ARSENIC AND LEAD LEVEL FROM UPPER TO LOWER INDUS BASIN OF PAKISTAN

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خلاصہ

64 مٹی کے نمونے جو بالائی اور زیریں سندھ طاس سے جمع کیئے گئے تھے انکی کیمیائی تجزیہ خاص طور پر آرسینک اور سیسہ کی آمیزش جانچنے کیلیئے کیا گیا یہ دیکھا گیا کہ بہت سارے نالے، جھرنے جو براہ راست برف سے ڈھکی چوٹیوں اور گلیشیر نکل رہے تھے انمیں سلٹ اور آرسینک کی مقدار نہیں پائی گئی جبکہ یہ تمام پانی کے نمونوں میں شامل تھا جن جگہوں سے نمونے لیئے گئے ان جگہوں کی غالب انواع کو بھی پیش کیا گیا۔ یہ نمونے 5579 میٹر کی بلندی سے 37 میٹر بلندی تک حاصل کیئے گئے۔ ان پانی کے نمونوں میں PH 6.53 سے 8.73 تک حل ہونے والی آکسیجن حضر سے Do جبکہ 1.9mg/L حضر سے 102.2% پائی گئی۔ ORP 11 سے 165.4، conductivity 41 سے 519 mS.cm، TDS 6 سے 260، نمکیات 0.02 سے 8.66% اور Pb 0.079 سے mg/L 2.53 پایا گیا۔ گو کہ چھ مقامات پر آرسنک موجود نہیں مگر اسکی مقدار دوسری جگہوں پر 400kg/L تک نوٹ کی گئی۔ مجموعی طور پر دیکھا گیا کہ دونوں بھارک دھاتوں کی مقدار بالائی سے نچلے علاقوں میں زیادہ ہے جو بین الاقوامی معیار سے 40 گناہ سے زیادہ ہے۔ یہ مقدار صحت کے لیے خطرہ ہے۔ لہذا اس پر قابو پانے کے لیے موزوں رابطوں کا اپنانا ضروری ہے۔

Abstract

Sixty four water samples were chemically analyzed from upper and lower Indus Basin plain with special reference to Arsenic and Lead contamination. It is shown that many springs and nallas originated from snow covered peaks and glaciers have untraceable amount of Arsenic and silt. However, amount of lead was found in each and every water samples. Dominant forest species, shrub and herb on water sampling site were also presented. The water samples were collected from lower to upper Indus Basin with 37 to 5579 meter elevation range. Among environmental variables the pH ranged from 6.53 to 8.73, dissolve oxygen (Do) from 0-1.9 mg/l with 0-102.2% dissolved oxygen. The oxygen reduction potential range was from 11 to 165.4, conductivity 41 to 519 microsiemens per centimeter (ms/cm) total dissolved solid (TDS) 6 to 260, salinity 0.02 to 8.66% and Pb were from 0.079 to 2.53 µg/L. Though in some areas Arsenic was absent but in some locations its values exceeded to 400 µg/L. The overall results showed that Arsenic and lead level increase dramatically from upper to lower Indus Basin and 40 times greater than internationally accepted level. The increase of arsenic and lead in Indus River is hazardous for human health. Therefore, possible control of these toxic metals and proper policies are suggested for this important River of Pakistan.

Introduction

The Indus is one of the few rivers in the world to exhibit a tidal bore. It is the main river which provides key water, hydroelectricity and food resources for Pakistan economy. The ultimate source of the Indus River is in Tibet. It begins at the confluence of the Sengge Zangbo and Gar Tsangpo River that drain in the Nganglong Kangri and Gangdise Shan mountain Range. The river than flows northwest through Ladakh and Skardu into Gilgit-Baltistan (upper Indus Basin) just South of the Karakoram Range, where thousands of nallas, springs, waterfalls fed by snow covered peak, glaciers and rain, drain their water in Shyok, Shigar, Hunza, Gilgit and many other sub river and then main river near Giglot. The Indus passes gigantic gorges 4500 to 5200 meter deep near the Nanga Parbat massif. It flows to the South coming out of the hills between Peshawar and Rawalpindi. It flows swiftly across Hazara and is dammed at the Tarbela Reservoir. The Kabul River joins it near Attock than it flows through Punjab and Sindh following a large dalta to the East of the Thatta before entering Arabian sea.
Only handful research being published describing the pollution or contaminated status of River Indus. Thousands of towns, small villages, shops, agriculture field, hotels and workshop are located in whole upper and lower Indus plans. They all throw their all types of waste in nallas, waterfalls sub/main river hence water is contaminated in the very early stage, closed to its origin. Khan *et al.*, (2013) warsar Dam, Sarwar *et al.*, (2007), Jhelum River, Ahmed and Shah (2007), Nomal valley, Farooq (2012) from Kashmoor to Keti-Bander were published the results of water analysis. Biber *et al.*, (2011) reported higher amount of Murcury from Gilgit and

