ASSESSMENT OF GROUNDWATER QUALITY ALONG BHAKARA MAIN LINE - HANSI BRANCH – BUTANA BRANCH - MULTIPURPOSE LINK CHANNEL (MPL) IN HARYANA, INDIA FOR DOMESTIC AND AGRICULTURAL PURPOSES

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ABSTRACT

Ground water quality study is carried out along Bhakra Main Line - Hansi Branch – Butana Branch - Multipurpose Link Channel using chemical approaches in Haryana. The link channel is planned for transfer of water from Bhakra main line system (western Haryana) to Yamuna Water Supply System (eastern Haryana). This channel is designed for the 986.79 million cubic meter (MCM) discharge and is about 110 km in length. The objective of the study is to assess water quality for the domestic and agriculture purposes due to contribution of seepage of the link canal in the ground water of the area. Forty-five groundwater samples were collected in the pre and post monsoon months of June, 2012 & February, 2013 respectively from different bore wells and tube wells located on both sides of link channel from its head to tail. Collected water samples were analysed for ions of Na, K, Cl, Ca and Mg values in the laboratory of NIT Kurukshetra. The study reveals that the agriculture activities, geological formation, local environment conditions and seepage from link channel control the groundwater quality. The concentration of the analysed ions and SAR values of groundwater along the middle part of MPL channel is observed to be highest. Groundwater suitability for domestic and agriculture purposes are examined using WHO and Indian standards classifications, it has been observed that groundwater at a few sampling sites, are not suitable for domestic and agriculture purposes.

Keywords: Chloride, Groundwater, Potassium, Sodium, Sodium-Absorption Ratio.

I. INTRODUCTION

All forms of life depend on water for their existence. However, it is mostly fresh water on which human beings and many species of animals and plants survive. Water is also important for crop production along with the good fertile soil. Water is not only available at surface of earth but also above surface of earth i.e. in the atmosphere and below the surface as ground water. However, the most of water which available on the surface of earth in river, lakes, etc. and available below the earth as ground water are useful for humans. Haryana is one of the most agricultural producing state of India where source of water is either canal water or ground water or both. However, the highly productive agricultural land of Haryana has problems of unequal distribution of water. The areas covered by Bhakhra Water System (BWS) are in excess of water, whereas areas covered by Yamuna Water System (YWS) system are in deficient. Haryana Government is trying to remove this difference by transfer of water from Bhakra main line to YWS System through construction of Bhakra main line – Hansi Branch - Butana Branch – multipurpose link channel. This channel is designed for the 0.8 million acres feet (MAF) discharge. It is regarded in the design that 50% of the water supplied through this channel will be utilized by National Capital Region (NCR) and for drinking water needs. Rest of its water is utilized for the irrigation purpose in Haryana. The benefited areas viz. Panipat, Rohtak, Bhiwani, Jajjhar, Rewari, Mahendergarh, Gurgaon, Jind, Karnal, Kaithal and Hissar from the project is envisaged as 85020 ha for Rabi Season.

Due to seepage of water from link channel, because of increasing utilization for human needs and because of the ill effects of the increased industrial activity the groundwater quality may be affected [1]. Poulichet et. al [2] reported on the importance of groundwater recharge on seasonal variation in the major-ion concentration of groundwater. Other studies have also reported that urban developments and agricultural activities directly or indirectly affect the groundwater quality [3, 4, 5, 6, 7, 8]. Various literature review reveals that the groundwater chemistry depends on a number of factors, such as general geology, degree of chemical weathering of the various rock types, quality of recharge water and inputs from sources other than water rock interaction. Such factors and their interactions results in a complex groundwater quality [9, 10, 11]. Raja and Venkatesan [12] as well as Juned and Bhosle[13] studies also reveal that ground water quality assessment can be done on the basis of analysis of cations and anions. With this background, the present study is taken up to investigate the effect on groundwater quality of the area lying all along Bhakra main line – Hansi Branch - Butana Branch – multipurpose link channel in order to assess its suitability for domestic and agricultural uses..

