Journal Home page : www.jeb.co.in ★ E-mail : editor@jeb.co.in

JEB

Journal of Environmental Biology

ISSN: 0254-8704
CODEN: JEBIDP

Analysis of physico-chemical characteristics and metals in water sources of chromite mining in Sukinda Valley, Odisha, India

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Publication Info

Paper received:
29 June 2011

Revised received:
12 February 2012

Re-revised received:
07 December 2012

Accepted:
24 December 2012

Abstract

The extraction of chromite is being carried out since 1950 in Sukinda valley region of Odisha in India. Different physico-chemical parameters and level of metals in groundwater (tube well and dug well), surface water (Damsal nala), mining drainage water and bottom sediment of Damsal nala were analysed. The results revealed that the total Cr content of groundwater (0.04-0.07 ppm), Damsal nala (0.10 - 0.20 ppm) and mine drainage water (20.12-56.51 ppm) exceeded the permissible limit in all seasons. The Cr (VI) content of mine drainage water exceeded the permissible limit (0.05 ppm as per the recommendation of WHO). The pH (6.5-7.9), available N (6.27-18.82 kg ha^{-1}), available PO_4^{-3} (15.39-123.11 kg ha^{-1}), available K^+ (21.07-410.89 kg ha^{-1}) and organic matter (0.20-1.55%) content of bottom sediment of Damsal nala varied seasonally and the lowest values were found during monsoon. The physico-chemical characteristics of water from Damsal nala, groundwater and mine drainage, like COD, total Fe, TDS, TSS, F^-, available PO_4^{-3}, available K^+ *etc*., including pH are a serious concerned in this study area.

Key words

Physico-chemical characteristics, Chromite mining, Sukinda Valley Region, Bottom sediments

Introduction

Sukinda and Nausahi Belt of Odisha are the major areas for chromium production in the country. Chromite mining was started at Sukinda valley of Odisha since 1950 mainly through open cast mining and underground mining in few places contributing over 97% of India's chromite ore, an important ingredient in the production of stainless steel, plating metal surfaces, glassware, leather tanning, catalysts, and alloys. Leaching of contaminants from the ore materials of the open dumping ground or from the wastages or degraded ore materials produced during the mining process caused groundwater contamination in the study area. There is also a high possibility of movement of the contaminants into the aquifer system through the seepage of bottom floor of the mining quarry (Dhakate and Singh, 2008). Sukinda valley is under the serious threat due to production of chromium and chromates which are known as potential carcinogenic substance for lung and nose cancer. Several authors have studied the spatial distribution of heavy metal concentration in soil and subsoil (Schnable and Tietje, 2002; Kamaludeen *et al*., 2003; Li, 2008) by establishing a statistical relationship between soil properties and soil use and heavy metal behaviour. Very little and scanty study has been carried out on the physico-chemical properties of groundwater, surface water and bottom sediment of Damsal nala. The present study aimed to study the different physico-chemical parameters (along with some heavy metals) of water samples from different source points including Damsal nala and its bottom sediment, dug well and tube well as well as mine drainage water.

Materials and Methods

Study areas : The study area encompasses two villages namely Chirgunia and Ghagiasai under Kaliapani Panchyet situated in the Jajpur district of Odisha of Sukinda valley. Water samples from groundwater (tube well - G_1 and dug well - G_2), surface water (Damsal nala - D_2, D_1), mine drainage water (M_1, M_2, M_3) and bottom sediment (Bs_1 and Bs_2) of Damsal nala were collected once in every season (winter, summer and monsoon) during the year 2009-2010. The entire study area lies between 21º 1'36.90" to 21º 2'18.75" N latitude and 85º 44'47.40" to 85º45'32.92"E longitude.

Sampling and physico-chemical analysis of water samples and sediments : Collection, storage and analysis of different physico-chemical parameters of water samples were carried out as per the standard methods of APHA (2005). pH and EC were measured on site by using pH meter [Model- Hanna pH meter-099(1)] and conductivity meter [Hanna conductivity model H 1983(3)] respectively and temperature was recorded by digital mercury thermometer. Free CO_2 (Titrimetric method) and DO (Winkler's method) were analysed immediately after sampling at the sites. Total chromium and lead were extracted by hot plate digestion method as per APHA (2005) and estimated absorption by Atomic Absorption Spectrometer (AAS) (Model GBC AVANTA 932).