Hunza valley and reported that all parameters were within the range of WHO limits. Status of heavy toxic matels in upper Indus Basin is not clear through chances of these metals in lower Basin are higher due to presence of hundreds of manufacturing factories, towns and large cities along the bank of River Indus. Bearing these points in mind present study was conducted to explore the presence of arsenic (AS) and lead (Pb) in the water of upper and lower Indus Basin.

Materials and Methods

Water samples were collected from the sub rivers, springs and nallas along the road side of Gilgit to Khangurab pass Chitral, Nalter Dossai Plan and from Skardu to Gilgit, covering area of upper Indus Basin. In addition from Alam idge to Hydeabad, from the main River Indus (Lower Indus Basin) eleven main cities were also selected to obtain water samples. Sixty four water samples were collected in air tight 250 mL plastic bottles. Elevation and coordinates were recorded from GPS while samples were analyzed using Hanna Multi parameters model HI9828. For Arsenic and lead, Atomic Absorption model PG-990 located in Dr. Moinuddin Ahmed Research Laboratory of Dendrochronology and Plant Ecology, Federal Urdu University, Karachi was used following the method given in Ismail (2002) and Nazim (2011).

Results and Discussion

Table 1 shows main location of sampled water and its geographical coordinate while Table 2 represent the results of water analysis of sixty four sites of Gilgit-Baltistan and main River Indus. According to Ahmed (1951) whole Northern area falls in subtropical continental highland (cold snowy winter, mostly Arid with mainly winter and spring rain. Study area fall under temperate disert bush type of bio-climate (Qadir, 1968) while champion *et al.,* (1965) included Gilgit-Baltistan under dry temperate region.

A. Gilgit to Khunjrab Pass

Beside some cultivated valleys along the road side from Gilgit to Khunjrab Pass, whole area is dry, barren and highly disturbed. This area characterized by rugged mountainous upland with extensive glaciers and contains Rakaposhi with a peak of 7788 m a.s.l. Ahmed (1973, 1986) described the vegetation of this area from 17 different places. *Ephedra gerardiana*, *Haloxylon thomsonic*, *Capparis spinosa*, *Geranium acorcilifolium* and *Artmesia scoparia* were the leading dominant species in 7, 5, 2, 2 and one stands. Inner glaciated valleys and snow covered peaks supporting pine or Juniperus trees also drain their water to the Hunza River. These valleys were dominated by *Juniperus excelsa*, *Pinus gerardiana*/*Picea smithiana* (Haramosh, Jutial) and *Pinus wallichiana* (Esper *et al*., 1995; Zafar *et al.,* 2015; Ahmed *et al.,* 2011). Khunjrab National Park (Chaprot) also dominated by herbs and bushes. Water samples were collected from 1306m to 4583m a.s.l at 16 places where 5 samples show (from side nalas) zero amount of As while Pb level ranges from 0.091 mg/L to 2.48 mg/L. Average As level was 226.1±45.34 µg/L and Pb level was 1.14±0.27 µg/L. Highest values of ORP (117.05±3.69) and TDS (113.00) were recorded from this river while salinity ranged from 0.07 to 0.25%.

