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Heavy Metal Contamination In Solid Aerosols And Top Soils Of Faisalabad Enviornment

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Abstract:-

The suspension of trace elements in the atmosphere as solid aerosols from natural and anthropogenic sources is an important factor for plants, animals and humans as well. AAS technique was used for the evaluation of trace elements in the solid aerosols and the soil samples of randomly selected sites related to Faisalabad environment. The concentration of Cd (54 %), Pb (24 %) ranging from (0.001 to 0.12), (0.001 to 0.082) with mean values 0.060, 0.042 respectively were in little excess from (TLvs) while Cu (3 %), Zn (Nil) were within permissible limits over all effect of all these trace elements on the environment is only 22.5%. While the concentration of trace elements in soil samples were found to be Cd(15.43%), Cu(3.61%), Zn(28.46%), Pb(52.50%) ranging from (0.17 to 1.37), (0.05 to 0.30), (0.47 to 2.36) and (0.62 to 4.62) respectively with mean values 0.77, 0.18, 1.42 and 2.62 having overall effect as 28.44%. Concentration factor for each element along with Pollution load index (PLI) was also calculated and it was found that origin of Cu and Zn in the solid aerosols was soil derived while Cd and Pb are present due to some other anthropogenic sources like industry and transport. Soil samples mostly related to industrial cum commercial areas with local and remote origin both. The reason behind that is the contribution of different kinds of industries like metallurgy, chemical industry, pulp, paper, fertilizers, textile, paint and leather industry are contributing these trace elements in the Faisalabad environment as additional pollutants and affecting the health of workers and residents living in the concerned areas.

Key words: elemental atmospheric air pollution, positive co-relationship with soil samples, overall effect of soil samples 28.44% > 22.5%, reason-industrial cum transportational environment, negative impact on human health, protective measures suggested.

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1. Introduction:

Cities all over the world are getting bigger as more and more people move from rural to urban sites, but that has created enormous problems with respect to environmental pollution and the general quality of life. The quality of air we breathe has worsened with the revolutions in industry and rise in the living standards of the inhabitants of earth. This state of affairs has given rise to abrupt climatological and meteorological changes along with serious health hazards to human beings and animals. Atmospheric aerosols are one of the important pollutants playing a key role in all these changes because of their sources/origin, generation processes, reaction mechanisms, transportation and effects on environment as well as on human health. Any substance that is present in nature in greater quantity than natural abundance due to anthropogenic activities ultimately has detrimental effects not only on environment but also on living organisms is called Pollutants e.g. CO_2, CO, SO_2, Cd, Hg, Cr, Pb, Zn, Cu, Mn, Ca, Co and Mg [1-2]. These chemicals are released into the atmosphere from different sources in the form of solid aerosols. No doubt a lot of work has been done on physico-chemical composition of aerosols yet they are not completely understood. Aerosols play a vital role in our atmosphere. They produce respiratory and cardiovascular health hazards, when inhaled and get deposited inside body, increasing mortality and morbidity rates not only in children but young people and elders too [3; 4].

The sources of solid aerosols consist of industries, transport, commercial and residential areas. High temperature industrial process release coarse fractions of aerosols containing Ng, Ca, Ni, Mn, Cu and Zn. Automobile exhaust and fertilizer industries also release these metals, their compounds, or other salts in the atmosphere [5]. All these metals produce different diseases like oxides of Zinc along with oxides of Iron produce gastric disorder and vomiting, irritation of skin and mucous membrane. Nickel, Chromium, Cadmium, Copper and Carcinogenic calcium causes slowing of heart rate [6].

