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Heavy metals distribution in different soil series of district Swabi, Khyber Pakhunkhawa, Pakistan

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ABSTRACT

The present research was carried out with the main aim to evaluate the levels of heavy metals in some contaminated or expected to be contaminated by industrial effluents and some non contaminated soils of district Swabi. A total of 30 soil samples were collected from 15 different selected soil series of Swabi area at 0-15 cm and 15-30 cm depths and analyzed for various chemical properties using standard analytical techniques and for extractable heavy metals Zn, Cu, Fe, Cr, Co, Ni, Cd and Pb using Atomic Absorption Spectrophotometer. All soil samples were found non saline having EC values between 0.13-0.56 dsm^{-1}. Soil reaction or pH value ranged from 7.21-8.60 except Mansabdar soil which had pH value of 9.21. It was found that swabi soil was moderately to strongly calcareous in nature, alkaline in reaction having deficient to marginal in organic matter content. Furthermore all soil samples were found almost adequate in Fe, Cu and Zn for most of agriculture crops. The higher concentrations of Ni (22.21 and 21.9 mg kg^{-1}) and Cr (8.02 and 5.11 mg kg^{-1}) at both surface and sub surface were recorded in Gadoom Amazai soils located near ghee mills and many other industries. Higher levels of heavy metals were observed in contaminated soils as compared with non contaminated soils. Decreased in concentration levels of metals were observed in majority of soils with increase in depth. No correlation was found between AB-DTPA extractable heavy metals and soil chemical properties and it might be due to samples collected from different locations with different thermodynamic characteristics.

***Keyword*:** Heavy metals, Swabi soils

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1. INTRODUCTION

Soil pollution by accumulation of heavy metals is becoming a serious threat to our soil environment and one of the key factors which contribute most is rapid industrialization. Industrial revolution brought heavy metals to almost everywhere because of their excessive use in industrial applications and their waste water is composed of highly toxic heavy metals which create problems to our soil [1, 2]. From industries all the wastes along with heavy metals are dumped into the soil where they find adsorption sites and bound closely and strongly on either organic or inorganic colloids [3]. Industrial effluents containing elements like Chromium (Cr), Cobalt (Co), Nickel (Ni), Lead (Pb), Cadmium (Cd), Iron (Fe), Zinc (Zn), Manganese (Mn), Copper (Cu) and Arsenic (As) which have been identified as heavy metals [4]. Some of the heavy metals in trace amount are essential for both plants and animals and play a key role in metabolic activities as well as in enzymatic reactions [5, 6]. However their higher concentrations may be toxic for both plants and animals and caused serious harmful effects [7].

Heavy metals are considered harmful because they are non-biodegradable in nature and have the potential to accumulate in the soil and some of them are extremely carcinogenic because of their solubility in water, even low concentration of heavy metals may cause serious damage to human and animals as there is no established mechanism for their elimination from the body [8]. In human heavy metals can directly damage the nervous system as well as various metabolic body processes [9]. Agriculture soils irrigated through waste water not only result in contamination of soil but also affect the safety and quality of food [10]. Heavy metals toxicity in plants is the result of complex interaction of major toxic ions with other essential or non essential ions. The adverse effect of heavy metals on plants was also reported by many investigators. The negative effect of Cd on seedling length and dry weight was reported by [11], reduces photosystem II activity, causes structural change in chloroplast and thus reduces photosynthesis, availability of carbon dioxide, lowers stomatal conductance, reduces total lipids, glycolipids and neutral lipids, interfere with membrane permeability and reduces respiration in leaves [12]. Similarly toxic levels of nickel, chromium and lead inhibits germination, total dry matter production, yield of agricultural crops as well as reduced nitrogen fixing ability of legumes [12].

The availability of heavy metals in soils depends on soil properties like pH, lime content, electrical conductivity and organic matter, therefore their study is must and paramount. Swabi soils are generally alkaline in reaction and produce almost all kind of fruits and crops, but due to insufficient use of fertilizers and poor soil management practices the production is not of the optimum level [13]. Heavy metals levels are necessary to be determined for evaluating the potential effects on crop productivity and toxicity to animals and human being. Keeping in mind the above mentioned facts the present study was organized to estimate heavy metals levels in non polluted soils and in soils potentially polluted by industrial effluents in district Swabi.

