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WATER QUALITY ASSESSMENT AND ITS IMPACT ON HUMAN HEALTH: A CASE STUDY OF SOMNI STREAM WATERSHED PATAN BLOCK, DURG DISTRICT, CHHATTISGARH

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ABSTRACT

Indiscriminate disposal of hazardous chemicals and industrial wastes causes pollution of ground water regime as well as subsurface soil layers. Various processes and mechanisms control the transport of pollutants when they come in contact with soil water system. Somni stream watershed is suffering from such disposal of effluents from steel industries. Therefore an attempt has been made to assess the water quality deterioration as well as its impact on human health. The present study area falls on Survey of India Toposheet no.64G/8 and 64 G/12. Based on the Survey results, a network of 23 observation sites were selected for periodic water quality in pre-monsoon and post-monsoon seasons. Water samples were collected and were analyzed for various physico-chemical characteristics. Waste effluent from steel industry were also collected and analyzed. The results of the analysis indicated significant variations in the ground water quality with respect to space and time. Based on the results, the causes for water quality with deterioration in the wells and surface water, seasonal trends in the level of contamination were identified. From analysis it is found that the trace elements like, Cyanide, Cadmium, Chromium, Boron, Lead and Phenol are present in both surface and ground water samples exceeding the limits prescribed by WHO and other agencies. Due to this higher concentration of trace elements health of the villagers residing in this watershed has been affected. Cases of skin diseases, diarrhea, jaundice, hepatitis are found in the present study area.

KEYWORDS: Industrial wastes, Soil water system, Diarrhea, Jaundice, Hepatitis.

The water which is essential to human life is the fresh water and it is 2.8% of the total water resources on the planet earth. Of this fresh water, 2.2% is surface water and 0.6% is present in the form of ground water. It is estimated that about 0.4%, of total water resources available on planet earth is available for direct utilization by man, animals and plants. As such, water is precious to man.

Pollution of air, water and soil is unavoidable with the "growth of industries in developing country like India. Keeping in view, the ill effects of the industrial activities on the sanctity of environment, the water quality evaluation work was selected for the present study. The Bhilai Steel Plant (BSP) which is a major industry of this region is disposing off its effluents in surrounding areas. One of the watershed which is directly affected by the disposal of BSP liquid waste is Somni Stream Water Shed. The study aims to assess the degradation of water resources of Somni Stream Water Shed.

The Somni Stream Water Shed is situated adjacent to Bhilai Steel Plant in the east, Durg District Chhattisgarh. The area is easily approachable by rail route and road both. The National Highway No.6 and Mumbai-Howrah rail route (via Nagpur) runs along, northern perimeter of the basin area. The Somni Stream Water Shed falls is Survey of India Toposheet No.64 G/8 and G/12. It is bounded by latitudes 21° 5' -2 10 14' 30" N and longitudes 81° 231 30" -810 341 10" E. (Figure 1)

MATERIALS AND METHODS

The study area is underlain by limestones of Chattisgarh Supergroup. Shales occur in small patches in NE and SW portions of the basin. A coarse textured drainage network drains the area. The first order tributaries of Somni Stream originating from BSP area receives liquid waste discharged by the steel plant. The physical and chemical quality of Somni stream water is badly affected by factory effluents. No aquatic biospecies are seen flourshing in stream water.

Some important Hydrological and Hydrogeological field investigations which are pre-requisites for understanding ground water pollution problems were carried out in the field. The surface water available annually by precipitation in the watershed area is "estimated to be 20438.38 ha m. The Somni Stream Water Shed is mainly drained by

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Somni, Pahandor and Amlidih streams. These streams are basically ephemeral, streams. The ground water structures present in the area are dug wells, dug cum bore wells and bore wells. According to the survey report of PHE Dept.1999 there are 274 dug wells and 284 tube wells present in the area. 38 dug wells, distributed over the entire water shed area were selected as observation wells. It is observed that the post monsoon static water level in the watershed area in generally lowered during pre-mansoon by 4-10 meter.