II. STUDY AREA

The study area is located between longitude 74°27’00’’ to 77°35’00’’ E and Latitude 27°39’00’’ to 30°55’00’’N and shown in Fig. 1.. Total land area is 44,212 Sq. Km and its physiography consist of hilly area of 682 Sq. Km and alluvial area of 43,530 Sq. Km. The rainfall of the area varies from 325 mm in south west monsoon to 988 mm in the north east monsoon with annual average rainfall of 573mm. The highest temperature of about 47º C was observed in the months of June- July and the lowest temperature was about 3º in the month of January.

The Bhakra Main Line-Hansi Branch-Butana Branch Multipurpose Link Channel traverses the study area in the N-S direction. This canal originates from the Bhakra Main Line Channel and carries waters of Satluj and Beas rivers that are originating from Upper Himalayas. It has a length of 110Km. The Gagger River aligns in E-W direction in the northern Part of the study area and originates from the Lower Himalayan ranges. The Ghagger river is believed to be following the course of the mighty river Saraswati of Himalaya origin, mentioned in many early literature and known to have existed before 3,000 BC.

IJARSE
ISSN 2319 - 8354

III. METHODOLOGY

The groundwater samples were collected from 45 bore wells/ tube wells depending upon the availability of these groundwater drawing structures in benefited region from head to tail of the channel. Sampling stations for the groundwater were located on both sides of the linking channel within the distance of 2.5 km from the banks of the channel. These sampling stations were at the distance of 10 – 20 km interval along the covered entire length of the channel. Names and locations of bore wells/ tube wells are shown in Fig. 1 by green circles.

All the groundwater samples were collected in HDPE bottles, before water sampling all the bottles were cleaned and rinsed thoroughly with water samples to be analyzed. The samples were analyzed for different parameter as Na, K , Cl , Ca and Mg ions following standards methods recommended by APHA [14]. All the reagents used were of analytical grade. Na and K ions were determined by flame photometer, Cl ion was determined by Argentometric method. For Ca, Mg ions and total hardness were determined by the titration with EDTA in the presence of solochrome black indicator. In addition to determinations of mentioned cations and anions, the pH value and electrical conductivity of each sample were determined by use of water analysis kit.

IV. RESULT AND DISCUSSION

Determined concentrations of cations, anions, total hardness, pH and electrical conductivity of various samples are shown in Table 1 and Table 2.

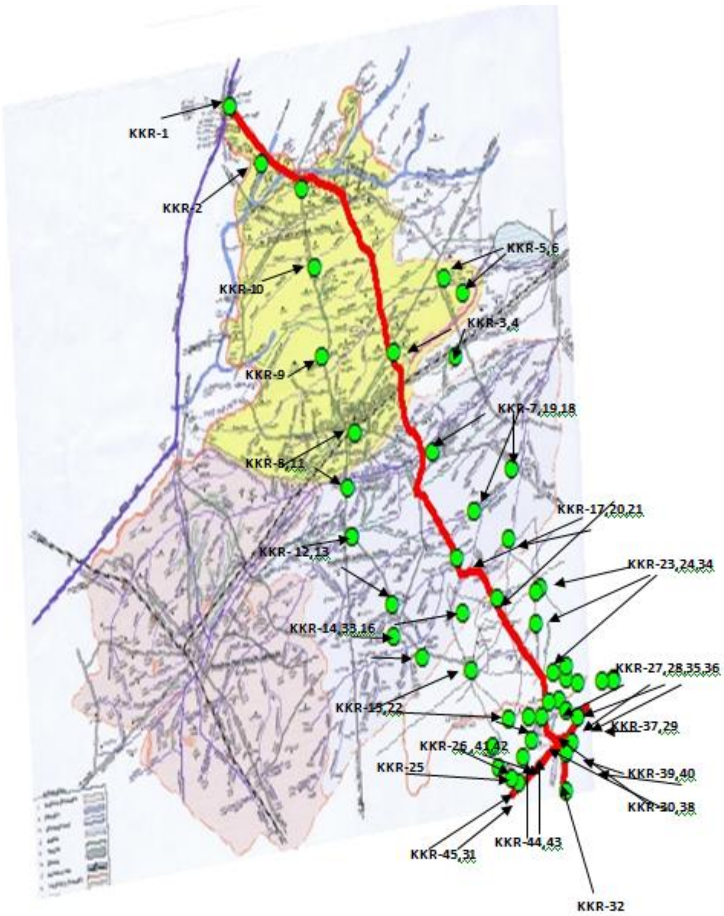

Fig. 1: Study Area and Water Sample Stations

Table 1: pH, Electrical Conductivity and Concentrations of Na, K and Cl Ions of Samples

