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Full Length Research

Assessments of dust induced crop nutrient (NPK) and heavy metal (Cd, Pb, Ni, Zn, Cu) deposition in Urban Agriculture of Kabul, Afghanistan.

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Kabul, capital city of Afghanistan where urban and peri-urban agriculture (UPA) is a major contributor to local livelihood strategies but like in many Central Asian countries at the same time a centre for heavy industry with poorly controlled emissions of heavy metals. In an effort to quantify dust inputs into agriculture, this study aimed at collecting during a 12-month period dust induced major crop nutrients(nitrogen N, phosphorus P, and potassium K, and heavy metals (cadmium Cd, lead Pb, nickel Ni, zinc Zn, and copper Cu) deposition in the city's UPA areas. The results showed that total dust precipitation dominated in April (12.5%) and July (12.1%) and was lowest in October, November (2.7%) and January (5.5 %). Across the year, Macrorian farm (MF)received the highest amount of dust (1,823 kg ha^{-1}) followed by Charah-e-Abdulhaq farm (CF) with 1,455 kg ha^{-1}, Guzargah farm (GF) with1,308 kg ha^{-1},Qala-e-Wazir farm (QF) with 2,001 kg ha^{-1}, and Agriculture College farm (AF)with 1,000 kg ha^{-1}. NPK raised serious environmental concerns due to total N abundance in dust during July (14.50%) followed by April (13.92%). P2O5 is second in terms of pollution by high concentration in dust during April (13.56%) followed by July (13.20%). Cd concentration was BDL in all farms. The amount of Pb, Ni, Cu, Zn, were higher in QF by (95.73%), (84.11%), (90.45).and (87.50%),respectively. The data show the strong seasonal variation in dust load for Kabul but also that heavy metal deposition in the dust is a serious concern for the city's inhabitants. This will require political action.

Keywords: Aerosol dust, Crop nutrient (NPK), Heavy metal, Kabul urban area, Kabul, Afghanistan**.**

1. INTRODUCTION

Urban and peri-urban agriculture (UPA) is of particular importance in Kabul city where it provides fresh produce to the population and creates job opportunities. UPA is expanding rapidly as a consequence of the continuing arrival of rural immigrants who leave the countryside where still 71% of the population lives due to political turmoil or infrastructural constraints (CSO 2018). Intensive traffic, uncontrolled industrial emissions, excessive use of agricultural inputs, and deposition of burned and unburned city wastes contribute to a deteriorating air, water and soil quality. Lacking collection and disposal infrastructure leads to 70% of Kabul's total solid waste (at least 300 t day^{-1}) being accumulated at the roadsides and in backyards, drains, rivers and open places where it represents a significant environmental hazard and to which the effluents of the virtually non-existent sewage system have to be added (Afghanistan Online, 2010; UN HABITAT, 2010). This likely contributes to human health problems such as *Methamoglobinemia*, c*ancer*, n*itrate poisoning* and as well as causing high infant mortality as a consequence of water-borne diseases (UNICEF, 2008). Possible cause-effect relationships exist between sewage water-related contamination of leafy vegetables (Drechsel et al., 2000; Sonou., 2001) and environmental problems by ground water contamination, Eutrophication of surface water, acid rain and ammonia evolution and redeposition and stratospheric ozone depletion and subsequent global climate change problems are largely ignored by decision makers. The same is true for heavy metals that are of growing concern in UPA-derived produce of many developing countries (Qadir et al., 2000; Abdu et al., 2011) as their accumulation via the atmosphere-soil-plant chain in the human body can lead to a variety of health disorders, including cancer (Voutsa et al., 1996; Anikwe et al., 2002; Türkdogan et al., 2002; Liu et al., 2006; Khan et al., 2008; Sediqi, A., 2013).Recent analyses of samples of irrigation water, crops and Kabul soil, suggest that the severity of crop and water contamination with heavy metals was negligible compared to the contamination with microbial pathogens (Safi et al., 2011) but the data base is sketchy and pollution levels have substantially increased. Given lacking quantitative data on NPK and heavymetals on polluted air and suspended dust in Kabul city, this study aims to determine the levels of NPK in dust and to determine the rate of carcinogenic trace elements/heavy metals in Kabul’s atmospheric dust.

1.1. Major farming practices and problem statements:

Kabul’s vegetable farming system is largely located in the highly populated areas along the Kabul River (1,765 m a.s.l.) where plot sizes range from 54 - 1,000 m^2. Night soil and city biosolids are the dominant inputs for crop production. Untreated sewage water is used for supplementary irrigation to vegetables such as radish (*Raphanussativus* L), coriander, (*Coriandrumsativum* L), leek (*Allium ampeloprasum* var. *porrum* L), onion (*Allium cepa* L), carrot (*Daucuscarota* L.), turnip (*Brassica compestris* var. *rapa* L.), eggplant (*Solanum melongena* L.), spinach (*Spinaciaoleracea* L.), pepper (*Capsicum annuum* L.), lettuce (*Lactuca sativa* L.), mint (*Menthaarvensis* L.), garlic (*Allium sativum*L.), cabbage (*Brassica oleracea* L.), pumpkin (*Cucurbita moschata* L.), tomato (*Lycopersiconesculentum* L.), and forages.

