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Contamination of Air, Soil and Water, As Evaluated on The Basis of Lead Contents in the Vicinity of Various Lakes and Dams within Pakistan

Abbas Khan and M. Jaffar
Department of Chemistry, Quaid-i-Azam University , Islamabad, Pakistan

Abstract: In order to study the lead levels in air ,soil and water in the vicinity of various Lakes and Dams within the Pakistan ,Samples were collected periodically from the selected sites for the three media ,and were analyzed by AAS.This investigation on Lakes and relevant air / soil / water showed that maximum concentrations of Pb were 717.5µ g/M^3,44.9 mg/ Kg and 217 µg/L in air, soil and water respectively . Analysis based on statistical parameters evidenced a positive correlation between air- soil ,air- water and soil- water systems .The values of X and G.M, emphasized a randomize distribution of Pb contents in the three media .Elevated Pb levels were determined at Khan Pur Dam in case of air and water system, while at Rawal lake in case of soil samples .Qauid-i-Azam University Lake was found free from Pb because Pb levels were below detection limits i.e. not detectable in case of water.

Key Words: AAS. Lead Pollution, Lakes, Contimation

Introduction

Metal pollution is a serious threat to human life. As for as presence of pb in air is concerned, a lot of analytical work has been done during the last decade with respect to various aspects of pb pollution and its sources in air.

As is to be expected, lead exposure in air must show related ecological and analytical impacts on other segments of the human environment. One such study focused on particular matter in the atmosphere. The samples pertaining to lead distribution were analyzed for highly populated town areas, under various wind directions and at various distances from the polluting source (Viman *et al.,* 1997) Lead may enter in the human body by the inhalation process. Inhalation of Pb fumes occurs in the general public from atmospheric pollution but to a potentially much greater degree in industrial workers, involved in the manufacture of batteries, rubber, paint and various enamel or glazed pottery. Lead has been determined in the blood of persons working in printing press and persons working in battery plants. The mean values of lead concentration determined ranged from 0.32 ppm to 1.16 ppm (Imtiaz *et al.*, 1995)

Numerous other studies on air borne levels of lead are reported in literature based on continues monitoring to ensure good human health. Such studies are important to monitor air and provide information on how individual sources of lead pollution may be controlled to provide clean air. Today, the air which contain as many as 188 Hazardous Air Pollutants (HAP) which USA-EPA study labels as major pollutants, the lead is one of these (Anon *et al.*, 1996).

Water, like air, is also an important part of our environment and is directly related to the sustenance of human beings or any other living organisms. Water is a major sink for pollutants from air or soil and also from industrial wastes. The contamination of water with lead is the major concern regarding lead poisoning throughout the world by using various techniques. Earlier work on the issue reported detection limits of Pb, Cd and Cu were represented (Kyung and NamPak: 1995). The water bodies close to the polluted air interface were found to have high Pb level contrary to the situation in which it is away from the sources of Pb pollution. Some sea organisms and sediments were used to this effect, and levels of Hg, Cd, and Pb were determined. After ascertaining background levels, the results were compared with concentrations of the same elements in equivalent material belonging to other waters (Bucci *et al.*, 1996)

Soil is also important sink for metal pollutants released through different human activities. IT is generally accepted that human activities have had a major impact on the global biogeochemical cycles of many trace elements. The biogeochemical cycle specially of Pb has possible been effected by man to a greater degree than that of most other heavy metals. It has been estimated that human activities over the past century have resulted in the doubling of Pb concentration in soil in some parts of the world (Yousfzai *et al.*, 1998)

The auto-exhausted lead pollution is the main route to introduce lead in soil and vegetation. To study the effect of vehicular exhaust Pb pollution on vegetation, a group of scientists have determined the Pb levels in piper bettle at different distances from the gasoline pumps (Kar and Misra; 1994) . Subsequent upon the use of gasoline in vehicles causing air contamination with Pb and Cd in roadside soil and plants, a correlation has been developed between the distance from the motorways and to the traffic levels and the concentration of Pb and Cd in vegetation and in soil samples simultaneously (Ferretti *et al.*, 1995). Mining process is also a cause of Pb contamination of soil and plants. The issue has been tackled in Korea to investigate heavy metal contamination of soil and plants in the vicinity of a Pb-Zn mine. It is concluded that concentration of heavy metal in soils decreased exponentially with distance from the mine source mainly due to dispersion by water (Chaljung and Thronton; 1996)