2. DESCRIPTION OF THE STUDY AREA

Swabi lies between the Indus River and Kabul River and situated at 34° 7', 48" N and 72° 28', 11" E of Khyber Pakhtun Khwa, Pakistan, at elevation of 341 meter above the sea level. It is the fourth most populous district of the province Khyber Pakhtunkhwa with a total population of 1.625 million. Swabi is blessed with fertile agriculture land and produced very good quality of tobacco and sugar cane, therefore swabi is known as "Home of tobacco". Mostly economy of the area is based on tobacco crop and Gadoon industrial Estate.

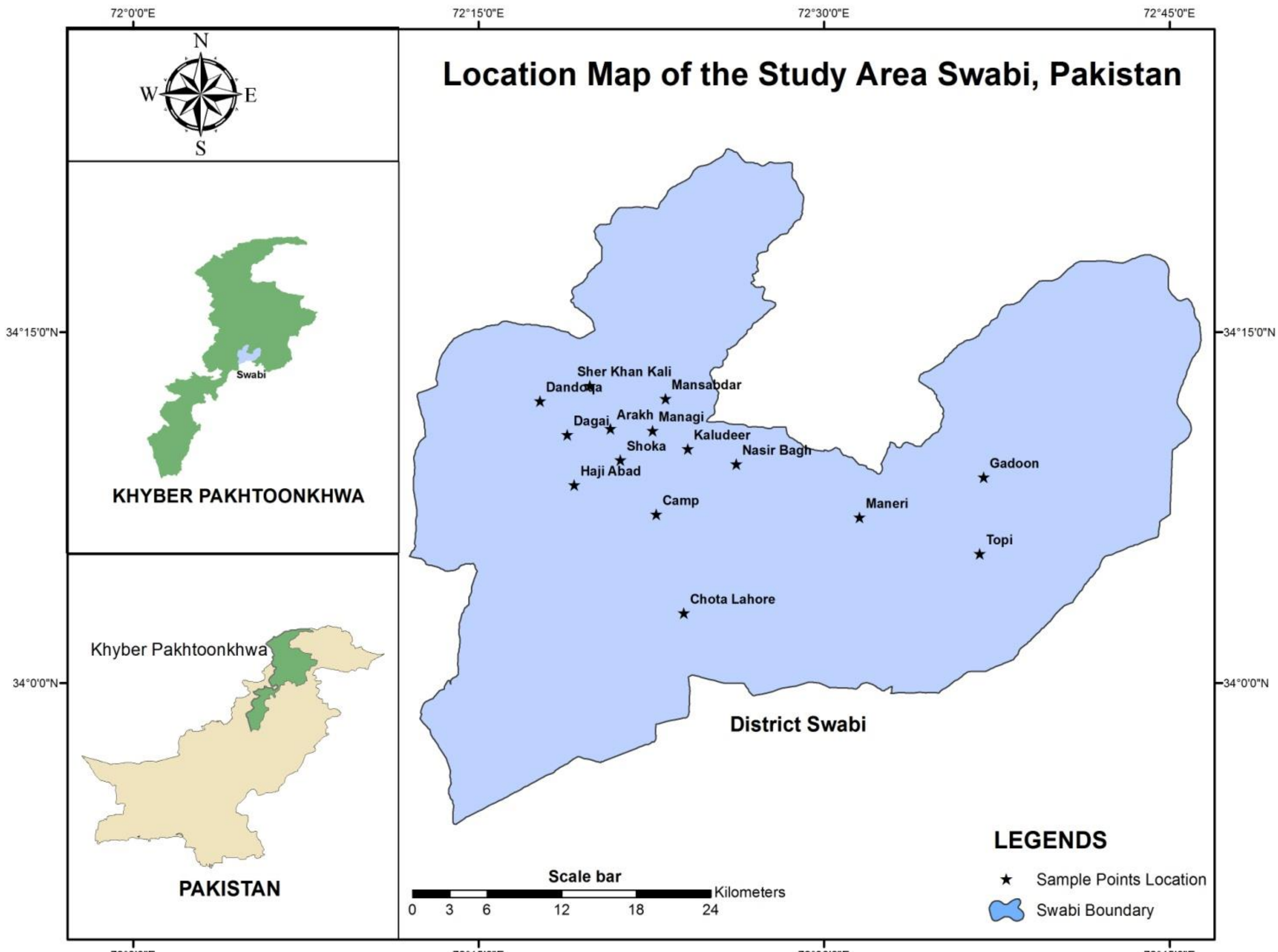

Fig. 1. Map of sampling areas

3. MATERIAL AND METHODS

A total of 30 different soil samples were collected from fifteen (15) different locations of district swabi at 0-15 cm and 15-30 cm depths (Table 1). All these samples were collected from soil which was expected to be affected by industrial effluents and also near that another soil which was not affected by industrial effluents. All the sampling was done in the sunny days of May 2018 with the help of wooden tool to avoid contamination of the soils with any of elements being studied. The soils of Dagai, Haji abad, Dandoqa, Managi, Sher khan kali (located near tannery industry), Kaludher, Mansabdar (located near marble factory), Nasir bagh, Camp, Maneri, Topay, Gadoon amazai (Industrial Estate), Chota Lahore, Shoka and Arah areas of Swabi district were selected for determination of heavy metals. The name and location of each sampling area is indicated in the area map.

3. 1. Analysis of soil samples

All the collected soil samples were brought to the laboratory of Soil and Environmental Sciences, dried in shade, crushed and followed by sieving through 2 mm sieve, stored in plastic bags and then analyzed for various chemical properties of soil like pH, EC, lime content, and Organic matter content by adopting the methods used by [13-15].

Heavy metals (Zn, Cu, Fe, Cr, Co, Ni, Cd and Pb) concentrations in all soil samples were estimated by Atomic Absorption Spectrophotometer (Shimadzhu-7000, Japan) by using respective hallow cathode lamp.

3. 2. Statistical analysis

The recorded data were subjected to simple arithmetic means and standard deviation.

