only 16.66% of total samples (i.e. only 1 out of 6 samples) is within maximum permissible limit. TDS values are ranging from 982 to 3838 mg/L and only 16.66% of the total samples are within maximum permissible limit. Values of pH are within maximum permissible limit in all the 06 samples. Calcium values are ranging from 3.30 to 325 mg/L and 50% of total samples are within maximum permissible limit. Values of Potassium are ranging from 0.08 to 5mg/L and no sample falls in more than maximum permissible limit. Sodium contents are ranging from 273 to 1113 mg/L and no sample falls within maximum permissible limit. Nitrate value is 00 and none of the samples is having value more than maximum permissible limit. Sulphate values are ranging from 00 to 19mg/L, all samples fall within maximum permissible limit. Chloride content is ranging from 11.0 to 2099mg/L and 50% of total samples are within the maximum permissible limit. Fluoride contents were ranging from 00 to 1.36mg/L and no sample is in more than maximum permissible limit. Magnesium is ranging from 2.50 to 114 mg/L and in 33.32% of total samples, it is more than maximum permissible limit. The TH of samples are ranging from 290 to 1250 mg/L and 50% of total sample are within maximum permissible limit. HCO_3 content is ranging from 5.40 to 500mg/L and all the samples falls within Maximum Permissible Limit.

Table 2: Permissible Limits of water paramters as per various standards

S.N.	Parameters	WHO	UNICEF	BIS
1.	pH	6.5-8.0	6.5-8.5	6.5-8.5
2.	TDS	500	500	500-2000
3.	Alkalinity	200	200	200-600
4.	TH	350	300	300-600
5.	FLUORIDE	1.5	1.5	0.5-1.5

6.	CHLORIDE	200	200	250-1000
7.	NITRATE	50	45	45-100
8.	CALCIUM	100	100	75-200
9.	MAGNESIUM	40	30	30-150

Table 3: Pre Monsoon Physico-chemical parameters in sites of Bikaner District

Sr. No.	Source	pH	EC mhos/ cm	TDS mg/l	Alk mg/l	TH mg/l	Ca mg/l	Mg mg/l	SO_4^- mg/l	Cl mg/l	F mg/l	NO_3 mg /l
1	T.W.	7.4	5100	4050	560	655	120	72	227	1220	2.2	24
2	POND	7.3	3181	2104	120	650	112	88	163	700	0.4	28
3	T.W	7.2	2522	998	190	340	67	36	7	110	0.3	57
4	H.P	7.5	3500	2986	490	240	32	26	141	760	4.9	38
5	O.W	7	952	571	260	50	17	24	45	10	3.5	35
6	H.P	7.6	4000	130	70	40	13	14	19	52	0.2	32
7	O.W	7.4	3158	2755	540	210	40	28	23	660	3.9	30
8	H.P	7.6	2084	2706	550	220	48	22	53	640	3.9	27
9	H.P	7.1	3827	3868	190	660	138	78	111	1320	0.4	19
10	H.P	7.3	2073	165	30	70	8	2	147	50	0.4	23
11	H.P	7.7	4321	4197	290	440	94	48	553	1170	3.3	43
12	T.W	6.9	2921	1264	450	220	38	14	12	180	1	32
13	POND	7.3	3126	2734	510	340	60	38	27	640	1.7	25
14	H.P	7.4	3990	3196	790	210	41	14	23	720	6.5	25
15	H.P	7.2	3280	3511	300	440	99	48	53	1670	3.4	48
16	H.P	7.2	2009	1656	690	180	32	16	61	280	1.6	42
17	H.P	7.5	2454	2286	120	270	52	28	91	720	2	52
18	H.P	7.6	2340	1810	90	210	48	26	113	560	1.6	41
19	H.P	7.9	2289	2176	130	220	42	24	23	700	2	42
20	H.P	7.2	7339	5009	290	540	102	58	51	1720	3.5	48

Table 4: Post Monsoon Physico-chemical parameters in sites of Bikaner District

Sr. No.	Source	pH	EC mhos/ cm	TDS mg/l	Alk mg/l	TH mg/l	Ca mg/l	Mg mg/l	SO_4^- mg/l	Cl mg/l	F mg/l	NO_3 mg/l
1	T.W.	7.3	5050	4000	530	635	105	59	215	1195	2.1	22
2	POND	7.2	3131	2054	90	630	97	75	151	675	0.4	25
3	T.W	7.1	2472	948	160	320	52	23	5	85	0.2	51
4	H.P	7.4	3450	2936	460	220	17	13	129	735	4.8	32
5	O.W	6.9	902	521	230	30	2	11	33	15	3.4	31
6	H.P	7.5	3950	80	40	20	2	5	7	27	1.2	28
7	O.W	7.3	3108	2705	510	190	25	15	11	635	3.8	26
8	H.P	7.5	2034	2656	520	200	33	9	41	615	3.8	24
9	H.P	7	3777	3818	160	640	123	65	99	1295	0.3	15
10	H.P	7.2	2023	115	20	50	7	11	135	25	0.6	19
11	H.P	7.6	4271	4147	260	420	79	35	541	1145	3.2	39
12	T.W	6.8	2871	1214	420	200	23	1	0	155	0.9	28
13	POND	7.2	3076	2684	480	320	45	25	15	615	1.6	21