SAMPLING OF WATER RESOURCES

The surface water and ground water samples have been collected from pre-selected sites during pre-monsoon and post monsoon seasons. The sampling site locations are shown in the figure 2 and 3. The preservation method recommended by Robert-Kerr Environmental Research Laboratory, Okhavhama were adopted while sampling of surface and ground waters.

Parameters like Temperature, Conductivity, and Total Dissolved solids were determined in each water sample in the field using portable analysis pit. The remaining parameters were determined using routine analytical techniques at Central Pollution Control Board Laboratory, New Delhi. The chemical analysis of surface and ground water includes three physical parameters viz. Temperature, Colour, Turbidity, twenty two inorganic parameters viz pH, Conductance, TDS, TH, Ca, Mg, Na, K, CO_3, HCO_3, Cl, SO_4, NO_3, NO_2, NH_3, F, CN, Cd, Cr, Fe, Pb, B and two organic parameters *viz*., COD and phenol. These elements were determined by the methods given in the book standard methods for the examination of water and waste water (APHA-AWWA-WPCF, 1985)

SUITABILITY OF WATER FOR DRINKING

The safe drinking water is the first and for most requirement for good public health. To safeguard public health, various agencies such as WHO, IS, ICMR have laid down certain guidelines for safe quality of drinking water. The physical and chemical parameters in the present work Table No. 1 & 2. are compared with guidelines values of IS : 10500 (1992) Table No.3. It is clear from the table that the surface waters in general show colours, turbidity, iron, phenol, fluoride, cadmium, chromium, cyanide and lead values exceeding the maximum permissible limit of IS drinking water specifications.

Surface Water

The pre monsoon surface waters are effluent mixed waters. The parameters such as colour, Turbidity and Iron of ground water show high values exceeding the maximum permissible limits and as such are unfit for drinking purpose. About 55% samples exceed maximum permissible limit of colour (25 Hazene unit) while 100% samples cross the max. permissible limit (1 ppm) of iron. 44% shows phenol concentration greater than 0.002 ppm, 55% samples show cyanide above 0.05 ppm and 33% samples indicate lead exceeding 0.05 ppm for drinking water.

The post monsoon surface water samples are partly effluent mixed Somni Stream Waters and partly fresh stream waters of Pahandor, .Amlidih, streams and Morid and Bendri tanks. The maximum permissible limit of parameters like colour is exceeded by 44% samples, turbidity by 66%, fluoride by 33%, Cd and Cr by 33% and CN by 22% water samples.

Ground Water

The pre monsoon ground water samples collected from adjacent area of Somni Stream Course show concentrations of Cd and Pb, exceeding the maximum permissible limits for drinking. 58% samples show C (Max.concentration 0.05 ppm) and 75% show Pb (more 0.14 ppm) concentrations exceeding the maximum permissible limit (Table 1).

The post monsoon ground water samples representing entire watershed area are in general, high in concentrations of turbidity, Total Hardness, Ca, Fe, Phenol, No3, Cd and Cr. About 8% samples show turbidity (max. 12 NTU in PoGW 18), Ca (max 226 ppm in PoGW8) and No3 (max. 117.30 ppm in PoGW 18) exceeding the permissible limit. About 16% samples show total hardness (max 9.88 ppm in PoGWll), 42% show Cr (Max. 0.08 ppm in PoGW 17) and 50% samples show Cd content in waters (max. 0.03 ppm is PoGW 1,2,4,5,6,9,10) exceeding the permissible limit of drinking water (Table-2).

It is thus found that only about 8% pre monsoon ground water representing adjoining area of Somni Stream Course and only about 4% of Post monsoon ground water samples representing entire basin area is safe for drinking purpose.