4. RESULTS AND DISCUSSION

4. 1. Soil Organic matter, pH, EC and Lime content

The soil organic matter content (O.M) decreased as soil depth increased and was found more at surface soil than at sub surface soil. At surface soil it varied from a minimum value of 0.35 % to a maximum value of 2.30 % with 1.19% as an average value, while at sub surface it ranged from 0.21% to 1.52% with mean value of 0.75 %. Maximum organic matter content of 2.3 % at surface soil was found at camp area (Table 1 and 2). More O.M content at surface soil might be associated with the addition of farm yard manure, crop residue and green manure to soil surface. Many investigators also concluded more O.M content at surface soil of the same soil series [13 and 14].

Soil pH at soil surface (0-15 cm) ranged from a minimum value of 7.21 to a maximum value of 9.21 having a mean value of 8.06, while at more depth (15-30 cm) it ranged from 7.32 to 8.88 (Table 1 and 2). High pH of 9.2 was recorded at Mansabdar area at surface soil and it might be due to microbial activities. Soil reaction or soil pH decreased with soil depth which was in lined with [13] who also confirmed decreased in soil pH with soil depth for the same soil series.

Electrical conductivity of all soil samples ranged from a minimum value of 0.13 to a maximum value of 0.56 dsm^{-1} with a mean value of 0.28 dsm^{-1} at surface soil while at sub surface it gradually increased and varied from 0.18 to 0.86 dsm^{-1} with an average value of 0.35 dsm^{-1} indicated the downward movements of dissolved salts [15]. The highest EC values of 0.56 and 0.86 dsm^{-1} were recorded in soil of Mansabdar located near marble industry (Table 1 and 2), the higher EC values in that area might be associated with falling dust containing salts [15]. Our result was in lined with the findings of [13 and 14] concluded that these soils were normal with respect to salinity.

Lime content at surface soil ranged from a minimum of 5.89 to a maximum of 16.65% with mean value of 8.61%, while at sub surface (15-30 cm) it gradually increased and ranged from 6.56 to17.81% with 8.98% as an average value (Table 1 and 2). The increased in lime content in sub soil may be due to precipitation of $CaCO_3$ in sub soils.

