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Lead Contamination of Air, Soil and Water in the Vicinity of Rawal Lake, Islamabad

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Abstract: The levels of lead in the air, soil and water of Rawal Lake and its vicinity has been determined during the temporal study. The measurement of Pb in air, soil and water appears to be a useful tool for evaluating the potential hazards of the environment. The AA technique was applied for these estimations conducted on 93 samples, 31 of each (air, soil and water) procured from the Rawal Lake. The study revealed that the range of concentration of Pb was around 33.3 to 338.7 µg/m^3 in air, 0.6-21.2 mg/Kg in soil and BDL to 170 µg/L in water. Standard deviation and geometric mean values elaborate the more random character fair, followed by water and their soil. The data collected shows that almost all the pollution is being generated by automobile exhaust and also that soil and water act as important sink for Pb released through different activities.

Key words: AAS, Lead Levels, Air, Soil, Water, Contamination

Introduction

Global and regional environmental conditions are changing rapidly due to the recent industrialization and urbanization efforts. As a result the international concern on environmental pollution is very high. Therefore, the measurements of elemental concentration in the environmental samples including air, soil and water are very important to solve pollution problems. An improved standard of living and increased demand on the transport sector and rapidly increasing population lead to congestion in cities.

Lead contamination arises mainly from the combustion of Petrol, to which alkyl lead compounds in the form of TML and TEL have been added as an antiknocking agent in order to prevent the fuel from spontaneously exploding before its ignition by spark plug. Lead standards were established in 1985 and are still being used in Pakistan, these standards allow to put 0.6-0.84 g/liter of lead.

Continuous monitoring of Pb in the atmosphere i.e. in air, soil and water is imperative, such studies are important to provide informations on how individual sources of lead pollution may be controlled to provide clean air, today the air which contains as many as 188 Hazardous Air Pollutants (HAP) which USA-EPA labels as major pollutants, the lead is one of these (Kalanydjieva and Irina, 1997).

Water, like air, is also an important part of our environment and is directly related to the sustenance of human being or any other living organisms. Water is a major since for such pollutants from air or soil and also from industrial wastes and contamination of water with lead is the major concern regarding lead poisoning throughout the world. The water bodies close to the polluted air interface were found to have high Pb levels contrary to the situation that is away from the source (Anon, *et al*;1998).

Some of the industrial processes e.g. battery recycling or lead smelting have been found responsible for Pb pollution in water, due to which some of the environmentally sensitive water bodies, including rivers and wetlands were found to require urgent remedial action (Bucci, *et al*;1996).

Soil is an important sink for metal pollutants released through different human activities. The auto-exhaust lead pollution is the main route to introduce lead in soil and vegetation (Moyammed,*et al*;1996).

The concentration of lead and other heavy metals in soil decreased exponentially with distance from the source, and their accumulation in the soil might vary from place to place (Kar and Misra, 1994 and Chaljung and Thronton, 1996).

The role of Pb is very critical in determining the quality of our atmosphere, because air, soil and water are directly interacting with each other. Growing lead pollution especially in air has led to an increase in the respiratory diseases, infant mortality and also act as a poison that effect the functioning of the blood, liver, kidney and brain. The measurement of lead accumulation in soil appears to be a useful tool for evaluating the potential lead hazards of the environment. The main objectives of this investigation are to estimate the content of lead in air, soil and water, and change in the concentration of lead level in these 3 media on temporal basis.

Materials and Methods

The investigation was based on 93 samples (31 for each of air, soil and water). These samples were procured from the Rawal Lake and its vicinity. 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 Rawal Lake and its vicinity by AAS technique.

Results and Discussion

The sampling code description and the concentration of lead in air, soil and water are summarized in Table 1. Statistical evaluation for the data is presented in Table 2. Normally, triplicate sampling was conducted for routine investigation and as many as thirty-one samples (each of air, soil and water) were procured for detailed temporal study pertaining to Rawal Lake, Islamabad. The concentration of lead in air is expressed in more commonly adopted units of µg/m^3, for soil as mg/Kg, dry weight basis and for water as µg/L, as elsewhere. The data description and its layout outlined above are also duly presented in figures in a logical sequence that follows the Table.

