HEAVY METAL POLLUTION IN SOIL, A WORLD REVIEW

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ABSTRACT*: This study reviews heavy metal pollutants concentration present in soil particles from various parts of world as well as in Pakistani soil. Heavy metal measurements carried on so far, are reviewed for various sub-continents of the world. Heavy metal concentrations for the Pakistani soil are compared to the rest of the world. It has been observed that the concentrations of heavy metal in Pakistani soils are mainly found lower for Cu and Pb when compared to the rest of the world. However in case of Cd and Ni the concentrations show similarity at most of the sampling locations. The comparison in case of Zn also shows similarity at some sampling points to the rest of the world. However the concentration of Zn is found lower at many other points when compared to the rest of the world.*

1. INTRODUCTION

The study of air pollutants is important due to their adverse health impacts on the human body as well as on the life of other living beings. It has been observed that as number of people increases in a particular region, there is an urgent need for the industrial and economic growth. The industrial development results in air pollutants release owing to the combustion and other related processes. The heavy metals like Cd, Cr, Cu, Ni, Pb and Zn are present in the atmosphere in the form of very fine dust particles. The dust particles are found in the soils of urban and rural areas. The vehicular exhausts are one of the major sources of heavy metals in the form of micron sized particles.

Keeping in view the importance of the heavy elemental pollutant particulates, the studies on the measurement of the heavy metals in different parts of the world are reviewed. The world review of heavy metal concentrations of a particular region is important to get sufficient information about the pollutants concentration levels. In this way the regional concentrations can be estimated for the heavy metals. So far very few review studies have been reported on the regional, continental and global levels for heavy metal pollutants in the dusts and soils. This review aims for the global scenario of heavy metal contaminations.

2. MATERIALS AND METHODS

The soil and dust samples were collected with the help of a plastic scoop from the soil surface. The soil or dust samples were collected from three to four points from a specified sampling location and then mixed uniformly to get the bulk sample. The soil samples were collected from different depths. If the depth of more than 5 cm is required the soil is digged and then the soil was collected. The soil samples were collected in the plastic bags. The soil samples were then transferred to the respective laboratory for the initial treatment before digestion. The labeling and storage of the soil samples was very important step after the sampling. The collected samples were carried to the laboratory and stored in plastic bottles. The bottles were labeled with a permanent marker. An inventory of samples was prepared in soft and hard form. The stored samples were dried in an oven for 4-5 hours at 90 degree centigrade in order to remove any moisture present in the soil samples. The samples after drying were subjected to the process of sieving. The suitable sieve size was selected and all the samples were sieved. The name of the sieve as well as the size was noted. The sieved samples were again transferred to the plastic bottles.

In order to digest the soil samples a suitable digestion procedure was adopted. The methodology of the soil digestion method was carefully followed. The required apparatus for the digestion process was made ready. The soil samples were weighed about 0.5-2 gm. The soil weighed samples were digested using acids including HNO_3, HCl, and HF to break up the matrix and isolate the metal of interest. The samples after digestion were available in the aqueous form. The samples were then filtered or centrifuged and diluted to 100 ml. The samples were ready for the heavy metal measurements.

The concentrations of the heavy metals were measured with help of the recommended analytical techniques like Atomic Absorption Spectrometry AAS, Inductively Coupled Plasma Optical Emission Spectrometry ICP-OES. The above mentioned instruments were used to quantify the amount of heavy metal in the soil sample. The spectrometers used were calibrated for each heavy metal measurements. After calibration the samples were run through the spectrometer.

3 Metal contents in Pakistani Soil

The review on heavy metal concentrations have been already carried out as given in the table [1]. It has been observed that the concentrations of the heavy element Cd were found low in comparison to the rest of the elements. Also the concentrations of Ni were found moderate throughout the studied areas however the concentrations of Cu, Pb and Zn were found higher.