The cereal production area (1,767 m a.s.l.) in the southern part of the city has typical plot sizes of 100 - 2,000 m^2. This area has no proper drainage and in spring occasional rainfall events may lead to flash floods that rush through the low laying areas. The local cropping system is dominated by wheat (*Triticumaestivum* L.), followed by potato (*Solanum tuberosum* L.), onion, turnip (*Brassica rapa* var. *rapa*L.), corn *(Zea mays*L.), and forages. Night soil and city biosolids are the dominant inputs of crop production. This system is largely subsistence-oriented whereby open land is used by pastoralists whose animals are freely grazing in the city surroundings.

The vineyards for raisin grape production (1,758 m a.s.l.) with plot sizes of 200-6,497 m^2 have a well-established irrigation infrastructure. In the spring, irrigation water for this area comes from Kabul River and during the remainder of the year from wastewater of residential areas complemented by sewage sludge compost. The deposited stream sludge and decomposed city bio-waste materials may contribute to substantial loads of organic and inorganic NPK and heavy metals.

In the above described three production systems the major input pathways of NPK and heavy metals to the soil are: 1) Atmospheric deposition, 2) Biological N_2-fixation, and 3) Mineralization of the waste material applied. Many fundamental aspects of the systems such as the application of irrigation water, city wastes, and location of the fields in the city, and soil parent materials are subject to human management. Unfortunately, human-induced movement of an element to a part of the environment where it can have a negative effect is often a synonym for pollution. Therefore, we need to enhance our basic understanding of these processes and develop practical means to minimize the effects of excesses NPK and heavy metals on soil, air, and water quality.

Background nutrient and heavy metal fluxes in UPA of Kabul (Safi et al., 2011) are controlled by naturally occurring minerals and biological processes but can be altered by atmospheric deposition and changes in soil processes from inputs of rainwater contaminated by human activities (Gary et al., 2005).

1.2. Research gap:

It is well known that air pollution in Kabul city is increasingly a problem which also leads to increasing elemental inputs into agriculture (Gary et al., 2005). Canadian soldiers were even warned about this in pre-deployment briefings which focused on fecal particles in aerosols (Aisa Pacific, Kabul Journal, 2013). Based on existent infrastructure for only half a million inhabitants, only 5% of Kabul’s homes are connected to a working sewerage system.

A study by UNEP in 2002 (Aisa Pacific, Kabul Journal, 2013) reports major amounts of sulfur dioxide (SO_2) and nitrous oxides (N_2O) in Kabul´s aerosols but no data exists on other contaminants, particularly heavy metals.

2007 data of the Asian Development Bank and the Afghan Government Environment Agency indicated large loads of heavy-metals in Kabul´s aerosols, likely the consequence of the widespread existence of open sewers and the burning of coal, tyres, and other wastes. The Asian Development Bank report calculated that current levels of air pollution – even without air-suspended faeces particles would result in 6000,000 additional asthma attacks annually and lead to an "excess annual mortality" of 2,287 in Kabul. The Aisa Pacific Kabul Journal (2013) concluded that Kabul's atmospheric conditions may even lead to more civilian victims than the war.

1.3. Objectives of the Study

The objectives of this study are to:

1. Analyze Kabul air dust (aerosol) for NPKand heavy metal contents.
2. Quantify the time course of dust induced precipitation of heavy metals.
3. Avoid health disorder (partly) caused by excess nutrient and heavy metals in air, drinking water and vegetables.

The ultimate aim of this research is, safe and efficient use of crop nutrient and identification of ways to avoid air, water, and agricultural produce contamination and pollution in UPA of Kabul.

1.4. Review of literature:

There have been many studies that have tried to determine dry and wet deposition. These studies have shown that there are many problems and some controversy regarding the existence of NPK and heavy elements in Kabul´s atmosphere. Some of these studies will now be briefly described to show the condition under which circumstances and procedures we plan to collect representative samples of wet/ dry deposition.