Higher value of 17.81% of $CaCO_3$ at Mansabdar soil reveals the influence of dust deposition from marble industry. All the soil samples were found calcareous in nature which not only effect soil properties by chemo-sorption of anions and cations [16] but also reduced soil nutrients [17]. Calcareous nature of these soils was also reported by [13].

Table 1. Organic matter content, electrical conductivity, calcium carbonate content and pH of soil samples collected from different locations of district Swabi.

Area Name	Depth (cm)	OM (%)	EC (dSm^{-1})	$CaCO_3$ (%)	pH
Dagai	0-15	0.51	0.56	7.25	7.91
	15-30	1.33	0.24	8.75	8.01
Haji Abad	0-15	0.62	0.28	8.21	7.34
	15-30	0.31	0.36	8.50	7.86
Dandoqa	0-15	0.70	0.23	8.76	8.40
	15-30	0.33	0.25	8.75	8.64
Mnagai	0-15	1.43	0.36	8.25	7.89
	15-30	0.96	0.46	8.82	8.25
Sher Khan kali	0-15	1.11	0.28	7.50	8.60
	15-30	0.45	0.35	7.98	6.88
Kaludher	0-15	0.35	0.22	7.75	7.70
	15-30	0.99	0.32	6.56	7.81
Mansabdar	0-15	1.35	0.25	16.65	9.21
	15-30	0.98	0.28	17.81	8.46
Nasir Bagh	0-15	1.32	0.27	8.75	7.75
	15-30	0.45	0.32	7.77	8.01
Camp	0-15	2.3	0.31	5.89	8.46
	15-30	1.52	0.35	9.0	8.74
Maneri	0-15	1.55	0.13	9.99	7.75
	15-30	0.75	0.36	9.3	8.21

Topay	0-15	1.45	0.32	8.81	8.21
	15-30	0.21	0.26	7.50	7.80
Gadoon Amazai	0-15	1.11	0.17	7.22	8.30
	15-30	0.82	0.18	8.21	8.51
Chota Lahore	0-15	1.64	0.35	5.97	7.21
	15-30	0.38	0.36	7.23	7.32
Shoka	0-15	1.21	0.38	8.45	8.21
	15-30	0.92	0.25	8.81	7.78
Arah	0-15	1.33	0.24	9.85	8.1
	15-30	0.95	0.35	9.77	8.5

Table 2. Ranges and mean values of soil chemical properties collected from different locations of district Swabi.

Chemical Properties	**Depth (cm)**	**Ranges**	**Mean**	**Standard deviation**
OM (%)	0-15	0.35-2.30	1.19	0.45
	15-30	0.21-1.52	0.75	0.39
pH	0-15	7.21-9.21	8.06	0.50
	15-30	7.32-8.88	8.18	0.43
Ec (dsm^{-1})	0-15	0.13-0.56	0.28	0.10
	15-30	0.18-0.86	0.35	0.06
$CaCO_3$ (%)	0-15	5.89-16.65	8.61	2.51
	15-30	6.56-17.81	8.98	2.58

4. 2. AB-DTPA Extractable Cu, Fe, Zn , Cd, Co, Ni, Cr and Pb

The ranges and mean values of AB-DTPA Extractable Cu, Fe, Zn , Cd, Co, Ni, Cr and Pb are presented in (Table 5). At surface soil (0-15 cm) the concentrations of heavy metals ranged from 2.33-19.15, 8.23-36.89, 8.26-26.55, 0.01-0.16, 0.8-6.99, 0.46-22.21, 0.23-8.02 and 0.4-2.23 mg kg^{-1} respectively with mean values of 7.16, 18.0, 17.61, 0.06, 2.37, 5.52, 2.18, and 1.12 mg kg^{-1} respectively .While at sub surface soil their concentrations ranged from 1.32-14.11, 8.22-30.95,7.7-24.20, 0.01-0.08, 0.33-5.46, 0.42-21.9, 0.54-5.11 and 0.08-1.99 mg kg^{-1} respectively. It was obvious from the results that the concentrations of heavy metals gradually decreased with increase in soil depth and it might be associated with adsorption on clay surface or organic matter or may be due to some inputs of industrial waste. Decreased in heavy metals concentration with soil depth was also reported by [15].