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The above mentioned effects are not confined to a single area or a specific region but due to migratory nature of aerosols, these have also been reached to remote areas. Pakistan along with other modern and developing countries like America, England, China, and India is also facing drastic environmental changes due to solid aerosol pollution. Shattering Earth quakes, catastrophic tsunamis, unpredictable rain falls, uneven seasonal distributions, swiftly melting polar ice caps and extensive flooding all over the world is the evidence of rapid climatological changes due to increased levels of solid aerosols in the environment. So, Air pollution is not just a city problem now. As many pollutants are dispersed over areas hundereds of miles away from their source where they affect many different ecosystems. These pollutants often remain toxic in the environment for a very long period of time where they continue to affect ponds, streams, fields and forests. Siol derived material aired regions of the earth are transported over long distances within the atmosphere even in extremely remote areas. The soil component is therefore an essential part of the total atmospheric aerosol burden. Various chemicals that are given out by various sources in to the air like Cu, S, Zn, Pb and Cr etc evantually were deposited in the form of wastes on the land which are to seep in to the soil [7-8].

Faisalabad being the “Manchester of Pakistan”, due to its industrial growth and haphazard urbanization along with transportation capacity has become the most critical area of Pakistan due to physico-chemical changes taking place in its environment [9]. Faisalabad is the third largest city in Pakistan with an estimated population of 4 million citizens. It is an important center for transport and production and is located in the Punjab province. The district lies between 73° and 74^{o} longitudes in east and 30° and 31.15° latitudes in North. It is bound by Gujranwala and Sheikhupura districts in its North. The district is a flat alluvial plain formed by Chenab and Ravi rivers. The Ravi flows along the South-Eastern boundary of the district [10-12]. Faisalabad district has made rapid strides in the field of industry after independence. Roughly, there are more than 512 large industrial units comprising 328 textile units, 92 engineering units and 92 chemicals and food processing units. Other industries include hosiery, carpet and rugs, nawar, and lace, printing and publishing and pharmaceutical products etc. there are also some 12000 house- hold industries, which include some 60,000 power loom factories.

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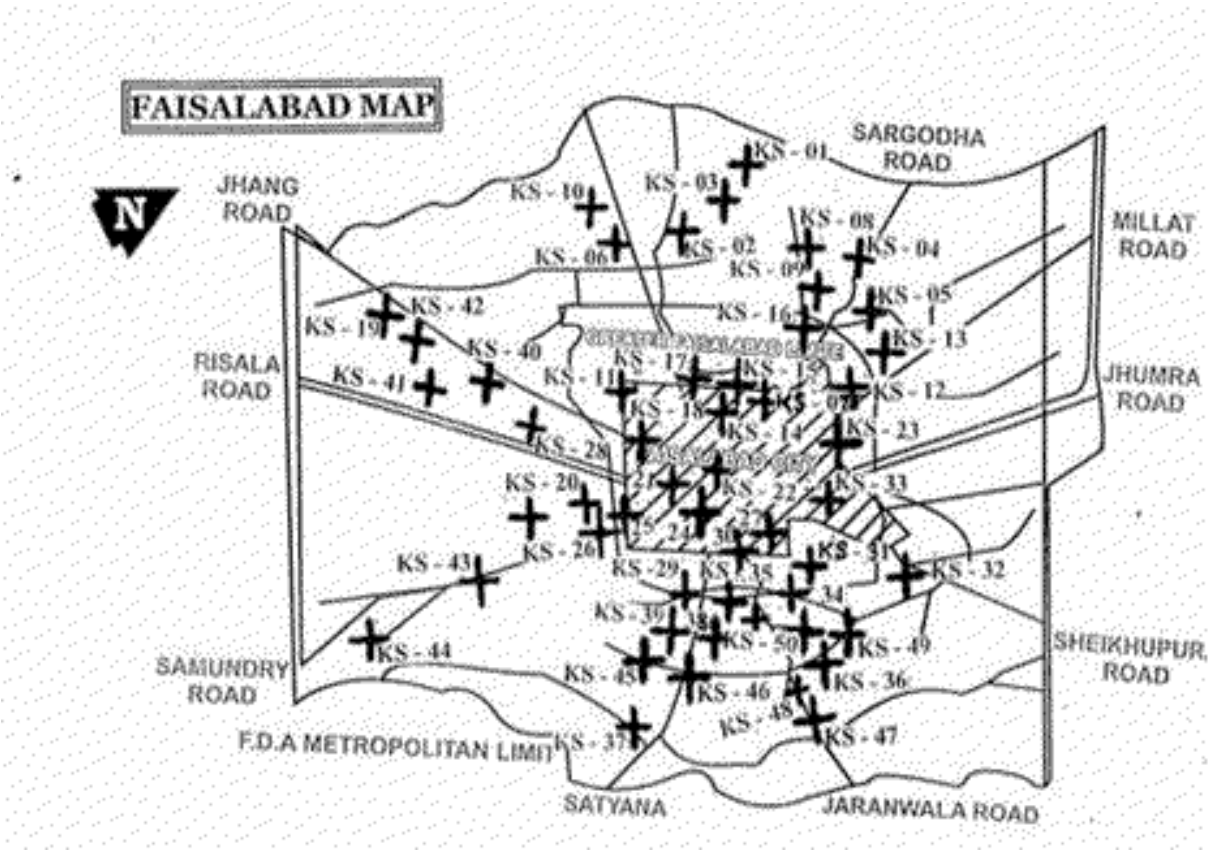

