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Research Article

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Assessment of ground water pollution due to fluoride concentration and water quality in and around Purulia district, West Bengal, India

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ABSTRACT

There is a severe fluoride in Purulia district of West Bengal. Peoples are suffering from dental and skeletal fluorosis. Total 84 nos. of water samples collected during the month January, 2013 from different tube wells, dug wells and streams and ponds in parts of Purulia district, West Bengal for physico-Chemical analysis. The analytical results indicate the fluoride concentration varies from 0.126 ppm to 8.16 ppm. The physico-Chemical parameters such as pH,electrical conductivity, total hardness,Na^+,K^+,Ca^{+2},Mg^{+2},TDS,SO_4^{-2},Total alkalinity,Cl^-,SiO_2,NO_3^-,F^-,PO_4^{3-}etc were determined using standard procedure. Thus this paper presents level of fluoride and water quality in purulia district for public awareness.

Keywords: Dental and Skeleton fluorosis, Groundwater, Purulia, Fluoride.

INTRODUCTION

Water is one of the five elements described in the "Hindu scriptures" to form life. The search of life in universe with the search of water. Groundwater is main source for drinking water. Water pollution is an acute problem in all major areas. Although three fourth part of earth is being surrounded by water but little portion of it can be used for drinking purpose. In India 62.5 million people are suffering from disorder of teeth or bones through fluorosis (Susheela A.K .2002). Seventeen states in India have been identified as endemic for fluorosis including West Bengal also. The fluoride concentration in ground water in parts of Purulia district is more than W.H.O and BIS permissible limits (1.5 mg/L). Fluorosis is an endemic disease resulting due to the excess intake of fluoride either from drinking water, food or dentifrices (>1.5 mg/L). Fluorosis of teeth affects the dental enamel. Chronic fluorine intoxication through drinking water containing above 10 ppm of fluorine results in pathological changes of bone leading to skeleton fluorosis (Preek R. 1994). So, pollution of water resources needs a serious immediate attention through periodical check-up of water quality. The purpose of this study is to evaluate groundwater quality in parts of Purulia district, West Bengal, India.

EXPERIMENTAL SECTION

STUDY AREA:
The study area falls in Hura, Para, Kashipur and Jaipur blocks of Purulia district, West Bengal in the Survey of India toposheet nos. 73 I/2, 3, 6, 7, 10, 11 & 15.

Water Sampling
Total 84 nos. of water samples were collected during the month January, 2013 in parts of Purulia district, West Bengal. Samples are collected in pre cleaned and rinse Tarson plastic bottles with necessary precautions. The

samples were collected in morning time between 9 am to 12 pm from manually operated hand pump, dug wells, streams and ponds.

Methodology:
The analysis of water samples was done as per standard methods. pH and EC by WTW. Ph meter.Cl^- by Argentometric titrimetric method.Na^+, K^+ by Systronic Flame photometer, $SO4^{-2}$ by Turbidity meter. Total hardness by titrimetric method.

The fluoride concentration in water samples was determined electrochemically using fluoride ion selective electrode (APHA1991).This method is applicable to the measurement of fluoride in drinking water in the concentration range of 0.01 to 1000 mg/L.The electrode used to be an orion fluoride electrode coupled with Orion TSE make (Thermo scientific).The Standard fluoride solutions (0.1 mg/L to 10 mg/L) were prepared from a stock solution 100 mg/L) of sodium fluoride.

TISAB: Take 114 ml glacial acetic acids in a beaker dilute it to a litre with demineralised water. Add 116 gm NaCl to this mixture gradually with stirring with a glass rod so that it dissolves completely in the solution. Then add 0.6 gm sodium citrate and stir to dissolve. Adjust the pH of the solution to 5.5 with drop wise addition of 20% NaOH solution using pH meter. Transfer the contents into 2 litre volumetric flask and dilute the solution to 2 litres with DM water and preserve in a polythene bottle for future use.

Citrate Buffer solution:
a) Dissolve 193 gm citrate in 1 litre demineralised water.
b) Dissolve 294 gm Na-citrate in 1 litre demineralised water.

Mixed equal volumes to 3.0 with 6M HCL using pH meter. This mixture is the citrate buffer.

5 ml TISAB (Total Ionic Strength Adjusting Buffer) was added with 5 ml of water samples.TISAB is mixture of 114 ml of acetic acid with 116 gm of NaCl and 0.6 gm of Sodium citrate in 1 litre and adjust pH 5.5 with 20% NaOH and make up to 2 litres.

RESULTS

All ground water samples collected in parts of Purulia district without any visible colour, odour and turbidity. The fluoride concentration varies in greatly in different location of study area.

Samples are located from different locations.