Sr No.	Sample Name	pH		Electrical Conductivity (ms/cm)		Na ion (mg/l)		K ion (mg/l)		Cl ion (mg/l)	
		PRM*	POM**	PRM	POM	PRM	POM	PRM	POM	PRM	POM
1.	KKR-1	8.14	8.06	0.17	0.24	2.1	12.8	0.3	0.0	7.1	10.65
2.	KKR-2	8.03	7.57	1.36	0.94	119.9	95.8	5.8	1.1	166.85	49.7
3.	KKR-3	8.43	7.89	1.06	1.24	101.6	124	5.4	1.5	74.55	60.35
4.	KKR-4	8.5	7.81	1.56	1.99	194.0	235	4.9	2.2	81.65	85.2
5.	KKR-5	8.29	7.88	1.71	0.89	206.4	95.4	7.1	1.6	202.35	35.5
6.	KKR-6	8.82	7.88	0.50	0.74	38.8	53.3	1.7	0.7	17.75	21.3
7.	KKR-7	8.86	7.72	0.75	1.05	65.3	97.5	3.0	1.1	17.75	17.75
8.	KKR-8	8.67	7.96	2.27	2.93	274.0	394.5	4.1	2.1	145.55	149.1
9.	KKR-9	8.56	7.45	1.06	1.89	101.4	222	4.2	3.6	63.9	113.6
10.	KKR-10	8.52	7.7	0.72	1.02	53.5	119	5.5	2.6	28.4	35.5
11.	KKR-11	9.04	8.02	1.55	2.02	240.6	294	5.6	5.4	85.2	81.65
12.	KKR-12	8.79	7.95	1.72	2.31	193.5	316.5	92.5	70.4	124.25	127.8
13.	KKR-13	8.56	8.42	1.51	0.97	202.5	178.5	0.7	0.9	81.65	42.6
14.	KKR-14	8.6	7.88	0.98	1.23	91.2	153	3.5	3.9	31.95	42.6
15.	KKR-15	8.57	7.91	0.96	1.16	97.9	142	3.9	3.7	53.25	49.7
16.	KKR-16	8.48	7.75	2.45	3.09	452.8	470.5	5.0	5.4	315.95	276.9
17.	KKR-17	8.6	8.29	0.71	0.87	151.6	144.5	0.3	1.6	35.5	21.3
18.	KKR-18	8.56	7.91	0.97	1.27	132.0	131	3.5	4.1	63.9	67.45
19.	KKR-19	8.98	7.77	0.93	1.52	170.4	180	4.5	4.3	56.8	71.0
20.	KKR-20	8.31	7.64	0.57	0.73	42.4	117	2.0	2.3	21.3	21.3
21.	KKR-21	8.5	7.46	3.52	3.45	495.2	414	4.4	136.5	347.9	298.2
22.	KKR-22	8.85	8.1	2.05	3.12	450.4	499.5	29.3	22.9	209.45	262.7
23.	KKR-23	8.8	8.13	1.92	2.27	371.6	475.5	7.3	6.1	63.9	56.8
24.	KKR-24	8.83	7.95	2.52	2.94	437.6	482.5	3.8	3.2	280.45	266.25
25.	KKR-25	8.52	7.58	1.04	1.49	97.2	126.5	25.1	18.5	102.95	99.4
26.	KKR-26	8.45	7.98	1.13	1.08	184.8	135	2.7	2.1	99.4	10.65
27.	KKR-27	8.53	8.15	0.59	0.65	30.0	112	60.3	38.6	24.85	10.65
28.	KKR-28	8.65	7.82	1.25	1.66	245.6	218.5	3.6	0.8	67.45	74.55
29.	KKR-29	8.86	7.83	0.57	0.73	45.1	36	2.3	0.5	14.2	14.2
30.	KKR-30	8.56	8.42	0.25	027	13.2	7.0	0.4	0.0	10.65	7.1
31.	KKR-31	8.4	7.96	0.42	0.61	12.3	7.3	1.3	0.8	17.75	7.1
32.	KKR-32	8.51	8.4	0.33	0.47	11.4	7.8	0.7	0.2	14.2	7.1
33.	KKR-33	8.56	8.17	0.53	0.81	77.4	76.6	2.1	0.7	14.2	14.2