B. Gilgit to Nalter

Gilgit to Nalter road side is also dry and barren while Nalter is a lush green valley with snow covered peaks and glacier. Largest pure *Picea smithiana* forest is distributed in this valley where on upper timber line *Betula utilis* and on lowest elevation *Pinus wallichiana*, *Juniperus excelsa* and *Juniperus communis* are distributed with *Betula utilis*. In bushes *Rosa webbiana*, *Berberis orthobotrys*, *Astragalus zarskarensis* and *leontopodium himalayannum* were dominated. As ranged from 388.2 to 398.8 µg/L while amount Pb was lowest in (0.18 ±0.01) in study area. Amount of dissolve oxygen was higher (1.26±0.32 µg/L) and percentage of dissolve oxygen was highest (21.67±9.67).

C. Gilgit to Dossai plan

Difference in topographic, amount of rainfall with increasing elevation and human disturbance controlled the vegetation along the way of Gilgit to Astore and Dossai plan. Though this area was also occupied by the same species listed in Gilgit to Khunjrab pass, here vegetation gradually changes with elevation increase. Ahmed (1988) reported *Periphoca aphyla*, *Juniperus excelsa* and *Fraxinus xanthocarpa* at the foolt hills of Astore. Along the river scattered trees of *Pinus gerardiana* were distributed on the steep slope. *Peganum harmala*, *Sophora alopecuroides* near the stream and *Rosa webbiana*, *Barbaris orthobotys* were reported near the stream and slightly upper side. Species like *Abies pindrow*, *Pinus wallichiana* and *Juniperus communis* on upper moist area (Ahmed *et al.,* 2010)

Highest Peak of this area was Nanga parbat (26600 feet) up to Dossai plan water samples from 13 places were collected. Among these samples nine mostly belonged to side Nalla coming from snow covered peak show no amount of As. Other samples show 202.5 to 399.6 µg/L Arsenic. Amount of Pb ranged from 0.131 to 2.428

µg/L with the average of 1.80±0.26 the highest amount. Lowest conductivity (94.69±18.17 ms/cm) was recorded in this river.

Table 1. Main location of various sampled sites and its geographical co-ordinate.

Sites	Main location	Elevation (m)	Latitude (North)	Longitude (East)
A. Gilgit to Khujrab Pass				
1	Atta Abad	1990	36^{0}14’22.41’’	74^{0}52’74.40’’
2	A.B lake	2010	36^{0}19’45.52’’	74^{0}29’18.20’’
3		2450	36^{0}24’71.10’’	74^{0}52’86.50’’
4		2300	36^{0}21’34.48’’	74^{0}51’17.51’’
5	K.N Park	2416	36^{0}41’29.12’’	74^{0}49’12.34’’
6	C. Border	2800	36^{0}51’36.19’’	75^{0}10’52.17’’
7		4583	36^{0}49’06.01’’	75^{0}20’59.24’’
8		4187	36^{0}52’35.04’’	75^{0}09’45.41’’
9		3607	36^{0}46’43.58’’	74^{0}52’05.59’’
10	Side Nalla	2957	36^{0}36’39.40’’	74^{0}50’52.10’’
11		1306	36^{0}30’52.50’’	74^{0}53’07.77’’
12		2562	36^{0}23’46.05’’	74^{0}52’10.00’’
13		2444	36^{0}21’38.56’’	74^{0}51’18.99’’
14	K. Abad	2415	36^{0}21’38.56’’	74^{0}51’18.91’’
15		2415	35^{0}53’59.47’’	74^{0}14’50.15’’
16		1647	36^{0}10’21.71’’	74^{0}51’07.65’’
B. Gilgit to Nalter				
17	T. Nalla	2450	36^{0}07’31.82’’	74^{0}14’05.06’’
18	Lake	2580	36^{0}09’55.29’’	74^{0}10’43.14’’
19	Karga	1650	36^{0}09’32.88’’	74^{0}11’32.88’’
20	Ast. Nalla	1640	35^{0}32’09.40’’	74^{0}43’49.05’’
21	do	1814	35^{0}27’11.85’’	74^{0}47’39.84’’
22	Rama	2800	35^{0}19’49.47’’	74v47’08.26’’
23	Rama	2800	35^{0}21’37.80’’	7^{0}50’33.16’’
24		2941	35^{0}09’36.03’’	74^{0}59’54.93’’
25		3109	35^{0}07’21.96’’	75^{0}02’28.33’’
26	Dossai	5579	35^{0}02’54.46’’	75^{0}06’15.52’’
27	do	3966	35^{0}00’49.01’’	75^{0}11’31.24’’
28	do	4099	34^{0}59’32.89’’	75^{0}16’30.89’’
29	do	3989	35^{0}00’15.51’’	75^{0}19’56.32’’
30	do	3889	35^{0}01’06.27’’	75^{0}24’54.19’’
31		3049	35^{0}09’23.89’’	7536’33.38’’
32	Side Nala	3011	35^{0}39’53.29’’	7516’53.18’’
33	Nalla	2213	35^{0}26’30.07’’	75^{0}28’41.29’’
34		2090	35^{0}32’49.07’’	75^{0}20’45.37’’
35		2067	35^{0}33’33.77’’	75^{0}20’51.40’’
36	Nalla	1890	35^{0}36’52.60’’	75^{0}91’47.08’’
37		2427	35^{0}38’19.43’’	75^{0}12’92.47’’
38		2247	35^{0}39’28.40’’	75^{0}55’24.06’’
39	Nalla	1980	35^{0}38’20.21’’	75^{0}55’20.87’’
40	Shawtoe	1462	35^{0}48’28.79’’	75^{0}44’38.27’’
E- Gilgit to Chitral				
41		1772	36^{0}25’73.39’’	74^{0}64’07.76’’
42		1743	36^{0}41’31.56’’	74^{0}41’16.10’’
43	D. Nalla	1803	36^{0}51’32.59’’	74^{0}06’21.10’’
44	Rioshim	1949	36^{0}13’49.09’’	73^{0}42’58.19’’
45	Gopis	2118	36^{0}13’12.54’’	73^{0}31’10.09’’