Table No.1

S.No	Sample	Latitude	Longitude	S.No	Sample	Latitude	Longitude
1	S-1	23º18’41.6”	86 º 37´29.9″	43	S-43	23 º 28´7.6″	86 º 30´45.8″
2	S-2	23 º 20´58.4″	86 º 39´21.6″	44	S-44	23º30’36.1”	86º30’40.9”
3	S-3	23 º 24´05.8″	86 º 38´31.4″	45	S-45	23º30’35.7”	86º30’59.0”
4	S-4	23 º 28´23.1″	86 º 40´01.7″	46	S-46	23º30’44.2”	86º31’52.6”
5	S-5	23 º 28´23.9″	86 º 39´59.6″	47	S-47	23º30’42.4”	86º31’59.6”
6	S-6	23 º 18´13.1″	86 º 40´11.2″	48	S-48	23º30’37.1”	86º34’48.6”
7	S-7	23 º 29´01.6″	86 º 39´14.5″	48	S-49	23º31’08.1”	86º34’44.5”
8	S-8	23 º 17´33.3″	86 º 29´29.9″	50	S-50	23º31’09.0”	86º34’44.0”
9	S-9	23 º 18´55.6″	86 º 29´46.1″	51	S-51	23º24’41.4”	86º51’00.7”
10	S-10	23 º 18´22.8″	86 º 32´39.6″	52	S-52	23º27’52.1”	86º49’17.8”
11	S-11	23 º 20´10.7″	86 º 35´02.5″	53	S-53	23º27’52.4”	86º49’11.1”
12	S-12	23 º 21´05.5″	86 º 34´28.1″	54	S-54	23º26’55.3”	86º47’01.3”
13	S-13	23 º 19´52.2″	86 º 32´25.4″	55	S-55	23º26’42.8”	86º47’03.4”
14	S-14	23 º 20´08.8″	86 º 32´26.7″	56	S-56	23º26’59.7”	86º45’51.0”
15	S-15	23 º 20´23.4″	86 º 31´35.8″	57	S-57	23º27’38.1”	86º44’51.8”
16	S-16	23 º 21´00.8″	86 º 31´52.0″	58	S-58	23º27’38.2”	86º45’08.3”
17	S-17	23 º 22´14.3″	86 º 12´19.3″	59	S-59	23º29’01.0”	86º43’55.2”
18	S-18	23 º 22´03.0″	86 º 12´36.1″	60	S-60	23º29’00.5”	86º43’55.8”
19	S-19	23 º 24´25.6″	86 º 11´21.3	61	S-61	23º16’16.2”	86º38’33.2”
20	S-20	23 º 25´16.4″	86 º 13´56.4″	62	S-62	23º20’34.7”	86º44’05.6”
21	S-21	23 º 28´23.7″	86 º 07´51.8″	63	S-63	23º21’16.1”	86º37’55.2”
22	S-22	23 º 28´16.1″	86 º 07´51.8″	64	S-64	23º23’57.5”	86º43’23.5”
23	S-23	23 º 29´36.9″	86 º 07´02.6″	65	S-65	23º24’04.4”	86º43’15.9”
24	S-24	23 º 29´46.6″	86 º 07´00.8″	66	S-66	23º24’23.4”	86º34’48.9”
25	S-25	23 º 30´18.7″	86 º 07´56.5″	67	S-67	23º24’41.6”	86º32’50.3”

26	S-26	23 º 31´44.8″	86 º 04´09.7″	68	S-68	23º24’43.2”	86º32’45.9”
27	S-27	23 º 30´19.0″	86 º 03´15.4″	69	S-69	23º24’34.1”	86º32’47.4”
28	S-28	23 º 30´29.9″	86 º 03´10.5″	70	S-70	23º29’04.7”	86º33’38.5”
29	S-29	23 º 30´24.0″	86 º 03´06.2″	71	S-71	23º29’08.7”	86º33’43.7”
30	S-30	23 º 30´40.3″	86 º ‘03´46.5″	72	S-72	23º28’25.9”	86º34’27.2”
31	S-31	23 º 30´22.2″	86 º 05´23.5″	73	S-73	23º28’20.8”	86º34’28.1”
32	S-32	23 º 30´22.1″	86 º 05´56.2″	74	S-74	23º27’40.5”	86º35’29.5”
33	S-33	23 º 30´19.1″	86 º 05´47.1″	75	S-75	23º27’47.3”	86º35’18.2”
34	S-34	23 º 30´21.5″	86 º 06´59.0″	76	S-76	23º27’27.4”	86º35’34.6”
35	S-35	23 º 29´28.7″	86 º 28´34.4″	77	S-77	23º28’28.8”	86º31’38.2”
36	S-36	23 º 29´38.1″	86 º 28´04.5″	78	S-78	23º28’01.3”	86º30’39.7”
37	S-37	23 º 29´53.0″	86 º 28´01.6″	79	S-79	23º28’44.0”	86º39’56.9”
38	S-38	23 º 32´59.9″	86 º 23´16.6″	80	S-80	23º29’49.0”	86º28’46.3”
39	S-39	23 º 32´38.7″″	86 º 23´42.8″	81	S-81	23º28’25.5”	86º28’34.2”
40	S-40	23 º 31´45.4″	86 º 23´51.7″	82	S-82	23º28’47.1”	86º30’50.0”
41	S-41	23 º 28´47.1″	86 º 30´43.9″	83	S-83	23º21’41.0”	86º38’49.8”
42	S-42	23 º 28´48.1″	86 º 30´46.1″	84	S-84	23º27’42.0”	86º35’02.8”