To this end bulk deposition collectors with a surface area of 0.09 m^2(Figure 2abc)was prepared and mound on metal stands in each of the five gardens which were described above. The collectors in each agricultural systems at the elevation of 2 m above ground as described by Drees et al. (1993) to minimize potential effects of nearby human activities, were installed. The plastic containers were covered with a white nylon mesh to reduce contamination from bird droppings, falling tree leaves and other unwanted materials. The dust in the traps was collected every week from December 2018 to November 2019 and monthly samples were pooled by season yielding three samples per year and location. Similarly wet deposition sampling was established following Lv et al. (2018). A comparison of data from the collected bulk and wet-only collectors will allow estimates of the contribution of dry deposition (David et al 1991).

a preliminary study conducted by Sediqi (2013) toassess air quality in Kabul. He concluded that until the 1980s Kabul was known for its clear air and spectacular views of snow-capped mountains. Today, the city's mountains are rarely visible given the severe deterioration of ambient air by pollutants, specially, suspended particulate and ozone. His study also indicated that air pollutants such as PM 2.5, CO, NO, SO_2, Pb, Benzene, Pyrene, Dioxane, PCBs, PAHs, Cd, Cr, Acetaldehyde and Formaldehydes were much higher than the recommended international limits.

UNEP and NEPA (BUR 2019 unpublished data) reported that 75% of Kabul´s air pollution is from transport given the import of tens of thousands of second hand cars every year and use of low grade fuel. Other contributors are households´ use of wood, coal and oil for cooking and heating, the unfiltered exhaust of brick factories, heating of public baths and small businesses burning tyres, plastics and combustible waste to run their business more cheaply. All of this is aggravated by thermal inversion in the winter, rapid population growth, unregulated urbanization, lack of vegetation, parks and green areas (Afghanistan Online, 2011).

Afghanistan´s National Environmental Protection Agency (NEPA) recently reported the annual death of more than 3000 people in Kabul due to air pollution. The data suggest that any increase of air particles sized 2.5 µg or smaller by 10 µg m^{-3}causes a 6% annual increase in cardiovascular deaths and an 8% increase in death from lung cancer (Afghanistan Online, 2011).The NEPA further argues that 70% of the disease cases in Kabul are linked to air pollution, unclean water and solid wastes.

2. MATERIALS AND METHODS

2.1. The agro-ecological setting and physical structure of the area

The gardens to be monitored (N 34° 29' 59.76" E 69°09' 22.06"; 1,765 m a.s.l.) are distributed along a 10 km transect crossing one of the most densely populated parts of Kabul city from Karta-e-Char to Qala-e-Wazir in an W-East direction (Figure 1). This area has an old irrigation infrastructure with temporary water courses along the Kabul River and several sewage channels.

In this area in April 2008 a baseline survey of 100 farms was conducted for which farms were selected to represent the major agricultural land use systems. Household selection followed a cluster analysis of production systems and socio-economic status, family composition, household members, on-farm income, off-farm income, education. Based on the survey results, five farm households were selected, their garden areas mapped with a handheld GPS and the cropping system recorded (Figure 2, Safi et al., 2010).