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ISSN 2319 - 8354

34.	KKR-34	8.5	7.92	0.96	1.13	134.4	166	3.3	0.8	7.1	53.25
35.	KKR-35	8.12	7.89	0.75	1.01	85.0	54.6	3.2	1.3	21.3	24.85
36.	KKR-36	8.55	8.08	1.11	0.66	102.9	30.0	4.1	0.4	17.75	14.2
37.	KKR-37	8.92	7.73	1.12	1.72	162.0	182	7.9	4.9	106.5	113.6
38.	KKR-38	8.62	8.28	0.81	1.02	176.0	183.5	3.1	1.6	17.75	24.85
39.	KKR-39	8.2	8.53	0.20	0.26	4.4	2.5	2.0	0.9	7.1	7.1
40.	KKR-40	8.06	7.69	2.13	3.35	210.8	323.5	7.9	5.5	244.95	291.1
41.	KKR-41	8.36	7.91	1.34	1.64	134.0	200	6.5	4.4	99.4	85.2
42.	KKR-42	7.92	7.42	1.87	1.77	22.0	21.9	9.4	4.4	340.8	216.55
43.	KKR-43	8.52	7.84	1.04	1.25	38.0	20.6	6.7	4.0	81.65	67.45
44.	KKR-44	8.69	8.16	1.31	1.63	220	208	3.3	1.7	60.35	67.45
45.	KKR-45	8.74	8.42	1.98	2.36	348.8	380	2.0	0.9	244.95	138.45
BIS permissible range [15]		6.5-8.5		2.2-4.6 x10^{-3}ms/cm		200mg/l		No limit listed		1000mg/l	
WHO permissible range		6.5 -8.5		---------		200mg/l		No limit listed		250mg/l	

Where PRM*- Pre Monsoon, POM**- Post Monsoon

Table 2: Total Hardness, Concentrations of Ca and Mg Ions and SAR Values of Samples

Sr No.	Sample Name	Total Hardness (mg/l)		Calcium (mg/l)		Magnesium (mg/l)		SAR	
		PRM	POM	PRM	POM	PRM	POM	PRM	POM
1.	KKR-1	126.37	100	21.98	65	17.14	35	0.48	3.09
2.	KKR-2	142.85	280	19.79	210	22.42	70	26.12	13.5
3.	KKR-3	401.09	295	39.56	145	72.53	150	13.57	18.1
4.	KKR-4	516.48	500	46.15	205	96.27	295	22.99	26.88
5.	KKR-5	412.08	290	46.15	125	71.222	165	26.94	14.26
6.	KKR-6	285.71	280	35.16	155	47.47	125	6.04	7.86
7.	KKR-7	348.9	325	32.97	140	63.96	185	9.38	13.77
8.	KKR-8	258.24	240	35.16	110	40.88	130	44.48	64.35
9.	KKR-9	362.63	545	43.96	190	60.66	355	14.02	24.74
10.	KKR-10	390.1	390	50.55	150	63.3	240	7.09	15.53
11.	KKR-11	274.72	295	17.58	65	55.38	230	39.9	46.15
12.	KKR-12	368.13	320	30.77	160	69.89	160	27.27	44.26
13.	KKR-13	208.79	55	10.99	30	43.52	25	38.79	59.5
14.	KKR-14	351.64	335	35.16	125	63.3	210	12.99	21.61