TABLE: 1 {Contd..}

	Cl	SO_4	No_3	No_2	Nh_3	F	CN	Cd	Cr	Pb	Fe	B	COD	Phenol
Surface Water														
PRSW-1	24	105	07.0	0.136	1.13	2.87	0.029	0.04	NT	0.05	3.21	0.02	16	ND
PRSW-2	58	97	07.0	0.013	NT	2.16	0.02	0.04	NT	NT	2.98	0.31	25	ND
PRSW-3	52	99	08.0	0.017	NT	0.47	0.053	0.02	0.02	NT	1.32	0.07	07	ND
PRSW-4	70	103	09.0	0.016	NT	0.45	0.006	0.04	0.01	0.04	0.87	NT	18	ND
PRSW-5	64	117	11.0	1.881	10.16	0.73	0.277	0.03	NT	0.04	2.07	NT	18	ND
PRSW-6	62	110	08.0	1.632	11.52	0.72	0.291	NT	NT	1.38	1.49	0.21	17	ND
PRSW-7	68	116	03.2	0.438	17.35	0.82	0.824	0.01	0.01	0.05	3.25	NT	42	ND
PRSW-8	100	88	01.2	0.979	23.74	0.57	1.445	NT	0.01	0.14	2.73	NT	50	ND
PRSW-9	62	154	NT	0.006	NT	0.50	0.013	0.01	0.02	0.11	1.06	0.14	43	ND
Ground Water														
PRGW-1	102	98	21.0	0.001	NT	0.28	0.012	NT	NT	0.06	0.43	NT	32	ND
PRGW-2	154	72	20.0	NT	0.11	0.22	0.003	NT	NT	0.10	0.34	0.26	12	ND
PRGW-3	120	16	74	0.057	NT	0.31	0.018	0.01	0.01	0.14	0.68	NT	04	ND
PRGW-4	26	46	02.6	0.045	NT	0.42	0.005	0.01	0.01	0.10	0.56	0.43	04	ND
PRGW-5	34	82	06.19	0.002	NT	0.85	NT	0.01	0.01	NT	0.17	NT	04	ND
PRGW-6	74	83	04.2	0.001	NT	0.27	NT	0.02	0.03	0.06	0.98	NT	08	ND
PRGW-7	114	173	04.7	0.001	NT	0.62	0.007	0.04	0.02	NT	0.77	0.17	08	ND
PRGW-8	46	106	20.0	0.171	0.65	0.33	1.299	0.02	0.03	0.08	0.31	0.07	04	ND
PRGW-9	24	12	05.0	0.005	NT	0.36	0.001	0.02	0.04	0.13	0.16	0.07	37	ND
PRGW-10	26	03.3	20.6	0.002	0.08	0.11	NT	0.05	0.05	0.13	0.37	NT	08	ND
PRGW-11	60	19	05.0	0.001	NT	0.53	0.002	0.02	0.04	0.04	0.22	0.14	08	ND
PRGW-12	68	28	20.5	0.005	NT	0.88	0.012	0.04	0.04	0.07	0.17	NT	04	ND

Note : From TDS to HCO all concentrations are in ppm * NT= Not traceable, * ND= Not detected

TABLE : 2 PHYSCIO CHEMICAL PARAMETERS OF POST MONSOON SURFACE WATER AND GROUND WATERS OF SOMNI STREAM WATERSHED

	TEMP (C)	Colour Hazene Units	Turbidity NTU	pH	Conductance in µs/cm	TDS	Total Hardness	Ca	Mg	Na	K	Co_3	HCO_3	Cl
Surface Water														
POGW-1	19.9	26.60	11	> 7< 7.5<	604	570	196	67	06	60	05	NT	55	29
POGW-2	17.5	18.90	11	> 7 7.5	756	480	214	75	06	64	03	NT	37	43
POGW-3	20.6	11.40	11	> 7< 8	290	1130	146	45	08	30	0.4	NT	116	12
POGW-4	22.7	7.60	10	8.0	314	1040	198	53	16	30	0.2	NT	110	12
POGW-5	17.6	30.4	11	> 7< 7.5	641	560	210	69	09	70	0.2	NT	49	46
POGW-6	17.6	30.4	12	> 7< 7.5<	< 597	580	200	64	10	68	0.4	NT	49	48
POGW-7	21.6	15.2	10	> 7 7.5	122	2670	94	19	11	14	0.2	NT	61	07
POGW-8	20.2	30.4	11	> 7 7.5	618	543	246	69	18	62	0.4	NT	55	46
POGW-9	21.8	7.59	10	> 7.5< 8	254	1250	180	59	08	18	NT	NT	104	12

