Groundwater Pollution due to Chromium Rich Hazardous Waste Disposal in Rania-Khanchandpur Area, Distt Kanpur Dehat(R), U.P., India : A Case Study

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Introduction

CPCB Zonal Office Lucknow received PMO referenced complaint about groundwater pollution in Rania-Jainpur area of Dist. Kanpur Dehat (U.P.) located at approx. 20 km west of Kanpur city. Considering the issues being of comprehensive in nature, detailed investigation was carried out. During the investigation, emphasis was laid on following issues:

a. Monitoring comprehensive groundwater quality at representative locations.

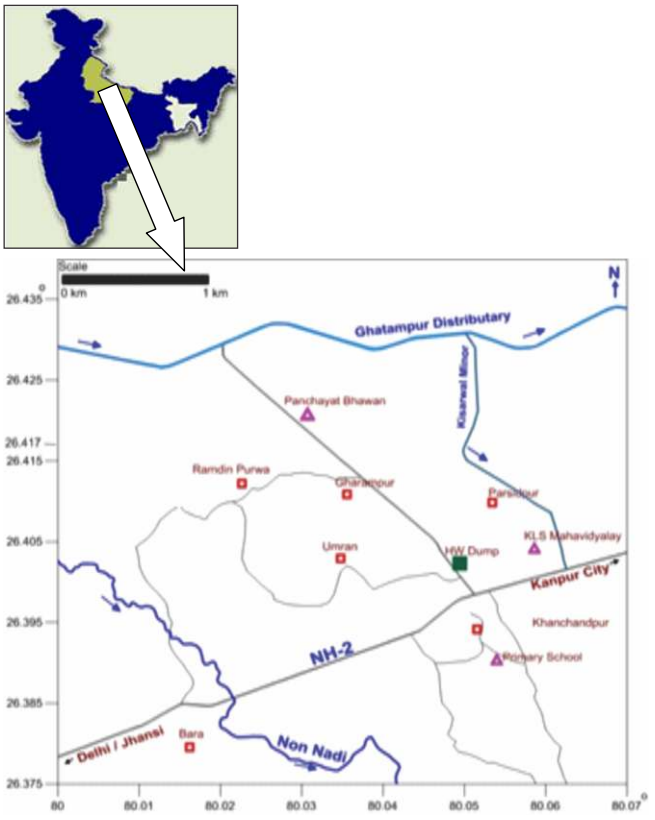
b. Assessment of impact of hexavalent chromium in and around hazardous waste dump area and affected village(s).

c. Investigation about pollution control measures and hazardous waste management status in major industries.

d. Interaction with local community / villagers in the area.

Industrial Scenario

The area spread over an elongated zone of approx. 6 km, lies on either side of National Highway No. 2 and is



dominated by industries manufacturing vegetable oil, synthetic textile and chemicals. Specific observations are appended as under:

a. One of the major problems identified in the area is lack of drainage facility for wastewater generated by industries (CPCB, 1996). As a result wastewater accumulates along the national highway and releases pungent smell apart from creating an overall unhygienic scenario.

b. The area has a huge stockpile of high chromium bearing sludge generated by local industries which while in operation, were engaged in manufacture of Basic Chrome Sulphate (BCS). The stockpile is located in village Umaran bordering Rania area in the south and seemingly scattered in the entire area as a result of indiscriminate disposal. The sludge contains total chromium in concentration of 100 g/kg wherein content of water soluble and hence volatile 'hexavalent' chromium is in the order of 80 g/kg (Clesceri, *et al* 2005). In consideration of the prevailing manufacturing practices adopted by BCS units in the area and their role in causing pollution of groundwater, U.P. Pollution Control Board in the year, 2005 directed for closure of all the six industries operational in the area. Since then and as on today, these units are lying closed as is regularly confirmed by UPPCB.

c. The quality of groundwater in area bordering the stockpile and nearby villages is badly affected. Concentration of 80 mg/L hexavalent chromium [(Cr^{6+}] is reported from the piezometer close to chromium dump in Umran village as monitored by CPCB as against the BIS permissible level of 0.05 mg/L.

d. Efforts made by UPPCB and local district administration for provision of alternative means of drinking water supply have yielded little impact on the prevailing situation and hence the local population especially villagers are forced to consume polluted drinking water.