46		2181	36^{0}13′35.53″	73^{0}27′12.13″
47		2242	36^{0}14′48.22″	73^{0}22′12.44″
48		2339	36^{0}11′58.23″	73^{0}14′40.55″
49	Shandoor	2513	36^{0}93′07.55″	73^{0}75′08.97″
50	Main	2916	36^{0}94′45.61″	72^{0}55′43.34″
51	do	3311	36^{0}81′37.61″	72^{0}39′12.43″
52	Pass	3400	36^{0}53′47.73″	72^{0}36′33.07″
53	Main	2241	36^{0}14′38.38″	73^{0}21′42.42″
54	A. bridge	1950	35^{0}25′52.09″	73^{0}12′24.18″
55	Pattan	1380	35^{0}01′20.81″	73^{0}03′37.01″
56	Besham	1170	32^{0}25′36.37″	71^{0}22′12.12″
57	Terballa	198	31^{0}50′19.58″	70^{0}55′35.63″
58	Chasma	172	30^{0}30′36.43″	70^{0}50′34.57″
59	D-I-Khan	137	28^{0}24′48.33″	69^{0}43′16.60″
60	Tonsa	90	27^{0}39′38.68″	68^{0}49′53.90″
61	Gudu	73	27^{0}25′19.88″	68^{0}16′45.75″
62	Shakher	59	26^{0}43′16.05″	67^{0}55′46.04″
63	Kotlii	47	33^{0}30′49.17″	73^{0}53′01.65″
64	Hyderabad	37	26^{0}94′44.46″	68^{0}15′5.89″

D. Gilgit to Skardu

The way from Gilgit to Sakardu along the main River Indus the valleys were dry except some planted valley ad towns while inner valleys were occupied by *Juniper excelsa*, pine specie, alphine shrub and meadows. Ahmed (1976) sampled lower dry area along the river and reported eleven species association i.e. 1) *Panicum-Cousnia* 2) *Paganum-Arnebia* 3) *Capparis-Salsola* 4) *vulgaris-Arnebia* 5) *Ephedra-Artemisia* 6) *Paganum-Sophora* 7) *Sophora-Artemisia* 8) *Sophora-Cousinia* 9) *Capparis-Peganum* 10) *Artemisia vulgaris-Artemisia scoporia*. Akber *et al.,* (2010) described vegetation of Skardu and reported *Pinus wallichiana-Juniperus excelsa-Betula utilis*; *Picea smithiana-Juniperus macropoda-Pinus gerardiana*; *Abies pindrow-Picea smithiana-Pinus wallichiana* and *Pinus wallichiana-Juniper excelsa* communities around inner valleys of snow covered peaks.