	So_4	No_3	No_2	Nh_3	F	CN	Cd	Cr	Pb	Fe	B	COD	Phenol
POGW-1	116	35	7.26	6.24	2.62	0.144	0.01	NT	NT	0.67	NT	19	NT
POGW-2	150	45.9	7.82	11.37	2.26	0.270	0.02	NT	0.05	0.64	NT	14	NT
POGW-3	11	NT	0.02	0.08	0.53	0.087	NT	NT	NT	0.45	NT	5	2 NT
POGW-4	14	NT	0.004	0.02	0.51	0.046	NT	0.08	0.05	0.55	NT		NT
POGW-5	124	45.3	8.64	7.93	2.65	0.043	NT	0.07	NT	0.8	NT	16	NT
POGW-6	130	35.8	5.94	5.51	2.41	0.0009	0.01	0.03	NT	0.74	NT	18	NT
POGW-7	3	NT	0.008	4.82	0.35	NT	0.03	0.01	NT	0.67	NT	7	NT
POGW-8	140	21.8	3.99	4.73	2.59	NT	NT	0.02	0.01	0.45	NT	16	NT
POGW-9	7	0.37	0.011	0.035	0.48	NT	0.03	0.07	0.02	0.76	NT	7	NT

Note : From TDS to HCO3 all concentrations are in ppm * NT= Not traceable, * ND= Not detected

TABLE: 2 {Contd..}

	TEMP .C	Colour Hazene Units	Turbidity NTU	pH	Conductance in µs/cm	TDS	Total Hardness	Ca	Mg	Na	K	Co_3	HCO
Ground Water													
POGW-1	21.5	7.6	10	> 7.5< 8	1541	200	656	205	35	225	0.2	NT	281
POGW-2	25.3	NT	09	> 7.5< 8	426	690	300	72	29	20	NT	NT	110
POGW-3	24.8	3.8	09	> 7< 7.5	ND	ND	320	88	24	22	0.2	NT	134
POGW-4	26.8	3.8	08	> 7.5< 8 <	< 1209<	240	500	166	20	96	13	NT	275
POGW-5	22.7	7.6	09	> 7.5 8	641	500	328	90	25	89	0.4	NT	287
POGW-6	21.6	7.6	10	> 7.5 8	613	540	228	56	20	65	5	NT	201
POGW-7	23.2	NT	09	> 7.5 8	312	1010	252	77	14	13	0.2	NT	122
POGW-8	26.8	NT	10	> 7.5 8	1407	210	808	226	59	42	0.4	NT	110
POGW-9	26.5	NT	10	8.0	581	510	220	45	26	95	0.4	NT	171
POGW-10	26.2	NT	16	8.0	411	730	148	26	20	83	NT	NT	207
POGW-11	25.9	NT	09	> 7< 7.5	< <746	400	440	134	25	25	0.2	NT	183
POGW-12	28.7	NT	10	8.0	519	550	252	99	1	12	0.4	NT	171
POGW-13	24.9	NT	09	> 7 7.5	469	646	280	80	19	24	NT	NT	214
POGW-14	26.9	NT	09	> 7 7.5	842	345	556	77	87	17	NT	NT	177
POGW-15	26.2	7.6	09	> 7.5< 8 <	546	521	428	158	8	35	NT	NT	116
POGW-16	25.0	NT	09	> 7.5 8	1206	239	606	78	98	79	NT	NT	165
POGW-17	26.4	NT	09	> 7< 7.5	390	746	512	186	12	8	0.4	NT	128
POGW-18	25.5	NT	12	8.0	2190	140	988	99	175	55	15	NT	195
POGW-19	25.1	NT	09	8.0	661	455	400	151	1	33	01	NT	134
POGW-20	28.3	NT	10	> 7.5< 8 <	< 554 <	552	368	130	10	11	0.4	NT	140
POGW-21	27.5	NT	10	> 7.5 8	458	638	332	128	3	8	0.2	NT	177
POGW-22	26.5	NT	09	> 7.5 8	498	588	480	72	72	12	0.2	NT	153
POGW-23	26.9	3.8	09	> 7.5 8	413	707	328	77	33	10	0.4	NT	110
POGW-24	28.0	3.8	10	> 7.5 8	705	402	396	85	44	12	0.2	NT	146

Note : From TDS to HCO3 all concentrations are in ppm * NT = Not traceable, * ND = Not detected

CONTD...

