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STUDY THE STATUS OF GEOMEDICAL HEALTH HAZARDS DUE TO QUALITY OF WATER IN JALGAON DISTRICT, MAHARASHTRA (INDIA)

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Abstract

The present study was carried out to study the relationship between hydro-geochemistry and health hazards in Jalgaon district, Northern part of Maharashtra state, India. For this study, 64 underground and surface water samples were collected to analyze their constituents which are closely related to the geological and hydrogeological conditions in the area. Analytical results suggest that most of the water samples are acidic in the pre monsoon season while they become alkaline in the post monsoon season. The major ions and electrical conductivity of water samples are higher in pre monsoon than during post monsoon period. Groundwater quality of the area shows that alkaline earth elements exceed alkali elements and weak acids exceed strong acids. Higher concentration of NO_3 is observed in a few water samples, indicating excessive use of nitrogenous fertilizers. Trace element concentrations in water show that Cd > Pb > Zn > Ni > Fe > Cu > Mn. Medical survey data reveal that patients with hypertension, anemia, cardiovascular, urine stone and skin disease are positively correlated to the concentrations of contaminants in the drinking water.

Keywords: Anthropogenic and Geogenic pollution, Hydrogeochemistry, Medical hazards.

1. INTRODUCTION

Groundwater is one of the most valuable natural resource. During the past several decades, a relative shortage in quantity has arisen because of increasing demand of water for human survival, economic development and also deterioration in quality (Vaux 2011). Earlier researchers prove that the infiltration of effluents is responsible for contamination of aquifers in different parts of the world (Raman 1995; Li et al. 2016). It is also believed that mega engineering projects and economic development policies may also have negative impacts on water availability and water quality (Li et al. 2016). The present work describes the hydro-geochemical characteristics of water from Jalgaon region, Northern Maharashtra, India with reference to human health hazards, as contaminated water can pose significant health risks to humans who drink it. In the study area, water quality deteriorates especially in dug and bore wells, mainly due to over exploitation of water and excessive use of fertilizers (Golekar et al. 2013). Therefore, the objectives of present work are:

a) To determine the physicochemical characteristics of groundwater and surface water
b) To identify the natural and anthropogenic causes of water pollution and health hazard

2. STUDY AREA

The study area (Latitude 20°15'00" and 21°25'00" North and Longitude 74°55'00" and 76°28'00" East) is situated in Jalgaon district, Northern part of Maharashtra state, India. The study area falls under the semi-arid climatic zone. The average annual rainfall is about 650 mm / per annum.

2.1 Geology of the study area

The major part of Jalgaon district is covered by Deccan Trap of Cretaceous to Eocene Periods (Fig. 1). Adjoining the River Tapi, a thick alluvium has been deposited on the basalts in the Jalgaon district (GSI 1976). Tapi alluvium can be subdivided into two sub units, i.e., the upper younger alluvium extending down to 70-80 m depth and the deeper older alluvium attaining a maximum depth of 450 m (GSI 1976).

The Deccan Traps are mostly exposed in the Satpura region of the area. Small patches of basalts are exposed as inlier in alluvium. The basaltic lava comprises two types of flows, viz., “Pahoehoe” and “aa”. “Pahoehoe” flows are compound flows with several units of varied thickness ranging within several meters (GSI 2000). Each unit shows basal massive basalt followed by vesicular basalt. The vesicles are spherical and filled with zeolites, or quartz. The upper surface of this flow is reddish curved or shows twisted-rope-like structures. Top surface of “aa” flow shows vesicles filled with zeolite and quartz. In these flows the basalt is massive, hard, and resistant, and shows spheroidal weathering and weathers deeply (CGWB 2009). Geological Survey of India has reported 15 lava flows to the North of Tapi River and 7 lava flows to the south of river. Out of these, three lava flows are of pahoehoe type and the rest show “aa” characters.

The Tapi-Purna alluvial plain is mainly composed of clay which is brownish to yellowish in colour and intercalated with several bands of sand and gravel. At some places, the pebbles and sand grains are cemented together by calcium carbonate to form a compacted conglomerate, which is found to be lying over the bedrock and below the alluvial sequence (Deshpande 1998). Calcretes are common in all layers.

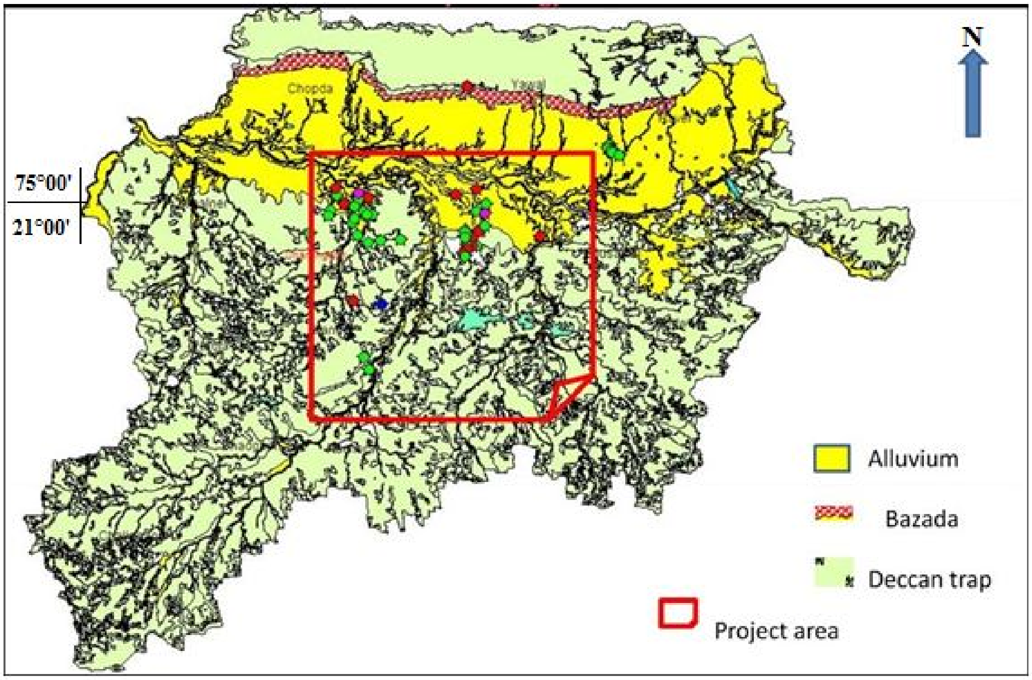

Fig. 1 Geological map of the Jalgaon district

2.2 Hydrogeology of the study area

Groundwater occurring in alluvium is under unconfined conditions. The deeper wells are under semi-confined to confined conditions due to clay found intermittently in alluvium (Patil and Baride 2010). In alluvial aquifer, groundwater level fluctuation is smaller as compared to in basaltic aquifer (Patil and Baride 2010). Groundwater is an important source of water supply for agriculture in this region and groundwater occurring in weathered, vesicular, jointed and fractured basalts is usually under unconfined condition (Golekar et al. 2013). In the northern part of the study area hand pumping and open well are generally feasible due to shallow water table. Deep water level has been observed in southern part with predominately tube wells drilled for drinking and irrigation purposes (CGWB 2009).