Findings

Groundwater quality for shallow aquifers (CGWB, 2000, 2001) through India-II / (desi) handpumps mainly used by the local community for house-hold purposes, was monitored in a phased manner.

Fig: Left : Groundwater with pale yellow color imparted by high Cr (VI),
Middle , Right : Impact of chromium leaching on the walls of building constructed in area where chromium rich sludge was dumped used for land filling.

In the first phase monitoring groundwater quality was monitored at seven locations spread over the entire area. The salient observations are as under;

- Groundwater is generally alkaline and possesses moderately high TDS and fluoride as compared to BIS standards. Highest fluoride reported is 3.72 mg/L, as against the (BIS) standard of 1.0 mg/L
- The entire area is noted with alarmingly high concentration of chromium which has imparted a strong pale yellow colour to groundwater. The other parameters which include nitrate, manganese and sulphate are generally within the BIS drinking water norms prescribed. Iron particularly was observed higher at one location. Summarised status of groundwater quality in the area is appended as under:

a. General parameters

SNo	Location code	Parameters monitored					
		pH	TDS	F-	SO_4^{2-}	PO_4-P	NO_3-N
01	K	7.45	728	1.33	99.3	0.018	0.18
02	L	7.55	426	1.38	42.29	ND	1.44
03	M	7.97	369	0.85	41.30	0.017	1.99
04	N	8.23	1244	3.72	395	1.44	0.10
05	O	8.23	573	1.45	75.73	BDL	0.53
06	P	7.45	1083	1.39	204.09	1.06	0.75
07	Q	8.02	777	1.31	203.3	0.52	1.05
BIS Standard for Drinking Water		6.5-8.5	500	01	200	-	45

b. Heavy metals

SNo	Location code	Parameters monitored			
		Cr+6	Total Cr	Fe	Mn
01	K	BDL	BDL	BDL	BDL
02	L	0.17	0.41	0.05	0.05
03	M	BDL	0.14	BDL	BDL
04	N	40.0	50.10	BDL	BDL
05	O	0.05	0.67	BDL	BDL
06	P	18	24.50	BDL	0.06
07	Q	3.8	6.48	1.97	0.10
BIS Standard for Drinking Water		0.05	-	0.3	0.1

All concentration except pH are in mg/L ; ND: Not detected; BDL: Below detection limit

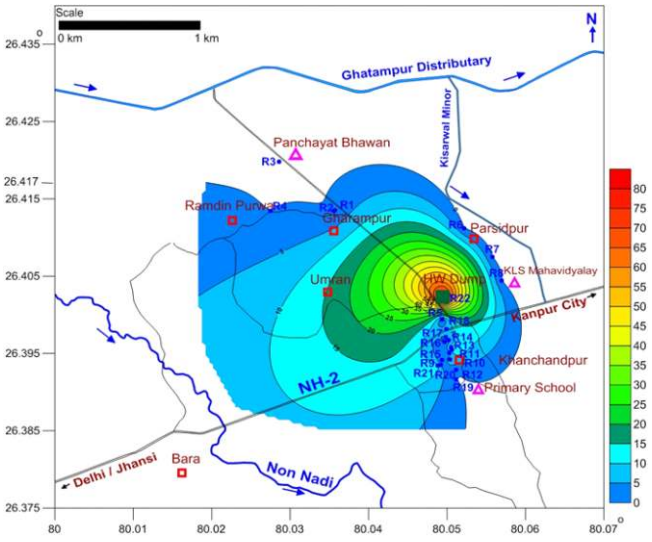
Location code description : K: GW sample adjacent to maingate of M/s Kansai Nerolac Paints, Jainpur, Kanpur (Rural); L:"vill. Sheonathpur 1 km west of chromium dump at Umran , Kanpur (R); M "vill. Umran in the premises of M/s B N Handmade Papers Ltd. , Kanpur (R); N: "premises of M/s Umakant Industries, 200 m east of chromium dump, Kanpur (R); O: vill. Khanchandpur, 400 m east of chromium dump, (R); P: "vill. Khanchandpur, r/o Sh Harimohan Singh, Kanpur (R); Q: " Primary School, Aryanagar-I, Rania, Kanpur (R).