Furthermore all the soils studied were found quiet adequate in Cu, Fe and Zn in term of their concentrations for agriculture crops which was similar to the findings of [13]. The concentrations of Cd in almost all soils were also found in acceptable proportion as in typical soils Cd concentration was reported less than 0.8 mg kg^{-1} [18] while its higher concentration was also reported in contaminated soil [5].

The concentrations of Ni was found highest (22.21 and 21.9 mg kg^{-1}) at both soil depths of Gadoon Amazai area located near ghee mills and many other small industries followed by Sher khan kali soils located near tannery industry where the concentration of Ni was found 13 and 12.5 mg kg^{-1} at both surface and sub surface soil respectively (Table 4 and Fig .2) and the higher concentration of Ni in these soils may be associated with the effect of industrial effluents on these soils. Similarly maximum concentrations of Cr (8.02 and 5.11 mg kg^{-1}) at both soil depths were recorded in Gadoon Amazai area soils followed by Sher khan kali soils where maximum concentrations (4 and 2.22 mg kg^{-1}) of Cr was observed at both surface and sub surface soil (Table 4).

The higher concentrations of Cr in these soils may be associated with the industrial effluents. Similarly the maximum concentrations of Pb (2.23 and 1.99 mg kg^{-1}) respectively at both soil depths of Gadoon Amazai revealed that these soils were at higher risk to be affected by industrial effluents. Furthermore no correlation was observed between the chemical properties of selected soils and the concentrations of AB-DTPA extractable heavy metals concentrations and it might be due to collection of soil samples from different locations having different thermodynamics conditions and also it might be possible that other geochemical properties or some anthropogenic process controlled the mobility and solubility of these metals in soils [19-21].

Table 3. ABDT-PA extractable Cu, Fe, Zn and Cd (mg kg^{-1}) collected from different locations of Swabi district.

Area Name	Depth (cm)	Cu	Fe	Zn	Cd
Dagai	0-15	8.44	36.89	8.26	0.05
	15-30	2.10	30.95	7.77	0.02
Haji Abad	0-15	3.54	33.72	9.75	0.09
	15-30	1.42	28.12	12.45	0.03
Dandoqa	0-15	9.90	20.50	14.52	0.06
	15-30	6.10	18.40	12.9	0.02

Mnagai	0-15	10.50	18.05	19.8	0.08
	15-30	14.11	11.77	20.32	0.04
Sher Khan kali	0-15	5.70	22.64	14.1	0.09
	15-30	6.54	11.90	10.26	0.04
Kaludher	0-15	4.56	14.32	21.55	0.05
	15-30	5.64	8.22	24.20	0.01
Mansabdar	0-15	6.56	18.22	9.53	0.01
	15-30	4.89	9.89	8.12	0.02
Nasir Bagh	0-15	8.77	20.68	17.70	0.03
	15-30	9.99	13.58	13.66	0.01
Camp	0-15	19.15	12.35	26.55	0.07
	15-30	11.32	19.21	14.59	0.04
Maneri	0-15	2.59	9.25	21.22	0.05
	15-30	5.02	16.20	13.98	0.02
Topay	0-15	2.64	13.50	20.75	0.06
	15-30	1.32	17.85	18.78	0.03
Gadoon Amazai	0-15	5.63	17.90	19.25	0.16
	15-30	5.01	20.30	12.63	0.08
Chota Lahore	0-15	2.33	11.52	23.8	0.07
	15-30	4.46	17.55	20.22	0.06
Shoka	0-15	9.22	8.23	17.50	0.02
	15-30	3.02	14.20	15.31	0.01
Arah	0-15	7.99	13.55	19.89	0.08
	15-30	10.89	18.60	16.88	0.04

Table 4. ABDT-PA Extractable Co, Ni, Cr and Pb concentrations (mg kg^{-1}) collected from different locations of Swabi district.