Collection, storage and analysis of different physico-chemical parameters of bottom sediments of Damsal nala (Bs_1 and Bs_2) were carried out using standard methods; pH and conductivity were measured as per Maiti (2003); organic matter (Black, 1965) and available nitrogen (Subbiah and Asija, 1956) were estimated titrimetricaly. Available phosphate (Olsen *et al*., 1954) and available potassium (Jaiswal, 2004) were analysed spectrophotometrically and flamephotometrically respectively. Cr (VI) and total Fe were estimated spectrophotometrically as per APHA (2005).

Results and Discussion

The physico-chemical characteristics of different water samples collected from Damsal nala, groundwater, and mine drainage water is given in Table 1. The pH of Damsal nala water (7.14-8.4) and mine drainage water (7.17-8.48) were slightly alkaline in nature whereas, the pH of the groundwater sample was acidic (4.68-6.24) in nature. The low pH may be due to corrosion of metallic trace elements (Dhakate and Singh, 2008).

The free CO_2 content of Damsal nala water ranged from 7.04 to 14.08 ppm during winter, summer and monsoon. Free CO_2 is produced in the water body due to decomposition of organic matter and respiration of organisms. Whereas, the free CO_2 content of groundwater and mine drainage water were found below detection limit. CO_2 dissolves in water more readily than oxygen and its dissolution depends on temperature, pressure and mineral content of the water. Combined CO_2 of Damsal nala water, groundwater and mine drainage water ranged from 3.8 to 14.4, 3.24 to 8.12 and 4.12 to 12.56 g equivalent weight of $CaCO_3$ respectively during winter, summer and monsoon. The variation of CO_2 was due to the absorption by plants for photosynthesis and activity of other living organisms. The abundance of CO_2 exerts certain specific effects on aquatic biota (Chandanshive *et al*., 2008).

The DO content of Damsal nala water, groundwater and mine drainage water ranged from 6.64 to 7.56, 1.2 to 2.56 and 3.92 to 4.66 ppm respectively during winter, summer and monsoon. Respiration of biota, decomposition of organic matter, rise in temperature, oxygen demanding wastes and inorganic reducing agents such as hydrogen sulphide, ammonia, nitrates, ferrous ions *etc*., reduce the level of oxygen in water (Rafeeq and Khan, 2002).

The EC of Damsal nala water, groundwater and mine drainage water ranged from 70 to 180, 90 to 180 and 190 to 370 ms cm^{-1} sec^{-1} respectively during winter, summer and monsoon. The high conductivity in mine drainage water may be due to the discharge of heavy metals and many other ionized elements with mining effluents. Conductivity depends on the presence of ions, their total concentration, mobility, valence and relative concentration. Conductivity increases with increasing amount and mobility of ions and can also be used as an indicator of water pollution. Higher the values of the dissolved solids, greater the amount of ions in water (Nagaraju *et al*., 2006).

Total alkalinity of Damsal nala water, groundwater and mine drainage water ranged from 7.2 to 14.4, 6.1 to 9.82 and 7.3 to 13.02 ppm respectively during winter, summer and monsoon. The value of total alkalinity was recorded well below the desirable specified limit in all the cases. Total acidity of Damsal nala water, groundwater and mine drainage water ranged from 11.2 to 22.4, 8.86 to 12.92 and 9.1 to 15.36 ppm respectively during winter, summer and monsoon.

Total hardness of Damsal nala water, groundwater and mine drainage water ranged from 36 to 100, 36.10 to 70.12 and 38.12 to 110.12 ppm as $CaCO_3$ respectively during winter, summer and monsoon. All the values were well below the specified permissible limit (WHO, 2011). Similar findings were reported by Dhakate *et al*. (2008).

The COD of Damsal nala water, groundwater and mine drainage water ranged from 32 to 64, 96 to 128 and 64 to 96 ppm respectively during winter, summer and monsoon. The maximum permissible limit for drinking water is 10 ppm and effluent discharge limit for inland surface water is 250 ppm (WHO, 2011). The high level of COD in tube well and dug well was a matter of great concern and it may be due to long history of leaching of heavy metals (Cr, Pb, Fe *etc*.,) through different soil horizons.