15.	KKR-15	346.15	275	32.97	130	63.3	145	14.11	21.58
16.	KKR-16	653.84	535	32.97	130	137.15	405	49.09	54.51
17.	KKR-17	98.9	80	6.59	50	19.78	30	41.75	39.26
18.	KKR-18	357.14	360	52.75	195	54.07	165	18.06	17.1
19.	KKR-19	355.16	390	24.17	205	65.94	185	25.38	22.67
20.	KKR-20	313.18	315	68.13	205	34.28	110	5.92	15.89
21.	KKR-21	626.37	725	52.75	205	118.69	520	53.48	40.74
22.	KKR-22	434.06	450	43.96	155	77.8	295	57.74	61.36
23.	KKR-23	307.69	295	17.58	20	63.3	275	58.51	55.67
24.	KKR-24	478.02	450	43.96	230	88.35	220	53.8	56.76
25.	KKR-25	505.49	595	26.37	265	105.5	330	11.97	13.14
26.	KKR-26	340.65	235	26.37	105	65.94	130	27.2	22.35
27.	KKR-27	214.28	185	26.37	115	35.6	70	5.38	20
28.	KKR-28	288.65	290	28.86	115	51.97	175	38.63	32.95
29.	KKR-29	288.65	285	47.42	155	40.82	130	6.78	5.27
30.	KKR-30	139.17	115	8.25	60	28.46	55	3.08	1.62
31.	KKR-31	262.88	110	59.79	55	27.21	55	1.86	1.74
32.	KKR-32	201.03	215	49.49	180	18.56	35	1.95	1.23
33.	KKR-33	185.56	185	22.69	55	30.93	130	14.95	14.87
34.	KKR-34	268.04	175	30.93	55	45.77	120	21.7	33
35.	KKR-35	345.36	395	53.61	210	50.72	185	11.76	6.81
36.	KKR-36	587.62	285	78.36	155	94.03	130	11.08	4.39
37.	KKR-37	257.73	400	14.43	175	53.2	225	27.85	23.12
38.	KKR-38	77.31	65	10.31	35	12.37	30	52.26	56.46
39.	KKR-39	118.55	120	33.00	70	8.66	50	0.96	0.55
40.	KKR-40	747.42	975	37.11	490	157.12	485	21.39	25.9
41.	KKR-41	293.81	295	47.42	120	42.06	175	20.03	29.85
42.	KKR-42	1139.2	870	138.15	425	190.52	445	1.71	1.86
43.	KKR-43	639.17	585	70.10	225	111.35	360	3.98	2.19
44.	KKR-44	97.93	105	14.43	45	14.84	60	57.5	51.74
45.	KKR-45	82.47	80	10.31	40	13.6	40	100.87	106.44
BIS permissible range		600mg/l		200mg/l		100mg/l		----------	
WHO permissible range		0-75 mg/l		200mgl		50mg/l		----------	
SAR values		0 to 10 suitable for all types of crops		10 to 18 Suitable for coarse textured of organic soil with good permeability		18 to 26 Harmful for almost all types of soils		Above 26 Unsuitable for irrigation	

The values of pH in groundwater in pre and post monsoon season are ranged between 7.42 to 9.04. The lowest concentration of pH in pre and post monsoon is 7.92 and 7.42respectively at stations KKR-42 and KKR-42 respectively. The highest pH values are 9.04 to 8.53 at stations KKR-11 and KKR-39 respectively as shown in Fig.2. It is seen that pH values gets reduced after the monsoon. This may be because geology of the aquifer might be containing few carbonate rocks.

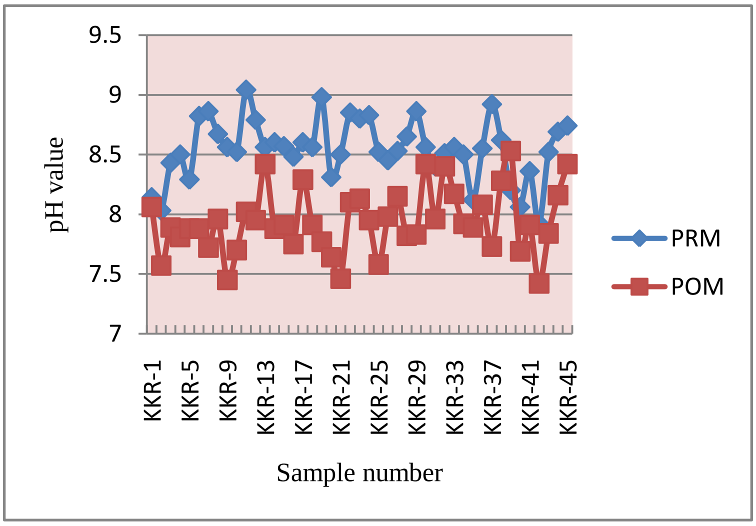

Fig.2: Pre-Monsoon and Post-Monsoon pH Values of Ground Water at Various Sampling Stations