Area Name	Depth (Cm)	Co	Ni	Cr	Pb
Dagai	0-15	2.40	6.99	1.37	1.35
	15-30	2.12	1.88	1.18	1.22
Haji Abad	0-15	1.88	4.18	1.20	1.54
	15-30	1.50	4.17	0.99	0.99
Dandoqa	0-15	2.11	4.62	2.55	1.44
	15-30	0.33	2.47	2.11	1.99
Mnagai	0-15	0.80	3.52	2.0	1.0
	15-30	0.60	2.77	1.23	0.98
Sher Khan Kali	0-15	6.99	13	4.0	0.40
	15-30	5.46	12.5	2.22	0.29
Kaludher	0-15	2.05	1.75	1.22	2.06
	15-30	2.12	1.00	1.99	1.80
Mansabdar	0-15	3.21	7.77	2.11	1.03
	15-30	2.82	5.55	1.03	0.98
Nasir Bagh	0-15	2.30	3.16	2.22	1.08
	15-30	2.19	3.09	1.66	0.08
Camp	0-15	0.99	2.59	0.23	0.99
	15-30	0.81	1.81	1.0	0.45
Maneri	0-15	1.07	2.21	1.0	0.45
	15-30	0.89	2.04	0.75	0.33
Topay	0-15	2.22	1.88	1.07	0.56
	15-30	1.98	1.50	1.21	0.43
Gadoon Amazai	0-15	2.35	22.21	8.02	2.23
	15-30	2.08	21.90	5.11	1.99

Chota Lahore	0-15	2.0	0.46	1.35	1.09
	15-30	0.44	0.42	2.0	0.08
Shoka	0-15	2.22	5.56	2.44	0.98
	15-30	1.99	5.10	1.99	0.87
Arah	0-15	3.01	3.00	1.99	0.66
	15-30	2.71	2.89	0.54	0.57

Table 5. Ranges and mean values of AB-DTPA Extractable Cu, Fe, Zn , Cd, Co, Ni, Cr and Pb (mg kg^{-1}) collected from different locations of district Swabi

Metals	Depth (Cm)	Ranges	Mean	Standard deviation
Cu	0-15	2.33-19.15	7.16	4.31
	15-30	1.32-14.11	6.12	3.84
Fe	0-15	8.23-36.89	18.0	8.18
	15-30	8.22-30.95	17.1	6.21
Zn	0-15	8.26-26.55	17.61	5.38
	15-30	7.77-24.20	14.80	4.62
Cd	0-15	0.01-0.16	0.06	0.03
	15-30	0.01-0.08	0.03	0.01
Co	0-15	0.8-6.99	2.37	1.44
	15-30	0.33-5.46	1.86	1.28
Ni	0-15	0.46-22.21	5.52	5.56
	15-30	0.42-21.9	4.60	5.59
Cr	0-15	0.23-8.02	2.18	1.83
	15-30	0.54-5.11	1.66	1.09
Pb	0-15	0.4-2.23	1.12	0.53
	15-30	0.08-1.99	0.87	0.64