Fig 1: Site selection for Faisalabad City

In the current era, increased attention is being paid to protect the environment in the developing countries. The concern stems primarily from recent advances in information concerning health problems associated with protection. Unfortunately, the evaluation of the projects and policy reforms for environmental protection in Pakistan has been rare. The purpose of this study is to provide credible information on the subject. This work is a continuation of our PhD project submitted and published elsewhere.

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2. Materials and Methods:

The research project was carried out to estimate the trace elements like Cd, Zn, Cu and Pb in the atmosphere of Faisalabad city. 50 sites for solid aerosols and 10 sites for soil samples were randomly selected for analysis covering industrial, Transportational, commercial and residential nature of the Faisalabad environment. Samples of solid aerosols were collected using kimoto high volume air sampler. The high volume air sampler used to pump 576m^3 volume of air and was equipped with the glass fiber filters having a collection efficiency of 90 % for particles. Samples were collected for a period of 12 hrs at an average flow rate of 0.8m^3/min. The filter was weighed before and after sampling. Then using oxidizing acid mixture samples were digested and analyzed by atomic absorption spectrophotometer (Hitachi 2-8200) [6]. A stainless steel trowel was used to take out the soil samples. The soil was taken from 0 to 5cm of each topsoil. The soil samples were placed in polythene bags and air was completely removed.10 samples were randomly collected keeping in view the residential, Industrial and commercial areas of Faisalabad. Cadmium (Cd), Copper (Cu), Lead (Pb) and Zinc (Zn) were determined using atomic absorption spectrophotometer (Model No.: Varian AA-1475) [13].

3. Results and Discussion:

Table-1: Concentration of Trace Elements Detected in Solid Aerosols

Code	Cd(PPm)	Cu(PPm)	Zn(PPm)	Pb(PPm)
2K01	0.11	0.09	2.82	0.04
2K02	0.10	0.07	0.72	0.25
2K03	0.10	0.09	1.01	0.050

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2K04	0.11	0.11	1.91	0.080
2K05	0.11	0.08	0.86	0.09
2K06	0.10	0.09	0.91	0.08
2K07	0.09	0.12	0.85	0.04
2K08	0.12	0.09	1.04	0.05
2K09	0.11	0.09	1.42	0.06
2K10	0.12	0.09	1.24	0.04
2K11	0.12	0.11	1.38	0.07
2K12	0.10	0.13	1.39	0.05
2K13	0.12	0.09	1.20	0.026
2K14	0.12	0.11	1.44	0.024
2K15	0.12	0.07	1.32	0.025
2K16	0.12	0.09	1.35	0.068
2K17	0.12	0.05	1.13	0.051
2K18	0.11	0.05	1.23	0.051
2K19	0.09	0.09	1.17	0.049
2K20	0.08	0.10	0.77	0.068
2K21	0.11	0.12	1.17	0.05
2K22	0.09	0.11	1.25	0.07
2K23	0.10	0.10	1.51	0.06
2K24	0.12	0.10	1.42	0.058
2K25	0.09	0.11	1.40	0.049