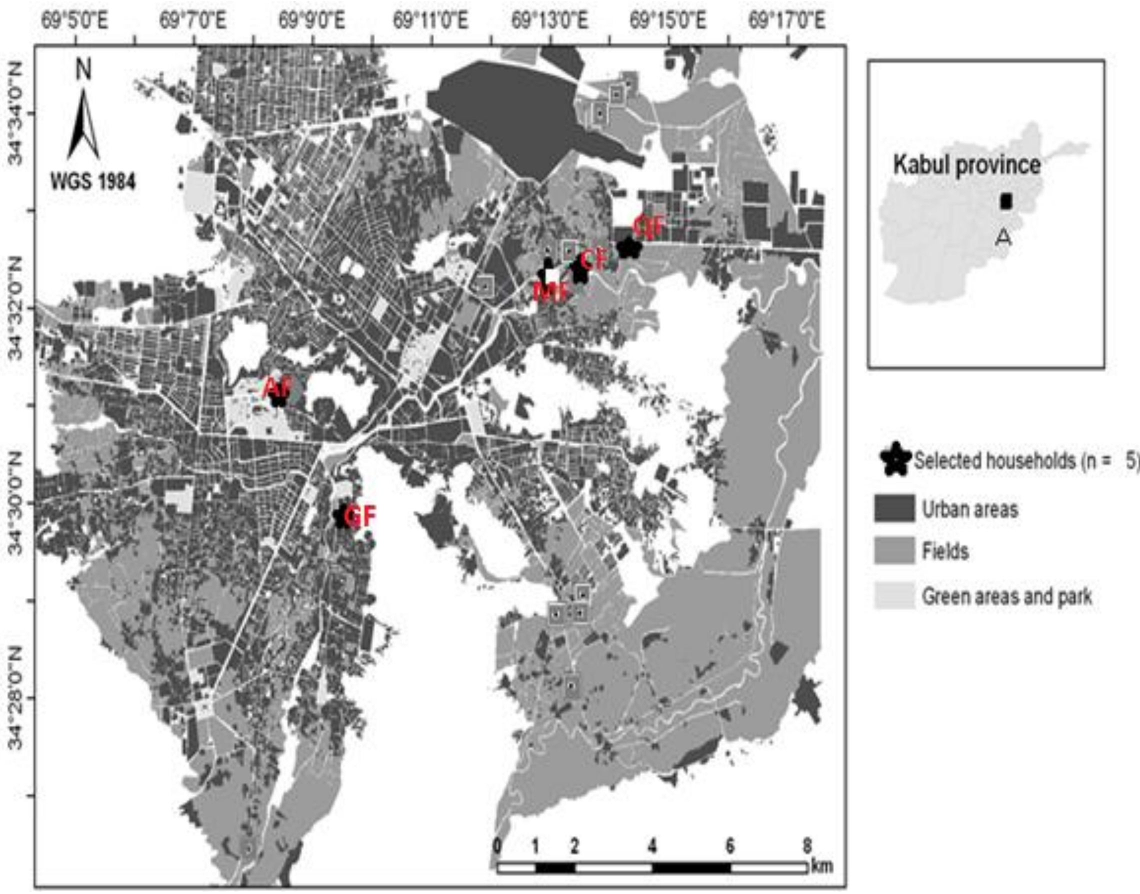

Figure 1: Map of Greater Kabul in Afghanistan showing the location of the selected Agriculture Farms.

Each farm was furnished with three metallic stands with an optimum orientation. Bulk deposition collectors (plastic bucket) as described above with a surface area of 0.09 m^2 have mounted in each of the three metallic stands in five gardens at elevation of 2m above ground surface as described by Drees (Dress et al.1993). Dry and wet deposition were collected throughout the experimental year (18 December 2018-18 November 2019's).

Dust samples were collected every month from December 2018 to November 2019, filtered and dried at room temperature. Subsequent to the drying, weighed and sealed in nylon plastic bag for subsequent analysis.

Total nitrogen is estimated by the micro-Kjeldahl method as per procedure suggested by (AOAC, 1995). Spectrometric (*UVmini-1240.* Spectrum Mode for Wavelength Scanning) methods were used to determine P_2O_5.For heavy metals analysis the sample were digested in 3ml HNO3+ 2ml HCL + 5 drop HF. After completion of the digestion, the solutions were filtered and brought to 25 ml with deionized water. Concentrations of Cd, Pb, Cu, Ni, and Zn were determined on duplicate samples by a GBC 906 atomic absorption spectrophotometer (AAS; GBC Scientific Equipment LLC, Hampshire, IL, USA).

2.2 Layout of the experiment

− Five household's farms weresubsampled3times.
− Three dust collector were installed in each farm randomly with reasonable distance (within 50 m a part).
− Farm size was medium with an average land of 0.2 to 2 ha.
− Major farming systems were vegetable productions which we have alluded above.

2.3 Measurements of sedimentations

Subsequent to the rainfall (snow and rain),dust were collected from the bucket, rinsed with distill water and transferred to the polyethylene bottles (Figure3), filtered and dried at room temperature. The dried samples were weighed and sealed in airtight plastics bag. A year quarter pooled samples were analyzed and the values were extrapolated to the rest dust samples.

2.4. Statistical analyses

Analyses of Variance (ANOVA; Annex 1, 2)and Univariate Analyses of Variances (UANOVA) were performed using SPSS (Version23.0,SPSSInc.,Chicago,IL,USA)todetermineth esignificanceofdifferencesbetweenthe different household (treatments) for dust nutrient, and heavy metals.

3. EXPERIMENTAL RESULTS

3. 1.Dust precipitation

The collected amount of precipitated dust of 12 months from five urban Farms (Table1) revealed that total amount of precipitated dust had different ashion ,with distribution and intensity throughoutthetwelvemonthsof18th December 2018-18thNovember2019 in five urban farms. Dust precipitation was dominated in early spring (April 12.49%) and early-summer (July 12.12%) and seemed considerable, but in the months of autumn (October, November, and December, had the lesser amount of precipitated dust with 9.27%, 2.72%, and 9.30%, respectively. November and January with dust precipitations of 2.72% and 5.53% were the least dust participations in 2019.

Among the farms, MF, (Figure 1) had the highest average amount of dust (1,823.23 kg ha^{-1}) followed by CF,GF and QF with an average amount of (1,455.38 kg ha^{-1}),(1,308.45 kg ha^{-1}) and (2,000.85 kg ha^{-1}), respectively. Where AF had the least amount of dust precipitation (1,000 kg ha^{-1}) among others. The data revealed that the density of precipitation mostly relates to the location of the farm in the city (Table 1).

