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Assessment of Quality of Ground And Surface Water At Selected Locations In The Surroundings of The Proposed BARC Complex Around Visakhapatnam

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ABSTRACT

The Department of Atomic Energy, DAE is expanding its nuclear research programme at various places throughout India. To understand the impact of the forth coming Bhabha Atomic Research Centre (BARC) activities of Department of Atomic Energy on the surrounding environment in future, a baseline quality of different matrices in the existing conditions including ground and surface water is essential. A study was taken up to assess the quality of ground and surface water and the results are presented and discussed in this paper. The surroundings of BARC complex were divided into three different zones. A total of 19 samples from ground and surface water sources were collected and all the samples were analyzed for different physicochemical parameters and trace metals. All the samples were collected once in every four months, covering all the seasons, rainy, winter and summer in a year. B, Al, V, Cr, Mn, Fe, Ni, Co, Cu, Zn, As, Sr, Mo, Ag, Cd, Se, Ba and Pb were analyzed using inductively coupled plasma-mass spectroscopy, (ICP-MS). It can be seen from the results of the groundwater samples, the salt content is high in terms of chloride, sulphate, total dissolved salts, calcium and magnesium and exceeded the desirable limits but are within the permissible limits as per BIS. The high alkalinity values are recorded in few samples and exceeded the desirable limit of BIS. The results showed the following trend among the ground and surface in the seasons, summer > winter > rainy for most of the parameters. The trace metals for which standards are prescribed are within the desirable limits in ground and surface water samples. The metals Zn, Sr and B were found to high than other metals in groundwater samples.

Keywords: Baseline quality, groundwater, physicochemical, metals.

INTRODUCTION

Visakhapatnam area is located on the east coast of India. In a study conducted by the United Nations, Visakhapatnam area is declared as one of ten fastest growing cities of the world economically, industrially and demographically [1]. Many industries are established and several other new industries are being established. The Department of Atomic Energy, DAE is expanding its nuclear research programme at various places throughout India. As a part of that, a very big BARC - Research complex is going to be established in Visakhapatnam area, Andhra Pradesh. The area selected of BARC complex is 52 km from the Visakhapatnam city centre. As BARC is establishing, the baseline data on water quality is essential for

assessing the impact of the activities in BARC complex on the surrounding villages. A study was taken up to assess the quality of ground and surface water and the results are presented and discussed in this paper.

MATERIALS AND METHODS

The sampling locations are selected on the basis of utilization of environment, industries and population density around the facility from areas surrounding 0-30 km radius of BARC site so as to give the best representative samples and a holistic representation which are presented in fig 1. The area has been divided into three zones, 7 groundwater samples in the area 0-10 km radius of main point of BARC complex and 4 ground samples in the 10-30 km radius area from the centre of the activity and 8 surface water samples covering in all three zones were collected and the details are presented in table 1. All the 19 samples were collected once in every four months, covering all the seasons rainy, winter and summer during 2008 to 2009. The samples were analyzed for different physicochemical parameters and trace metals.In general, the groundwater in the study area is available in the range 25 to 35 feet depth, but the local authorities dug bore wells up 140 feet range to get continuous supply of huge quantity of water. The groundwater has been collected from the bore itself after draining two buckets of water. The water samples were collected in clean polythene containers 2 L capacity after rinsing the containers thoroughly with the sample being collected.

All the chemicals, reagents, used were of Analytical grade quality. Double distilled water was used for preparations of all solutions. For trace metal analysis, Suprapure nitric acid Merck, Germany was used. The samples were preserved in dilute nitric acid followed by solvent extraction technique with APDC/MIBK and back extracted with 4 M HNO_3 made with 1% HNO_3 [2]. Internal standard solution of 10% (v/v) Rh of 1 mg/l concentration was added in all samples [3] and analyzed for trace metal analysis using ICP-MS of Elan DRC II Perkin Elmer Sciex in NGRI, Hyderabad. Multielement standard 1640 of National Institute of standards and Technology (NIST, USA) was used to calibrate ICP-MS. The physicochemical parameters were determined by following standard methods [4]. The fluoride in water samples was determined by WTW inolab level 3 (Germany),ion selective electrode meter [5].