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2K26	0.10	0.09	1.23	0.049
2K27	0.10	0.10	1.20	0.024
2K28	0.13	0.09	1.36	0.023
2K29	0.11	0.09	1.21	0.025
2K30	0.12	0.12	1.21	0.038
2K31	0.11	0.21	1.42	0.034
2K32	0.006	0.57	1.42	0.024
2K33	0.007	1.28	1.40	0.076
2K34	0.006	1.18	0.95	0.25
2K35	0.007	0.09	0.97	0.82
2K36	0.440	0.07	0.60	0.052
2K37	0.007	0.10	0.99	0.049
2K38	0.007	0.09	0.99	0.037
2K39	0.007	0.08	0.99	0.048
2K40	0.006	0.12	1.20	0.059
2K41	0.007	0.10	0.75	0.058
2K42	0.007	0.17	1.10	0.022
2K43	0.007	0.08	1.05	0.032
2K44	0.007	0.09	1.26	0.048
2K45	0.007	1.62	0.97	0.024
2K46	0.007	2.12	0.90	0.074
2K47	0.007	2.08	0.75	0.069

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2K48	0.007	1.09	1.05	0.034
2K49	0.007	0.84	1.07	0.060
2K50	0.007	0.08	1.25	0.062
PERMISSIBLE LIMITS				
	0.005	1.3	5	<0.05

Ref: US, EPA, D/H_2O STANDARD E.C.A.F.E & UNESCO D/H_2O STANDARD

Table-2: Concentration of Trace Elements Detected in Soil Samples

Soil samples	Pb(ppm)	Zn(ppm)	Cd(ppm)	Cu(ppm)
$2KS_1$	4.62	1.05	1.15	0.10
$2KS_2$	0.92	0.78	0.28	0.08
$2KS_3$	2.30	0.94	0.74	0.13
$2KS_4$	2.66	1.37	0.97	0.14
$2KS_5$	0.96	1.35	0.26	0.28
$2KS_6$	3.89	2.36	0.78	0.30
$2KS_7$	3.77	2.26	1.34	0.22
$2KS_8$	0.62	0.84	0.80	0.18
$2KS_9$	1.74	0.47	0.17	0.05
$2KS_{10}$	4.46	1.78	1.37	0.21

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Table-3/i : Statistical Analysis of Identified Phases in SPM

Phase	Maximum	Minimum	Mean	SD	CV
	Range				
Cd	0.440	0.006	0.223	0.217	97.31
Cu	2.12	0.05	1.085	1.035	95.39
Zn	2.82	0.60	1.71	1.11	64.91
Pb	0.82	0.022	0.421	0.399	94.77

Table-3/ ii : Statistical Analysis of Identified Phases in soil Samples

Phase	Maximum	Minimum	Mean	SD	CV
	Range				
Cd	1.37	0.17	0.77	0.60	77.92
Cu	0.30	0.05	0.18	0.125	69.44
Zn	2.36	0.47	1.42	0.945	66.55
Pb	4.62	0.62	2.62	2	76.34

Table-4: Comparison B/W C.V of Soil Samples and C.V of SPM Samples

Phases	Ratio = $C.V_{soil}/C.V_{SPM}$
Cd	0.80
Cu	0.73
Zn	1.02

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Pb	0.81

Table-5: Concentration Factor and Pollution Load Index for Solid Aerosols with respect to Soil