In the second phase monitoring of groundwater quality with special reference to hexavalent chromium was carried out at 21 locations spread over in the area of indiscriminate sludge disposal sites near village Umran and in village Khanchandur lying approximately 2 km (south) down-gradient of sludge disposal area referred above. The groundwater quality observed at these locations is summarized as under:

SN	Description / location	Type	Groundwater Quality						
			pH	TDS	Cond	F-	SO_4^{2-}	NO_3-N	Cr^{6+}
01	Vill. Gharampr, Tiraha	India-II	7.74	696	1056	1.18	47.76	17.64	0
02	Vill. Gharampur, R/o Suresh	Local	7.04	1069	1606	1.06	252.54	4.39	1.51
03	Panchayat Bhawan, Bilwahar, Sarvankheda	India-II	7.44	690	1090	0.68	23.69	2.93	0
04	Vill. Santoshpurwa, l R/o Mewala	India-II	8.0	874	1332	3.20	64.18	6.73	0
05	Dadda Dhaba, adj. road to Umran	India-II	7.87	1282	1902	3.84	293.85	0.13	0
06	Vill. Dhankalpurwa	Local	7.17	385	640	1.14	27.91	0.63	0
07	Vill. Parsidhpur R/o Sunderlal Sharma	India-II	7.24	500	689	1.05	23.58	0.53	0
08	Kundan Lal Shukla Mahavidyalay, Parsidpur	Local	7.35	474	752	1.33	12.39	0.12	0
09	R/o Kallu Pardhan, Opp. Post Office Kanchanpur	Local	7.54	504	904	1.12	81.8	0.85	0
10	R/o Shivraj Pal, Vill. Kanchanpur	Local	7.04	658	1196	0.73	160	0.22	10.6
11	R/o Lallan Khan, Khanchandpur	India-II	7.50	530	907	0.96	83.0	1.25	0.35
12	O/H tank, Khanchandpur	T/W	7.49	492	916	1.01	89.7	1.31	0.37
13	Hata Baburam, Khanchandpur	Local	6.86	1286	2092	0.65	296	3.17	15.2
14	Shiv Temple,Ashok Yadav, Pradhan	India-II	7.30	790	1263	0.83	160	1.46	14.3
15	R/o Sanjay Yadav, near HT Tower	India-II	7.63	1250	1957	2.51	372	1.26	2.7
16	R/o Gyan Singh	India-II	7.58	671	1137	1.29	153	0.93	0
17	R/o Virendar Singh, AMC	India-II	6.93	1337	2220	0.58	178	0.12	10.8
18	R/o Jay Singh	Local	6.92	1088	1811	0.91	254	1.48	7.7
19	Primary School Khanchandpur	India-II	7.69	443	805	1.31	51.9	0.91	0
20	R/o Master Pappu	India-II	7.55	606	1049	1.17	135	1.19	2.21
21	R/o Vishwanath Pal	Local	7.20	806	1304	0.96	199	0.014	13.8
22	Piezometer at Umran waste dump	Piezo-meter	-	-	-	-	-	-	80

Conductivity in µS /cm, all other concentrations except pH are in mg/L

Additionally, a detailed investigation about status of hexavalent chromium was undertaken by a joint team of CPCB and CGWB at 22 locations spread in the area of sludge dump at village Umran and its impact reported at village Khanchandpur. Hexavalent chromium isopleths (iso-concentration lines) were drawn for the 22 locations revealed that pollutant (hexavalent chromium) migration (Eco-cycle, 2005) has been in accordance to the prevailing hydraulic gradient towards south-western part and calls for an immediate measure for migration containment followed by remediation.