Table 1. Ground and Surface Water Sampling Locations

Zones & Direction	Sampling Code	Name of the sampling station	Type of water	Water source
Zone I: East to NNE	GW 1	Jogannapalem	Groundwater	Bore well
	SW 1		Surface water	Pond
	GW 2	Gandivanipalem	Groundwater	Bore well
	GW 3	Paravada	Groundwater	Bore well
	SW 2		Surface water	Pond
	GW 4	Vadachipurapalli	Groundwater	Bore well
	GW 5	Rajivnagar	Groundwater	Bore well
	SW 3	Kanthi Reservoir	Surface water	Reservoir
Zone II: NNE to NW	GW 6	Atchutapuram	Groundwater	Bore well
	GW 7	Anakapalli	Groundwater	Bore well
	SW 4	Sharada river	Surface water	River
	GW 8	Avasommavaram	Groundwater	Bore well
Zone III: NW to SW	GW 9	Elamanchili	Groundwater	Bore well
	SW 5		Surface water	Pond
	SW 6	Kuthuru bridge	Surface water	River
	GW 10	Pudimadaka	Groundwater	Open well
	SW 7		Surface water	Pond
	GW 11	Dupiturru	Groundwater	Bore well
	SW 8	Rambill	Surface water	River and sea mixing point