In the present study, 37 representative dug wells were selected for detailed hydrogeological survey to understand the relationship between the topography and water level. The selection of dug wells for well inventory survey was given to represent lithology, shallow and deep aquifers. The number of dug wells penetrating basaltic aquifers are 21 and rest 16 are tapping alluvial aquifers. The seasonal water table fluctuations for these wells were recorded for two periods for the years 2010 to 2011 and 2011 to 2012 (Table 1). Fluctuation in water table varies from 1.0 to 4 m from 2010 to 2011, whereas in 2011-2012 it varies from 0.5 to 6.0 m, which suggests a decline in water table.

Table 1: Groundwater level data from the study area

n = 37	DWL (bgl) Post Monsoon 2010	DWL (bgl) Pre Monsoon 2011	Fluctuation (m)	DWL (bgl) Post Monsoon 2011	DWL (bgl) Pre Monsoon 2012	Fluctuation (m)
Maximum	70.0	74.0	4.0	74.0	80.0	6.0
Minimum	1.0	2.0	1.0	2.5	3.0	0.5
Average	19.7	24.1	4.3	20.4	24.9	4.5

All values in meters, DWL = Depth of water level, m bgl = meter below the ground level, n= number of wells

3. METHODOLOGY

3.1 Water sampling and analyses

In this study for hydrogeochemical analysis, 64 water samples for each sampling period (pre and post monsoon) were collected for detailed geochemical analysis. 53 samples were taken from shallow (3 to 20 m bgl) and deep aquifers (32 to 70 m bgl) and the other 11 were surface water samples. Samples were collected for 3 post monsoon periods and 2 pre monsoon periods, Viz. post monsoon (December 2010, December 2011 and December 2012) and pre monsoon (May 2011 and May 2012). Locations of water samples from Jalgaon District, Northern Maharashtra have been depicted in Fig. 2.

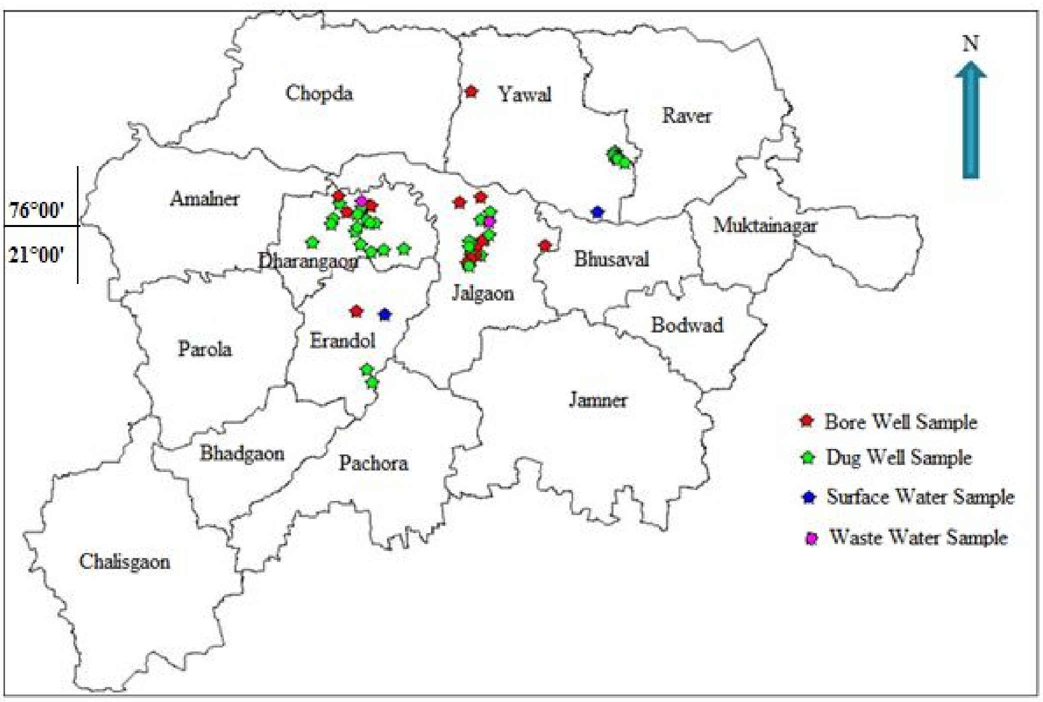

Fig. 2: Water sampling location map, Jalgaon District, Maharashtra (India)

3.2 Chemical analyses of water samples

After the collection of water samples, chemical analysis was carried out in the School of Environmental and Earth Science, North Maharashtra University Jalgaon, India. pH, EC and TDS were analysed by digital water analysis kit using EI make Model No. 1160 Microprocessor before acidification. Volumetric method was employed for the analysis of total alkalinity, calcium, total hardness and chloride. Alkalinity was determined by simple acid base titration method (APHA 1998). In this method, hydroxyl ions present in the sample as a result of dissociation or hydrolysis is determined by titration with strong acid like HCl and phenolphthalein and methyl orange as indicators. Total hardness (TH) and Ca^{++} is determined by standard EDTA titrimetric method, $AgNO_3$ was used to estimate Cl^- and magnesium was determined by calculation of the difference in total hardness and calcium (APHA 1998). Sulphate was analyzed by spectrophotometric method using ammonium molybdate and barium chloride solution at 420 nm (APHA 1998). Nitrate was analyzed by spectrophotometric method using brucine sulphate solution at 540nm (APHA 1998). Phosphate was analyzed by spectrophotometric method using ascorbic acid spectrophotometric solution at 880 nm (APHA 1998). Boron was analyzed by spectrophotometric method using Curcumin solution at 540nm (APHA 1998). AAS (Thermo scientific double beam model) was used to determine the concentrations of different elements present in water. In the present study, seven different eco- sensitive trace elements (Cd, Cu, Fe, Mn, Ni, Pb and Zn) and three cations (Mg, Na and K) were determined by Atomic Absorption Spectrophotometer as per the standard methods and procedures (APHA 1998). For the analyses of above mentioned trace and major elements, water samples were collected in polyethylene bottles and acidified by addition of 5 ml concentrated HNO_3 to minimize absorption of metal on the container, and to retard any biological action, hydrolysis of chemical compounds and formation of complexes as well as reduction of volatility of constituents.

Before carrying out chemical analysis, the samples were filtered through 0.45 µm membrane filter paper using suction filtration assembly. Addition of standard solution of chosen element for analysis was carried out as standard addition method gives better accuracy in the analysis of trace elements. For the interpretation of water quality data consider the average value of 3 post monsoon (2010, 2011 and 2011) and 02 pre monsoon period (2011 and 2012) for respective parameters. Medical survey was carried out through questionnaires filled by the Doctors in the area under study to understand the trends in the health hazards. The doctors of these villages were also contacted and enquired about the occurrence of methaenoglobinaemia (blue baby) and kidney stones in the doubtful villages in the area under study.