14	H.P	7.3	3940	3146	760	190	26	1	11	695	6.4	22
15	H.P	7.1	3230	3461	270	420	84	35	41	1645	3.3	42
16	H.P	7.1	1959	1606	660	160	17	3	49	255	1.5	38
17	H.P	7.4	2404	2236	90	250	37	15	79	695	1.9	46
18	H.P	7.5	2290	1760	60	190	33	13	101	535	1.5	35
19	H.P	7.8	2239	2126	100	200	27	11	11	675	1.9	36
20	H.P	7.1	7289	4959	260	520	87	45	39	1695	3.4	42

5 Conclusions

Studies carried out reveals that major parts of Bikaner district is having Electrical conductivity, TDS and Sulphate concentrations more than permission limits indicating high salinity in groundwater and therefore unsuitable for drinking as well as irrigation purposes. However, pH values, Potassium, Fluoride, Nitrate and Sulphate concentrations in groundwater are within maximum permissible limits in the larger areas of study in Bikaner. It is found that Electrical Conductivity, TDS and TH increase during pre-monsoon period. However, no such changes are recorded in Sulphate, Nitrate and Fluoride contents after rainfall. Salinity in groundwater is owing to prevailing as well as palaeo-aridity in the region especially salinity in alluvial geo-formations. Salinity in consolidated formations is mainly due to connate nature of groundwater entrapped during their origin. There is also increase in salinity because of rapid declining of water levels over the period of time due to over-exploitation of groundwater resources in the study area. Enhancement in pre-monsoon – post-monsoon salinity is due to dissolution of salts by the rainwater through soils and zone of aeration during monsoon precipitations. De-salination of groundwater is recommended for sustainable drinking water supply so as to combat ill health effects among the common people in the study area. Possibilities of growing salt tolerant crops like wheat and gram may be explored and promoted especially in coarse textured soils in the study area.

Mass awareness, water literacy and community participation is needed for addressing various issues of concern effectively and efficiently which will be fruitful for improving local ecosystem, socio-economic scenario and contribution towards development of not only Bikaner District but other arid areas of the state of Rajasthan.

- Awareness program to teach about preservation of valuable ground water assets and preparing on water collecting will be advantageous to check decrease in water level and legitimized use.
- Ground water improvement in over-took advantage of, basic and semi-basic region ought not be energized.
- Utilization of water saving gadgets like sprinklers, close field dispersion channels and so on ought to be advanced.
- Current farming administration methods must be taken on for powerful and ideal use of the water assets. This can be accomplished by keeping up with water system through least siphoning hours according to least necessity of water by the harvest and furthermore choosing most appropriate practical yield design.

- High water necessity harvests to be deterred. Legitimate horticulture augmentation administrations ought to be given to the ranchers so they can go for substitute low water necessity prudent yields.
- Salt safe harvests can be planted in the space having harsh ground water.
- In Kolayat and Lunkaransar blocks, which fall under safe class, further ground water advancement is proposed.
- Customary water reaping structures like tankas, rooftop top downpour water capacity ought to be urged for meeting everyday prerequisites which will lessen ground water withdrawal.
- Enormous scope re-energize possibilities exist in drained springs. Execution of counterfeit re-energize in such regions through external surface water sources like lift channel from IGNP framework or floodwater during abundance stormy years be advanced.
- Conjunctive utilization of ground water and surface water ought to be empowered in trench order regions to forestall further water signing in the CCA. Hostile to water logging measures must be embraced in the trench order regions.

References

1. Anon, 1994. Resource Atlas of Rajasthan, D. S. T, Govt. of Rajasthan. 231p.
2. Anon, 2009. Groundwater Scenario of Bikaner District. Central Groundwater Board, Jaipur, 22p
3. Anon, 2012. Indian Standard Drinking Water — Specification. Bureau of Indian Standards, New Delhi. Pp-1-163. Anon, 2013a. Hydrogeological Atlas of Rajasthan Bikaner District, Groundwater Department, Rajasthan
4. Anon, 2013b. Groundwater Information, Bikaner District,. Central Groundwater Board, Rajasthan, 15p.
5. Anon, 2017. Report on Aquifer Mapping and Ground Water Management, Bikaner District. Central Groundwater Board, Rajasthan, 28p.
6. Roy, A.B and Jakhar, S.R., 2002. Geology of Rajasthan (Northwest India). Precambrian to Recent. Scientific Publisher, Jodhpur, 421p.
7. Widana, I.K., Sumetri, N.W., Sutapa, I.K., Suryasa, W. (2021). Anthropometric measures for better cardiovascular and musculoskeletal health. *Computer Applications in Engineering Education*, *29*(3), 550–561. https://doi.org/10.1002/cae.22202
8. Vyas Arun, Mittal G.S. and Gaur C.P. 2015. Lignite Deposits of the Bikaner – Bikaner Basin, around Matasukh- Kasnau in Bikaner District of Rajasthan. Jour. Geol. Soc. India, 86(12), pp. 742-746.
9. WHO (1984). Guide lines for drinking water quality, vol.1 Recommendations, Geneva.