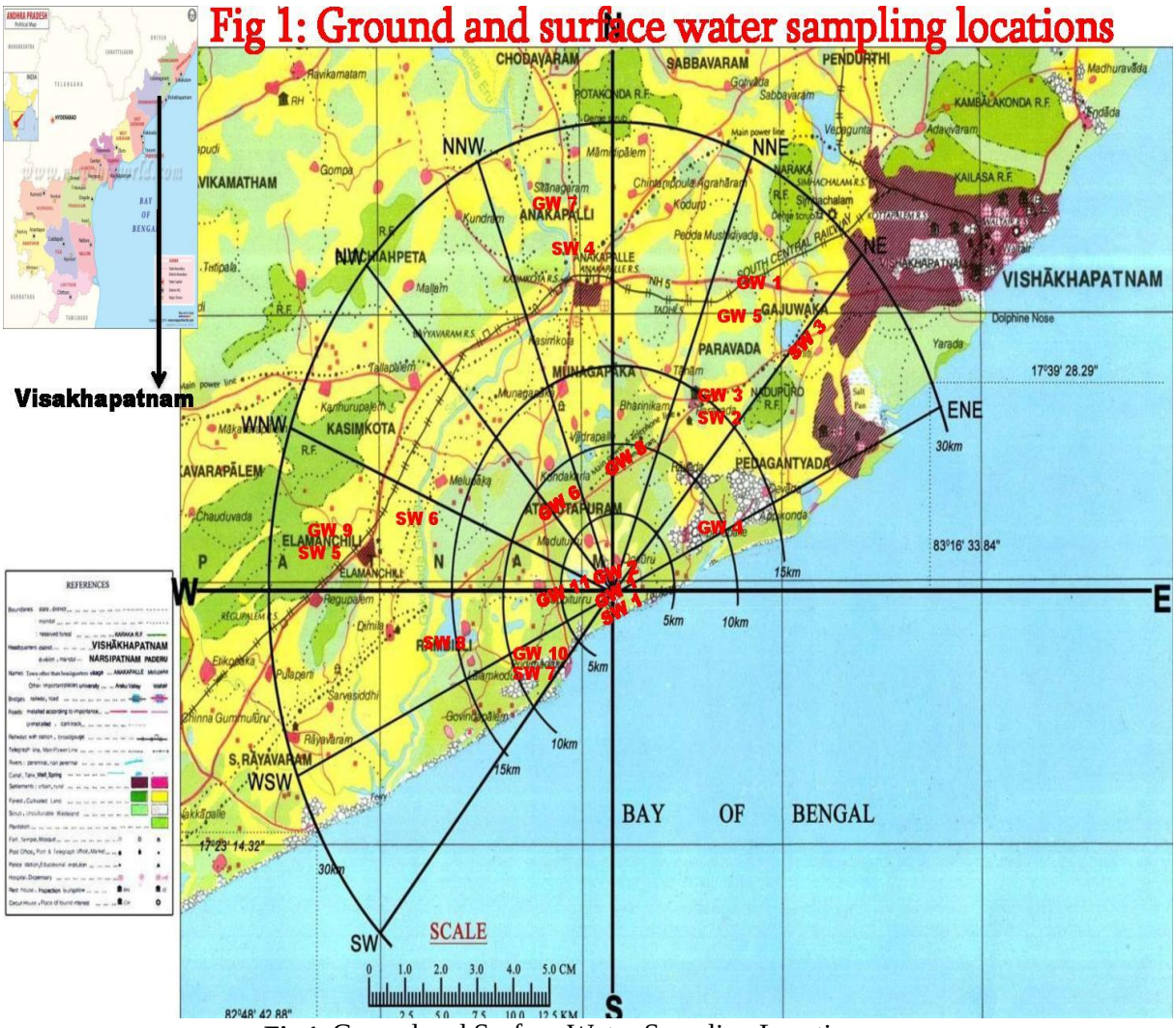

Fig 1. Ground and Surface Water Sampling Locations

RESULTS AND DISCUSSION

The water quality results and discussion are presented in two sections ground and surface water respectively. The results of the parameters were compared to the standards prescribed by BIS, 2003 [6].

Physicochemical parameters of groundwater: The results of the physicochemical parameter of groundwater samples are presented in table 2. From the table, it can be seen that the water samples showed very less variation in pH in different locations in a particular season. The pH values are in the range of 6.7 to 8.3. None of the samples exceeded the prescribed limit of BIS, ISO: 10500 [6]. The alkalinity values are 94 to 544 mg L^{-1} for different seasons. The high alkalinity values are in sampling locations GW 3, GW 4, GW 5, GW 6, GW 8, GW 10 and GW 11 which have exceeded the desirable limit of ISO. High values of alkalinity in the water may give an unpleasant taste. In the absence of an alternate source of water, alkalinity up to 600 mg L^{-1} is permissible. High values of conductivity indicate high concentration of soluble salts. The EC of all the samples showed almost similar trend like TDS. The TDS in the samples GW 4, GW 5, GW 6, GW 7, GW 10 and GW 11 are above 1000 mg/l in almost all the seasons, which may be due to the geological conditions, seawater intrusion and enhanced activities by man. A similar trend can be seen in the total hardness in samples GW 4, GW 5, GW 6, GW 7, GW 8, GW 10 and GW 11 which have exceeded the desirable limits in all the seasons. But samples GW 4, GW 5 and GW 11 have even

exceeded the permissible limits also for total hardness.

The chlorides in the samples are in the range of 48 to 574 mg L^{-1}. The chlorides are high in the above mentioned groundwater which are close to the sea shore. The intrusion of sea water in to groundwater may be due to the over pumping of the groundwater along the sea coast [7]. The samples GW 4, GW 5, GW 6, GW 10 and GW 11have exceeded the desirable limits of chloride concentration in all the seasons. The SO_4^{2-} concentration has varied from 20 to 151 mg L^{-1} and high concentrations are found among the samples GW 5, GW 6, GW 10 and GW 11 but they have not exceeded the desirable limit. A study in Visakhapatnam urban area have reported the SO_4^{2-} concentration in the range 24 to 324 mg L^{-1} [8,9]. High concentrations of sulphate cause a laxative effect when combined with calcium and magnesium [10].The dissolved oxygen is in the range from 1.2 to 7.3 mg L^{-1}. The GW 11 recorded low values of 1.9 and 1.2 mg L^{-1} in both winter and summer season respectively. Depletion of dissolved oxygen in the water encourages the microbial reduction of nitrate to nitrite and sulphate to sulfide, which are toxic to human beings. This is clear from the results. NO_2^- is high in GW 11. The seepage of waste water near GW 11 source is observed. The nitrate values varied from 10 to 56 mg L^{-1}.

Nitrate values are higher than the desirable limits in GW 4, GW 5, GW 6 and GW 11. The maximum values are high in summer season. The likely sources of nitrate in groundwater aquifer are anthropogenic sources like seepage from septic tank and other wastes. Nitrates are highly soluble dissolves in water and may move freely through the soil and aquifer. The nitrate concentrations in other groundwater areas are in the range 29 to 77 mg L^{-1} [9,11].

Fluoride concentrations in the range 0.6 to 1.4 mg L^{-1} are within the limits in all the seasons. Phosphate values are in the range 0.01 to 0.11 mg L^{-1}. The values of dissolved silica varied from 13 to 68 mg L^{-1} in different seasons. Higher concentrations of dissolved silica are not desirable in drinking waters. From the results it can be seen that, the following trend among the seasons, summer > winter > rainy for most of the parameters.