Hexavalent Chromium isopleths in Study Area
(Map to-the-scale 1:25000)

Recommendations

Rania-Jainpur area in Kanpur Dehat has a long standing problem due to indiscriminate disposal of high concentration chromium bearing sludge by BCS units and also due to improper drainage in the area. The area needs immediate attention on following actions;

a. The concerned agencies of the State Govt. are required to undertake comprehensive effort for ensuring proper drainage in the area. Additionally, issues of collection and treatment of industrial waste generated by the industries are required to be addressed. .

b. Declaration of high chromium bearing water sources (wells, handpumps) in the area, prohibit their use and provision of alternate and safe water supply through tankers in affected villages like Umran, Khanchandpur, etc.

c. Organized effort for isolation of the area around high chromium bearing stockpile in Umran/ Khanchandpur area followed by groundwater remediation.

d. Proper treatment and disposal of sludge in the stockpile on priority.

e. Techno-economic feasibility must be explored for chemical treatment (immobilization) of chromium bearing sludge and its judicious disposal in either of the two land-fill (TSDF) facilities operational in close proximity at village Kumbhi, Distt Kanpur Dehat may be utilised.

f. Awareness in the local community to prohibit use of chromium rich hazardous sludge referred above, as a land-filling material, in order to restrict magnification of chromium impact.

g. Exploitation of groundwater resources is required to be judicious and regulated so as to restrict development of cone of depression in and around area of sludge dump and migration of pollutants.

h. Decision to undertake organized study for demarcating pollutant migration pathways followed by remedial intervention is imminent. Reference can be taken to a pilot-scale remediation (Evanko, 1997) of groundwater achieved by CPCB in Noraiyakheda area, Distt. Kanpur Nagar (U.P.) wherein, hexavalent chromium in groundwater has been (bio) remediated through remedial additive injection and validated results have been reported (Singh et al, 2009).

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References

Central Pollution Control Board, 1996. Report on Standard for liquid effluents, gaseous emissions, automobile exhaust, noise and ambient air quality no. PCL / 4 /1995-96

Central Pollution Control Board (CPCB), 1997. Groundwater quality in Kanpur, Status Sources and Control Measures, Delhi, India, Report no. GWQS/8/1996-97, pp. 82.

Central Ground Water Board (CGWB), 2000. Groundwater Pollution Studies in Unnao-Kanpur Industrial Areas, Lucknow, India, pp. 21

Central Ground Water Board, Lucknow, 2000, Groundwater Pollution Studies in Unnao-Kanpur Industrial Areas, Uttar Pradesh, pp 21

Central Ground Water Board, New Delhi, 2001, Groundwater for Every One, pp1

Clesceri, L.S., Greenberg, Arnold E. and Trussel, R.R., 2005. Standard Methods for the examination of water and wastewater, 20th edition, APHA-AWWA-WPCF, American Public Health Association, Washington D.C, USA, pp.10-161

Evanko, C. R. and Dzombak D. A., 1997. Remediation of Metals-Contaminated Soil and Groundwater. Ground-Water Remediation Technologies Analysis Center (GWRTAC) Office of Solid Waste and Emergency Response Technology Innovation. U.S. Environmental Protection Agency Washington, DC, pp. 61

Ecocycle Corporation (EC) Technical Guide, 2005. Bio-remediation of Hexavalent Chromium with EDC-M: Eco-cycle Corporation, 694-2, Akada; Toyama, Japan, pp.939.

Singh, R.K., Sengupta, B., Bali, R., Shukla, B.P., Gurunadharao, V.V.S. and Srivastava, R., 2009. Identification and Mapping of Chromium (VI) plume in groundwater for remediation: A case at Kanpur, Uttar Pradesh. Jour. Geol. Soc. Ind., 74.pp 49-57

Lady harvesting water chestnuts (Photo credit : Pratibha Singh)

" We will never know the true worth of water till the last well is dry."

– Thomas Fuller