4. Results and Discussion

The major ions concentrations of water samples are shown in the Table 2 and 3. The trace elements concentrations of water samples are shown in the Table 4.

Table 2: The major ions concentrations of water samples from the study area

Sample ID	pH	pH	EC	EC	TDS	TDS	TH	TH	TA	TA
	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre
1	7.4	6.5	1636.7	1774.5	1092.9	1117	255.8	303	412.3	531
2	7.4	6.7	1270.6	1606	810.5	953.5	295	286	257.5	460.5
3	7.5	6.9	1859.3	2206.5	1233.7	1405.5	624.6	610	365.2	432
4	7.5	6.9	1330.4	1505.5	853.3	965.5	286.3	270	181.8	338
5	7.1	7.1	1175.7	1716.5	750.2	1094	266.4	242.5	445.9	548.5
6	7.8	7.1	2279.6	2480	1425.6	1670	623.3	567.5	223.9	444.5
7	7.9	6.4	1638	1958	1058.6	1268.5	319.6	417.5	279.4	425
8	7.9	6.6	623.3	580.5	437.1	385	190	181	238.9	247.5
9	7.3	6.7	1009.1	1215	687.8	774.5	320.3	225.5	279.4	392.5
10	7.4	6.8	1202.3	1199	826.1	782	627.2	337	287.9	318.5
11	7.3	7.1	1734.4	1782.5	1174.5	1184.5	514.3	392	324.9	419.5
12	7.3	7.4	1147.7	1550.5	840.6	1032	291	234	284.4	535.5
13	7.4	6.6	927.9	741.5	669.4	485.5	255.2	186	262.5	318
14	8.7	6.7	1174.1	1231	784.1	799	426.6	330	366.8	399.5
15	8.3	7.1	1193.6	1167.5	765.2	786.5	435.9	348	427.3	417
16	8.7	6.9	1194.4	1234	767.6	815.5	441.9	432	434.3	433
17	8	7.1	1457.9	1518.5	900.2	919	590.7	579	513.3	474
18	7.8	7.1	609.7	1325	403.3	785	229.3	521	277.8	325
19	7.7	7.2	1337.5	1348.5	877.1	865	544.9	516	430.8	437
20	7.8	7.4	1281.3	1137.5	849.4	726	526.9	432	444.3	399.5
21	8.6	7.9	1264.2	1402.5	814.8	901	424.6	549	404	442
22	8.3	7.1	880.8	923	602.7	616	182.7	157.5	269.4	244.5
23	7.1	7.1	586.6	856.5	373.7	549	172.1	159	171.7	238
24	8	7.3	1128.9	1240	836.4	824.5	299.7	293	395.5	492.5
25	7.9	7.2	871.2	1014.5	636.6	665	382.7	385	308	300
26	8.1	7.4	1004.8	1132.5	726.7	731	453.1	430	306.4	305
27	7.3	7	2545.1	2858	1653.9	1856	1182.2	1150	353.5	302.5
28	7.7	7.1	3298.9	3535	2141.8	2292	765.6	820	471.1	472.5

29	8.2	7.6	1328.6	1373	854.7	893.5	337.5	325	437.7	472.5
30	8.4	7.4	1942	1970	1235	1268.5	495.7	475	483	462.5
31	7.2	7	335.9	326.5	223.1	216.5	200.6	170	165	142.5
32	7.2	7	1033.4	1072	676.5	702.5	393.3	390	316.6	302.5
33	7.9	7.3	1294.7	1401.5	870.4	940.5	431.8	435	469.3	475
34	7.9	7.3	2568.4	2638	1692.2	1734	465.1	445	614.3	612.5
35	9.2	8.1	1507.1	1543.5	964.4	1001	269	250	781.1	787.5
36	7.7	7.6	2767.8	3159	1885.1	2111	375.5	445	770.8	787.5
37	8.3	7.8	1692.6	1732.5	1132.4	1147.5	209.9	197	681.8	725
38	8.8	8.2	1194.4	1251	783.9	810	227.2	191	505	562.5
39	7.8	7.7	1661.2	1682	1136.4	1139	617.8	575	343.3	387.5
40	8	7.3	1392.2	1370.5	909.1	894.5	408.7	390	255.6	310
41	7.8	7.3	1635.7	1511	1068.5	978	474.4	437	329.8	337.5
42	7.5	7.4	3183.4	3177.5	2125.1	2117	1009.9	1000	472.8	455
43	8	7.6	1725.1	1674	1162.4	1132	1043.9	1220	261.1	275
44	8.1	6.6	748.9	671	688.8	441	305.7	198	267.6	170.5
45	8.2	7.2	1863.9	1036	1059.1	683	438.6	380	560.5	255.1
46	7.6	6.4	2465.8	2502.5	1568.1	1581	274.4	310	849.9	742
47	7.3	6.7	2681.7	2609.5	1716.6	1645	328.9	381	807.5	640
48	7.4	7.3	1765.2	1931	1169.4	1251	247.5	276	733.8	612.5
49	7.8	6.4	3369	3107.5	2219.7	2088	402	417	779.4	604
50	8.5	6.1	2903.8	2528	1836.1	1723.5	439.2	458.5	112.7	137.5
51	8.4	6	3181.3	2795	2017.7	1840.5	528.2	504	133	153
52	8.7	7.5	2685.7	1968	1942.1	1308	470.4	442	799.4	510.5
53	7.8	6.9	2394.8	2937.5	1423.2	1907.5	938.3	1009	412.3	338
54	7.8	7	3801.6	3696	2464.4	2443	1320.4	1246	462.8	378
55	7.7	7.5	4353.6	4129.5	2778.4	2177	1392	1278	610.3	419.5
56	7.7	6.6	4193.6	7206	3385.4	4885.5	1226.6	1393	366.8	399
57	7.7	6.9	5357.1	4415	3421.9	2996.5	1518.4	1468	336.6	238.5
58	7.6	6.4	11104.9	4085	7211	2774.5	523.6	586	754.1	377
59	6.9	6.9	1934.4	1477.5	1222.2	978.5	569.5	422.5	419.1	298.5
60	8.4	6.6	2797.5	2795	1941.8	1927	855.7	967.5	393.9	293.5

61	7.4	6.9	1578.6	2189.5	1086.4	1464.5	569.7	702.5	299.6	285
62	8.4	7.2	1272	936	807.1	594	189.3	180	424.3	315
63	7.7	6.9	1496.1	1476	953.8	1080.5	552.5	572.5	260.8	343
64	8.2	7.2	1343	1330	915	945	402	407	740.6	632
Maximum	9.2	8.2	11104.9	7206	7211	4885.5	1518.4	1468	849.9	787.5
Minimum	6.9	6	335.9	326.5	223.1	216.5	172.1	157.5	112.7	137.5
Average	7.9	7	1972.2	1936.6	1305.3	1266.7	506	498.2	419.2	411.4
BIS limit	6.5 – 8.5	6.5 – 8.5	1500	1500	500	500	300	300	200	200

Avg. Post is the average concentration of Post Monsoon (2010, 2011 and 2012). Avg. Pre is the average concentration of Pre Monsoon (2011 and 2012). EC is the electrical conductivity, TDS is the total dissolved solids, TH is the total hardness and TA is the total alkalinity. All values are expressed in ppm except EC in µs/cm and pH. Underlined values indicate beyond the permissible limit of BIS.