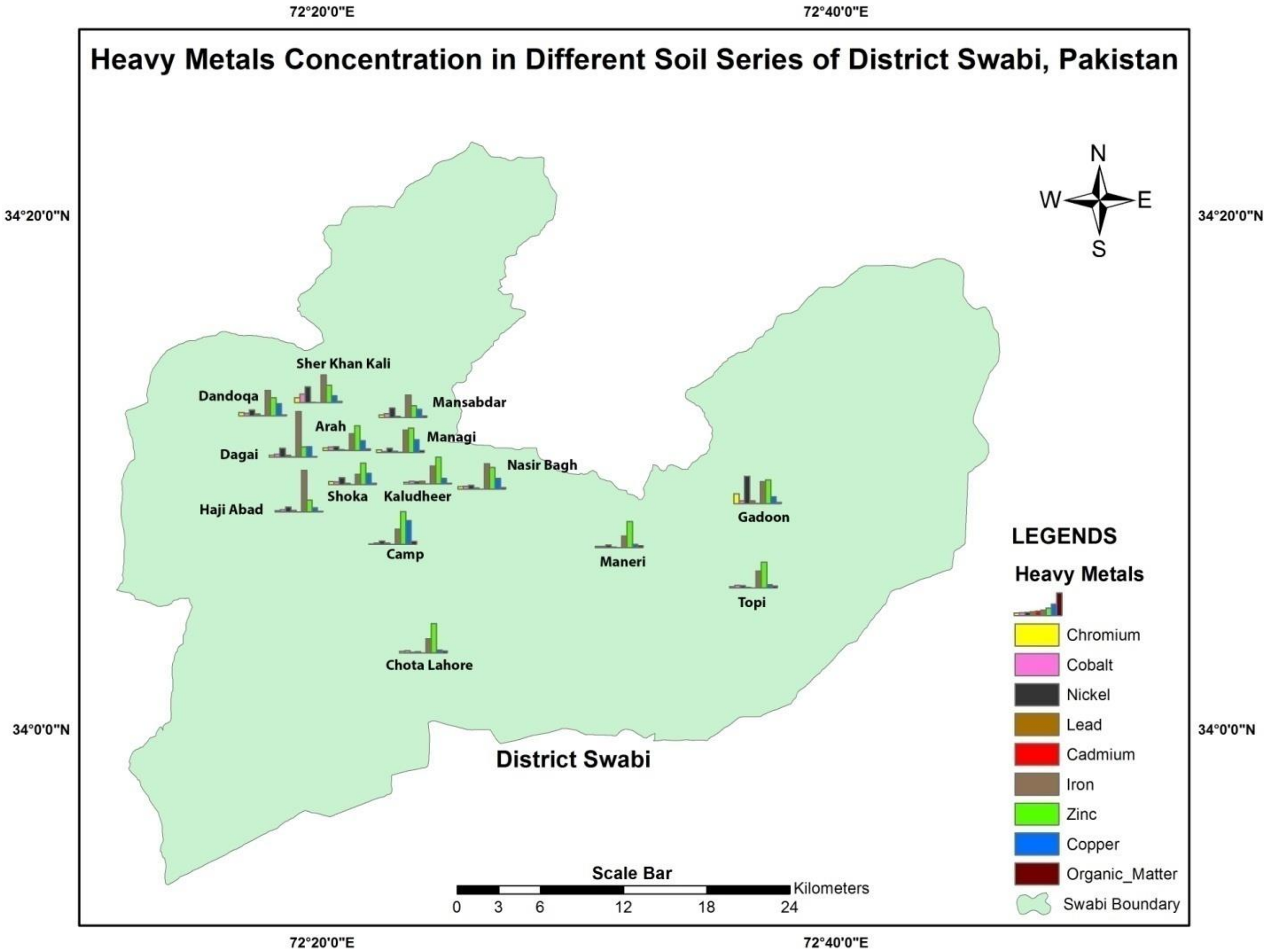

Fig. 2. Map showing different concentrations of heavy metals in different soil series of Swabi.

5. CONCLUSIONS

From the results it was concluded that all the soil samples collected from different locations of district Swabi were found adequate in Cu, Fe and Zn which are essential for agriculture crops, moreover the higher concentrations of heavy metals were found more in contaminated soils than in non contaminated soils. The higher concentrations of Ni, Cr and Pb in Gadoon Amazai soils may cause potential hazard for agriculture crops as well as for grazing animals on these soils over long period of time. Furthermore no correlation was found between AB-DTPA extractable heavy metals and soil chemical properties.

References

[1] Singh, K.P., D. Mohan, S. Sinha and R. Dalwani. 2004.Impact assessment of treated/ untreated wastewater toxicants discharged by sewage treatment plants on health,

agricultural, and environmental quality in the waste water disposal area. *Chemosphere* 55: 227–255.

[2] Chen, Y., C. Wang and Z. Wang. 2005. Residues and source identification of persistent organic pollutants in farmland soils irrigated by effluents from biological treatment plants. *Environment International* 31: 778-783.

[3] Silveira, M. L. A., Alleoni, L. R. F., & Guilherme, L. R. G. (2003). Biosolids and heavy metals in soils. *Scientia Agricola*, 60(4), 793-806.

[4] Asaolu. 1995. Lead content of vegetable and tomatoes at Erekesan Market, Ado-Ekiti. *Pakistan Journal of Scientific and Industrial Research* 38: 399-401.