Serial No.	Concentration factor Cd	Concentration factor Cu	Concentration factor Zn	Concentration factor Pb
1	0.095652174	2.1	1.352380952	0.007359307
2	0.021428571	7.125	1.820512821	0.026086957
3	0.009459459	9.846154	1.489361702	0.033043478
4	0.006185567	8.428571	0.693430657	0.093984962
5	0.026923077	0.321429	0.718518519	0.854166667
6	0.564102564	0.233333	0.254237288	0.013367609
7	0.005223881	0.454545	0.438053097	0.012997347
8	0.00875	0.5	1.178571429	0.059677419
9	0.041176471	1.6	2.106382979	0.027586207
10	0.004379562	0.571429	0.674157303	0.0132287
Pollution Load Index (PLI)	3.8748E-08	43.99037	5.8354887	4.38973E-07

Trace elements were detected by AAS, and it was seen that percentage of Cd (54 %), Pb (24 %) ranging from (0.001 to 0.12), (0.001 to 0.082) with mean values 0.060, 0.042 respectively were in little excess from (TLvs) while Cu (3 %), Zn (Nil) were within permissible limits. Over all effect of all these trace elements on the environment is only 22.5 %. While the concentration of trace elements in soil samples were found to be Cd(15.43%), Cu(3.61%), Zn(28.46%), Pb(52.50%) ranging from (0.17 to 1.37), (0.05 to 0.30), (0.47 to 2.36) and (0.62 to 4.62) respectively with mean

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values 0.77, 0.18, 1.42 and 2.62 having overall effect as 28.44%. High concentration of above said elements is due to expended industrialization, rapid urbanization, mechanized transportation . They generate 50 % of Co, Pb, Cd, Cr, Ni, Zn etc causing increase in respiratory diseases. It was found that the trace elements like Cd, Cu, Pb and Zn found in soil samples were also found in solid aerosols related in industrial cum transportational areas of Faisalabad city. The media possibly was the wind erosion and anthropogenic activities. Moreover, high concentration in soil samples is also high in solid aerosols. However, the concentration of some trace elements high in solid aerosols, which may be possible because of the migratory effect by wind erosion that shows that soil of the certain locality (Industrial cum Commercial), is an active source for the air pollution of the Faisalabad environment [14-16]. However, the trace elements which do not exist in the soil but present in the solid aerosols, it is proposed that their source may be remote i.e., climatological, meteorological and geographical factors are also contributing. The homogeneity in the trace elements in some samples and heterogeneity in some other samples is apparently due to that fact that said aerosols in the Faisalabad environment are well mixed as a product of continuous deposition in those places whereas on other places this do not happen which means that environment of Faisalabad is polluted in patchy areas and (homogenous and heterogenous) is very complex [17-18].

The metal levels in Faisalabad environment were also compared with those reported in other parts of the world which showed that the metal levels are in excess than those reported for eurpeon industrial and urban sites. Similarly data for various asian sites revealed that the levels of metals for the present study were lower than those reported for highly polluted cities of the world. Since considerable amount of toxic metals have been observed in solid aerosols and soil related to Faisalabad environment, legislation and regulations for health and welfare of humanity id desireable in the developing countries like Pakistan.

From these experimental findings it was concluded that trace elements in solid aerosols are not imposing any serious risks for the time being, as shown by slight variations of means, standard deviations and CVs, but precautionary measures are still required because absence of trace elements

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depends upon many factors, the most important factor was the use of filters for detection and filtration purposes, it may be possible that most of trace elements remain in filter residue, moreover the trace elements were estimated in soluble form. Bondage of trace elements in the form of insoluble compounds may also be responsible for exclusion of these traces, without this, seasonal variations may have adverse effects on trace elements. For controlling the solid aerosols in the air, it is suggested that government must run a campaign on missionary basis for a lot of tree plantation for the eradication of the unnecessary addition of solid aerosols in the atmosphere of Faisalabad city. Since trees are the best antidote for the cleaning of atmosphere. *Currently they are not posing any serious risk for human health as was confirmed by slight variations in means, CVs, and SDs; But precautionary measures are still required because the cause of low concentrations may be due to use of filters and soluble form analysis of metals.* The concerned authorities, the corporate sector and public must fight together against the demon of pollution, as this is the real threat to the human health [19-24].