Table 2 Analysis of Groundwater

All values are expressed in mg L^{-1} except pH and EC(µS)

S.No	Locations	Season	p^H	E.C.	D.O	TH	Ca^{2+}	Mg^{2+}	TA	Cl^-	SO_4^{-2}	PO_3^{4-}	T.D.S	NO_2^-	NO_3^{2-}	F^-	DS
1	GW 1	Rainy	6.7	526	3.2	147	43	9	99	61	20	0.01	342	0.07	15	0.7	39
		Winter	6.7	1005	3.4	157	35	17	167	56	26	0.03	653	0.08	27	0.9	47
		Summer	6.9	1228	2.8	180	44	17	178	76	33	0.04	798	0.10	41	1.2	57
2	GW 2	Rainy	7.1	575	6.4	186	47	17	94	71	23	0.01	374	BDL	18	1.1	33
		Winter	7.4	769	7.0	196	47	19	196	85	28	0.02	500	0.04	25	1.2	41
		Summer	7.5	918	5.9	290	60	34	238	86	34	0.03	597	0.04	32	1.2	53
3	GW 3	Rainy	7.6	828	6.0	295	55	38	163	71	45	BDL	538	BDL	33	0.7	39
		Winter	7.7	1097	6.3	304	51	43	264	72	38	0.01	713	0.02	40	0.9	41
		Summer	7.8	1252	5.5	320	48	48	317	118	60	0.01	814	0.01	45	1.2	49
4	GW 4	Rainy	7.2	1992	5.2	657	86	106	213	354	56	BDL	1295	0.03	25	0.7	35
		Winter	7.8	2182	5.8	660	92	103	301	380	65	0.02	1418	0.05	39	0.9	42
		Summer	7.9	2694	3.6	696	98	108	327	402	98	0.04	1751	0.05	53	1	50
5	GW 5	Rainy	6.7	2186	4.2	770	120	113	178	314	92	0.03	1421	0.01	34	0.9	40
		Winter	7.2	2369	4.4	781	141	103	287	386	134	0.05	1540	0.03	35	1.2	65
		Summer	7.5	2458	3.9	853	153	113	296	425	125	0.08	1598	0.05	56	1.4	68
6	GW 6	Rainy	7.4	1665	3.4	402	43	71	238	238	89	0.02	1082	0.07	35	0.8	44
		Winter	7.9	2258	3.4	441	82	56	315	368	102	0.05	1468	0.08	40	1	43
		Summer	8.2	2292	3.2	500	84	70	382	409	118	0.07	1490	0.08	49	1.1	45
7	GW 7	Rainy	7.5	735	6.2	304	63	35	109	48	26	BDL	478	BDL	12	0.9	15

		Winter	7.7	1354	6.0	377	83	41	215	79	22	0.01	880	0.01	18	1.1	25
		Summer	7.9	1454	4.4	500	88	67	185	100	22	0.02	945	0.04	21	1.2	23
8	GW 8	Rainy	6.8	835	3.4	324	66	20	168	85	33	0.05	543	0.03	29	0.6	35
		Winter	7.3	911	4.5	353	74	40	303	120	36	0.10	592	0.09	32	1	58
		Summer	7.8	946	2.1	340	76	36	318	158	44	0.09	615	0.11	35	1.2	68
9	GW 9	Rainy	7.9	545	6.5	137	39	9	229	61	33	BDL	354	BDL	10	0.6	13
		Winter	8.0	638	7.3	235	55	24	245	59	35	0.01	415	0.02	15	0.8	16
		Summer	8.1	883	5.9	250	44	34	238	96	27	0.02	574	0.08	18	1.1	20
10	GW 10	Rainy	7.5	3111	4.3	549	106	68	168	387	45	0.03	2022	0.06	26	0.7	26
		Winter	7.6	3618	5.4	560	124	60	362	416	71	0.05	2352	0.08	27	0.9	39
		Summer	7.9	3692	4.2	800	100	132	324	574	95	0.08	2400	0.12	36	1.2	49
11	GW 11	Rainy	7.5	2489	3.1	638	78	106	233	446	131	0.04	1618	0.07	35	0.9	45
		Winter	7.9	2563	1.9	696	102	106	539	479	138	0.08	1666	0.11	39	1.1	51
		Summer	8.3	3052	1.2	800	108	127	544	550	151	0.11	1984	0.14	48	1.3	60

Note: TH: Total Hardness in $CaCO_3$, **TA:** Total Alkalinity in $CaCO_3$, **DS:** Dissolved silica,
BDL: Below detectable limit

Trace metals in Groundwater: The results of trace metals in the samples from different areas for all the three seasons are presented in table 3. There are no standards for V, Ni, Co, Sr, Ag and Ba. The values are low indicating there are no sources of contamination of these metals in these areas. Other metals, for which standards are prescribed, are within the limits. The following trend was observed among the metals in groundwater samples Zn > Sr > B > Fe > Mn > Ba > Al >Cu > Cr > Pb > As > Ni > Mo > V > Ag > Cd > Co > Se.