Water samples were collected from 1462m to 2427 m a.s.l from nalas and main river. Only three nalas show untraceable arsenic value whereas other has 365.4 to 400.9 µg/L range. Lead range from 0.079 to 2.098 µg/L with comparatively low (0.36±0.25 µg/L) amount. Salinity was similar (0.13±0.02%) from Gilgit to Khunjrab area. TDS was highest (142.88±21.77 ppm) while ORP was lowest (102.88±7.77) in the sampling area.

E. Gilgit to Chitral

Ahmed and Qadir (1976) described the vegetation along the river/road side from Gilgit to Gopies, Yasin and Shundor to Chitral. They reported *Myricaria germarica*, *Tamarix* sp and *Sophora alopecuroides* with *Salsola Kali* near the stream. *Fraxinus xanthoxyloides*, *Rosa webbiana*, *Juniperus excelsa*, *Ephedra gerardiana* and *Artemisia vulgaris* on upper side of the road. *Capparis spinosa*, *Haloxylan griffithii* and *Heliotropium* species were also the associated species of fry sites. Forested areas of this site is never explored. Thirteen water samples were collected in this area where 9 nallas show no arsenic in other nallas range was 36.36 to 396.1 µg/L with the lowest (96.84±46.94 µg/L) arsenic in the study area. Amount of lead ranged from 0.098 to 2.498 µg/L with an average of 1.63±0.29 µg/L. Amount of salinity, TDS, and conductivity were the lowest in the study area.

Table 2- Analysis of water from Indus Basin and main River Indus.

S. No	pH	Do (mg/L)	Do (%)	ORP	Cond ms/cm	TDS (ppm)	Salinity (%)	As (µg/L)	Pb (µg/L)
A. Gilgit to Khujrab Pass									
1	7.49	0.46	0.62	117.8	241	79	0.4	215.3	2.08
2	7.81	0.93	11.9	121.4	144	72	0.07	396.5	0.225
3	7.69	0.31	0.3	114.6	261	112	0.12	396.2	2.48
4	7.35	0.1	0.02	115.4	388	195	0.19	399.2	0.195
5	7.06	1.09	18.5	165.4	519	260	0.25	396.7	0.225
6	7.95	0.92	11.4	102.2	254	127	0.12	0	2.0
7	7.69	0.88	11.3	111.4	281	140	0.13	0	2.259
8	7.96	0.1	0.2	101.9	202	101	0.09	107.6	2.436
9	7.95	0.1	0.2	104.5	205	102	0.1	163.4	2.362
10	7.95	0.02	0.3	103.8	191	95	0.09	365	0.13
11	7.43	0.09	1.1	120.7	369	185	0.18	0	0.194
12	7.38	0.6	7.7	122.6	142	71	0.07	0	2.428
13	7.56	0.94	11.8	112.5	52	26	0.02	398.9	0.117
14	7.57	0.95	11.8	117.1	48	24	0.1	0	0.091
15	7.59	0.66	8.6	121.6	212	106	0.09	390	0.692
16	7.51	0.63	7.8	119.9	230	113	0.07	389	0.125
Mean±S.E	7.62±0.06	0.55±0.10	6.47±1.51	117.05±3.69	233.69±29.93	113.00±15.16	0.13±0.02	226.11±45.34	1.14±0.27
B. Gilgit to Nalter									
17	7.86	0.94	12.1	116.2	188	94	0.09	398.8	0.169
18	7.21	0.93	11.9	132.9	220	111	0.1	395.7	0.164
19	8.08	1.9	4.1	66.9	218	109	0.1	388.2	0.192
Mean±S.E	7.72±0.26	1.26±0.32	9.4±2.6	105.33±19.81	208.67±10.35	104.67±5.36	0.10±0.001	394.23±3.15	0.18±0.01