TABLE: 2 {Contd..}

	Cl	SO4	NO3	NO2	NH3	F	CN	Cd	Cr	Pb	Fe	B	COD	Phenol
Ground Water														
POGW-1	243	115	87.5	0.004	NT	0.741	NT	0.03	NT	0.04	0.73	NT	2	NT
POGW-2	36	4	18.97	0.026	NT	0.291	NT	0.03	NT	0.02	0.81	NT	20	NT
POGW-3	29	11	4.22	0.003	NT	0.291	NT	NT	0.02	0.01	2.6	NT	20	NT
POGW-4	102	128	35.8	0.003	NT	1.014	NT	0.03	0.03	NT	0.82	NT	6 2	NT
POGW-5	52	62	11.4	0.624	NT	0.98	NT	0.03	NT	NT	1.06	NT		NT
POGW-6	66	65	19	0.003	NT	0.25	NT	0.03	0.06	0.03	0.88	NT	10	NT
POGW-7	15	1	6.2	NT	NT	0.4	NT	0.02	0.05	NT	0.89	NT	20	NT
POGW-8	235	116	144.3	NT	NT	0.532	NT	0.01	0.03	NT	0.74	NT	14	NT
POGW-9	32	36	NT	NT	NT	0.295	NT	0.03	NT	NT	1.94	NT	3 1	8 NT
POGW-10	11	15	0.99	0.001	NT	0.241	NT	0.03	0.06	0.02	3.26	NT		NT
POGW-11	97	20	25.3	0.002	NT	0.173	NT	0.01	0.07	NT	1.16	NT		0.166
POGW-12	55	14	50.5	NT	NT	0.419	NT	0.02	0.05	NT	1.26	NT	20	NT
POGW-13	25	7	2.98	0.013	NT	0.473	NT	0.02	0.06	0.02	0.91	NT	2 7	3 NT
POGW-14	138	26	98.9	0.004	NT	0.3	NT	NT	NT	NT	1.7	NT		0.01
POGW-15	65	9	13.39	0.023	NT	0.364	NT	0.01	0.01	0.01	1.17	NT		NT
POGW-16	298	53	29.4	0.007	NT	0.323	NT	NT	0.07	0.03	1.53	NT	14	0.008
POGW-17	31	8	15.9	0.001	NT	0.022	NT	NT	0.08	NT	1.08	NT	7	NT
POGW-18	441	138	147.3	0.069	NT	0.209	NT	0.02	0.06	NT	3.78	NT	33	0.008
POGW-19	68	53	11.4	NT	NT	0.45	NT	NT	0.04	NT	0.73	NT	3 7	NT
POGW-20	63	20	35.1	0.01	NT	0.196	NT	0.01	0.05	NT	1.29	NT		NT
POGW-21	17	4	7.06	0.03	NT	0.378	NT	NT	0.06	0.03	0.91	NT	NT	0.008
POGW-22	112	23	31.6	0.069	NT	0.359	NT	NT	0.07	0.02	1.04	NT	NT	0.008
POGW-23	43	16	26.5	0.001	NT	0.318	NT	0.01	0.07	0.01	0.93	NT	2 1	0.008
POGW-24	108	24	37.2	0.017	NT	0.218	NT	0.02	0.03	NT	1.17	NT		0.024

Note : All concentrations are in ppm. * NT= Not traceable, * ND= Not detected

TABLE: 3 Drinking Water Classification Criteria and Classification of Water for Drinking Purpose