Temporal study incorporating air, soil and water samples collected on a given day/time from Rawal Lake area, Islamabad. The study encompassed four phases; Phase 1 comprises 21 samples (7 for each), Phase II, III and IV comprised 24 samples (8 for each), (Table 1). the soil samples showed a substantial variation in lead contents, ranging between 0.6 mg/kg and 19.2 mg/kg from the same idealized location where from the air/water samples were also procured, if a 12-13 mg/kg lead level is envisaged for normal back ground of the metal in soil arising mainly from the lithosphere contribution, then only three samples (TS-29, TS-4 and TS-5) could be labeled as having higher lead than the back ground levels.

This could be due to some sporadic effect whereby the soil lead went up, or it could be due to the aquatic leaching effect on the bank site. On the same date (15-01-2001) highest levels of lead was seen in sample TS-11 and relatively high level of the metal in water on the following day. These incidents might have some correlation among each other.

As for as the air samples are concerned, the highest lead concentration was 338.7 µg/M^3 and the lowest 51.3 µg/M^3, an obviously episodal event whereby both soil and water were effected (Table 1). The water showed highest level of 163 µg/L lead, which tapered off to 140 µg/L and then rose to a higher value (161 µg/L) with in the next couple of days. Since surface water samples were taken for analysis, it is conceived that the reported data relate only to the surfacial concentration of the metal.

The Phase-II temporal study was identically carried out to confirm the observation of Phase-I temporal study. Table 1 summarizes the relevant data, for Phase-II. For this batch, the soil samples mainly exhibited the average background levels, with only one exception where a higher concentration (21.2 mg/kg) was encountered. This was the day with only a marginally low level of lead in air, but a relatively much higher level in water.

The atmospheric intrusion carrying a high flux of lead from an active source could have caused this event. However, as seen in Phase-I study, the temporal variation in the three media is characteristically different. Largest variations are observed in the lead levels in air, followed by water, and then by soil.

The later part of the temporal study (Phase III and IV), also augments the above observations, with the only difference that here the levels of lead were markedly higher than Phase-II temporal study. The soil samples showed a little higher than average (≈ 12-13 mg/kg) lead levels; the air samples showed elevated lead levels and the water again, showed levels of metal onto the higher side, as compared with Phase-I.

Some statistical parameters were calculated to make the results more elaborate. This analysis presents a mathematical evaluation of the data in term of its distribution for lead concentration in three media. Table 2 presents the average lead levels in air, soil and water and their values stands at 169.1 µg/M^3, 12.1 mg/µg, dry weight of soil and 71.3 µg/L for air, soil and water, respectively. Since in this study the sample size was considerably very large (n=31) the average Pb levels in air, soil and water samples could be taken as true representation of three media. The average soil

Table 1: Estimated Lead Levels in Soils (mg/kg, dry weight), Air (µg/m^3) and Water (µg/L) Samples from Rawal Lake, Islamabad

Air Sample Code	Pb µg/m^3	Soil Sample Code	Pb mg/Kg	Water Sample Code	Pb µg/L
Phase 1					
Ts-1	250.0	Ts-2	13.4	Ts-3	15.0
Ts-4	256.2	Ts-5	15.6	Ts-6	163.0
Ts-7	93.7	Ts-8	6.7	Ts-9	84.0
Ts-10	292.5	Ts-11	16.3	Ts-12	53.0
Ts-13	51.3	Ts-14	19.2	Ts-15	140.0
Ts-16	148.7	Ts-17	0.6	Ts-18	24.0
Ts-19	338.7	Ts-20	9.1	Ts-21	161.0
Phase 2					
Ts-22	146.6	Ts-23	1.1	Ts-24	22.0
Ts-25	159.1	Ts-26	14.0	Ts-27	4.0
Ts-28	35.8	Ts-29	12.4	Ts-30	121.0
Ts-31	69.1	Ts-32	8.4	Ts-33	23.0
Ts-34	73.3	Ts-35	5.6	Ts-36	48.0
Ts-37	75.0	Ts-38	21.2	Ts-39	91.0
Ts-40	33.3	Ts-41	12.8	Ts-42	13.0
Ts-43	195.0	Ts-44	10.4	Ts-45	
Phase 3					
Ts-46	260.5	Ts-47	14.4	Ts-48	117.0
Ts-49	255.3	Ts-50	16.4	Ts-51	153.0
Ts-52	95.8	Ts-53	16.6	Ts-54	160.0
Ts-55	285.0	Ts-56	14.3	Ts-57	84.0
Ts-58	251.2	Ts-59	19.4	Ts-60	170.0
Ts-61	149.7	Ts-62	15.3	Ts-63	120.0
Ts-64	330.9	Ts-65	13.1	Ts-66	80.0
Ts-67	280.4	Ts-68	10.2	Ts-69	55.0
Phase 4					
Ts-70	149.6	Ts-71	2.3	Ts-72	24.0
Ts-73	169.1	Ts-74	14.1	Ts-75	07.0
Ts-76	135.8	Ts-77	11.5	Ts-78	132.0
Ts-79	90.2	Ts-80	7.9	Ts-84	31.0
Ts-82	81.3	Ts-83	6.7	Ts-84	14.0
Ts-85	175.0	Ts-86	20.3	Ts-87	71.0
Ts-88	130.0	Ts-89	14.6	Ts-90	21.0
Ts-91	185.0	Ts-92	10.2	Ts-93	10.0