The values of sodium in groundwater pre and post monsoon under the consideration are ranged between 2.1 mg/l to 499.5mg/l. The lowest concentration of sodium in pre and post monsoon is 2.1 mg/l and 2.5 mg/l at stations KKR-1 and KKR-39 respectively and the highest concentration are in the ranged between 495.2 mg/l to 499.5 mg/l found in KKR-21 and KKR-22 respectively as shown in Fig. 3. There is minor increase in sodium ion concentration of groundwater at almost all sample stations in post monsoon season. This increase is due to excessive use of fertilizer by farmers.

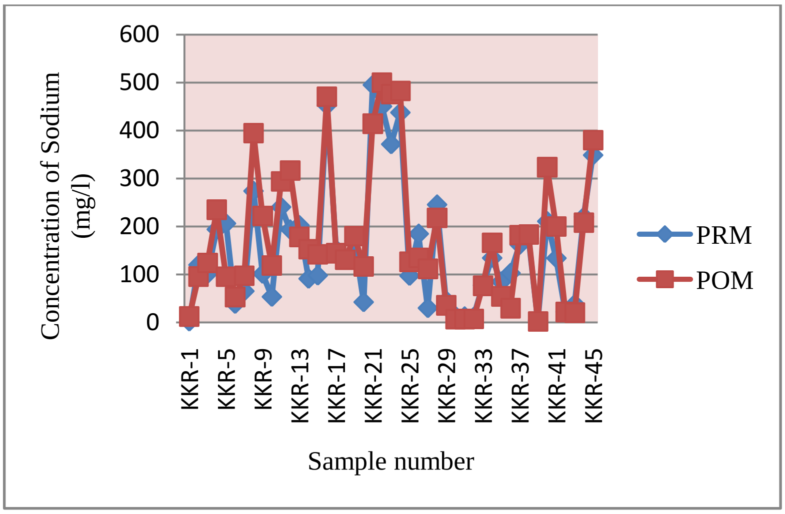

Fig.3: Pre-Monsoon and Post-Monsoon Na ion Concentration of Ground Water at Various Sampling Stations

International Journal of Advance Research in Science and Engineering
Vol. No.4, Issue 07, July 2015
www.ijarse.com
IJARSE
ISSN 2319 - 8354
The values of potassium in groundwater pre and post monsoon under the consideration are ranged between 0.0 mg/l to 136.5 mg/l. The lowest concentration of potassium in pre and post monsoon is 0.3mg/l and 0.0 mg/l for KKR-1, 17 and KKR- 1, 30 respectively and the high concentration are in the ranged between 92.5mg/l and 136.5 mg/l for KKR-12 and KKR-21respectively as shown in Fig. 4. The increasing potassium in groundwater of MPL near to agriculture is to use of fertilizer. Thus, the excess amount of potassium present in the water sample may lead nervous and digestive disorder [16].