SR. No.	Parameters	WHO (1971) International Standards		ICMR (1985) Standards		ICMR (1985) Standards		Water showing values exceeding recommended guideline			
		Highest Desirable	Max Permissible	Highest Desirable	Max Permissible	Highest Desirable	Max Permissible	Premonsoon surface water (PRSW 1 to 9)	Postmonsoon surface water (PRSW 1 to 9)	Premonsoon surface water (PRSW 1 to 12)	Postmonsoon surface water (PRSW 1 to 12-
(A)	Physical Parameters										
1.	Colour (Hazene Units)	05	50	05	25	05	25	1,5,6,7,8, 55.55%	1,5,6,8 44.44%	-	- - -
2.	Turbidity (NTU)	05	25	05	10	05(JJU)	25(JJU)	1,2,3,4,5, 6,7,8,9, 100%	1,2,3,5, 6,8 66.66%		10,18 8.32%
(B)	Chemical Parameters										
1.	pH	7.0-8.5	6.5-9.2	6.5-8.5	6.5-9.2	7.0-8.5	6.5-9.2	- -	- -		- -
2.	TDS (mg/l)	500	1500	500	2000	500	1500				
3.	TH as CaCo3 (mg/l)	100	500	300	600	300	600		-		1,8,16,1816.64%
4.	Ca (mg/l)	75	200	75	200	75	200		7 - 11.11%		1,8 8.32%
5.	Iron (mg/l)	0.05	1.5	0.3	1.0	0.1	1.0	1,2,3,4,5, 6,7,8,9, 100%	- - –		3,5,9,10,11,12,14,15 16,17,18,19,20,21,24 58.33%
6.	Chloride (mg/l)	200	600	250	1000	200	1000	-	-		-

Contd...

TABLE: 3 Contd...

SR. No.	Parameters	WHO (1971) International Standards		ICMR (1985) Standards		ICMR (1985) Standards		Water showing values exceeding recommended guideline			
		Highest Desirable	Max Permissible	Highest Desirable	Max Permissible	Highest Desirable	Max Permissible	Premonsoon surface water (PRSW 1 to 9)	Postmonsoon surface water (PRSW 1 to 9)	Premonsoon surface water (PRSW 1 to 12)	Postmonsoon surface water (PRSW 1 to 12-
7.	Phenol (mg/l)	0.001	0.002	0.001	0.002	-	-	1,3,7,8 44.44%	-	12 8.33%	11,14,16,18,21,23,24 33.28%
8.	Flouride (mg/l)	0.6-0.9	0.8-1.78	1.0	1.5	1.0	1.5	1,2 22.22%	1,2,5,6,8 55.55%	-	- -
9.	Nitrates (mg/l)	-	- 45	- 45 -	- 100	20	100	-	-		8,18 8.32%
10.	Cadmium (mg/l)		0.01	0.01	No Relaxation	-	- 0.01	- 1,2,3,4,5 55.55%	2,7,9 33.33%	6,7,8,9,10,11,12 58.31%	1,2,4,5,6,7,9,10,13 18,24– 50.00%
11.	Chromium (mg/l)		-	0.05	No Relaxation		-	-	4,5,9 33.33%	-	6,10,11,13,17,18, 21,22–41.60%
12.	Cyanide (mg/l)		0.05	0.05	No Relaxation		0.05	3,5,6,7,8 55.55%	1,2 22.22%	8 8.33%	-
13.	Lead (mg/l)		0.1	0.05	No Relaxation		0.05	6,8,9 33.33%	-	1,2,3,4,6,8,9, 10,12 75.00%	-

DISCUSSION AND CONCLUSION

The Somni Stream Water Shed water resource quality evaluation results indicate that the surface and ground waters both are unfit for drinking except one borewell water of village Aundhi and one from Aunri village. The main parameters responsible for water contamination are physical parameters like colour and turbidity and dissolved constituents like iron, phenol, fluoride, cadmium, chromium, cyanide and lead.

Amongst ground waters, the concentration of parameters like phenol, cadmium, cyanide and lead have made about 92% of pre monsoon ground waters unfit for drinking. About 95% of post monsoon ground waters are disqualified due to the presence of high turbidity, total hardness, calcium, iron, phenol, nitrates, cadmium and chromium.

The rate of toxicity can be correlated with time. During the study it was observed that some pollutants are found less in concentration in the post monsoon season as compared to pre monsoon season perhaps because of dilution factor. No appreciable change in concentration of conductivity and Cadmium is observed in ground water sampled during pre and post monsoon period. Lead show higher concentration in pre monsoon and Phenol in post monsoon ground water. Cyanide is present in appreciable concentration in pre monsoon while untraceable in post monsoon ground water.

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