Table 1: Total monthly precipitated dust(Kg $ha^{-1}month^{-1}$) from five urban farm of Kabul city

Farm	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.
AF	49.26	39.23	100.50	100.50	143.26	109.98	61.71	115.49	57.96	145.46	68.32	9.92
AF	42.76	31.74	209.71	209.71	154.28	65.02	63.25	118.35	23.80	130.03	56.20	11.02
AF	35.81	31.85	88.60	88.60	154.28	71.96	39.56	195.05	41.21	80.44	44.08	13.22
GF	49.59	99.18	131.80	131.80	187.34	184.91	62.59	132.24	102.37	180.72	152.07	50.69
GF	51.13	76.81	107.66	107.66	187.34	127.17	72.51	123.42	108.32	122.32	133.34	69.42
GF	44.63	73.50	94.88	94.88	187.34	124.63	76.92	132.24	80.66	109.10	115.71	39.67
CF	105.68	87.94	97.64	97.64	215.99	103.15	203.42	175.21	112.18	79.34	153.17	69.42
CF	67.22	87.06	117.14	117.14	187.34	119.90	190.97	154.39	172.13	130.03	146.56	58.40
CF	86.84	104.03	107.39	107.39	132.24	36.92	95.21	161.99	148.99	128.93	159.79	47.39
MF	96.97	80.06	166.73	166.73	249.05	202.65	207.17	209.38	159.57	169.70	272.19	124.52
MF	33.39	131.36	110.75	110.75	220.40	186.90	99.29	196.15	82.10	115.71	205.52	49.59
MF	124.30	28.76	171.14	171.14	260.07	167.17	203.09	275.49	124.52	134.44	138.85	24.24
QF	544.60	123.64	133.45	133.45	238.03	139.29	153.17	240.23	173.67	130.03	179.62	7.71
QF	342.11	123.09	163.09	163.09	138.85	112.51	162.65	312.96	119.01	123.42	219.29	14.33
QF	443.35	139.84	125.40	125.40	188.44	80.66	157.91	217.09	102.81	136.65	65.02	28.65

AF: Agriculture college Farms; **GF:** Guzarghah Farm; **CF:** Charrahi-e-Abdulhaq Farm; **MF:** Macrorian Fam; **QF:** Qala-e-Wazir Farm.

3. 2. Dust induced NPK concentrations in five urban farms.

N concentration was higher in precipitated dust during July (14.50%) followed by April (13.93%) while November revealed less amount of N in dust (table 2). Same to the N concentration, P concentration was also higher in April (13.56%) followed by July (13.20%) while November had less (2.31%) P in precipitated dust (table 3). Due to few limitation we have skipped to measure K in dust.

Table 2: Total monthly precipitated N in dust (Kg ha^{-1} $month^{-1}$) in five urban farm of Kabul city

Kg total N ha^{-1} $month^{-1}$												
Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Total kg N ha-1 Site-1
858.35	683.61	1751.27	1751.27	2496.33	1916.41	1075.34	2012.43	1010.05	2534.73	1190.56	172.82	17453.18
745.06	553.03	3654.24	3654.24	2688.35	1132.95	1102.23	2062.35	414.77	2265.90	979.33	192.03	19444.49
1292.84	1149.64	3198.30	3198.30	5569.17	2597.62	1428.10	7041.03	1487.77	2903.93	1591.19	477.36	31935.24
84.66	169.31	225.00	225.00	319.82	315.68	106.86	225.75	174.77	308.53	259.62	86.54	2501.53
127.04	190.84	267.50	267.50	465.46	315.96	180.16	306.65	269.14	303.92	331.30	172.49	3197.97
35.84	59.02	76.19	76.19	150.44	100.08	61.77	106.19	64.78	87.61	92.92	31.86	942.88
310.91	258.72	287.25	287.25	635.44	303.46	598.48	515.49	330.04	233.43	450.64	204.25	4415.35
59.22	76.69	103.19	103.19	165.03	105.62	168.24	136.01	151.64	114.55	129.11	51.45	1363.96
367.73	440.53	454.76	454.76	560.00	156.33	403.20	686.00	630.93	546.00	676.66	200.67	5577.56
414.15	341.91	712.05	712.05	1063.61	865.48	884.77	894.18	681.46	724.76	1162.44	531.80	8988.67
21.67	85.25	71.88	71.88	143.05	121.30	64.44	127.31	53.28	75.10	133.39	32.19	1000.74
185.17	42.85	254.94	254.94	387.42	249.03	302.55	410.40	185.50	200.28	206.84	36.12	2716.04
1195.22	271.36	292.88	292.88	522.40	305.70	336.17	527.23	381.16	285.38	394.22	16.93	4821.52
1481.31	532.98	706.18	706.18	601.21	487.17	704.27	1355.11	515.32	534.41	949.53	62.03	8635.71
196.62	62.02	55.61	55.61	83.57	35.77	70.03	96.27	45.60	60.60	28.83	12.71	803.24
Kg total N ha^{-1} $Year^{-1}$												
7375.80	4917.75	12111.26	12111.26	15851.29	9008.57	7486.60	16502.40	6396.21	11179.11	8576.58	2281.23	
Percent Kg N $month^{-1}$ $Year^{-1}$												
Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	
6.48	4.32	10.64	10.64	13.93	7.92	6.58	14.50	5.62	9.82	7.54	2.00	

Table 3: Total monthly precipitated P_2O_5 in dust (Kg ha^{-1} $month^{-1}$) in five urban farm of Kabul city.