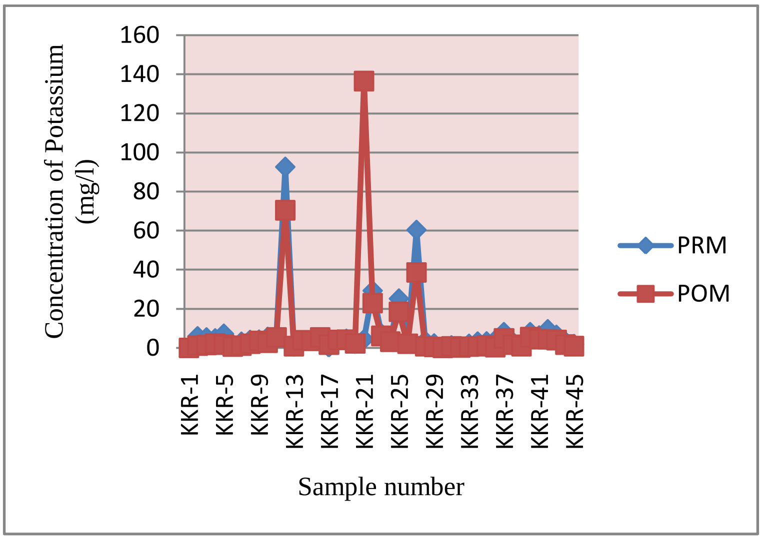

Fig.4: Pre-Monsoon and Post-Monsoon K Ion Concentration of Ground Water at Various Sampling Stations

The value of chloride for the groundwater pre and post monsoon under consideration is ranged between 7.1mg/l to347.9mg/l. The lowest values of chloride pre and post monsoon concentration is 7.1 mg/l found in KKR-1,34,39 and KKR-30,31,32,39 respectively while the highest values are 347.9mg/l and 298.2 mg/l for KKR-21 along MPL as shown in Fig. 5. High chloride content due to the uses of inorganic fertilizers, land fills, leachates, septic tank effluents and industrial and irrigation drainage. Chloride imparts a salty taste and some time high concentration causes laxative effect in humane being [17].

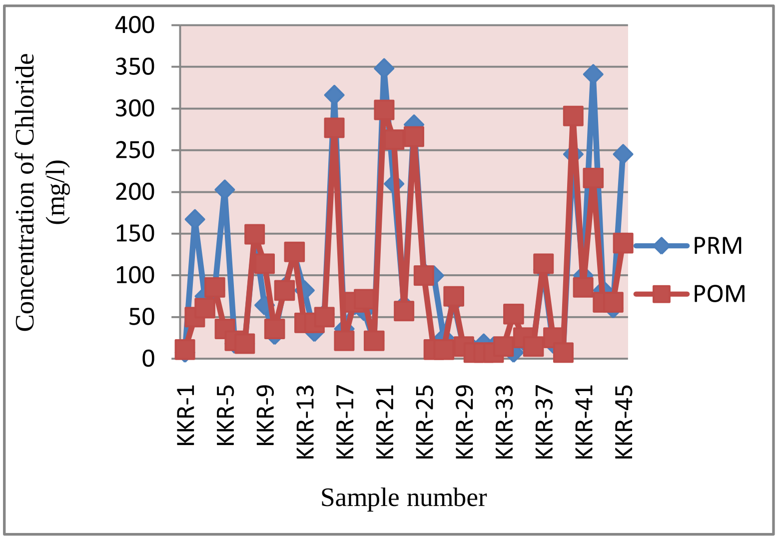

Fig.5: Pre-Monsoon and Post-Monsoon Cl ion Concentration of Ground Water at Various Sampling Stations

International Journal of Advance Research in Science and Engineering
Vol. No.4, Issue 07, July 2015
www.ijarse.com

IJARSE
ISSN 2319 - 8354

The values of total hardness in groundwater pre and post monsoon under the consideration are ranged between 55 mg/l to 1139.2 mg/l. The lowest concentration of total hardness in pre and post monsoon is 77.31 mg/l and 55 mg/l found in KKR-38 and KKR-13 respectively and the high concentration are in the ranged between 1139.2 mg/l to 975 mg/l found in KKR-42 and KKR-40 respectively as shown in Fig. 6. It is seen that total hardness values gets reduced after the monsoon. The increasing total hardness in groundwater is due to use of fertilizers in agricultural activities.