If concentration of Pb in soil is high than it is obvious that vegetations grown in that soil will be also have high concentration of Pb; having a bearing to the human also as the food is ingested by man. A study was undertaken on the exposure of urban population to Pb and Cd showing that the dietary Pb intake (25.8µg/day) and Pb in blood (56.7 µg/L) in Chinese were higher than these in Japanese women (11.6 µg/day & 32.1µg/L respectively (Zhang *et al.*, 1997)

It was also evidenced that accumulation of Pb and other heavy metals in the soil might vary from place to place (Yousfzai *et al.*, 1998)

Materials and Methods

The samples were procured the selected points at Terbela , Khanpur ,Simly ,Mangla and Rawal Lakes/Dams and also from Quaid-i-Azam university stream . The surface soil samples were collected from various locations adjacent to the relevantly selected points for air and water monitoring. A 20-25 grams portion of field moist sample was scooped from soil in 0-5 cm surface depth. The fine fraction was obtained by passing the samples through a 177 µm size sieve. The samples were homogenized and subsequently dried in an electric drying oven at 80° ± 1°C. An exactly weighed amount (between 1-2 g) of the prepared soil samples were gently refluxed with 15 ml of 65% pure nitric acid for 30 minutes. In parallel to this step a blank was also prepared simultaneously. After cooling the contents were filtered through whatman 42 into a 50 ml flask with plentiful washing with distilled water and finally making the volume up to the level with distilled water.

The water samples were procured from the selected points of the lake. A plastic scoop sampler (250 ml capacity) was used to collect surface water samples from with in 0-12 inches depth. The sample was transferred to a prewashed, predried strong polythene bottle and stoppered immediately. Each sampling bottle was labeled appropriately and was immediately transported to the lab for analysis.

The nitric acid based scrubbing method was used to collect air samples from various locations in close vicinity of location selected for soil and water sampling. The sampling flow rate was adjustable up to 2 L/minutes on the rotameter of the air pump used for air sampling. The air could be trapped in scrubbing solution through suction or bubbling, a dual mechanism optionally available within the pump. In the present study the suction mode was used to prevent damage that could be caused by the ensuing nitric acid vapors from the scrubbing tube. The nitric acid used as a scrubbing solution was prepared from 65% 12 E-Merck concentrated acid with a density of 1.04 g/ml, and a volume of 25 ml of this solution was used in the scrubbing tube during each monitoring event.

The analysis was performed by a Shimadzu Atomic Absorption spectrophotometer (Model AA-670/GV-6). The optimum measuring conditions were determined as a function of instrumental parameter as per instructions given by the manufacturer. Undertaking absorption measurements for triplicate runs checked the reproducibility. The precision achieved was better than ± 1.5% inter laboratory comparison of finished data was conducted at NIH, Islamabad. Research grade chemicals were used throughout the investigation Merck standards/salts of guarantied purity (> 99.9%) were used to prepare standards. Pb was estimated in air, soil and water in these Lakes and their vicinity by AAS technique.

Results and Discussion

The lake data related to soil /air /water system appear in Table 1 through Table 5 and for steam ,Quaid-i- Azam university in Table 6 .The corresponding general statistical parameters for lead distribution are spread over Table 7-9 . In Table 1, the data project a range of soil, air and water lead content as follows: for soil, the range is 8.7 mg/kg to 14.3 mg/kg; for air, from 421.2 µg/m^3 to 697.5 µg/m^3 and for water from 8.0 µg/L to 150 µg/L. These data pertain to Terbela Dam. Correspondingly, the Khanpur Dam evidenced these levels as: for soil 6.5-14.4 mg/kg; for air from 488.7-717.5 µg/m^3 and for water 133.0-217.0 µg/L (Table 2). A mark of distinction must be pointed out here in respect of the stream, Quaid-i-Azam University wherefrom soil and water samples were collected along with air samples relevant to the site. The soil lead was found to be the highest ranging between 15.4-35.8 mg/kg, air from 501.2-315 µg/m^3 and the water from BDL*-153 µg/L. Thus in the latter case the minimum to maximum differential in concentration is the highest. Environmental factors, the soil chemistry of the soil, the trapping of air in the sampling region could have contributed to the observed lead levels. A comparison with Tables 3 and 4 revealed that the lead distribution is the three media has a random distribution, following occasionally a pattern of linear correlation, to be duly supported by a proper mathematical procedure. This aspect would be taken up in the forthcoming section.