Table No. 2

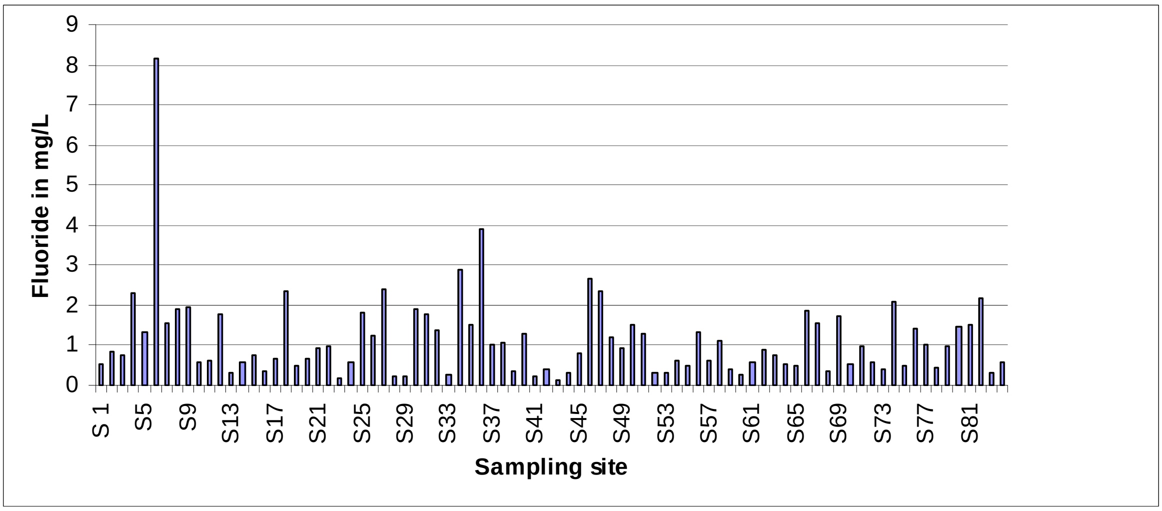
S.No	pH	EC	HCO_3^-	SO_4^{-2}	NO_3^-	Cl^-	TH	Ca^{+2}	Mg^{+2}	Na^+	K^+
S-1	7.01	599	599	30.86	1.1	110	340	94	25.2	28.45	2.46
S-2	6.86	492	190	31.05	2.21	70	220	58	18	29.4	3.53
S-3	7.2	351	190	11.25	2.2	70	180	52	12	38.54	3.61
S-4	7.35	774	360	22.9	<0.22	30	260	72	19.2	30.54	7.2
S-5	7.25	715	470	15.91	0.66	65	320	94	20.4	105.5	1.69
S-6	8.33	877	110	39.28	<0.22	40	40	14	12	39.32	5.69
S-7	7.2	1219	510	65.21	3.32	145	490	160	21.6	100.8	1.77
S-8	7.24	785	300	58.81	1.1	60	270	84	14.4	50.25	3.49
S-9	6.83	1206	310	87.92	13.28	170	450	150	24	55.95	3.19
S-10	7.08	1063	210	38.23	8.85	190	360	124	12	48.85	9.07
S-11	6.84	585	310	33.8	0.28	50	290	92	14.4	30.25	3.2
S-12	6.92	526	295	12.6	2.65	55	240	68	16.8	42	5.02
S-13	6.72	1065	320	43.8	4.42	180	440	144	19.2	52.5	3.56
S-14	6.94	1335	400	50	4.42	250	600	112	76.8	65.75	1.41
S-15	6.7	1082	240	10.4	8.85	250	465	152	20.4	44.75	2.86
S-16	7.09	670	190	102.8	4.42	110	295	96	13.2	53.7	1.3
S-17	7.49	371	180	3.2	1.32	70	200	56	14.4	18.65	3
S-18	7.33	919	365	109.4	27.67	120	430	108	38.4	68.8	5.24
S-19	7.28	1145	250	40	2.65	130	400	128	19.2	5.05	18.65
S-20	7.51	265	155	10.4	5.53	40	150	44	9.6	15	2.47
S-21	7.36	452	200	56.2	<0.22	50	210	68	9.6	34.55	1.94
S-22	7.13	352	190	4	<0.22	55	130	44	4.8	46.55	3.05
S-23	7.03	670	120	6.6	<0.22	145	270	100	4.8	19.85	1.16
S-24	7.32	230	150	2.2	0.66	70	190	40	21.6	15.6	1.14
S-25	7.54	332	210	10.8	8.85	110	250	48	31.2	36.6	3.59
S-26	7.09	1100	280	102.2	<0.22	165	500	168	19.2	31.4	1.37
S-27	6.93	196	140	1.2	53.13	3	70	20	4.8	36.95	4.11
S-28	7.33	1555	380	61.2	5.53	200	490	172	14.4	3.7	129.25
S-29	7.02	119	70	1	4.42	25	70	12	9.6	11.9	0.3
S-30	6.95	169	100	2.8	0.22	40	85	20	8.4	23.35	0.67
S-31	6.55	684	130	43.6	<0.22	150	265	72	20.4	45	1.64
S-32	7.02	345	160	1.2	6.64	65	130	28	14.4	43.95	2.84
S-33	7.16	117	95	4.8	2.65	20	90	16	12	9.1	0.85
S-34	7.18	143	110	0.6	2.65	20	90	16	12	14.7	0.46
S-35	6.76	246	50	5.8	13.28	90	120	36	7.2	25.7	0.66
S-36	7.29	200	360	1.8	5.53	40	250	68	19.2	47.45	2.89
S-37	6.74	1657	310	95	5.53	340	720	212	45.6	58	1.19
S-38	7.1	309	140	84.6	3.32	50	150	40	12	27.45	2.67
S-39	6.74	1078	220	96.8	13.28	180	430	148	14.4	51.75	1.22
S-40	7.11	377	215	7.8	<0.22	70	200	52	16.8	40.85	0.84
S-41	7.69	1618	360	82.8	13.28	250	630	216	21.6	10.25	58.75
S-42	7.92	1634	340	95.6	15.49	210	500	184	9.6	1.05	140
S-43	7.81	1124	260	102.6	17.71	155	440	156	12	16.65	53.1
S-44	6.89	801	230	41.8	2.65	110	340	116	12	6.85	20.9
S-45	6.85	532	260	77.6	3.32	180	460	160	14.4	38.8	1.03
S-46	7.15	532	300	65.2	1.1	130	470	76	67.2	21.75	0.95
S-47	6.97	596	150	47.8	4.42	120	260	80	14.4	40.85	0.88
S-48	6.91	634	220	53	<0.22	120	350	88	31.2	28.7	0.63
S-49	6.84	1208	300	90.2	3.32	180	480	188	2.4	53.2	4.69
S-50	7.25	292	140	11.6	3.54	40	130	32	12	27.45	0.72
S-51	7.2	789	420	30.6	<0.22	40	210	88	2.4	84.25	10.9