Table 1: Concentration of heavy metals (mg/kg) in the soils of Pakistan

City	Cd	Cu	Ni	Pb	Zn	Reference
Urban parks						
Islamabad	1.3	40	135	27.5	87.2	[1]
Rawalpindi	2.1	45	135	43	70.6	[1]
Faisalabad	-	24.08	21.44	21.44	48.57	[1]
Urban soil/Road dust						
Islamabad	5.0	52	23	104	116	[1]
Islamabad (Built up)	3.54	17.73	92.47	212.3	1638	[1]
Islamabad (Drain	3.58	18.37	90.34	202.9	1634	[1]

Side)						
Islamabad (Green area)	3.37	17.39	90.81	209.2	1658	
Rawalpindi	8.4	156.9	47.8	145.8	890	[1]
Lahore	10.4	67	35	168	452	[1]
Gujranwala	3.1	-	-	113	-	[1]
National Highway						
Lahore	0.64	14.19	7.91	23.70	107.50	[1]
Multan	0.56	11.01	7.11	13.20	27.66	[1]
Bahawalpur	0.67	6.05	5.96	13.23	36.50	[1]
Rahimyar Khan	0.85	17.26	11.85	16.33	41.00	[1]
Ubauro	1.25	10.36	8.71	29.71	44.66	[1]
Sukkur	0.79	5.26	6.43	12.30	13.83	[1]
Moro	0.62	9.68	7.83	18.76	22.16	[1]
Hyderabad	1.15	26.88	10.31	176.01	180.00	[1]
Karachi	1.05	15.41	13.23	24.80	37.16	[1]
Karachi	-	33.3	-	42.1	99.5	[1]
Faisalabad City (North East Punjab)						
Sargodha Road	-	20.6	-	3.6	43.49	[1]
Sumandari Road	-	20.9	-	8.75	55	[1]
Jaranwala Road	-	21.7	-	2.5	85.45	[1]
Canal Road	-	21.5	-	1.4	19.17	[1]
Sheikhupura Road	-	42	-	17	336.75	[1]
Jhang Road	-	22.2	-	0	44.67	[1]
Susan road	-	18.62	-	12.2	87.27	[1]
Club Road	-	11.25	-	0.95	26.55	[1]
Peshawar	0.05	0.50	0.15	5.7	0.69	[1]
Agricultural soils						
Lahore	2.6	94.5	55.8	68.4	108	
Faisalabad	2.7	70.3	46.9	63.9	105.6	[1]
Multan	2.53	65.30	23.61	68.85	136.63	[1]
Kasure	2.6	44.6	46.4	50.6	125.6	[1]
WahCantt	2.0	70.8	50.8	77.9	139.3	[1]
Islamabad	2.5	52.9	47.4	71.2	124.2	[1]
Adiala	1.3	10.2	128.8	21.7	35.3	[1]
Pirwadhai	2.2	28.8	34.0	35.8	69.7	[1]
Taxilla	2.7	25.0	30.4	22.8	20.5	[1]
Wah factory	2.1	25.7	38.9	28.2	67.4	[1]
Northern area soils						
Pazang site	2.0	193	99	117	361	[1]
Lahor Site	20	205	172	1753	5123	[1]
Konadas	1	147	52	35	590	[1]
Dainyor	0.85	99	31	36	1193	[1]
Nagirl	0.3	55	36	43	172	[1]
Jageerbaseen	0.75	72	57	29	210	[1]
Naltar	2.3	71	24	138	460	[1]
Peshawar	0.89	15.5	54	11	48	[1]

4. Metal contents in World Soil

The heavy metal concentrations for Cd, Cu, Ni, Pb and Zn in various countries of the world have been analyzed and are given in Table 2. In the sub-continent of Africa very few countries were selected for the heavy metal pollution assessment. The maximum concentration was found in the city of Luanda in Angola. The minimum concentration of heavy metals was observed in the city of Mubi located in Nigeria.

The highest concentrations of the Cd, Ni and Pb were found in Bahrain among the countries chosen for Asia. However the concentration of Zn was found highest for the city of Baoji in China. The minimum concentration of Cd was found in the city of Urumqi in China. The minimum concentrations for the rest of the heavy metals Cu, Ni, Pb and Zn were found in the city of Karak in Jordan.