Zinc is found naturally in water and the concentrations of the Zn are found to be maximum in the groundwater samples GW 8, GW 9, GW 10 and GW 3 and the concentrations ranged from 176 to 1470 µg L^{-1}. The strontium content is in the range of 127 to 1130 µg L^{-1} and found to be high in three samples GW10, GW 5 and GW6. The Sr concentrations in other study areas found to be high than the present study [12,13].

In GW5, GW 6 and GW 10 boron recorded high concentrations than others. The boron values are less compared to other areas [12]. In the case of Cr, Mn, Fe, Co, Zn, As, Se, Cd and Pb, the values are low in all the samples. Iron concentrations in the eleven groundwater samples are in the range of 249 to 749 µg/l, the concentrations reported are in the same range as reported in Visakhapatnam urban area [8,9,14].
The samples GW 2, GW 3, GW 4, GW 7 and GW 9 showed higher Al values than the desirable limit but are well within the permissible limit of 200 ppb. The concentrations of different metals in the samples GW 5, GW6, GW 7 and GW 10 are high compared to other samples.

Physicochemical parameters of Surface Water: The physicochemical parameter results of surface water are presented in **Table 4**. The pH values for different seasons ranged from 5.9 to 8.5. The higher value of pH may be because the water source receives wastes from agricultural lands and other sources. The alkalinity values are 92 to 356 mg L^{-1}. The high alkalinity values are recorded in SW 2, SW 5, and SW 6 and exceeded the desirable limit of BIS, 2003. The conductivity values are in correlation with the TDS for all the seasons. SW 8 is joining point of Sharada River into the sea, this is evident from the results of SW 8. The SO_4^{2-} values are from 13 to 141 mg L^{-1}. The dissolved oxygen is from 4.8 to 8.2 mg L^{-1}. The nitrate values are from 10 to 46 mg L^{-1}. NO_2^- values are mostly BDL. Fluoride concentrations in the range 0.3 to 1.4 mg L^{-1} are within the limits. Phosphate values are in the range 0.02 to 1.26 mg L^{-1}. The high values recorded in SW 8 are similar to the values reported in sea[15]. Most of the surface water bodies are surrounded by agricultural lands in this area. The values of dissolved silica in surface water are in the range of 10 to 41mg L^{-1}

Table 3. Statistical Data of trace metals in Groundwater samples for all the seasons (n = 3)
All values are expressed in µg L^{-1}

Locations / Metals	GW 1	GW 2	GW 3	GW 4	GW 5	GW 6	GW 7	GW 8	GW 9	GW 10	GW 11	Mean	SD	Min	Max
B	262	260	571	483	861	906	646	613	267	904	434	564	250	260	906
Al	21.3	38.3	26.3	28.2	22.8	26.8	47.3	20.2	56.6	27.8	23.7	30.8	11.7	20.2	56.6
V	0.37	0.75	0.52	0.34	0.54	3.16	0.81	1.57	1.80	2.45	3.68	1.45	1.18	0.34	3.68
Cr	8.50	10.6	3.10	2.43	2.84	5.21	3.40	5.32	5.46	14.4	5.50	6.07	3.71	2.43	14.4
Mn	58.2	57.8	106	46.4	175	126	74.6	84.8	42.0	277	39.5	98.8	72.0	39.5	277
Fe	296	430	580	310	794	761	499	457	249	760	460	508	194.11	249	794
Ni	1.95	2.30	2.24	1.60	3.79	4.53	5.91	1.95	3.23	8.75	3.24	3.59	2.14	1.6	8.75
Co	0.33	0.26	0.34	0.30	0.48	0.47	0.36	0.31	0.18	0.85	0.33	0.38	0.18	0.18	0.85
Cu	18.4	11.3	1.61	1.11	2.30	9.58	3.61	4.35	5.00	23.2	3.51	7.63	7.31	1.11	23.2
Zn	797	398	1050	554	252	176	859	1470	1380	1200	403	776	455	176	1470
As	3.37	2.94	8.42	5.56	5.63	10.4	6.83	5.63	1.50	11.7	7.12	6.28	3.09	1.5	11.7
Se	0.06	0.25	0.03	0.01	0.05	0.31	0.08	0.07	0.15	0.21	0.24	0.13	0.10	0.01	0.31
Sr	127	166	643	437	888	842	626	534	333	1130	349	552	312	127	1130
Mo	0.50	1.71	6.02	3.64	1.33	2.29	1.64	2.86	1.10	5.85	2.07	2.64	1.84	0.5	6.02
Ag	1.10	1.05	0.67	1.06	0.97	0.93	1.04	1.17	0.88	1.01	1.03	0.99	0.13	0.67	1.17
Cd	0.39	0.67	0.58	0.22	0.63	0.88	1.05	0.50	0.69	0.87	0.86	0.67	0.24	0.22	1.05
Ba	41.6	32.2	27.0	14.3	53.7	63.7	23.0	34.3	13.5	78	53.6	39.54	20.72	13.5	78
Pb	1.09	0.86	2.35	1.91	3.20	2.13	1.40	1.91	0.75	11.8	3.59	2.82	3.11	0.75	11.8