Table 3: The major ions concentrations of water samples from the study area

Sample ID	Ca	Ca	Mg	Mg	Na	Na	K	K	Cl	Cl	NO_3	NO_3	SO_4	SO_4	PO_4	PO_4
	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre
1	39.7	69.5	11.7	13.6	13.4	20.7	16.5	21.1	205.8	136.5	11.2	9.8	61	79	8.7	29
2	69.8	73.5	11.7	14.5	14	21	15.7	20.3	201.3	161.5	56.9	38.5	65	85	30.9	35
3	89	156	12.8	19.2	13.8	14.6	13.5	13.2	378.9	323.5	48.5	28.3	120	138	0.6	2.5
4	64.5	94	10.9	14.2	13.7	20.6	11	6.9	186.6	175	23.4	20.9	80	91	3.7	6.5
5	90.8	92	11.5	14.3	13.5	21.1	15.6	16.5	155.8	190.5	18.4	13.1	60	84	41.4	88
6	118.5	189	13	18.1	13.9	20.8	15.1	11.7	346.5	260	59.5	54.4	125	154	3.2	10.5
7	40.8	130	12.2	15.5	14.3	20	16.6	15.1	222.4	213.5	16.6	15	102	159	1.1	5
8	64.5	46.5	10.6	12.2	13.4	17.6	11.4	2.9	81.7	52	64.4	53.2	20	21	3.2	7.5
9	75.7	70.5	11.5	12.8	13.3	14.3	16.6	14	109.2	111.5	28.6	20.4	32	41	6.4	8.5
10	161.3	122.5	12.1	14.5	13.1	14.5	12.2	3.9	181.9	118	50	51.3	80	123	17.4	44.5

11	181.4	113	12.3	15.8	14	18.6	12.6	2.8	275.6	195.5	69	48	64	66	12.8	23.5
12	62.5	66.5	11.4	13.6	12.7	18	12.5	16.9	162.1	153.5	76.8	56.2	49	85	47.6	75.5
13	86.1	73.5	11.5	11.8	13.9	14.7	1.9	2.6	114.2	84	18.2	14.3	32	35	9.1	15
14	89.1	60.5	12.9	16.8	12.8	14.8	2.7	1.1	101.9	102.5	26.7	24.8	24	36	9.4	24
15	92	76.3	12.9	17.8	13	16.1	4.4	0.7	81.7	84	43	38.2	18	26	2.9	4.5
16	84.2	87	12.8	16	13.4	14.5	2.2	0.7	91.3	101.5	39.9	33.6	26	31	3	3.5
17	102.3	78.5	12.6	16.9	13.6	15.3	1.2	0.5	135.3	149	41.5	26.9	54	75	2.9	2.5
18	43.7	92	11.8	14.6	13	13.6	1.7	0.9	56.2	122	22.6	26	23	48	2.2	0.9
19	68.3	73	12.1	16.2	13.1	15.4	1.4	0.6	123.1	118.5	33.2	21.6	26	42	2.3	3.3
20	67.4	56	12.7	16.3	13.6	15.4	3.5	0.7	125.7	111.5	40.9	20.7	28	33	5	6.6
21	46.1	64.5	12.8	17.3	13.9	14	1.8	0.8	168.1	121	36.3	19.3	32	46	1.8	1.8
22	26	17	10.9	13.6	12.9	16.6	2.7	3.5	136.7	166	2.4	1.8	36	41	8.8	14.5
23	32.9	33	11.3	13.2	13.2	18	2.2	7.5	56.3	102	2.7	0.6	19	22	9.9	25.2
24	46.7	52	11.8	14.7	14.1	18.2	1.8	2.1	131	133.5	0.9	0.6	42	45	3.9	2.9
25	83	91.1	11.6	13.9	13.3	15.9	2.1	2.1	95	123.6	28.5	36.8	21	30	25.8	48.7
26	104	84.6	10.7	13	13.1	16.2	1.7	2.3	95.3	149.6	16.7	18.6	36	52	13.7	24.7
27	171.2	174.2	13.2	16.6	13.9	16.6	1.7	1.5	293.8	520.8	41.1	49.3	86	127	35.7	74.8
28	73.9	101	13.1	16.7	14.5	18.2	2.1	1.7	311.4	472.3	8.6	6.5	95	120	34.8	6.9
29	30.9	28.5	11.1	13.1	13.9	17.1	1.3	1	107.9	149.1	3.4	3.1	24	27	3.3	3.3
30	43.9	48	12.2	14.5	14.3	18	12.8	8.7	173.3	230.7	3.9	4	80	73	4.9	4.3
31	53.9	49.6	9.8	11.6	11.9	14.2	4.3	4.9	50.7	41	8.6	6.5	19	32	8.9	6.3
32	79.2	80.1	11.5	13.2	13.1	16.1	8.7	6.3	70.7	97.8	18.6	19.2	30	41	15.8	19.2
33	44.5	50.7	12	14.2	13.6	16.9	1	1	122.7	152.7	40.2	48.9	57	76	34.6	45.2
34	48.4	58	11.8	14	14.7	18.5	15.7	10.9	197.6	273.3	7	5.8	100	153	8.3	5.5