4. Concluding Remarks:

Present studies revealed that concentration of heavy metals were significantly higher than the permissible limits prescribed by the regularity authorities. Among the selected trace metals highest concentration was noted for Cu and Zn followed by Pb in solid aerosol samples and Pb and Zn followed by Cu in soil samples. The estimated metal concentration in solid aerosols and soil both in this study were higher than that of the most of the Eurpeon studies but lower than large metropolitan cities of the world. The co-relationship between solid aerosols and soil samples was found to be positive.Major sources of these trace elements were found to be industrial emissions and wind blown soil dust.Pollution load index (PLI) for Cu and Zn is greater than 1 while for Cd and Pb it is lower than 1; which confirms that toxic metals Cu and Zn being the natural components of the soil were shifting from soil to solid aerosols while reverse behavior of Cd and Pb confirms some physio chemical changes taking place in the environment due to industrial waste treatment because these metals are not the ingredients of natural soil.

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AUTHOR,S PROFILE:

Dr Khan has received his M.Phil Degree in Solid State Physics from CSSP (PU) Lahore Pakistan with research project entitled "Radioactive Pollution and its Health Hazards, a Study by SSNTDs and XRD analysis" and Master Degree in Physics with specialization in "Advance Electronics" from G.T.I.College (new Campus) Rabwah, PAKISTAN affiliated with PU, Lahore. Recently has completed his PhD Degree with project in Solid State Physics entitled "A Comprehensive Investigation of Solid Aerosols Using XRD and ASS Techniques" He has completed other relevant Post graduate training courses as participant, presenter and as a faculty member in his areas of specialization from PINUM, NIAB, PNRA, NIFA, EPD etc the well reputed institutions of Pakistan Atomic Energy Commission and Environmental Protection Department along with his Professional in service training. Recently He is working as Associate Professor of Physics in the Department of Physics GCU (UDC/CC) Faisalabad. As for as his research Experience is concerned it is multidimensional, He has more than 30 years of academic and research experience at graduation and post graduation level, his areas of interest are Solid state Physics, Surface Physics, Aerosol Physics, Thin Film Technology, Crystal Growth, Cloud Nucleation Theory, Nano Physics Atomic and Nuclear Physics, Health and Medical Physics, Radiation Physics, Radiography and Medical Imaging Geo Physics, Soil Physics, Climatology and Meteorology, X-ray Crystallography etc. More than 95 Research Projects have been completed under his supervision with breakup as Atomic and Environmental research Project Physics (33), Health and Medical Physics (12), Radiation Physics and Dosimetery (33), Solid State Physics " Electronics and Electrical Instrumentation (09), Soil and Geo Physics (05), Laser and Plasma Physics (03) respectively and have 95 research publications along with 20 manuscripts in progress and expected to be published very soon in well reputed journals in his credit, He is Ex. Pakistan Nuclear Regularity Authority (PNRA) certified Health Physicist RPO, RSO (PAEC) as attachment with atomic and Nuclear Physics research lab. Editor ,executive editor ,associate editor Active member of advisory boards, Editorial Committee and reviewer/ referee in above said areas of interest for more than 15 national international journals Dr Khan has also honored to be a member of world class societies, institutes, webs, organizations and important links related to his areas of specialization like Prof. Abdul Salam Physics Society, Pakistan Institute of Physics (PIP), Physics web (the community websites of Institute of Physics), Nanotech web org. (the community websites of Institute of Physics), Medical Physics web (the community websites of Institute of Physics), Optics org. (The community websites of Institute of Physics), PASTIC. (Pakistan Science Foundation), the Aerosol Society" the science of airborne particles, USA. American Association of Physics Teachers (AAPT). American Physics Society (APS), Particle and High energy physics, global research and consulting network, Radiation protection and Dosimetry (RPD), Saudi medical physics

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