S-52	6.57	397	150	26.4	3.54	60	200	40	24	19.95	1.78
S-53	6.85	550	200	32.6	2.65	75	240	76	12	25.7	4.87
S-54	7.11	431	260	2.8	2.65	40	180	52	12	42.95	1.92
S-55	6.94	727	260	7.2	17.71	90	330	108	14.4	36.15	3.52
S-56	6.63	1266	370	80.2	3.54	170	520	132	45.6	49	5.98
S-57	6.97	1978	540	145.4	2.65	335	910	252	67.2	75.75	3.47
S-58	7.46	835	570	26	2.65	40	440	104	43.2	46.35	6.99
S-59	6.97	757	320	28.4	2.21	100	380	128	14.4	22.95	0.79
S-60	7.02	743	290	25.2	<0.22	100	360	116	16.8	20.5	0.75
S-61	8.68	444	245	29.2	0.44	70	280	92	12	27.1	1.23
S-62	8.72	448	250	45.6	0.66	70	330	108	14.4	10.55	2.57
S-63	8.5	1550	310	28.2	0.66	380	660	184	48	72	4.75
S-64	8.34	647	240	10.6	0.44	120	300	88	19.2	33.05	0.87
S-65	8.2	520	155	7.2	2.21	100	230	68	14.4	22.45	0.64
S-66	8.29	427	180	64	<0.22	40	150	40	12	55	2.71
S-67	8.11	923	270	61	1.32	160	460	124	36	25.7	1.48
S-68	8.3	468	110	92.8	0.44	90	200	48	19.2	45.1	11.3
S-69	8.18	1232	270	40.6	13.28	190	320	132	19.2	44.5	17.4
S-70	8	1440	205	41	<0.22	270	460	152	2.4	85.25	18.25
S-71	8.15	1115	350	55.6	13.28	240	640	148	64.8	22.5	1.68
S-72	8.27	190	100	16	<0.22	40	130	28	14.4	10.6	0.61
S-73	8.27	371	170	10.8	0.44	70	220	52	21.6	16.05	0.83
S-74	8.47	428	230	81.4	1.32	20	210	72	7.2	34.2	11.25
S-75	8.18	1105	290	41.4	33.21	170	460	124	36	28.35	2.03
S-76	8.49	560	250	19.6	4.42	50	250	60	24	26.5	0.96
S-77	8.3	1861	510	40.6	3.32	380	900	208	91.2	47.75	2
S-78	8.24	1268	310	68.6	17.7	200	530	136	45.66	32.15	1.68
S-79	9.11	505	260	25.2	0.22	50	230	68	14.4	39.6	1.31
S-80	8.76	456	270	10.4	2.21	50	250	56	26.4	22.2	1.56
S-81	8.85	1011	420	26.6	2.21	150	420	100	40.8	70.25	5.97
S-82	8.88	574	200	27	0.22	50	200	60	12	7.65	33.05
S-83	8.81	320	180	3.8	<0.22	60	180	60	7.2	26.15	1.34
S-84	8.67	687	320	41.8	2.65	70	370	108	24	17.05	2.23