35	20.4	19.5	11.3	12.7	14.7	19	12.4	8.6	99	80.9	30.9	37.2	13	12	30.2	34.3
36	33	41.5	12.1	15.2	14.3	18.3	3.8	2.7	181.8	305	33.2	38.8	75	110	35.6	43.2
37	26	29	10.9	12.5	14.4	18.1	1.7	1.4	113.7	143.7	10	10.4	26	32	7.8	38.8
38	21.1	21.3	10.5	12.4	13.9	18.3	2.5	1.8	66.6	82.1	53.6	67.4	12	16	51.5	54.6
39	90.2	90.1	12.4	14.8	13.3	16.8	1.6	1.2	177.5	242.6	37.7	48.5	56	77	32.8	35.1
40	68.2	64.1	12	14.3	15.4	15.8	3.8	2.6	153.2	177.3	36.5	42.6	46	49	36	49.1
41	88.7	76.6	12	13.7	14.2	17.5	1.2	1.2	178.5	223.7	26.7	29.8	52	82	24.7	35.2
42	96.9	99.1	25.2	16.3	14.2	18.2	1.8	0.9	350.9	514.5	35.3	44.4	86	127	34	53.3
43	238.7	272.5	12.3	12.3	12.3	14.9	0.9	0.4	193.7	284	4.9	3.8	69	74	5.4	5.5
44	68.9	53	10.3	16.6	12.5	18.1	1.1	1.2	82.8	47	4.9	6.2	32	43	6.3	3.4
45	77	48.3	12.1	15.7	13.6	10.6	12.1	18.7	188.3	112.5	1.4	1.6	89	63	1.6	2.5
46	74.8	35.5	11.9	16.4	14.2	18.6	3.1	1.8	190.5	177	2	4	104	154	7.9	9.1
47	43.1	39	12.1	13.9	13.7	21.5	1.6	1.8	214.4	246.5	16.3	20	120	150	6.4	10.5
48	38.9	30.5	11.5	15.5	14.9	19.4	3.1	13.2	125	193	14.2	21.3	107	129	2.5	4.9
49	42.8	83	12.2	10.2	14.9	22	2.1	2.9	196.9	227	12	21.9	165	320	15.6	20.5
50	83.2	142	26	7.9	14.1	21.7	5.3	2.1	447.5	482.5	14.4	22.6	157	216	4	9
51	150.8	163.5	10	15.6	13.9	20.6	17.1	18.5	461	532	10.9	21.3	171	278	2.4	2.3
52	91.5	92.1	13.3	17.8	14	15.7	3.4	5	369.3	286.5	9.8	10.3	50	70	20.8	24
53	220.8	229.5	13.7	21.6	13.5	18	1.1	1.8	335.2	614.5	16	13.6	144	212	5.8	6.9
54	235.7	283.5	14.3	22.4	14	18.9	7.8	1.2	539.5	650.5	2.4	7.5	140	233	6.8	8.6
55	148.8	148	14.2	16.7	14.4	22.3	12.3	18.9	631.3	838.5	15.7	20.5	196	281	5.6	5.7
56	173.9	170.5	11.9	22.6	14.9	19.1	7.4	2.6	715.6	832.5	10	9.3	162	175	61.6	8.5
57	423.4	442.5	13.6	17.1	14.5	16.7	11.1	14.6	61.9	726	25.6	39.9	225	335	11.7	11.5
58	120.5	135.5	11.7	16.2	14.7	17.6	10.6	3.1	813.6	695	27.4	41	187	236	64.5	10.5

59	199.5	94.5	12.3	14.5	13.5	15.9	3.1	3.6	229.5	235	3.5	2.4	79	104	4.3	8.5
60	223	216	12.6	18.2	13.6	18	3.1	2.6	254.8	269.5	1.9	1.7	118	151	2.1	6
61	126.6	163	12.8	16	14.6	17.9	4.1	2.1	152.2	152.5	1.7	1.5	46	87	8.4	7.5
62	22.9	24.8	11.5	12.6	13.6	16.6	2	3	67.5	92.2	3.4	2.9	56	59	3.6	2.8
63	131	141	12.1	15.9	12.7	16	3.8	1.3	244.8	165.5	2.1	2.2	61	82	1.9	3.6
64	44.1	39.5	12	15.7	13.1	18.8	12.3	0.8	91	88.5	1.8	1.6	46	54	3.4	3.5
Maximum	423.4	442.5	26	22.6	15.4	22.3	17.1	21.1	813.6	838.5	76.8	67.4	225	335	64.5	88
Minimum	20.4	17	9.8	7.9	11.9	10.6	0.9	0.4	50.7	41	0.9	0.6	12	12	0.6	0.9
Average	93.8	97.5	12.4	15.1	13.7	17.4	6.3	5.4	207.4	240.9	23	22.4	73	99	14.5	18.7
BIS limit	75	75	30	30	200	200	10	10	250	250	45	45	250	250	-	-

Avg. Post is the average concentration of Post Monsoon (2010, 2011 and 2012). Avg. Pre is the average concentration of Pre Monsoon (2011 and 2012). All values are expressed in ppm. Underlined values indicate beyond the permissible limit of BIS.

Table 4 The trace elements concentrations of water samples from the study area

Sample ID	B	B	Cd	Cd	Cu	Cu	Fe	Fe	Mn	Mn	Ni	Ni	Pb	Pb	Zn	Zn
	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre	Avg. Post	Avg. Pre
1	0.9	0.8	0.045	0.081	0.11	0.053	0.059	0.046	0.032	0.102	0.017	0.012	0.56	0.297	0.003	0.002
2	1	0.9	0.067	0.133	0.116	0.048	0.192	0.098	0.082	0.037	0.087	0.002	0.03	0.236	0.223	0.183
3	1.1	1	0.026	0.056	0.064	0.039	0.24	0.107	0.086	0.176	0.084	0.003	1.351	0.304	0.054	0.003
4	0.8	0.9	0.008	0.011	0.076	0.066	0.461	0.482	0.053	0.224	0.065	0.001	1.14	0.498	0.001	0.002
5	0.9	1.1	0.011	0.04	0.079	0.06	0.014	0.013	0.07	0.082	0.088	0.079	0.483	0.533	0.043	0.034
6	0.8	0.8	0.014	0.015	0.076	0.077	0.146	0.063	0.086	0.118	0.13	0.078	0.685	0.435	0.145	0.082
7	1	1.1	0.019	0.037	0.266	0.084	0.728	0.492	2.177	0.126	0.074	0	1.507	0.352	0.057	0.008