Table 1 : Showing results of physicochemical parameters of different water sources

Sampling station		Value	pH	Free CO_2 (mg of CO_2 l^{-1})	Combined CO_2 (gm eq. wt. of $CaCO_3$)	DO (mg of O_2 l^{-1})	EC (ms cm^{-1} sec^{-1})	Total alkalinity (ppm)	Total acidity (ppm)	Total hardness (ppm as $CaCO_3$)
			Limnological parameter							
Damsal nala	D_2	Mean	7.82±0.63	10.56±3.52	11.26±5.08	6.96±0.32	140± 52.91	10.53±3.62	19.73±2.8	77.86±29.78
		Range	(7.14-8.4)	(7.04-14.08)	(5.4-14.4)	(6.64-7.29)	(80-180)	(7.2-14.4)	(16.8-22.4)	(44-100)
	D_1	Mean	7.66±. 0.48	9.79±2.50	8.16±3.78	7.13±0.38	131.66±54.84	9.8±3.01	16.53±4.7	66.79±26.84
		Range	(7.24-8.2)	(7.14-12.12)	(3.8-10.12)	(6.8-7.56)	(70-175)	(7.2-13.1)	(11.2-20.1)	(36-85.24)
Ground water	G_1	Mean	5.90± 0.47	BDL	6.06±2.47	1.28±0.08	156.66±20.81	8.45±1.57	10.96±1.69	53.14±14.84
		Range	(5.36-6.24)		(3.24-7.84)	(1.2-1.36)	(140-180)	(7.02-10.14)	(9.86-12.92)	(36.10-63.21)
	G_2	Mean	5.46±0.67	BDL	6.46±2.23	2.32±0.28	96.66±5.77	7.72±1.90	10.10±1.74	57.82±16.37
		Range	(4.68-5.92)		(3.92-8.12)	(2.0-2.56)	(90-100)	(6.10-9.82)	(8.86-12.10)	(39.24-70.12)
Mine drainage water	M_1	Mean	7.52± 0.34	BDL	8.34±3.66	4.09±0.16	326.66±45.09	9.59±2.45	12.07±2.81	68.11±25.99
		Range	(7.32-7.92)		(4.12-10.64)	(3.92-4.24)	(280-370)	(7.4-12.24)	(9.24-14.86)	(38.12-84.10)
	M_2	Mean	8.18± 0.38	BDL	10.05±4.06	4.31±0.22	300±36.05	10.33±2.52	12.34±2.38	85.57±34.31
		Range	(7.74-8.48)		(5.36-12.56)	(4.12-4.56)	(260-330)	(7.92-12.96)	(9.96-14.72)	(46.36-110.12)
	M_3	Mean	7.55± 0.35	BDL	9.8±4.05	4.51±0.15	256.66±58.59	9.78±2.93	12.14±3.13	80.49±33.12
		Range	(7.17-7.86)		(5.12-12.36)	(4.36-4.66)	(190-300)	(7.3-13.02)	(9.10-15.36)	(43.12-106.24)

Sampling station		Value	COD (mg of O_2 l^{-1})	K^+ (ppm)	PO_4^{-3} (ppm)	Total Fe (ppm)	F^- (ppm)	TDS (mg l^{-1})	TSS (mg l^{-1})	Cr (VI) (ppm)	Total Cr (ppm)
			Limnological parameter								
Damsal nala	D_2	Mean	32±0.0	4.74±0.54	0.04±0.04	5.32±4.28	0.08±0.14	133.33±24.79	48.66±36.02	0.03±0.03	0.19±0.01
		Range	(32-32)	(4.12-5.12)	(0.00-0.08)	(0.68-9.12)	(0.00-0.25)	(111-160)	(24-90)	(0.0-0.06)	(0.18-0.20)
	D_1	Mean	58.66±9.23	3.89±0.29	0.04±0.04	5.89±4.74	0.04±0.06	114.33±30.11	51±38.94	0.03±0.03	0.12±0.02
		Range	(48-64)	(3.56-4.12)	(0.00-0.08)	(0.76-10.12)	(0.00-0.11)	(90-148)	(21-95)	(0.0-0.06)	(0.10-0.14)
Ground water	G_1	Mean	110.66±16.16	4.82±0.63	0.01±0.01	5.64±1.47	0.04±0.01	200.66±70.54	18.66±19.40	0.02±0.03	0.05±0.01
		Range	(96-128)	(4.12-5.36)	(0.00-0.02)	(4.30-7.22)	(0.03-0.05)	(145-280)	(6-41)	(0.0-0.05)	(0.04-0.06)
	G_2	Mean	117.33±18.47	4.79±0.56	0.009±0.007	0.89±0.55	0.03±0.03	138.66±38.08	4.66±1.53	0.03±0.03	0.06±0.01
		Range	(96-128)	(4.160-5.242)	(0.00-0.02)	(0.45-1.52)	(0.00-0.06)	(105-180)	(3-6)	(0.0-0.06)	(0.05-0.07)
Mine drainage water	M_1	Mean	74.66±18.47	27.70±2.5	0.22±0.10	3.42±0.82	0.11±0.02	362.33±44.09	31.66±13.87	0.02±0.02	24.29±4.01
		Range	(64-96)	(25.11-30.11)	(0.11-0.32)	(2.78-4.34)	(0.09-0.13)	(323-410)	(20-47)	(0.0-0.05)	(20.12-28.12)
	M_2	Mean	74.66±18.47	5.87±0.31	0.094±0.02	1.93±1.29	0.04±0.01	386±26	19±5.57	1.72±1.44	52.05±4.22
		Range	(64-96)	(5.52-6.13)	(0.08-0.12)	(0.54-3.10)	(0.03-0.05)	(356-402)	(14-25)	(0.06-2.64)	(48.12-56.51)
	M_3	Mean	64±0.0	4.00±0.89	0.057±0.05	5.06±2.54	0.02±0.01	227.66±46.76	26.66±8.14	0.04±0.03	25.34±3.03
		Range	(64-6.4)	(3.12-4.90)	(0.00-0.09)	(2.45-7.54)	(0.01-0.03)	(190-280)	(21-36)	(0.0-0.06)	(22.10-28.10)