Table No.3

S.No	PO_4^{-3}	SiO_2	TDS	Fe	F^-
S-1	0.1	2	359	0.068	0.528
S-2	0.1	3	295	0.057	0.858
S-3	0.1	3	211	0.052	0.75
S-4	0.1	3.4	464	0.097	2.31
S-5	0.1	3.4	429	0.095	1.34
S-6	0.1	3.2	526	0.059	8.16
S-7	0.1	3.6	731	0.044	1.55
S-8	0.1	2.4	471	0.053	1.92
S-9	0.1	3	724	0.04	1.93
S-10	0.1	3	638	0.069	0.573
S-11	0.1	10	351	0.067	0.599
S-12	0.1	10	316	0.032	1.79
S-13	0.1	12	639	0.053	0.31
S-14	0.1	12	801	0.043	0.561
S-15	0.1	10	649	0.065	0.735
S-16	nil	10	402	0.051	0.339
S-17	0.1	8	223	0.079	0.671
S-18	nil	6	551	0.104	2.37
S-19	0.1	10	687	0.135	0.489
S-20	0.1	12	159	0.049	0.674
S-21	0.1	10	271	0.058	0.951
S-22	nil	8	205	0.055	0.982
S-23	nil	10	402	0.097	0.167
S-24	nil	6	138	0.04	0.571
S-25	0.1	4	199	0.059	1.8
S-26	0.1	10	660	0.082	1.25
S-27	0.3	16	118	0.07	2.41
S-28	4	12	933	0.048	0.243
S-29	0.1	4	71	0.116	0.21
S-30	0.1	12	101	0.066	1.9
S-31	nil	12	410	0.072	1.77
S-32	0.1	1	207	0.206	1.37
S-33	0.1	4	70	0.21	0.251
S-34	nil	10	86	0.268	2.87
S-35	0.1	10	148	0.058	1.49