8	0.8	0.8	0.01	0.057	0.115	0.093	0.124	0.012	0.096	0.138	0.129	0.204	1.183	0.602	0.016	0.026
9	1.8	2.3	0.021	0.018	0.058	0.056	0.012	0.018	0.05	0.079	0.102	0.062	0.596	0.521	0.201	0.194
10	1	1.7	0.015	0.049	0.062	0.055	0.059	0.007	0.125	0.184	0.071	0	0.975	0.303	0.373	0.48
11	0.8	0.8	0.01	0.042	0.082	0.059	0.129	0.045	0.116	0.26	0.054	0	1.445	0.553	0.054	0.003
12	0.8	0.9	0.015	0.055	0.385	0.053	0.158	0.063	0.124	0.174	0.115	0.141	1.28	0.721	0.147	0.128
13	0.9	1	0.021	0.049	0.183	0.051	0.048	0.048	0.167	0.258	0.064	0	0.55	0.204	0.936	0.73
14	0.8	0.9	0.001	0.001	0.242	0.061	0.126	0.063	0.018	0.113	0.093	0.076	1.259	0.482	0.154	0.089
15	0.9	0.9	0.015	0.051	0.146	0.048	0.113	0.028	0.078	0.125	0.063	0.099	1.77	0.189	0.342	0.292
16	1	1	0.013	0.032	0.227	0.053	0.135	0.025	0.045	0.079	0.151	0.146	1.118	0.651	0.258	0.259
17	1.2	1.5	0.024	0.047	0.101	0.048	0.062	0.013	0.026	0.044	0.112	0.074	0.576	0.315	0.228	0.183
18	1	0.9	0.006	0.007	0.301	0.024	0.175	0.196	0.011	0.017	0.085	0.162	1.077	0.164	0.125	0.136
19	0.9	0.8	0.015	0.008	0.297	0.042	0.188	0.093	0.248	0.364	0.068	0.069	1.659	0.659	0.204	0.186
20	1	0.9	0.013	0.044	0.074	0.04	0.223	0.093	0.312	0.46	0.058	0	0.957	0.455	0.315	0.049
21	1.1	0.9	0.038	0.045	0.359	0.039	0.094	0.045	0.173	0.501	0.065	0	0.502	0.211	0.118	0.048
22	0.7	0.8	0.009	0.025	0.261	0.044	0.08	0.048	0.173	0.248	0.216	0.314	1.904	0.558	0.051	0.012
23	0.9	0.9	0.016	0.034	0.267	0.043	0.109	0.033	0.18	0.258	0.072	0.084	1.629	0.535	0.172	0.041
24	0.8	0.8	0.013	0.048	0.297	0.037	0.183	0.012	0.247	0.369	0.062	0	1.98	1.886	0.147	0.027
25	0.9	0.9	0.01	0.025	0.392	0.057	0.522	0.373	0.016	0.03	0.06	0	0.657	0.604	0.113	0.023
26	0.9	0.8	0.04	0.038	0.196	0.078	0.002	0.003	0.022	0.04	0.002	0.003	1.636	0.614	0.155	0.067
27	1	0.9	0.02	0.056	0.183	0.076	0.204	0.108	0.021	0.038	0.052	0	1.768	0.334	0.025	0.022
28	0.9	1	0.021	0.04	0.079	0.086	0.117	0.012	0.022	0.039	0.04	0.027	1.128	0.78	0.021	0.033
29	1	1.4	0.007	0.016	0.084	0.06	0.299	0.156	0.019	0.037	0.003	0.005	0.703	0.48	0.124	0.026
30	0.7	0.8	0.024	0.062	0.348	0.48	0.105	0.038	0.029	0.047	0.069	0.038	1.514	0.659	0.113	0.027
31	0.7	0.7	0.026	0.063	0.155	0.153	0.041	0.003	0.026	0.044	0.055	0	1.77	0.477	0.018	0.028

32	0.8	1.1	0.014	0.026	0.118	0.084	0.097	0.018	0.019	0.036	0.021	0.033	0.958	0	0.035	0.029
33	0.7	0.8	0.033	0.036	0.165	0.211	0.126	0.033	0.019	0.042	0.03	0	0.768	0.272	0.121	0.077
34	0.7	0.9	0.042	0.091	0.085	0.066	0.067	0.037	0.036	0.055	0.064	0.004	1.138	0.488	0.075	0.022
35	0.6	0.7	0.018	0.008	0.081	0.076	0.032	0.014	0.265	0.392	0.059	0.003	1.859	0.248	0.017	0.046
36	0.6	0.7	0.026	0.034	0.078	0.09	0.088	0.003	0.031	0.049	0	0	1.209	0.496	0.1	0.023
37	0.8	0.9	0.028	0.081	0.119	0.086	0.418	0.45	0.019	0.039	0.055	0.004	0.535	0.809	0.072	0.038
38	0.8	0.9	0.019	0.022	0.053	0.062	0.034	0.004	0.034	0.052	0.061	0.005	1.954	0.827	0.043	0
39	0.8	0.7	0.045	0.043	0.082	0.07	0.248	0.325	0.024	0.038	0.021	0.033	1.504	0.633	0.086	0.05
40	0.7	0.7	0.031	0.079	0.129	0.073	0.404	0.49	0.027	0.051	0.028	0.003	1.039	0.743	0.066	0.011
41	0.7	0.8	0.029	0.064	0.091	0.071	0.097	0.004	0.02	0.038	0.055	0.003	0.704	0.99	0.053	0.037
42	0.8	0.9	0.018	0.019	0.098	0.073	0.1	0.028	0.021	0.031	0.056	0	1.71	0.479	0.058	0.022
43	0.7	0.7	0.05	0.097	0.16	0.045	0.028	0.067	0.031	0.075	0.002	0.005	1.493	0.475	0.113	0.087
44	0.9	0.8	0.048	0.067	0.11	0.067	0.058	0.003	0.031	0.053	0.025	0.003	0.944	0.37	0.058	0.056
45	0.9	0.9	0.026	0.066	0.098	0.066	0.11	0.022	0.031	1.334	0.083	0.049	0.501	0.602	0.043	0.031
46	0.8	0.8	0.042	0.072	0.134	0.064	0.186	0.122	0.036	0.417	0.06	0	1.79	0.516	0.063	0.053
47	0.8	0.8	0.051	0.074	0.138	0.094	0.068	0.098	0.04	0.065	0.033	0.05	1.313	0.537	0.096	0.029
48	0.9	0.9	0.036	0.02	0.115	0.101	0.107	0.086	0.035	0.057	0.048	0.039	0.681	0.506	0.038	0.044
49	0.9	0.8	0.074	0.105	0.113	0.086	0.175	0.092	0.046	0.064	0.105	0.073	0.931	0.294	0.045	0.032
50	1	0.8	0.075	0.136	0.072	0.089	0.159	0.116	0.071	0.097	0.347	0.549	1.755	0.336	0.097	0.016
51	1.4	0.8	0.084	0.169	0.07	0.057	0.103	0.105	0.05	0.1	0.137	0.133	1.195	0.732	0.072	0.047
52	1.1	2	0.101	0.121	0.077	0.037	0.164	0.118	0.003	0.018	0.07	0.002	0.64	0.587	0.009	0.035
53	0.8	0.8	0.084	0.152	0.064	0.063	0.193	0.127	0.041	0.061	0.071	0.075	1.241	0.371	0.045	0.059
54	1.6	1	0.123	0.158	0.097	0.057	0.163	0.081	0.044	0.069	0.089	0.088	1.814	0.637	0.146	0.023
55	2	2	0.122	0.201	0.264	0.061	0.097	0.112	1.33	0.07	0.066	0	1.191	0.731	0.095	0.014