Where; BDL = Below Detection Limit; D_2 = Damsal nala water (at Chirgunia village); D_1 = Damsal nala water (at Ghagiasai village); G_1 = Tube well water (at Chirgunia village); G_2 = Dug well water (at Ghagiasai village, approximately 24 ft below the ground); M_1 = Mine waste water coming from TISCO; M_2 = Mine waste water coming from TISCO (from another source); M_3 = Mine waste water coming from Balasore Alloys Ltd

The K^+ content of Damsal nala water, groundwater and mine drainage water varied from 3.56 to 5.12, 4.12 to 5.36 and 3.12 to 30.11 ppm respectively during winter, summer and monsoon. All the values (except M_1) were well below the maximum permissible limit of 5 - 10 ppm (WHO, 2011).

The PO_4^{-3} content of Damsal nala water, groundwater and mine drainage water ranged from zero to 0.08, zero to 0.02 and zero to 0.32 ppm respectively during winter, summer and monsoon. Here the values were within the specified limit in all the cases. The source of this very little amount of phosphate in the study area may be due to the discharge of human excreta, use of fertilizers in croplands, washing of cloths through detergents *etc*.

The total Fe content of Damsal nala water, groundwater and mine drainage water ranged from 0.68 to 10.12, 0.45 to7.22 and 0.54 to 7.54 ppm respectively during winter, summer and monsoon. The groundwater was not fit for drinking purpose because in all the cases it exceeded the permissible limit of Fe for drinking water as per Indian Standards (IS: 10500), 2004. Fe concentration was more in groundwater samples as well as in the Damsal nala samples due to the top lateritic soil cover which itself was of ferruginous nature (Dhakate and Singh, 2008). The desirable limit of Fe for drinking water was 0.3 ppm and maximum permissible limit was 1.0 ppm as per Indian Standards (IS: 10500), 2004.

The F^- content of Damsal nala water, groundwater and mine drainage water ranged from zero to 0.25, zero to 0.06 and 0.01 to 0.13 ppm respectively during winter, summer and monsoon.

The TDS of Damsal nala water, groundwater and mine drainage water ranged from 90 to 160, 105 to 280 and 190 to 410 ppm respectively during winter, summer and monsoon. This moderate amount of TDS was due to livestock waste, landfills, hazardous waste and dissolved minerals like iron, chromium, lead *etc*. All the values were within the specified permissible limit. Similar findings were also evidenced by Tiwary *et al*. (2005).

The TSS of Damsal nala water, groundwater and mine drainage water ranged from 21 to 95, 3 to 41 and 14 to 47 ppm respectively during winter, summer and monsoon. All the values of groundwater sources were within the specified limit (except G_1 during winter sampling). The TSS values of Damsal nala water and mine water were much above the specified limit. The high concentration of TSS may be due to the insolubility of trace elements in water and they may be remained in suspended form.