Kg P2O5 ha^{-1} $Month^{-1}$											
Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Total (P2O5kg ha^{-1} $Site^{-1}$)
75.04	192.23	192.23	274.02	210.36	118.04	220.90	110.87	278.23	130.69	18.97	1915.80
30.18	199.44	199.44	146.73	61.83	60.16	112.56	22.64	123.67	53.45	10.48	1061.26
66.07	183.81	183.81	320.07	149.29	82.08	404.66	85.50	166.89	91.45	27.43	1835.37
18.47	24.54	24.54	34.88	34.43	11.65	24.62	19.06	33.65	28.31	9.44	272.82
30.07	42.15	42.15	73.35	49.79	28.39	48.32	42.41	47.89	52.21	27.18	503.95
28.45	36.73	36.73	72.52	48.25	29.78	51.19	31.23	42.23	44.79	15.36	454.54
34.79	38.63	38.63	85.46	40.81	80.49	69.32	44.38	31.39	60.60	27.47	593.79
36.14	48.62	48.62	77.76	49.77	79.27	64.08	71.45	53.97	60.84	24.24	642.66
55.36	57.15	57.15	70.37	19.65	50.67	86.21	79.29	68.61	85.03	25.22	700.92
21.72	45.23	45.23	67.56	54.97	56.20	56.80	43.29	46.04	73.84	33.78	570.95
26.27	22.15	22.15	44.08	37.38	19.86	39.23	16.42	23.14	41.10	9.92	308.38
1.90	11.29	11.29	17.16	11.03	13.40	18.18	8.22	8.87	9.16	1.60	120.29
35.23	38.03	38.03	67.83	39.69	43.65	68.46	49.49	37.05	51.18	2.20	626.02
27.80	36.84	36.84	31.36	25.42	36.74	70.69	26.88	27.88	49.54	3.24	450.51
46.57	41.77	41.77	62.76	26.86	52.59	72.30	34.24	45.51	21.65	9.54	603.22
Total Kg P_2O_5 ha^{-1} $monthe^{-1}$ $year^{-1}$											
534.07	1018.62	1018.62	1445.90	859.53	762.95	1407.53	685.37	1035.04	853.85	246.06	
Percent $P_2O_5ha^{-1}Month^{-1}$ $year^{-1}$											
Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	
5.01	9.56	9.56	13.56	8.06	7.16	13.20	6.43	9.71	8.01	2.31	

3. 3. Dust induced Cd's concentrations in five urban farms.

Result of the study (Table 3) showed that Cd concentration in precipitated dust was under detectable limit in all farms of Kabul City.

3.4 Dust induced Pb concentrations in five urban farms

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Lead concentration detected higher in QF (95.73%) followed by MF (2.73%) and AF had the least amount as compared to others farms (Table 4).

Table 4: Monthly average PbKg ha^{-1} $year^{-1}$(n=36) in five urban farms of Kabul (December-November, 2019).

Farm		Mean	Std. Deviation	N
Kg Pb ha^{-1}	AF	840.67	1400.93	36
	GF	637.82	1016.65	36
	CF	2,421.01	3773.85	36
	MF	6,857.76	3738.24	36
	QF	239,640.28	406122.87	36
	Total	50,079.51	203210.89	180

P<0.001

3. 5. Dust induced Ni concentrations in five urban farms.

In our experiment the participated dust revealed high amount of Ni in the QF farm (84.11%) followed by CF (12.97%), MF and (1.66%) and GF (1.20%) while AF had the least amount of Ni in participated dust (Table 5).

Table 5: Monthly average Ni Kg $ha^{-1}year^{-1}$(n=36) in five urban farms of Kabul(December-November, 2019).

Farm		Mean	Std. Deviation	N
Kg Ni ha^{-1}	AF	104.37	174.33	36
	GF	3,500.10	1918.02	36
	CF	37,618.62	47098.83	36
	MF	4,830.52	6435.86	36
	QF	243,837.67	405055.13	36
	Total	57,978.26	203451.56	180

P<0.001

3. 6. Dust induced Cu concentrations in five urban farms.

The results revealed higher amount Cu in QF (90.45) followed by CF (6.22%), MF(1.82%) and GF (1.01%), while AF showed the least amount (0.45%) (Table 6).

Table 6: Monthly average Cu Kg ha^{-1} $year^{-1}$(n=36) in five urban farms of Kabul(December-November, 2019).