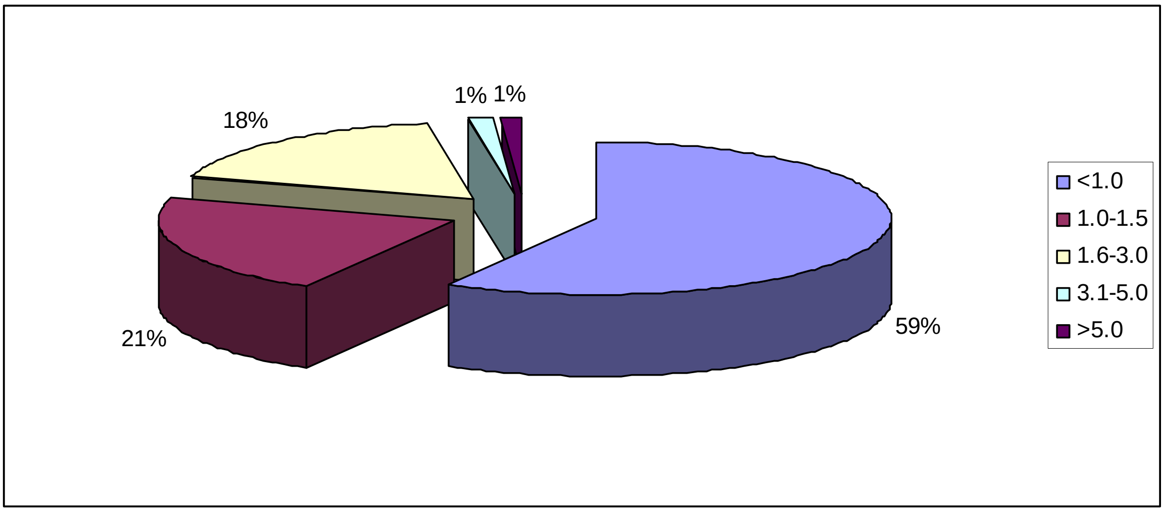
S-36	0.1	8	120	0.076	3.92
S-37	nil	8	994	0.039	1.01
S-38	nil	8	185	0.084	1.06
S-39	0.1	8	647	0.118	0.346
S-40	0.1	10	226	0.046	1.3
S-41	0.1	8	971	0.057	0.204
S-42	1	6	980	0.044	0.408
S-43	1	8	674	0.04	0.126
S-44	0.1	10	481	0.057	0.314
S-45	0.1	6	319	0.048	0.812
S-46	nil	6	319	0.04	2.68
S-47	0.1	8	358	0.057	2.34
S-48	nil	8	380	0.077	1.18
S-49	1	6	725	0.851	0.923
S-50	0.1	10	175	0.103	1.52
S-51	nil	8	473	0.064	1.29
S-52	0.1	4	238	0.032	0.308
S-53	0.1	8	330	0.043	0.331
S-54	nil	8	259	0.047	0.638
S-55	nil	6	436	0.018	0.475
S-56	nil	4	760	0.024	1.31
S-57	nil	4	1187	0.04	0.627
S-58	nil	4	501	0.038	1.12
S-59	nil	8	454	0.04	0.396
S-60	0.1	8	446	0.029	0.28
S-61	0.1	16	266	0.033	0.589
S-62	nil	12	269	0.024	0.866
S-63	nil	8	930	0.032	0.733
S-64	0.1	16	388	0.029	0.545
S-65	1	16	312	0.048	0.493
S-66	nil	16	256	0.044	1.85
S-67	1	12	554	0.044	1.55
S-68	0.1	16	281	0.042	0.361
S-69	0.1	12	739	0.081	1.72
S-70	0.1	12	864	0.262	0.521
S-71	0.1	8	669	0.033	0.975
S-72	0.7	20	114	0.082	0.558
S-73	0.1	10	223	0.035	0.41
S-74	0.3	16	257	0.025	2.1
S-75	0.3	12	663	0.044	0.504
S-76	0.1	10	336	0.05	1.43
S-77	nil	4	1117	0.025	1.02
S-78	nil	8	761	0.032	0.461
S-79	0.1	4	303	0.026	0.954
S-80	0.1	4	279	0.022	1.47
S-81	0.1	4	607	0.036	1.5
S-82	nil	4	344	0.018	2.16
S-83	0.1	4	192	0.031	0.316
S-84	nil	8	412	0.027	0.566



The results of fluoride concentration in ground water in table were categorised according to following concentration.
1. Category I: Fluoride concentration below 1.0 mg/L
2. Category II: Fluoride concentration between 1.0-1.5 mg/L
3. Category III: Fluoride concentration between 1.6-3.0 mg/L
4. Category IV: Fluoride concentration between 3.1-5.0 mg/L
5. Category V: Fluoride concentration above 5.0 mg/L

Category I (<1.0) ppm	S1,S2,S3S10,S11,S13,S14,S15,S16,S17,S19,S20,S21,S22,S23,S24,S28,S29,S33,S39,S41,S42,S43,S44,S45,S49,S52,S53,S54,S55,S57,S59,S60,S61,S62,S63,S64,S65,S68,S70,S71,S72,S73,S75,S78,S79,S83,S84
Category II (1.0-1.5) ppm	S5,S7,S26,S32,S35,S37,S38,S40,S48,S50,S51,S56,S58,S67,S76,S77,S80,S81,
Category III (1.6-3.0) ppm	S4,S8,S9,S12,S18,S25,S30,S31,S34,S46,S47,S66,S69,S74,S82
Category IV (3.1-5.0) ppm	S36
Category V (>5.0) ppm	S6

Figure: Percentage of villages affected by range of fluoride concentration.



pH: The value of PH ranges are 6.55 to 9.11.The sample station no 79, 80,81,82,83 and 84 are exceeds the permission value according WHO i.e. 6.5 to 8.5.Thus a slightly variation was due to alkalinity nature. However the pH value of all the samples falls within the permissible limit.

Conductivity: The conductivity value varies from 117 µS/cm to 1978 µS/cm.The sample station no.37,42,57,63 had relatively higher conductivity ,which may due to contamination of conducting material in water samples.

Total dissolved Solids: According to BIS standards, the acceptance limit for TDS in groundwater is 500 mg/L, which may go up to 1500 mg/L.The Presence of excessive solids in water indicates pollution which can lead to a laxative effect.