56	1.5	2.1	0.1	0.15	0.072	0.063	0.165	0.123	0.505	0.054	0.115	0.07	0.666	0.162	0.003	0.005
57	1.1	1.5	0.021	0.08	0.085	0.08	0.228	0.147	0.307	0.049	0.044	0.032	1.298	0.028	0.042	0.012
58	1.4	0.8	0.045	0.065	0.161	0.088	0.534	0.133	0.312	0.047	0.085	0	1.741	0.197	0.138	0.054
59	0.9	0.9	0.136	0.161	0.072	0.073	0.112	0.161	0.024	0.038	0.123	0.099	1.092	0.349	0.021	0.026
60	0.9	0.9	0.063	0.123	0.105	0.077	0.143	0.132	0.022	0.041	0.094	0.048	0.583	0.428	0.006	0.01
61	0.9	0.8	0.077	0.141	0.071	0.057	0.184	0.148	0.025	0.037	0.023	0.036	1.649	0.538	0.103	0.005
62	1	1.1	0.031	0.033	0.081	0.032	0.109	0.003	0.035	0.054	0.044	0.003	1.681	0.518	0.122	0.053
63	0.8	0.8	0.024	0.055	0.05	0.063	0.052	0.003	0.024	0.044	0.057	0.002	1.285	0.958	0.008	0.013
64	0.8	0.8	0.021	0.052	0.065	0.088	0.022	0.005	0.018	0.036	0.042	0.004	0.927	0.837	0.011	0.017
Maximum	2	2.3	0.136	0.201	0.392	0.48	0.728	0.492	2.177	1.334	0.347	0.549	1.98	1.886	0.936	0.73
Minimum	0.6	0.7	0.001	0.001	0.05	0.024	0.002	0.003	0.003	0.017	0	0	0.03	0	0.001	0
Average	0.9	0.9	0.036	0.064	0.141	0.074	0.157	0.097	0.133	0.133	0.072	0.049	1.175	0.505	0.11	0.07
BIS limit	1	1	0.01	0.01	1.5	1.5	1	1	0.3	0.3	0.07	0.07	0.05	0.05	5	5

Avg. Post is the average concentration of Post Monsoon (2010, 2011 and 2012). Avg. Pre is the average concentration of Pre Monsoon (2011 and 2012). All values are expressed in ppm. 0 indicates below the detection limit. Underlined values indicate beyond the permissible limit of BIS.

4.1 Major ions

pH for water samples from the study area varied from 6.9 to 9.2 in the post monsoon and from 6.0 to 8.2 in the pre monsoon seasons. The permissible limit of pH is 6.5 to 8.5 (BIS 2003). Beyond this range the water will affect the mucous membrane and/or water supply system (BIS 2003). pH results showed that 06 water samples for pre monsoon becomes acidic and 06 samples for post monsoon shows alkaline nature. Remaining water samples are within the permissible limit.

Electrical conductivity is a good measurement of salinity; if the conductivity crosses 3000 µS/cm water becomes saline (BIS 2003). The EC concentration in post monsoon periods ranges from 335.9 to 11104.9 µS/cm and in pre monsoon ranges from 326.5 to 7206 µS/cm. According to Mondal et al. (2005), from the irrigation point of view, water can be classified into (1) fresh (<1500 µS/cm), (2) brackish (1500-3000 µS/cm) and (3) saline (>3000 µS/cm). Based on the above classification, water samples from each group clearly show that 31 water samples in post monsoon and 28 samples in pre monsoon belong to fresh quality, 24 water samples in post monsoon and 27 water samples in pre monsoon are brackish nature. In the study area, about 09 water samples for the post monsoon and pre monsoon fall under the saline water category.

TDS in water originates mainly from natural sources, sewage, urban and agricultural runoff and industrial wastewater. Permissible limit of TDS is 500 ppm (BIS 2003). Beyond this palatability decreases and may cause gastro intestinal irritation (BIS 2003). In the present study, 60 out of the 64 samples are not suitable for drinking purpose. Higher TDS concentrations are usually observed in the open and bore wells near the wastewater streams. The health data reflects that the cardiovascular patients in Jalgaon and Dharangaon area are increasing. In earlier studies, relationships between TDS concentrations in drinking water and the incidence of cancer and cardiovascular disease were reported (Burton and Cornhill 1977).

Hardness is mainly due to the presence of bicarbonates of Ca^{++} and Mg^{++} ions. It is an important parameter in detection of water pollution. Total hardness concentration in 46 water samples in post monsoon and 47 water samples in pre monsoon was observed exceed than permissible limit of BIS (300 ppm). In deep aquifer the total hardness is higher than in the shallow aquifer. According to Durfor and Becker's (1964) classification of total hardness, water was very hard (> 180 ppm) at all locations except in three sites (Sample ID 22, 23 and 31).

Calcium concentration in water of shallow aquifer is higher compared to that from deep aquifers. Calcium concentration in groundwater samples in pre monsoon period exceeds that in the post monsoon. Ca is one an alkaline earth metal and is known to indicate or produce health hazards. The calcium results show that more than 50 percent of the water samples are beyond the permissible limits. Medical survey data reveals that the kidney stone is one of the results from higher concentration of calcium in the water samples.

Magnesium ion concentration in almost all water samples are within permissible limits for drinking water according to BIS (30 ppm). Magnesium ion concentration in groundwater slightly increases in pre monsoon compared to post monsoon period. Though sodium concentration is insignificant in all water samples of both seasons, it may still have an effect on the human health if consumed for a long period of time. Disease such as renal failure, diabetic coma and dehydration may be related to increased potassium in drinking water. Potassium concentration in the waters of study area is observed to exceed permissible limit (10 ppm) of BIS (BIS 2003). 21 water samples from the post monsoon and 14 water samples from the pre monsoon period exceed the permissible limit for potassium. Agricultural practices are involved in using fertilizers in greater proportion in order to have maximum crop yield. Jalgaon district is now 3rd largest consumer of chemical fertilizers is in India. The use of fertilizers in order of its consumption is Urea, MOP, SSP, NPK (10:26:26), NPK (18:18:10) and NPK (15:15:15). Excessive use of potash fertilizer is one of the major causes of K concentrations are found beyond the limit from the study area.

The total alkalinity concentration in the post monsoon varies from 112.7 to 849.9 ppm and from 137.5 to 787.5 ppm in pre monsoon. In the study area about 90 percent of the water samples are beyond the permissible limit as per BIS drinking water standard for alkalinity (200 ppm). Chloride concentration varies from 50.7 to 813.6 ppm for post monsoon, while in pre monsoon it is 41 to 838.5 ppm. 18 water samples of post monsoon season and 15 water sample of the pre monsoon are not safe for drinking, because chloride concentration is greater than 250 ppm (BIS 2003; ICMR 1975). Chloride in groundwater may be of both natural and anthropogenic origin. Use of inorganic fertilizers, septic tank effluents, animal feeds, industrial effluents and irrigation drainage could contribute to chloride abundance.

The permissible limit of nitrate in waters for drinking purpose is 45 ppm (BIS 2003). Beyond this methaenoglobinaemia takes place (BIS 2003). Nitrate concentration in water samples from the study area ranged from 0.6 to 76.8 ppm. About 08 and 9 water samples of post monsoon and pre monsoon, respectively, display nitrate concentration beyond the permissible limit in the study area. Higher concentration of nitrate is attributed to excessive use of nitrogenous fertilisers and human waste. Jalgaon district occupies 3rd position among users of chemical fertilisers in India. The nitrate concentration in drinking water from Jalgaon urban area exceeds the permissible limits. The opinions of the doctors from the study area is that during the last few year's hemoglobin levels have reduced in the blood which may be due to the continuous consumption of nitrate contaminated water in rural areas.