Farm		Mean	Std. Deviation	N
Kg Cu ha^{-1}	AF	1,091.67	1840.43	36
	GF	2,328.00	1277.31	36
	CF	14,283.82	12294.70	36
	MF	4,182.77	4749.21	36
	QF	207,528.06	347885.47	36
	Total	45,882.86	174038.79	180

P<0.001

3. 7. Dust induced Zn concentrations in five urban farms.

In our collected precipitated dust it was revealed that QF had the higher amount of Zn (87.50%) followed by CF (9.26%) and MF(1.61%). While the AF had the least amount of Zn in precipitated dry and wet dust (Table 7).

Table 7: Monthly average Cu Kg ha^{-1} $year^{-1}$(n=36) in five urban farms of Kabul(December-November, 2019).

FARM		Mean	Std. Deviation	N
Kg Zn ha^{-1}	AF	8,220.46	11450.18	36
	GF	11,358.32	5494.20	36
	CF	112,361.44	109137.27	36
	MF	19,549.92	10356.94	36
	QF	1,060,789.85	1739555.58	36
	Total	242,456.00	874026.57	180

P<0.001

4. DISCUSSION

4. 1*. Dust precipitation*

The urban environment is strongly influenced by human activities including the growth of population, industrial activities and vehicles in large cities. Such human activities result in the significant enrichment of heavy metals in soil, on roads, and on building and foliage surfaces]. Road dust is the particles from atmospheric dust and other urban non-point sources deposited on the impervious pavement of the street by wind, hydraulics and gravity, which have become one of the most widespread pollutant carriers on the surface. In addition, foliar dust can be formed by the retention of atmospheric particles on the special surface organization of plant. Through long-term accumulation, the components of foliar dust are more complex and can show the input characterization of elements at a certain time and region, which is a good indication of the environmental conditions (Qiu Y., 2009).

The collected amount of precipitated dust of 12 months from five urban farms(Table1)which caused by natural events that occur mainly in arid areas, reducing air quality and visibility (Nazaris H., 2016) revealed that total amount of precipitated dust had different fashion, dominantly in early spring (April 12.49%) and early-summer (July 12.12%), seemed considerable, but in the months of autumn (October, November, and December), had lesser amount of precipitated dust with 9.27%, 2.72%, and 9.30%, respectively. November and January with dust precipitation of 2.72% and 5.53% was the least dust participation in 2019. However the background studies carried out shows that in Pakistan, Afghanistan, Iran and China, the occurrence of storms is severely impacted by the region's topography, such that its decrease raises dust storms (Prospero JM, 2002).

Among the farms, MF (Figure 1) had the highest average amount of dust (1,823.23 kg ha-1) followed by CF with an average amount of 1,455.38 kg ha-1, GF with in average amount of 1,308.45 kg ha-1 and QF with an average amount of 2,000.85 kg ha-1. Where AF had the least dust precipitation (1,000 kg ha-1). The data revealed that the density of precipitation mostly relates to the location of the farm in the city (Figure 1). The intensity of these effects depends on the particles concentration, physical and chemical compositions of particles and their sizes. Most dust storms occur in spring and summer and, less frequently, in autumn and winter. It was reported that during the day, dust storms occur most often from noon until sunset in different regions of the world (Furman HKH., 2003; Goudie A., 2006 and .Nazaris H., 2016).

NPK in dust due to its abundance in precipitated dust raised serious environmental pollution in Kabul city which was apprehension of Canadian forces in Afghanistan. They warned about this in pre-deployment briefings which focused on fecal particles in aerosols (Aisa Pacific, Kabul Journal, 2013). Complicated nature may be in the form of small amounts of plant pollen, human and animal hairs, textile fibers, paper fibers, minerals from outdoor soil, human skin cells, burnt meteorite particles, and many other materials, in our offices, and other human environments. Estimates on dust impacts on the nutrient cycles rely on an accurate knowledge on the atmospheric dust concentration and its spatio-temporal variability (Schepanski K., 2020). It is necessary to be mentioned that, since we analyzed pooled samples and the NP concentration results extrapolated to the rest of the month wise precipitated dust, which may need to be clarified by each month analysis.

In the result of our experiment (Table 3) it was found that Cd concentration in participated dust was under detectable limit in all farms under study in urban fields of Kabul City.