DISCUSSION

CHEMICAL PARAMETERS

Total hardness of water samples were found in the range from 40 mg/L to 910 mg/L. The total hardness of sample nos.14, 37, 41, 56,57,63,71 and 77 is higher than BIS standard value 500 mg/L.Total hardness values are high due to the high concentration of calcium and magnesium salts. Hardness leads to heart diseases and kidney stone formation.

The chloride content of water samples varies from 25 mg/L to 380 mg/L.The Chloride content of sample no.14,15,37,41,42,58,63,70,71 and 77 were higher than BIS permissible limits which is 200 mg/L.The excess chloride concentration due to presence of soluble chlorides from rocks.

Total alkalinity varies from 70 mg/L to 570 mg/L. The sample no.4,5,7,8,9,11,12,13,14, 18,26,28,36, 37,41,42,43,45,46,49,51,54,55,56,57,58,59,60,63,67,69,71,75,77,78,79,80,81 and 84 are exceeds the BIS permissible limit which is 250 mg/L. The higher alkalinity in water samples leads to sour taste and salinity.

Sulphates of water samples collected in Purulia district ranges from 3.8 mg/L to 145.4 mg/L which falling on the permissible limit of BIS standard 200 mg/L.

Nitrates of water samples were ranges from 0.22 mg/L to 53.13 mg/L. The only sample no.27 is out of permissible limit of BIS value which is 50 mg/L. High nitrate concentration in water bodies leads to organic pollution causes blue baby syndrome.

The phosphate values lies in range from 0 ppm to 4.0 ppm. The higher values may come from land which is used for cultivation.

The iron varies in study area ranges from 0.018 mg/L to 0.851 mg/L. The only sample no.49 (0.851 mg/L) is higher than specified value.

Fluoride concentration in Purulia district ranges from 0.126 mg/L to 8.16 mg/L in ground water samples with lowest in sample no.43 and highest in sample no.6. The study reveals that out of 84 nos. of water sample. The 53% of water sample have fluoride concentration below 1.0 mg/L. 21 % water sample have fluoride concentration 1.0 to 1.5 mg/L and 18% of water sample have fluoride concentration of 1.6 mg/L to 3.0 mg/L which is above the permissible limit prescribed by BIS and WHO. At this concentration teeth lose their shiny appearance and chalky black, Grey or white appearance of teeth known as mottled enamel. 1% of water samples have fluoride concentration of 3.1 to 5.0 mg/L and 1% of water samples have fluoride concentration of 5.0mg/L to 8.0 mg/L. the fluoride intake per day by the population of Purulia district is very high which causes dental as well as skeletal fluorosis. Skeletal fluorosis which has a crippling effect on the individuals due to the deposition of fluoride in the bone. The most sensitive effect tooth paste mottling occurs at very low concentration of 0.8 ppm to 1.6 ppm. Skeletal fluorosis occurs if 2 ppm to 80 ppm of fluoride ingested daily for a period of more than 10 year.

Table: Physio-chemical standard of ground water quality for drinking purpose

Parameter	BIS	WHO
pH	6.5-8.5	6.5-8.5
TDS	500(ppm)	500(ppm)
TH	600(ppm)	500(ppm)
Ca^{+2}	200(ppm)	75(ppm)
Mg^{+2}	200(ppm)	150(ppm)
Na^{+}	200(ppm)	200(ppm)
K^{+}	50(ppm)	50(ppm)
CO_3^{2-}	200(ppm)	200(ppm)
HCO_3^{-}	200(ppm)	200(ppm)
SO_4^{2-}	250(ppm)	250(ppm)
F^{-}	1.5(ppm)	1.5(ppm)
Fe	0.3(ppm)	0.3(ppm)

Sources of Fluoride

The presence of fluoride in groundwater can be attributed to geological reasons. (A.K.Yadav et al.2009). Fluoride exists naturally in water sources. Generally most groundwater sources have higher fluoride concentrations than surface water. The main source of fluoride in groundwater is basically from the rocks minerals shown in table. These minerals are commonly associated with the rocks through which the ground water percolates under variable temperature conditions. Besides these minerals, alkali rocks, hydrothermal solutions, phosphate fertilizers, burning coal, manufacturing process of aluminium, steel and bricks may also contribute to higher concentration of fluoride in groundwater.