* Below detection limit.

Table 1: Estimated Lead Levels in Soil (mg/kg, Dry Weight), Air (µg/m^3) and Water (µg/L) Samples from Terbela Dam

S.No.	Sample Nature/Code	Pb Concentration
1.	Soil/SAW-1	8.7
2.	Soil/SAW-2	13.7
3.	Soil/SAW-3	14.3
4.	Air/SAW-4	697.5
5.	Air/SAW-5	421.2
6.	Air/SAW-6	616.2
7.	Water/SAW-7	8.0
8.	Water/SAW-8	43.0
9.	Water/SAW-9	150.0

The data on lake water, soil and air samples taken within close vicinity of the selected lakes are reported on statistical ground in Table 7. In no case $\bar{X}$ was comparable with the G.M. again emphasizing a randomize distribution which could probably be represented by log normal distribution.

In Table 8 identical data appears for the three media , the - soil and air-water system in this case exhibited a relatively strong positive correlation indicating the interrelationship between the lead concentration in air and water The presence of high concentration of lead in air and water present an obvious risk specially to children living in that area. It has also been established that particulate matter, soil, dust and water are potential sources of lead in the surroundings of these Lakes / Dams.

When these data are compared with the corresponding data available from international sources pertaining the different parts of the world. The situation causes a grave concern regarding the status quo of Pb pollution problem in Rawal Lake and its vicinities. For a study conducted in Taiwan on distribution of Pb and other

Table 2: Estimated Lead Levels in Soil (mg/kg, Dry Weight), Air (μg/m³) and Water (μg/L) Samples from Khanpur Dam

S.No.	Sample Nature/Code	Pb Concentration
1.	Soil/SAW-10	14.4
2.	Soil/SAW-11	6.5
3.	Soil/SAW-12	9.2
4.	Air/SAW-13	712.5
5.	Air/SAW-14	717.5
6.	Air/SAW-15	488.7
7.	Water/SAW-16	212.0
8.	Water/SAW-17	133.0
9.	Water/SAW-18	217.0

Table 3: Estimated Lead Levels in Soil (mg/kg, Dry Weight), Air (μg/m³) and Water (μg/L) Samples from Simly Dam, Islamabad

S.No.	Sample Nature/Code	Pb Concentration
1.	Soil/SAW-19	11.2
2.	Air/SAW-20	532.5
3.	Water/SAW-21	62.0

particulate matter in air the value of 10 μg/M³ was obtained on average basis in nearby area of a battery recycling smelter (Tseum *et al.*, 1999). The corresponding data for a typical rural site in Bulgaria was 0.06-0.6 μg/m³ (BUCCI *et al.*, 1995). Lead levels in water were determined in Canada and was found 1.1-30.7 μg/L (Moyammed *et al.*, 1996).

The study revealed that the instant Pb levels both in air and water are quite higher and in many case acrossed the allowed upper safe limits layed down by WHO and other responsible organizations. This upper safe limits has been layed down for air as 2-4 μg/m³, 0.1 μg/L for water and with a natural background of 12-15 mg/Kg

Table 4: Estimated Lead Levels in Soil (mg/kg, Dry Weight), Air (μg/m³) and Water (μg/L) Samples from Mangla Dam

S.No.	Sample Nature/Code	Pb Concentration
1.	Soil/SAW-22	9.5
2.	Soil/SAW-23	5.6
3.	Soil/SAW-24	6.0
4.	Air/SAW-25	340.0
5.	Air/SAW-26	383.7
6.	Air/SAW-27	438.7
7.	Water/SAW-28	70.0
8.	Water/SAW-29	10.0
9.	Water/SAW-30	9.0

of soil. Seen in this respective the present situation of Pb distribution in local environment of Rawal Lake is quite serious needed immediate attention of the relevant authorities.