Lead (Pb) is a hazardous metal which is persistent in the environment and can be added to soils and sediments through deposition from sources of lead air pollution. Other sources of lead to ecosystems include direct discharge of waste streams to water bodies and mining. Elevated lead in the environment can result in decreased growth and reproductive rates in plants and animals, and neurological effects in vertebrates. In our study it was detected higher in QF (95.73%) which is surrounding by factories in the east side of Kabul, followed by MF (2.73%) enclosed by residential area in the Center of Kabul and AF located in the light residential area western side of Kabul city, had the least amount of Pb(Table 4). It was confirmed by (US Environmental Protection Agency., 2020), that Sources of lead emissions vary from one area to another. At the national level, major sources of lead in the air are ore and metals processing and piston-engine aircraft operating on leaded aviation fuel. Other sources are waste incinerators, utilities, and lead-acid battery manufacturers. The highest air concentrations of lead are usually found near lead smelters. The concentration can be decreased as a result of EPA's regulatory efforts including the removal of lead from motor vehicle gasoline, levels of lead in the air (BUR 2019 unpublished year & source; Yie Yanng et al., 2016).

Nickel (Ni) is found in earth's crust, therefore, small amounts are found in food, water, soil, and ambient air. As a result of releases from oil and coal combustion, nickel metal refining, sewage sludge incineration, manufacturing facilities, and other sources may enhance its concentration in air (National Cancer Institute, 2020). In our experiment the participated dust revealed high amount Ni in QF(84.11%) who surrounded by factories as we mentioned above followed by CF (12.97%) by MF (1.66%) and GF (1.20%). while AF had the least amount of Ni in precipitated dust (Table 5). The possible reason for these concentration may those what we mentioned for lead. Ni has most serious harmful health effects during exposure to it, such as chronic bronchitis, reduced lung function, and cancer of the lung and nasal sinus, have occurred in people who have breathed dust containing certain nickel compounds while working in nickel refineries or nickel-processing plants (U.S. Environmental Protection Agency. 1986; Yie Yang et al., 2016).

Copper (Cu) can enter the environment through releases from the mining of copper and other metals, and from factories that make or use copper metal or copper compounds. Copper can also enter the environment through waste dumps, domestic waste water, combustion of fossil fuels and wastes, wood production, phosphate fertilizer production, and natural sources (for example, windblown dust, from native soils, volcanoes, decaying vegetation, forest fires, and sea spray). Therefore, copper is widespread in the environment. About 1,400,000,000 pounds (640,000,000,000 grams) of copper were released into the environment by industries in 2000 (Agency for toxic substances and disease registry. date accessed 2020). Copper is often found near mines, smelters, industrial settings, landfills, and waste disposal sites. In our experiment the collected wet and dry precipitated dust showed higher amount of Copper (Cu) in QF Farm

(90.45) followed by CF(6.22%), MF (1.82%) and GF 1.01%), while AF showed the least amount (0.45%) (Table 6).possible reason for Cu concentration dust could be those what we have mentioned above (Yie Yang et al., 2016).

Zinc (Zn)is the 24thmost abundant element in Earth's crust and has five stable isotopes. The most common zinc ore is sphalerite (zinc blende), a zinc sulfide mineral. The largest workable lodes are in Australia, Asia, and the United States.In our collected precipitated dust it was revealed that QF had higher amount of Zn (87.50%) followed by CF (9.26%) and MF (1.61%). While the AF Farm had the least amount of Zn in precipitated dry and wet dust (Table 7).Possible reason for this sequence of Zn accumulation in Kabul city may be Zn as a solid particles in smoke from fires and in other emissions from factory chimneys are eventually deposited on land or sea; most forms of fossil fuels contain some heavy metals and this is, therefore, a form of contamination which has been continuing on a large scale since the industrial revolution began. For example, very high concentration of Cd, Pb, and Zn has been found in plants and soils adjacent to smelting works (Raymond A. W. and Felix E. O., 2011). Another major source of soil contamination is the aerial emission of Pb from the combustion of petrol containing tetraethyl lead; this contributes substantially to the content of Pb in soils in urban areas and in those adjacent to major roads. Zn and Cd may also be added to soils adjacent to roads, the sources being tyres, and lubricant oils (SEPA, Report, 1996; Raymond A. W., and Felix E. O., 2011;Yie Yang et al., 2016).

5. Conclusions and recommendations

In the result of our study on “Dust induced crop nutrient and heavy metal in urban agriculture of Kabul” it was revealed that urban area and agricultural fields of Kabul are victims of pollution in the country.Insuch circumstances living ecosystem seems to be not feasible for living. In addition, vegetables produced in such environment due to contamination with foliar heavy metals may not be appropriate for consumptions. In the light of our research findings few points have to be recommended as below:

- Due to considerable loads of N and P in the precipitated dust of Kabul, Kabul air can be environmental scarifications, deterioration of ecosystem, underground water pollution and N borne diseases among the inhabitants.
- Industrial activities has to be exiled from the city.
- Factories’ manufacturing materials has to be removed from the city.
- Growing of those vegetables which can be consumed as a leafy around the factories has to be avoided.
- Construction’s disposal has to be managed.
- Further research is required to explore daily, weekly and monthly concentrations of the heavy metals in the dust and soil of vegetables’ field.

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