C. Gilgit to Dossai									
20	7.78	0.53	0.3	117.7	97	136	0.04	0	2.059
21	7.5	0.02	0.4	122.2	283	141	0.133	0	2.199
22	7.41	0.12	10.1	107.8	162	81	0.08	0	2.219
23	7.44	0	0	128	45	22	0.02	0	2.275
24	7.93	0	0	118	72	36	0.03	0	2.330
25	7.96	0	0	140	68	34	0.03	259	2.232
26	7.9	0.99	12.1	91.7	69	34	0.04	202.5	2.363
27	7.5	0.59	7.4	103.9	57	29	0.03	399.6	2.428
28	7.56	0.6	7.6	108.1	44	22	0.02	396	2.428
29	8.09	1.36	16.9	103.6	58	29	0.03	0	2.457
30	7.56	0.65	9.1	108.6	92	46	0.04	370	0.097
31	7.33	0.93	11.9	124.6	122	61	0.06	394.6	0.131
32	7.5	0.53	20	57.3	62	39	0.05	0	0.194
Mean±S.E	7.65±0.07	0.49±0.12	7.37±1.90	110.12±5.61	94.69±18.17	54.62±11.26	0.05±0.01	155.52±50.81	1.80±0.26
D. Skardu to Gilgit									
33	8.1	1.55	17.2	109.7	209	105	0.10	0	2.098
34	7.78	0	0	106.3	220	110	0.10	395.5	0.122
35	8.31	1.4	17.4	116.3	194	97	0.09	0	0.126
36	7.95	1.42	17.3	114.8	276	138	0.13	394.3	0.144
37	8.09	1.42	17.5	112.8	190	95	0.09	0	0.106
38	8.38	1.53	17.5	107.7	197	248	0.24	400.9	0.108
39	8.01	1.34	16.3	106.1	245	232	0.19	396.9	0.079
40	7.24	1.55	26.6	49.3	236	118	0.11	365.4	0.134
Mean±S.E	7.98±0.13	1.28±0.18	16.23±2.60	102.88±7.77	220.88±10.55	142.88±21.77	0.13±0.02	244.13±71.57	0.36±0.25
E. Gilgit to Chitral									
41	8.11	1.31	11	11	150	75	0.07	0	2.154
42	7.97	0.88	3.1	47.2	164	82	0.088	36.36	2.186
43	7.66	0.25	6.5	117.2	42	21	0.02	0	2.226

44	7.52	0.51	7.4	96.9	47	24	0.02	0	0.160
45	7.41	0	0	145	54	27	0.02	0	2.327
46	7.69	0.49	4.9	137	56	31	0.02	44.9	2.149
47	7.77	0.59	7.6	116.8	51	35	0.02	0	2.372
48	7.47	0.6	11.9	102.1	79	39	0.04	396	2.409
49	7.84	0.94	7.9	116.8	41	20	0.02	396.1	2.395
50	7.97	1.36	16.8	116.8	50	25	0.02	385.5	2.498
51	7.72	0.64	11.9	124.5	112	56	0.05	0	0.098
52	7.5	0	0	132.2	84	42	0.04	0	0.109
53	7.6	0.95	11.4	88.9	98	49	0.04	0	0.122
Mean±S.E	7.71±0.06	0.66±0.12	7.72±1.37	104.03±10.38	79.08±11.42	40.46±5.57	0.04±0.01	96.84±46.94	1.63±0.29
F. Main Indus River									
54	7.2	0.47	4.8	136	55	27	0.03	383.5	0.227
55	6.53	1.01	12.3	158	223	111	0.10	396.7	0.228
56	7.1	1.05	9.8	149	127	98	0.11	397.8	0.231
57	8.35	0.47	102.2	128.1	92	46	0.04	399.2	0.195
58	8.73	1.01	11.1	123.8	186.2	93.1	0.94	397.9	0.229
59	6.82	0.91	7.7	137.5	119	6	0.05	394.1	0.161
60	6.7	1.55	7.9	131.9	154.8	77.4	0.77	400.1	0.146
61	8.39	0.92	11	103.4	123.9	62.2	1.2	394.6	0.166
62	8.2	0.97	12	150	440.8	221	2.34	395.7	2.424
63	8.02	1.53	11	96	149.7	74.8	8.66	399.4	2.445
64	8.18	1.62	10.9	135	157.8	95.6	8.21	400.5	2.530
Mean±S.E	7.66±0.24	1.05±0.12	18.25±8.42	131.70±5.67	166.29±30.59	82.92±16.86	2.04±0.98	396.32±1.44	0.82±0.32