According to James et al., the concentration of sulphate below 192 ppm is very excellent, 192 to 336 ppm is good, 336 to 576 ppm is permissible, and 576 to 960 ppm is doubtful and concentration above 960 ppm is unsuitable (James et al. 1982). In the study area most of the water samples are under excellent category except 02 water samples in post monsoon and 08 water samples in pre monsoon. Those water samples shows higher concentration of sulphate these site is either waste water flowing steam or dugwells from the bank of waste water flowing streams.

Elevation of phosphate concentration in groundwater is also due to the increased use of fertilizers. Phosphorous being added to the water bodies even in small amount can promote growth of algae and aquatic vegetation and cause eutrophication (Handa 1990). Phosphate pollution has been reported in groundwater by several investigators (Hamilton 1992; Raju et al. 2011; Shriniwas and Rajendra Prasad 1997). Phosphorus is also a source element for various minerals (Handa 1990). The study area is geologically covered by basaltic rocks. Basalt is mainly composed of pyroxene and plagioclase feldspar minerals in this area. Pyroxene and plagioclase feldspar are phosphorus containing minerals, and about 89 and 25 ppm phosphorus occurs in pyroxene and plagioclase, respectively (Konrad and Dennis 1994). Phosphorous in the groundwater samples from the study area ranges from 0.6 to 64.5 ppm for the post monsoon and 0.9 to 88 ppm for the pre monsoon which is within the permissible limits. In a few water samples phosphorous concentration is high due to excessive use of phosphatic fertilizer in the form of NPK 15:15:15, 18:18:10, 10:26:26 and superphosphate as well as due to presence of phosphate in pyroxene and plagioclase feldspar.

4.2 Trace elements

Trace elements, usually in moderate levels, originate primarily from parent rocks and are usually harmless to organisms. However, when their concentrations increase, they become considerably harmful to human and other living organisms. Trace elements concentrations in the waters of the study area have increased in groundwater during the last few years, as it has been contaminated by human activities, such as agriculture, fossil fuel burning and industrial effluent. It is clear that trace elements are entering aquatic system from both point and non-point sources (Elder 1988). Trace element concentrations in water were thus determined for water samples from the urban and rural water supply wells in the study area.

Boron concentration higher than 1 ppm in drinking water is not fit for human consumption (BIS 2003). The excessive amount of boron can cause nerve disorders (APHA 1998). Boron concentration in the study area varies from 0.6 to 2.3 ppm. Some samples show concentration more than 1 ppm in shallow aquifer (post-monsoon). In general the boron is low in the fresh water, but high in brackish and saline water. The boron observed in the groundwater has some correlation with salinity. It is found that 08 water sampling sites were observed to be in the range of EC > 3000 µS/cm, B > 0.7 ppm and > 1500 ppm TDS. The data from medical survey suggest that the nerve disorder diseases are not observed in the study area.

Cd in groundwater in the post-monsoon varied from 0.001 to 0.136 ppm and from 0.001 to 0.201 in the pre-monsoon. The permissible limit for Cd in drinking water is 0.01 ppm (BIS 2003). About 91 and 94 % of the water samples for post monsoon and pre monsoon periods, respectively, exceed the maximum permissible limit, which suggests that the water is not suitable for drinking purposes with respect to Cd. The health hazard data from Erandol, Dharangaon and Jalgaon primary health centers (PHC) reflect that anaemia patients are mostly women. The data suggest that the number of anaemia patients in the Jalgaon district is high and it may be due to cadmium and lead in drinking water.

Cu in water samples ranged from 0.05 to 0.392 ppm during the post monsoon period and 0.024 to 0.48 during the pre-monsoon period. The maximum permissible limit for Cu in drinking water is 1.5 ppm (BIS 2003). This suggests that the Cu concentration in all water samples collected from the study area is within the permissible limit.

Fe concentrations in water samples were found to range from 0.002 to 0.728 ppm during the post monsoon period and from 0.003 to 0.492 ppm for the pre monsoon period. The maximum permissible of Fe concentration is 1 ppm for drinking purpose, indicating all the samples from the study area are within the BIS limit for Fe concentration (BIS 2003).

Mn concentration in water samples during the post monsoon season ranged from 0.003 ppm to 2.177 and ranged from 0.017 to 1.334 ppm for pre monsoon season. The maximum permissible limit for Mn in drinking water is 0.3 ppm (BIS 2003). About 6 and 7 water sampling sites for post monsoon and pre monsoon periods, respectively, exceed the maximum permissible limit, which suggests that this water is not suitable for drinking purpose with respect to Mn. The disease caused by Mn is reflected in the medical survey as digestive disorders are observed within the study area.

In small quantities, nickel is essential for human health. However, evidences from human and experimental studies indicate that high exposure via the respiratory route of nickel results in respiratory cancer (Hayes 1997; McNeely et al. 1979). Ni concentration in water samples during the post monsoon season ranged from BDL to 0.347 ppm and ranged from BDL to 0.549 during the pre-monsoon season. The maximum permissible limit for Ni in drinking water is 0.07 ppm (BIS 2003). Ni concentration in 25 and 17 water sampling sites from the study area exceeds the maximum permissible limit for post and pre monsoon, respectively.

The main source of lead contamination is the burning of fossil fuel from vehicles (Smirjakova 2005). Pb concentration during the post monsoon season varied from 0.030 to 1.98 ppm and BDL to 1.886 during the pre-monsoon season. The maximum permissible limit for Pb in drinking water is 0.05 ppm (BIS 2003). Pb concentration in numbers of water samples from the study area is above the maximum permissible limit, which suggests that the water is not suitable for drinking purposes regarding Pb. The diseases caused by Pb such as cardiovascular disease and hypertension have been observed in the study area.

Zinc concentration during the post monsoon period ranged from 0.001 to 0.936 ppm and ranged from BDL to 0.730 ppm in the pre monsoon period. Zinc concentration in all samples of the study area is within the maximum permissible limit (BIS 2003). The main source of zinc may be fertilisers, pesticides and herbicides used for agriculture. Zinc is an essential element for human health and agriculture, and it plays an important role in protein synthesis and carbohydrate metabolism (Taylor and Demayo 1980). Zinc is relatively non-toxic up to 25 ppm in drinking water (McNeely et al. 1979).

5. CONCLUSION

Assessment of the potability of drinking water is mainly based on the permissible limits recommended by Bureau of Indian Standards. When the parameters of water exceed the permissible limits, the water is unfit for human consumption. All major ions in groundwater samples of the area showed increase trends in pre monsoon as comparing the post monsoon, which may be caused by excessive withdrawal of groundwater. The majority of people living in the rural area consume water without treatment. They may be affected by water borne diseases. Medical survey revealed that there is no medical report on methaenoglobinaemia. The drinking water source of a few villages with high total hardness in the groundwater samples was expected to pose harmful effects on human health such as kidney and or Urine stones. However, the villages surveyed for this disease showed only rare occurrence of stones in kidney or urine. The total dissolved solids are higher than 1400 ppm at Faizpur and Dharangaon areas in the study area. The medical questionnaire data are correlated with TDS; few kidney and urine stone patients reported may be because of high TDS in drinking water.

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