Minerals	Chemical composition
Fluorite(Fluorspar)	CaF_2
Fluorapatite	$Ca_5(F,Cl)PO4$
Mica Biotite Muscovite Lepidolite	$K(MgFe^{+2})_3(AlSi_3)O_{10}(OHF)_2$ $KAl_2(AlSi3O_{10})(OHF)_2$ $K_2(Li,Al)_5(Si_6Al2)O_{20}(OHF)_4$
Amphiboles Hornblende Tremolite Actinolite	$NaCa_2(MgFe^{+2})_4(AlFe^{+3})(SiAl)_8O_{22}(OHF)_2$ $Ca_2(MgF^{+2})_5(Si_8O_{22})(OHF)_2$
Topaz	$Al_2SiO_4(OHF)_2$
Rock phosphate	$NaCa_2(MgFe^{+2})_4(AlFe^{+3})(SiAl)_8O_{22}(OHF)_2$

The concentration of fluoride I water sources depends upon various factors like sources of water, solvent action of water on the rocks and soil of earth's crust, porosity of the rocks or soil through which water passes, the speed with which water flows, the temperature of the interaction of through rock and water, the hydrogen and calcium ion concentration, amount of annual rain fall etc. (AK.Yadav et al 2009; Tailor and Chandel 2010; singh p. et al 3011; Hessian et al.2012)

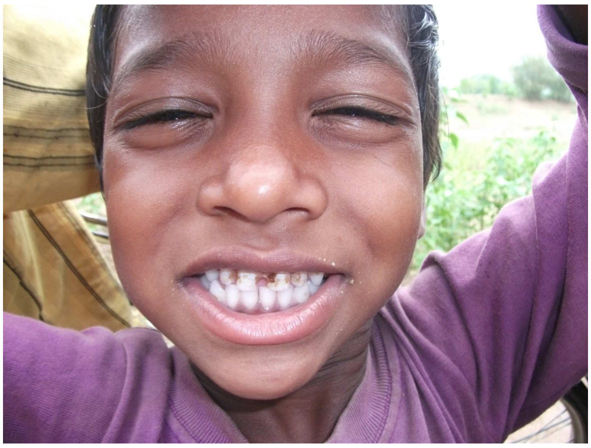
Effects of fluoride on human health

Fluoride in drinking water has both positive and negative effects on human health. Low levels of fluoride in drinking water results in incorporation of fluoride in to teeth during the formative years of children, which makes the teeth resistant to decay and development of dental cavies (Tailor and chandel, 2010). But high intake of fluoride causes both short term and long term effect. Acute high level exposure to fluoride causes immediate abdominal pain, excessive salvation, nausea and votimiting.Seizures muscle fibrillation and numbness of mouth may also occur. Long term effect of excess fluoride through water appears to create fluorosis which manifests itself as dental, skeletal and non-skeletal fluorosis.

In dental fluorosis, excessive fluoride usually causes yellowing of teeth, white spots and pitting or mottling of enamel. The natural shine or lustre of the teeth disappears. In the early stage, the teeth appear chalky white and then gradually become yellow, brown or black. The discoloration will be horizontally aligned on the tooth surface as lines away from the gums. Dental fluorosis affects both the inner and outer surface of the teeth. The disease has mostly cosmetic implications and has no treatment.

Excessive fluoride intake may also result in slow progressive crippling scourge known as skeletal fluorosis.It causes pain and damage to bones and joints. Skeletal fluorosis affects the bones/skeleton of the body. Skeleton fluorosis can affect both young and old people. One can have aches and pain in the joints. The joints which are normally affected by skeletal fluorosis are neck, hip, shoulder and knee. Fluoride mainly gets deposited in these joints and makes it difficult to walk and movements are painful. Rigidity or stiffness of joints also sets in. (Beg.2009).At advanced stage vertebrae may fuse together and a victim may be crippled (Meenakshi and Naheswari. 2006)

Field photographs of dental and skeletal fluorosis noticed in the study area.



a) Dental fluorosis.

b) Dental fluorosis

c) Skeltal fluorosis.

d) Dental fluorosis

Apart from bones and teeth an excessive intake of fluoride can damage or impart ill effects on other soft tissues, organs and systems also, categorised as non skeletal fluorosis.A review by earlier workers reveals that almost all systems of body including muscle, liver, kidney, blood, Cardiovascular and reproductive affect. The symptoms include gastro-intestinal complaints, loss of appetite, pain in stomach, constipation followed by intermittent diarrheoea.Muscular weakness and neurological manifestations leading to excessive thirst tendency to urinate more frequently are common among the afflicted individuals. Cardiac problems may arise due to cholesterol production. Repeated abortions or still birth, male infertility due to sperm abnormalities are also some of the complications (tailor and chandel 2010; Singh P et al, 2011).

CONCLUSION

This study provides an overview of the fluoride contamination statues of ground water and show that there is an acute fluoride problem in parts of purulia district of West Bengal. As only 59 % of groundwater samples have fluoride content with in the permissible limit (>1.5 mg/L, WHO) and remaining 41 % of villages are having high fluoride concentration. The favourable factor which contributes to rise of fluoride in groundwater is presence of fluoride rock salt system. The result of current study also reveals that there is an immediate requirement of defluoridation techniques and public awareness programmes to prevent the population from fluorosis.

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