Table 4 Analysis of Surface Water
All values are expressed in mg L^{-1} except pH and EC(µS)

S.No	Locations	Season	p^H	E.C.	D.O	TH	Ca^{2+}	Mg^{2+}	TA	Cl^-	SO_4^-	PO_3^-	T.D.S	NO_2^-	NO_3^{2-}	F^-	DS
1	SW 1	Rainy	7.7	352	5.2	137	27	16	151	44	25	0.15	219	BDL	10	1.2	17
		Winter	8.0	337	5.8	180	43	17	165	48	28	0.27	242	BDL	20	0.8	18
		Summer	8.0	545	4.8	210	48	21	215	56	32	0.40	373	0.01	26	1.3	24
2	SW 2	Rainy	7.4	393	5.6	128	27	14	180	58	35	0.18	253	0.04	12	1.1	26
		Winter	7.9	404	5.4	140	30	15	227	72	38	0.22	276	0.08	19	1.2	28
		Summer	8.3	415	5.1	196	51	16	269	84	47	0.20	280	0.10	24	1.4	41
3	SW 3	Rainy	7.9	286	7.0	144	28	17	127	48	40	BDL	189	BDL	14	0.6	18
		Winter	7.8	234	6.0	167	32	20	158	58	38	0.02	145	BDL	15	0.8	30
		Summer	8.0	352	5.5	177	35	21	184	69	42	0.05	252	0.01	21	1.0	38
4	SW 4	Rainy	7.8	361	6.8	157	39	14	92	41	24	0.24	258	BDL	16	1.1	17
		Winter	8.0	444	6.3	167	42	14	105	52	24	0.49	280	BDL	18	0.9	21
		Summer	8.2	495	6.0	300	55	37	215	48	29	0.68	320	0.01	24	1.0	24
5	SW 5	Rainy	7.5	1092	6.4	284	40	42	198	248	64	0.07	714	BDL	21	1.0	21
		Winter	8.2	1327	6.7	327	49	47	244	362	80	0.19	810	0.03	18	1.0	25
		Summer	8.3	1318	5.6	350	51	51	258	392	92	0.28	916	0.04	29	1.0	33
6	SW 6	Rainy	7.5	1220	5.9	100	20	12	242	60	43	0.21	800	0.03	32	1.2	10
		Winter	8.1	1094	7.5	147	35	14	215	179	19	0.26	702	BDL	14	0.9	12
		Summer	8.5	1244	5.1	130	28	14	356	76	13	0.34	841	0.09	46	1.3	14

7	SW 7	Rainy	7.2	656	5.4	137	40	9	107	48	15	0.11	452	BDL	16	0.6	30
		Winter	7.4	710	5.8	163	35	17	120	54	20	0.18	475	BDL	19	0.8	34
		Summer	7.0	791	6.1	185	46	16	155	61	24	0.20	509	0.01	21	1.1	36
8	SW 8	Rainy	5.9	-	8.2	2352	392	316	116	5232	37	1.10	18456	0.09	12	0.3	15
		Winter	7.6	-	7.3	5300	320	1035	147	5456	141	1.26	20543	0.10	22	0.6	16
		Summer	7.8	-	7.7	6500	418	1255	149	5623	124	1.20	22457	0.12	35	0.5	20