The review for various countries in Europe shows that the concentrations of Cd, Cu and Zn are found highest for city of Paris in France. The concentration of Ni is highest for the city Coventry in United Kingdom. The concentration of Pb is highest in city Madrid in Spain. The concentrations of Cd, Cu and Ni were minimum in Sweden. The concentration of Pb was lowest for city Coventry in United Kingdom. The concentration of Zn was lowest in city Palermo of Italy.

In Continent North America the maximum concentration of Cd and Zn was found in Hermosillo located in Mexico. The maximum concentration of Cu and Pb was found in Cincinnati located in Ohio USA. The maximum concentration of Ni was found in Honolulu located in Hawaii USA. The minimum concentration of Cd and Zn was found in Ottawa located in Canada. The minimum concentrations of the elements Cu, Ni and Pb were found in Hermosillo located in Mexico.

Table 2: Concentration of heavy metals (mg/kg) in the sub-continents of World

	Heavy metal					
Continent	Cd	Cu	Ni	Pb	Zn	**Reference**
Africa						
Luanda/Angola	1.15	41.78	10	351.3	316.6	[2]
Mubi/Nigeria	0.67	25.06	-	121.53	206.64	[3]
Accra/ Ghana	-	48.25	15.88	58.66	161.43	[4]
Asia						
Amman/Jordan	3.1–11.2	66.5–350	43–88	210–1131	166–410	[5]
Aqaba/Jordan	1.9–2.9	21–56	51–115	93–212	103–160	[6]
Aqaba–Shuna/Jordan	5	-	40	79	79	[7]
Bahrain	**72**	-	**126**	**697.2**	151.8	[8]
Baoji/China	-	123.17	48.83	408.41	**715.1**	[9]
Beijing/China	1.67	42	72	126	167	[10]
Calcutta/India	3.12	44	42	536	159	[11]
Dhaka/Bangladesh	-	46	26	74	154	[12]
Guangzhou/China	2.41	176	23	240	586	[13]
Hong Kong/China	2.18	24.8	-	93.4	168	14]
Hong Kong/China	-	110	28.6	120	**3840**	[15]
Istanbul/Turkey	1.5-2.3	49-234	30-33	105–556	447-594	[16]
Karak/Jordan	-	**11.3**	**4.2**	**11.2**	**13.1**	[17]
Kayseri/Turkey	2.53	36.9	44.9	74.8	112	[18]
Shanghai/China	1.23	**196.8**	83.98	294.9	733.8	[19]
Sivas/Turkey	2.6	84	68	197	206	[20]
Taejon/Korea	-	47–57	-	52-60	172–214	[21]
Urumqi/China	**1.17**	94.54	43.28	53.53	294.47	[22]
Xi'an/China	–	94.98	–	230.5	421.5	[23]
Europe						
Coventry/UK	0.9	226.4	129.7	47.1	385.7	[24]
Palermo/Italy	1.1	98	14	544	207	[25]
Paris/France	1.7	1075	25	1450	840	[26]
North America						
Cincinnati/Ohio USA	-	253.0	-	649.7	-	[27]
Hermosillo/Mexico	4.25	26.34	4.70	36.15	387.98	[28]
Ottawa/Canada	0.37	65.84	15.2	39.05	112.5	[29]

5 CONCLUSIONS

The comparison of heavy metal concentration levels throughout the world is important for the continental pollution analysis. The concentrations of the heavy metals of Pakistani soil data are compared with the rest of the world. It has been observed that the concentrations of Cd in Pakistani soils are similar to the rest of the world. The concentration of Cu are seen lower in many places of Pakistani soil in comparison to the rest of the world. The concentration of Ni in Pakistani soil in most of the places is found similar and found lower at few places in comparison to the rest of the world. The concentration of Pb is found lower in most of the places for Pakistani soil in comparison to the rest of the world. However the concentration of Pb is found similar at very few places when compared to the rest to the world. The concentration of Zn in Pakistani soil is found similar as well as lower when compared to the rest of the world.

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