The Cr (VI) content of Damsal nala water, groundwater and mine drainage water ranged from zero to 0.06, zero to 0.06 and zero to 2.64 ppm respectively during winter, summer and monsoon. The highest values were found during summer and exceeded the permissible limit. It is very harmful for the aquatic environment of the study area. It is presumed that chromite mining is the main source of Cr (VI) in the study area. Mine drainage water contained Cr(VI) contaminates surface as well as groundwater of the study area. Heavy metals are known to be hazardous pollutants in aquatic environments, even at very low concentrations (Balachandran *et al*., 2005).

The total Cr content of Damsal nala water, groundwater and mine drainage water ranged from 0.10 to 0.20, 0.04 to 0.07 and 20.12 to 56.51 ppm respectively during winter, summer and monsoon. The total Cr content of groundwater crossed the permissible limit (WHO, 2011). The Damsal nala was not found fit for drinking purpose as per total Cr content is concerned. The high concentration of Cr was due to the discharge of Cr through mine drainage, leaching of overburden dumps during rainy season *etc*. The desirable limit of total Cr for drinking water is 0.05 ppm (WHO, 2011). The effluent discharge limit in public sewers, inland surface water and marine as well as coastal water for total cr is 2.0 ppm (MoEF, 2002). Mining effluents generating from processing unit contribute significant amount of heavy metals such as chromium, cadmium, iron, lead *etc*., to the nearby water bodies (Gupta *et al*., 2007).

The groundwater in the Sukinda valley region was nearly neutral to mild alkaline in pH (6.1 - 7.6) with low to moderate TDS (50 - 507 ppm) and high TSS (4 - 64 ppm). TSS levels are higher than the normal permissible limits of potable water and require a proper filtration process before human consumption (Dhakate and Singh, 2008). Cr (VI) concentration in the groundwater sources showed considerable temporal variation, presumably because of some complex hydrogeological dynamics. The Damsal rivulet crossed the mining belt along the length. This being the main source of water (at least during the earlier days), settlements and villages have developed around this rivulet. Damsal carries the mine drainage water from almost all the mines. Failure of any one treatment system may result in a considerable increase in the Cr (VI) concentration. Apart from the Cr (VI) problem, Damsal, like any other natural water body, could also be polluted otherwise, particularly due to decomposition of the detritus of plant materials and open defaecation therefore it should not be straight way used as a source of drinking water without treatment as per guidelines of OSPCB (2008).

Certain parameters like COD, total Cr, total Fe *etc.,* were found very high in the groundwater whereas parameter like F^- was found very low especially in the groundwater and thus making the water unsuitable for drinking purpose and may cause serious health hazards to the consumers. Damsal nala was also contaminated with chromium and can not be used for drinking purpose.

Table 2 : Physico-chemical characteristics of bottom sediment of chromite contaminated Damsal Nala (Bs_2 , Bs_1)

Parameter	Sampling stations	Winter	Summer	Monsoon	Mean	Range	SD	SE	Limit
pH	Bs_2	7.9 (28ºC)	7.83(33ºC)	6.5(27.1ºC)	7.41	6.5-7.9	0.78	0.45	5-8 (USDA–
	Bs_1	7.7(28ºC)	7.5(33ºC)	6.8(27.1ºC)	7.33	6.8-7.5	0.47	0.27	NRCS, 2001)
EC	Bs_2	50 (28ºC)	40 (31.9ºC)	440 (26.7ºC)	176.66	40-440	228.10	131.69	-
(ms cm^{-1} sec^{-1})	Bs_1	56(28ºC)	48(31.9ºC)	392(26.7ºC)	165.33	48-392	196.33	113.35	
Available N	Bs_2	15.68	18.82	6.27	13.59	6.27-18.82	6.528	3.769	272-544 kg ha^{-1}
(kg ha^{-1})	Bs_1	16.12	17.94	7.25	13.77	7.25-17.94	5.71	3.296	(Medium)
Available PO_4^{-3}	Bs_2	71.82	123.11	15.39	70.11	15.39-123.11	53.881	31.108	22.5-56 kg ha^{-1}
(kg ha^{-1})	Bs_1	73.12	118.14	18.3	69.85	18.3-118.14	50.00	28.868	(Medium)
Available K^+	Bs_2	298.51	410.89	21.07	243.49	21.07-410.89	200.65	115.845	136-337 kg ha^{-1}
(kg ha^{-1})	Bs_1	289.23	402.12	25.36	238.9	25.36-402.12	193.35	111.634	(Medium)
Organic	Bs_2	1.48%	1.51%	0.20%	1.06%	0.20-1.51%	0.746	0.431	0.5-0.75%
matter (%)	Bs_1	1.50%	1.55%	0.19%	1.08%	0.19-1.55%	0.769	0.444	(Medium)
Cr (VI)	Bs_2	BDL	0.009	BDL	0.003	0.000-0.009	0.005	0.003	-
(mg g^{-1})	Bs_1	BDL	0.007	BDL	0.002	0-0.007	0.004	0.002	
Total Cr	Bs_2	24.69	26.41	30.51	27.20	24.69-30.51	2.98	1.72	-
(mg g^{-1})	Bs_1	25.12	27.45	29.21	27.26	25.12-29.21	2.05	1.18	
Pb (mg g^{-1})	Bs_2	0.02	0.03	0.03	0.028	0.02-0.03	0.004	0.002	-
	Bs_1	0.027	0.029	0.03	0.029	0.027-0.03	0.002	0.001	
Total Fe	Bs_2	0.63	0.78	0.85	0.76	0.63-0.85	0.11	0.06	-
(mg g^{-1})	Bs_1	0.68	0.75	0.84	0.76	0.68-0.84	0.08	0.046	