lead standing at 12.1 mg/Kg proves the argument in close agreement with the average terrestrial Pb soil levels. The standard deviation shows more random character for air, followed by water and then soil. The geometric mean values do differ with respect to the average values for the three media, thereby indicating that the data on lead concentration are random in character. The range values are substantially high, thereby indicating large dispersion in the soil, air and water composition with respect to Pb.

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 Rawal Lake, Islamabad.

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 particulate matter in air the value of 10 µg/m^3 was obtained on average basis in nearby area of a battery recycling smelter (Yousfzai,et al;1998). The corresponding data for a typical rural site in Bulgaria was 0.06-0.6 µg/m^3 (Gidikova,et al;1998). Lead levels in water were determined in Canada and was found 1.1-30.7 µg/L .

The study revealed that the instant Pb levels both in air and water are quite higher and in many case crossed the allowed upper safe limits laid down by WHO and other responsible organizations. This upper safe limits has been laid down for air as 2-4 µg/m^3, 0.1 µg/L for water and with a natural background of 12-15 mg/Kg of soil. Seen in this respective the present situation of

Table 2: Relevant Statistical Parameters for Temporal Study.

S.no	Medium	n	$\bar{X}$	S.D.	G.M.	Range
1.	Soil	31	12.1	5.3	9.93	20.59
2.	Air	31	169.1	89.6	153	305.4
3.	Water	30	71.3	57.4	47.88	170.0

Pb distribution in local environment of Rawal Lake is quite serious needed immediate attention of the relevant authorities.

References

Yousfzai A. H. K., D.R. Hashmi and A. Salam, 1998. "Measurement of Lead and Heavy Metal Accumulation in the Soil of Urban Areas of Karachi", J. Chem. Soc. Pak., 20: 168-175.

Anon, 1998. Locating and Estimating Air Emissions From Sources of Lead and Lead Compounds, U.S.A., Environ. Prot. Agency, off Air Qual. Plann. Stand., (Tech. Rep.) EPA-(EPA-454/R-98-006), 1-379.

Bucci D., E. Benetti and S. Galassi, 1996. "Mercury, Lead and Cadmium Contents in Environments And Marine Organisms of Micronesia, Belize and New Hebrides", *Inqunamento,* 38: 64-66.

Kalanydjieva and G. Irina, 1997. "A New Method For Determination of Tetraethyl and Tetramethyl Lead in Air", Toxicol. Environ. Chem., 62: 11-20

Chaljung M. and I. Thronton, 1996. "Heavy Metal Contamination of Soils And Plants In The Vicinity Of Lead", *Appl. Geochem.,* 11: 53-59

Gidikova p., Deliradeva and Rositza, 1998. "Air Lead Pollution and Lead Exposure of Experimental Animal and Children In Stara Zogara Town (Bulgaria)", Int. J. Environ. Health Res., 8: 303-313

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

Moyammed T. I., I. Changyen and I. Bekele, 1996. "Lead Pollution in East Trinidad Resulting From Lead Recycling and Smelting Activities", Environ. Geochem. Health, 18: 123-128.