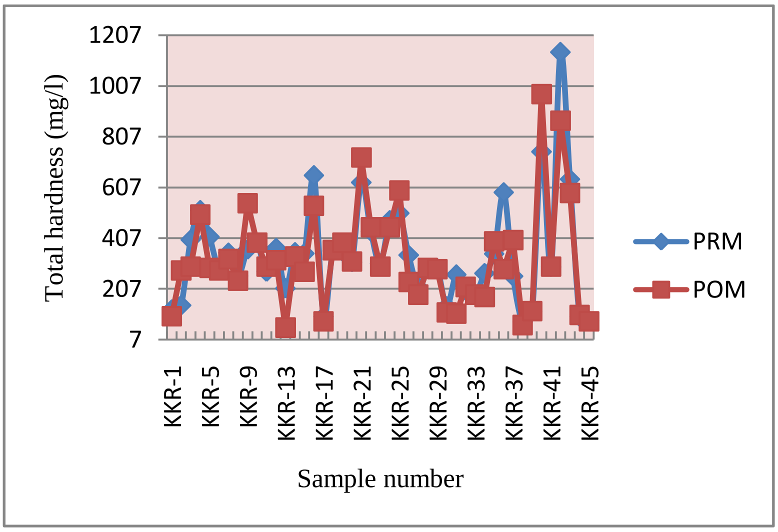

Fig.6: Pre-Monsoon and Post-Monsoon total Hardness of Ground Water at various Sampling Stations

SAR values for the groundwater along MPL for pre and post monsoon are observed in the range between 0.475 to 106.44 as shown in Fig.7. More than the fifty percentage groundwater samples are in under permissible limit of SAR value, that indicated suitable for all types of crops and for coarse textured of organic soil but unsuitable in fine textured which require good drainage, high leaching and addition of gypsum. The groundwater samples KKR-8, 11, 12, 13, 16, 17, 21, 22, 23, 24, 28, 33, 37, 38, 41, 43, 44 and 45 are unsuitable for irrigation purpose.

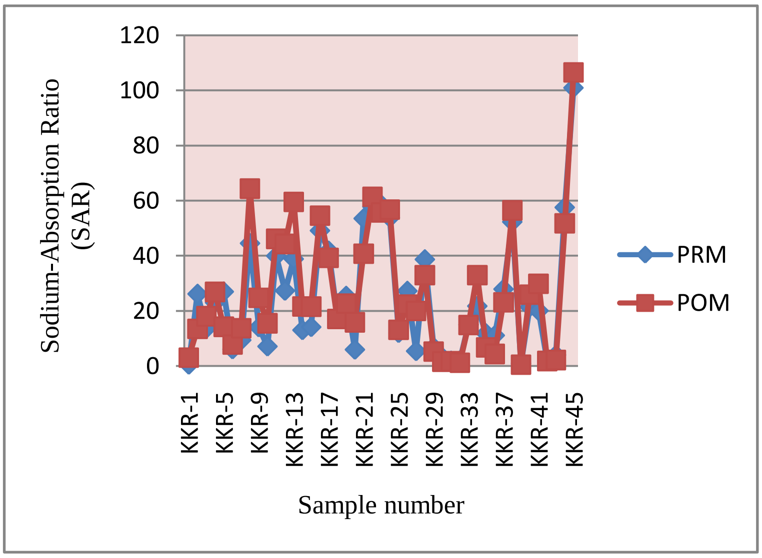

Fig.7: Pre-Monsoon and Post-Monsoon SAR Values of Ground Water at Various Sampling Stations

V. CONCLUSION

From the analysis of above results obtained for the groundwater samples taken along the Bhakara Main Line - Hansi Branch – Butana Branch - Multipurpose Link Channel (MPL) in Haryana, the concentration of the investigated ions like Sodium, Potassium and Chloride are within the permissible limits for the drinking water recommended by BIS (1991) and WHO (1984) at head (origin), and tail end of the link, except for the middle part which is above the permissible limit.

SAR values of these water samples along this link is also indicated, that the groundwater at the head and tail end of the MPL channel are suitable for the irrigation purpose. But at the middle part of the link, groundwater sample to be make suitable for irrigation after proper treatment.

Above cited results shows that overall groundwater quality along MPL channel is suitable for drinking as well as domestic consumption and irrigation purpose in absence of other sources.

VI. ACKNOWLEDGEMENTS

This study is part of a research project ' Study of Groundwater along Bhakra Main Line- Hansi Branch - Butana Branch - Multipurpose Link Channel using Isotopic and Chemical Approaches ' funded by DST, New Delhi through Centre for Water Resources Developments and Managements, Kozhikode, Kerala (India).

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