Note: TH: Total Hardness in $CaCO_3$, **TA:** Total Alkalinity in $CaCO_3$, **DS:** Dissolved silica,
BDL: Below detectable limit

Trace metals in Surface Water: The results of trace metals for different samples for all the three seasons are presented in **Table 5**. There are no standards for V, Ni, Co, Sr, Ag and Ba. The following trend is observed among the metals in the surface water samples [Sr > Zn > B > Ba > Fe > Mn > As > Al > V > Cr > Mo > Pb > Ni > Cu > Co > Ag > Cd > Se] which is different from that of groundwater samples.

The strontium content is in the range of 64.5 to 1024 µg L^{-1} in surface water samples. Zn is in the range 307 to 940 µg L^{-1}. Boron is in the range between 121 to 475 µg L^{-1} which are low when compared to the reported values [12]. In case of Cr, Mn, Fe, Co, Zn, As, Se, Cd and Pb, the values are low in all the water samples.

Table 5. Statistical Data of trace metals in Surface water samples for all the seasons (n = 3)
All values are expressed in µg L^{-1}

Locations / Metals	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	Mean	SD	Min	Max
B	121	154	146	127	129	219	368	475	217	132.8	121	475
Al	22.8	26.5	28.3	38.6	25.8	17.6	20.9	29.5	26.3	6.4	17.6	38.6
V	0.23	0.35	2.69	0.13	0.26	0.45	20.3	21.6	5.75	9.4	0.13	21.6
Cr	1.33	2.93	3.01	2.63	1.50	2.89	15.3	17.5	5.89	6.5	1.33	17.5
Mn	13.1	22.2	14.8	32.2	15.1	49.9	51.1	71.5	33.7	21.6	13.1	71.5
Fe	63.2	64.8	96.0	60.5	72.5	61.4	79.7	108	75.7	17.7	60.5	108
Ni	0.81	1.22	0.60	0.83	1.01	1.18	8.7	10.3	3.08	4.0	0.6	10.3
Co	0.42	0.10	0.19	0.15	0.80	1.25	1.08	2.08	0.76	0.7	0.1	2.08
Cu	1.24	1.29	5.20	2.70	1.62	1.08	1.92	7.6	2.83	2.3	1.08	7.6
Zn	766	623	307	559	940	917	575	713	675	207.1	307	940
As	2.83	2.16	1.14	2.17	3.31	43.3	35	45.3	16.90	20.3	1.14	45.3
Se	0.08	0.10	0.16	0.07	0.10	0.16	0.14	0.14	0.12	0.0	0.07	0.16
Sr	64.5	109	109	88.2	86.1	851	1024	797	391	418.7	64.5	1024
Mo	1.42	1.36	2.53	1.79	1.76	5.73	14.6	13.5	5.34	5.6	1.36	14.6
Ag	0.68	0.68	0.47	0.56	0.92	0.53	0.86	0.94	0.71	0.2	0.47	0.94
Cd	0.63	0.29	0.27	0.56	0.63	0.27	0.36	0.2	0.40	0.2	0.2	0.63
Ba	55.9	45.8	28.5	53.0	61.9	51.1	160	154	76.3	50.8	28.5	160
Pb	1.15	2.44	1.24	1.60	1.05	3.53	13.9	17.8	4.66	5.3	1.05	17.8

APPLICATIONS

This information is very useful as physicochemical parameters and trace metals data of ground and surface water of this area is not available and form the baseline data of BARC complex. So it will be helpful for assessing the impact of BARC activities in this area in the future. The local authorities and people in this area may take necessary measures to improve the ground and surface water quality as people in this area are using these sources for drinking purpose.

CONCLUSIONS

19 water samples from ground and surface water sources were collected and all the samples were analyzed for different physicochemical parameters and trace metals. The results showed the following trend among the seasons in ground and surface water samples, summer > winter > rainy for most of the parameters. All the parameters were well within the desirable limits in groundwater samples but for total hardness in few samples exceeded the permissible limits. The trace metals for which standards are prescribed are within the desirable limits in ground and surface water samples.

This is the baseline information for the ground and surface water sources for the future. Any impact on the water quality can be understood on comparison with these results.

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