Note: mg/L= milligram per litter, Do= dissolved oxygen, ORP= oxygen reduction potential, Cond= conductivity, ms/cm= microsiemens per centimeter, ppm = part per million, µg/L = micrograms per liter, As= Arsenic, Pb= lead, A.B lake= Atta Abad lake, K.N Park= Khunjerab National Park, C. Border= China boarder, K. Abad= Kareem Abad, T. Nala= Thole Nala, Ast. Nala= Astore Nala, D. Nala= Dilmati Nala, A. bridge= Alam bridge

F. Main Gilgit to Hyderabad

All above mentioned sub rivers from upper Indus Basin drain their water in one main river called Indus River. From Alam Bridge to Bisham several other sub River (Chilas, Khandia and Dubair rivers of Indus Kohistan) also drain water in Indus River. Vegetation along the river/road side from Gilgit to Chilas was sampled by Ahmed (1988). *Tamarix species*, *Sophora alopecuroides* (River Bank)/ *Capparis spinosa*, *Artemisia vulgaris*, *Heliotropium dasycarpum*, *Ephedra gerardiana* (Near partab Bridges), *Periphoca apyla*, *Masbusium vulgaris*, and Aristida sp were reported. Inner and upper forested area of Indus Kohistan was explored by Khan *et al.,* (2016). They reported *Cedrus deodara*, *Pinus wallichiana*, *Abies pindrow*, *Picea smithiana*, *Taxus fauna* and *Quercus baloot* from this dry temperate area of Pakistan. After the heavy rain due to the dry banks of sub rivers, main River Indus water carries a large amount of dust and silt, though most of the nallas coming from the snow cover peaks, glaciers through forested area or green Belts show cristal clear water. Therefore, amount of silt or dirt directly related to plant cover of the passage of the water. Legal or illegal cutting of the forest, overgrazing and uncontrolled picking of herbs, shrubs of medicinal importance promote soil erosion and increase amount of silt and dust in river which create sitting problems in our dams. Highest amount of Do % (18.25±8.42) ORP (131.70±5.67%), salinity (2.04±0.98%) and the highest amount of arsenic (399.32±1.44 µg/L) were recorded in main river. The permissible limit of arsenic and lead in drinking water is 10 µg/L or 0.01 mg/L. According to the WHO standard. The arsenic level in the Indus River are twice the level mentioned in Bangladesh in the late 1990s, eight time higher than the national limit and 40 times greater than the internationally accepted level.

The results are alarming and warrant urgent attention of policy maker and scientist. Eighty percent of agriculture and domestic need of Pakistan dependent upon this contaminated water (River Indus) which would have far-reaching environmental and health implication. Long term exposure to arsenic can cause cancer, skin lesions, cardiovascular disease, neurotoxicity and diabetes. Lead cumulative toxicant which affect multiple body system and particularly harmful for young children. It creates significant public health problems according to WHO (2003). Removal of vegetation cover increase in silt but also increase the amount of lead in water. Therefore, this practical should be stopped. Thousands of small towns of upper Indus Basin dump their domestic animals, restaurants and small motor worker shops waste directly into the nallas, waterfall, springs and sub river which contaminate and polluted water just from the beginning. Glaciers, timber line and higher waster shed areas are also affected by overgrazing and their dungs. Even Dossai plan, people wash their vehicles in the streams. At lower Indus level cities located near the River bank also drain their domestic and industrial waste into the River. Therefore, Indus water contains many toxic heavy metals which should be identified for proper control.

Acknowledgement

Author wish to express their gratitude to Dr. Mobeen Ahmed Aziz Director Geo links (Pvt) Ltd. for providing funds for the water survey in Gilgit-Baltistan area and Mr. Immad Ahmed Siddiqui, Director "Empower The Future" based in Washington D.C for providing funds for water analysis.

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