Bs_2=Bottom sediment of Damsal nala water (at Chirgunia village); Bs_1=Bottom sediment of Damsal nala water (at Ghagiasai village)

Bottom sediment : The result of physico-chemical parameters of bottom sediment of chromite contaminated Damsal nala (Bs_1 and Bs_2) are mentioned in Table 2. The pH of bottom sediment of Damsal nala ranged from 6.5 to 7.9. The overall pH values varied from slightly alkaline and slightly acidic nature. Rain water may have a role in decreasing soil pH. Soil pH ranged between 5.0 and 8.0 and was considered ideal for most soil organism (USDA-NRCS, 2001).

The EC (40 to 440 ms cm^{-1} sec^{-1}) of bottom sediment of Damsal nala varied seasonally. The high conductivity in the bottom sediment of Damsal nala during monsoon may be due to low pH which in turn increased the concentration of heavy metals and many other ionized elements. The available nitrogen in the bottom sediment of Damsal nala ranged from 6.27 to 18.82 kg ha^{-1}. The low amount of available nitrogen may be due to erosion of soil caused by extensive mining.

The available PO_4^{-3} content in the bottom sediment of Damsal nala ranged from 15.39 to 123.11 kg ha^{-1}. The available PO_4^{-3} content of bottom sediment of Damsal nala was found high during winter and summer while it was found low during monsoon. It may be due to leaching of available PO_4^{-3} of bottom sediment of Damsal nala by rain water.

The available K^+ in the bottom sediment of Damsal nala ranged from 21.07 to 410.89 kg ha^{-1}. The available K^+ in the bottom sediment of Damsal nala was found medium, high and very low during sampling in winter, summer and monsoon respectively. There is a direct relationship between available potassium and organic matter content. The low organic matter content resulted in the decrease of available potassium in the bottom sediment of damsal nala during monsoon.

The organic matter content in the bottom sediment of Damsal nala ranged from 0.20% to 1.55% indicating that it was very high during sampling in winter and summer while it was very low during the monsoon. The presence of organic matter in the bottom sediment may be due to decomposition of leaf, algae, fish and other aquatic organisms. Rain water may influence the lowering of organic matter content in the bottom sediment of Damsal nala during monsoon. The amount of Cr (VI) in the bottom sediment of Damsal nala was found below the detection limit (BDL) during winter and monsoon while it was found 0.007-0.009 mg g^{-1} during summer.

The amount of total Cr (24.69 to 30.51 mg g^{-1}), Pb (0.02 to 0.03 mg g^{-1}) and total Fe (0.63 to 0.85 mg g^{-1}) content in the bottom sediment of Damsal nala showed seasonal fluctuation. The degree of heavy metal accumulation in the bottom sediment of Damsal nala was found in the order of Cr>Fe>Pb. Ochieng *et al.* (2007) reported high concentration of heavy metals in water and sediments in five rift valley lakes in Kenia. In the bottom sediment of Damsal nala huge amount of total Cr and total Fe was found. This may transfer to the water of the Damsal nala and from there to the entire food chain through the primary producers and finally to the human beings.

Acknowledgment

The authors are indebted to the Head, Department of Environmental Sciences, The University of Burdwan for providing laboratory facilities.

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