Table 5: Estimated Lead Levels in Soil (mg/kg, Dry Weight), Air (μg/m³) and Water (μg/L) Samples from Rawal Lake

S.No.	Sample Nature/Code	Pb Concentration
1.	Soil/SAW-31	32.9
2.	Soil/SAW-32	44.9
3.	Soil/SAW-33	0.1
4.	Air/SAW-34	146.6
5.	Air/SAW-35	36.8
6.	Air/SAW-36	70.0
7.	Water/SAW-37	24.0
8.	Water/SAW-38	84.0
9.	Water/SAW-39	60.0

Table 6: Estimated Lead Levels in Soil (mg/kg, Dry Weight), Air (μg/m³) and Water (μg/L) Samples from Quaid-i-Azam University Lake

S.No.	Sample Nature/Code	Pb Concentration
1.	Soil/SAW-40	18.3
2.	Soil/SAW-41	35.8
3.	Soil/SAW-42	15.4
4.	Air/SAW-43	315.0
5.	Air/SAW-44	477.5
6.	Air/SAW-45	501.2
7.	Water/SAW-46	BDL*
8.	Water/SAW-47	153.0
9.	Water/SAW-48	3.0

* Below detection limit.

Table 7: Relevant Statistical Parameters for Samples from Lake and their Vicinity

S.No.	Medium	n	$\bar{X}$	S.D.	G.M.	Range
1.	Soil	16	15.4	12.2	10.2	44.82
2.	Air	16	430.9	21.2	344.4	680.70
3.	Water	15	77.4	73.9	45.2	212.00

Table 8: Evaluation of Correlation Coefficient for Paired Media (Lake and their Vicinity)

S.No.	Medium	Correlation coefficient	Significance
1.	Air-Soil	-0.39	A relatively strong negative correlation
2.	Air-Water	0.36	Relatively strong positive correlation
3.	Soil-Water	0.08	A relatively week correlation

References

Anezaki K., X. Chem and K. Ohzeki, 1998. "Determination of Cadmium and Lead in Tap Water by GFAAS after Preconcentration on Finely Divided Ion-Exchange Resin as the Pyrrolidinedithiocarbamate Complexes", Anal. Sci., 14: 523-527.

Berthelsen B. O., E. Steinnes and L. Jingsen, 1995. "Metal Concentration in Relation to Atmospheric Heavy Metal Deposition", J. Environ. Qual., 24: 1018-26.

Chaljung M. and I. Thronton, 1996. "Heavy Metal Contamination of Soils and Plants in the Vicinity of Lead", Appl. Geochem., 11: 53-59.

Deng S., X. Li and P. Zhou, 1996. "Determination of Lead and Cadmium in Soil By Platform G.F.A.A.S. with Solid Sampling", Guangpuxue Yu Chanpu Fenxi, 16: 106-110.

Ferretti M., E. Cenni and P. Batistoni, 1995. "Vehicle-Induced Lead and Cadmium Contamination of Roadside Soil and Plants in Italy", Chem. Ecol., 11: 213-228.

Holgado T. M., J.M.P. Macias and L. Hernandez, 1995. "Voltammetric Determination of Lead with a Chemically Modified Carbon Paste Electrode with Diphenylthio-Carbazone", Anal. Chim. Acta, 309: 117-22.

Imtiaz N., T. Aftab and M. Hanif, 1995. "Effect of Lead on Human Health", Sci. Int., 7: 441-442.

Kar S. and P.K. Misra, 1994. "Impact of Auto-Exhaust Lead Pollution on Vegetation", Acta Ciene Indica. Chem., 83-86.

Roesner and Ulrike, 1998. "Effect of Historical Mining Activities on Surface Water and Ground Water. An Example From Northwestern Arizona", Environ. Geol., 33: 224-230.

Wang J., G. Ye and S. Wang, 1994. "Derivative Oscillopolarographic Determination of Lead in Air", Lithua Jiangyan, Huaxue Fence, 30: 365.

Yan X. P., M. Sperling and B. Welz, 1999. "Determination of (Ultra)Trace Amount of Lead in Biological Materials by Online Coupling Flow Injection Microcolumn Separation and Preconcentration to Electrothermal A.A.S. Using A Macrocycle Immobilized Silica Gel Sorbent", J. Anal. At. Spectrom., 14: 1625-1629.

Zhang Z.W., C.S. Moon and M. Ivoda, 1997. "Background Exposure of Urban Pollution to Lead and Cadmium. Comparison Between China and Japan", Int. Arch. Occup. Environ. Health, 69: 273-281.