[5] Mildvan, A. S. (1970). 9 Metals in Enzyme Catalsis. In The enzymes (Vol. 2, pp. 445-536). Academic Press.

[6] Singh, J., & Kalamdhad, A. S. (2011). Effects of heavy metals on soil, plants, human health and aquatic life. *International Journal of Research in Chemistry and Environment*, 1(2), 15-21.

[7] Malla, R., Y. Tanaka, K. Mori and K.L. Totawat. 2007.Short term effect of sewage irrigation on chemical buildup in soil and vegetables. *The Agricultural Engineering. International CIGR Ejournal Manuscript* 9: 14.

[8] Khan, A., Javid, S., Muhmood, A., Mjeed, T., Niaz, A., & Majeed, A. (2013). Heavy metal status of soil and vegetables grown on peri-urban area of Lahore district. *Soil Environ*, 32(1), 49-54.

[9] Flora, S. J. S., Mittal, M., & Mehta, A. (2008). Heavy metal induced oxidative stress & its possible reversal by chelation therapy. *Indian Journal of Medical Research*, 128(4), 501.

[10] Muchuweti, M., J.W. Birkett, E. Chinyanga, R. Zvauya, M.D. Scrimshaw and J.N. Lester. 2006. Heavy metal content of vegetables irrigated with mixture of wastewater and sewage sludge in Zimbabwe: implications for human health. *Agriculture, Ecosystem and Environment* 112: 41–48.

[11] Raza, S.H., F. Shafiq and M. Tahir. 2013. Screening of cadmium tolerance in sugarcane using antioxidantive enzymes as a selection criteria. *Pakistan Journal of Life and Social Sciences* 11: 8-13.

[12] Guala, S. D., Vega, F. A., & Covelo, E. F. (2010). The dynamics of heavy metals in plant–soil interactions. *Ecological Modelling*, 221(8), 1148-1152.

[13] Jamal, A., & Jamal, H. (2018). Assessment and Distribution of Macro and Micro Nutrients in Different Soil Series of District Swabi, Khyber Pakhtunkhwa, Pakistan. *Journal of Horticulture and Plant Research*, 23.

[14] S. Perveen, Z. Malik, W. Nazif, Fertility status of vegetable growing areas of Peshawar, Pakistan, *Pak. J. Bot.* 42(3) (2010) 1871-1880.

[15] Mohammadzai, I., Khan, N., Khan, M. J., & Khattak, R. A. (2001). Heavy metals (Cu, Fe, Mn, Zn, Cd, Co, Ni, Mo, Cr and Pb) status in some selected soils of Peshawar and Nowshera districts. *Journal of the Chemical Society of Pakistan*, 23(1), 23-30.

[16] Safari-Sinegani, A. A., & Safari-Sinegani, M. (2011). The effects of $CaCO_3$ on adsorption, immobilization and activity of cellulase in a decarbonated soil. *Journal of soil science and plant nutrition*, 11(3), 99-109.

[17] Tariq, M., Sharif, M., Shah, Z., & Khan, R. (2007). Effect of foliar application of micronutrients on the yield and quality of sweet orange (Citrus sinensis L.). *Pak. J. Biol. Sci.* 10(11), 1823-1828.

[18] Tóth, G., Hermann, T., Da Silva, M. R., & Montanarella, L. (2016). Heavy metals in agricultural soils of the European Union with implications for food safety. *Environment international*, 88, 299-309.

[19] W.H. Allaway, Agronomic Control over the Environmental Cycling of Trace Elements, *Adv. Agron.* 20, 235 (1968)

[20] Apakama N. Chukwuemeka, Verla E. Ngozi, Ihenetu S. Chukwuemeka, Verla A. Wirnkor. Physicochemical properties and selected metals in soils of Ohaji-Egbema, Imo State, Nigeria. *World News of Natural Sciences* 10 (2017) 39-48

[21] Verla Andrew Wirnkor, Verla Evelyn Ngozi. Risk associated with heavy metals in children playground soils of Owerri metropolis, Imo State, Nigeria. *World News of Natural Sciences* 10 (2017) 49-69