Study of Some Heavy Metals and Radioactive Element from Soil Samples, Nyala Area -Sudan

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Abstract: ***In this work X-ray fluorescence (XRF) technique was used to evaluate the soil pollution with heavy metals for 40 surface and sub-surface soil samples (0–5 cm in depth) from various locations to cover the area of Nyala city, Sudan. Concentrations of eleven elements Cr, Ni, Cu, Zn, Pb , Co, Fe, Zr , Y, Rb and V were determined. The study established as the data baseline to the major and minor trace elements from study area that has not been investigated before. The elemental concentrations were compared with the normal values and other studies in different locations from the world. The correlation between elements indicates that no pollution exists inside the investigated area. The results indicated that all the samples analyzed are safe in general for the toxicity levels. The results establish a database reference of radioactivity background levels for the study around Nyala city.***

Keywords: XRF, Heavy metals, Soil samples, Environmental pollution, Nyala area.

1. Introduction

Heavy metals are defined as metallic elements that have a relatively high density compared to water [1].With the assumption that heaviness and toxicity are inter related, heavy metals also include metalloids, such as arsenic, that are able to induce toxicity at low level of exposure [2]. In recent years, there has been an increasing ecological and global public health concern associated with environmental contamination by these metals. Also, human exposure has risen dramatically as a result of an exponential increase of their use in several industrial, agricultural, domestic and technological applications [3].sources of heavy metals in the environment include geogenic, industrial, agricultural, pharmaceutical, domestic effluents, and atmospheric sources [4]. Environmental pollution is very prominent in point source areas such as mining, foundries and smelters, and other metal-based industrial operations [1, 3, 4].

Heavy metals induced toxicity and carcinogenicity involves many mechanistic aspects, some of which are not clearly elucidated or understood. However, each metal is known to have unique features and physic-chemical properties that confer to its specific toxicological mechanisms of action. This review provides an analysis of the environmental occurrence, production and use, potential for human exposure, and molecular mechanisms of toxicity, genotoxicity, and carcinogenicity of arsenic, cadmium, chromium, lead, and mercury [1, 2, 3, 4]. Measurements and studies of natural radioactivity in soil and rocks are very important to determine the amount of change of the natural background activity with time as a result of any radioactive release; monitoring of any release of radioactivity to the environment is important for environmental protection [5] .

In recent years, attention has been drawn to the development and steady introduction of analytical methods suitable for quantification of thorium and uranium tracers. From the viewpoint of radiation protection, determination of natural radionuclide's such as ^{238}U, ^{40}K and ^{232}Th in soil samples are also important.

Studying the levels of radionuclide distribution in the environment provides essential radiological information [5,6,7,8]. As a result of rapid urbanization and industrial development, heavy metal contamination has been threatening human health [9].

A soil pollution assessment becomes very complex when different sources of contamination are present and their products are variably distributed. In these cases, the spatial variability of heavy metal concentrations in soils is basic information for identifying the possible sources of contamination and to delineate the strategies of site remediation. The main objective of this study is to determine the level of soil pollution and assess the heavy metal and trace elements contamination for surface and subsurface soil samples of Nyala Area, and to compare with other studies, whose activity of human lasted few years, being one of the most important metallurgical complexes and representing a great potential of environmental contamination [5-8, 10].

2. Material and Methods

40 soil Samples were collected during July 2015 and August 2015, at surface level (0–5 cm in depth) from various locations to cover study area, Nyala city is the capital of South Darfur state in the western part of the Sudan. its located at elevation 2,208 feet (673 m) in Darfur region.[11] located at the intersection of longitude 24.53 degrees east and latitude 12.03 degrees north, It is important to note that this area is high density populated and tourisms area. The soil samples were dried, homogenized and sieved at 200 mesh grain size. Pressed powder pellets were prepared to avoid the elements contaminations, heavy metals and trace element analysis of samples by X-Ray fluorescence performed using a Philips PW XU unique, This instrument is connected to a computer system using X-40 program for spectrometry. The trace elements concentrations are calculated from the program's calibration curves which were set up according to international reference materials, (standards). The detection limit is the lowest concentration, and it is function of the level of background noise relative to

an element signal [12].The distance between each successive sample about one kilometer.

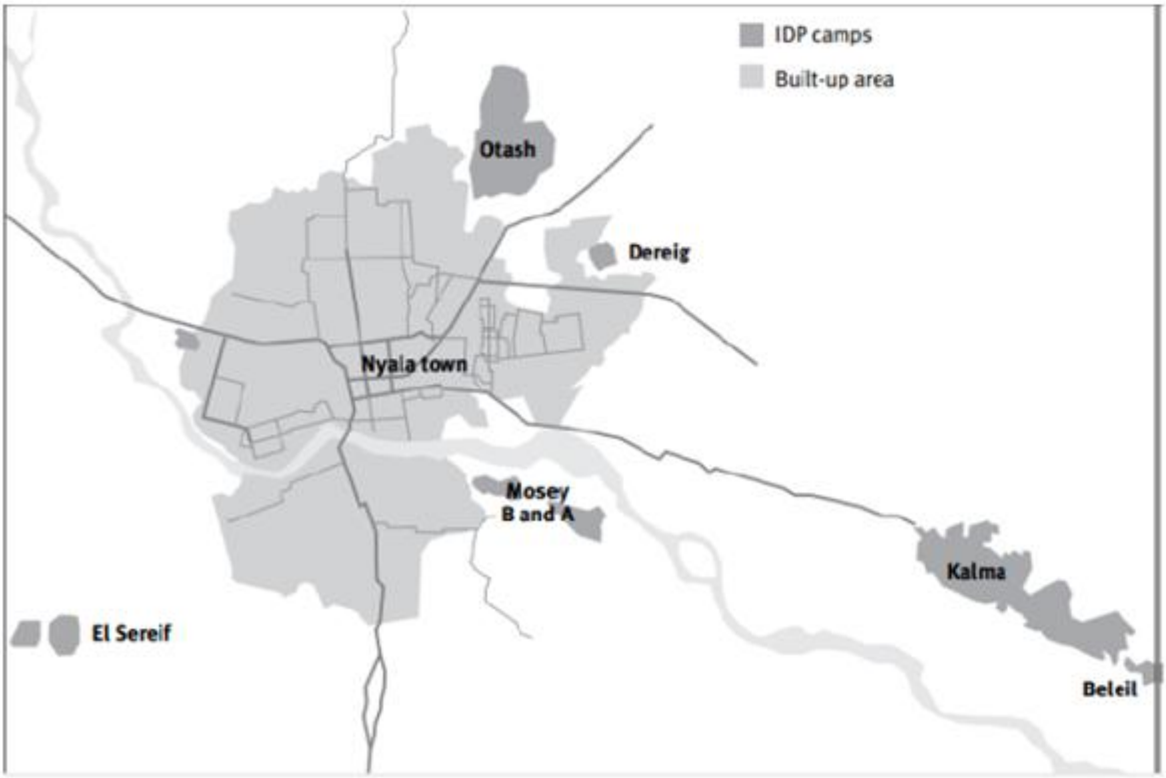

Figure 1: Map of Nyala city , South Darfur state, Sudan [11]

3. Results and Discussion

The concentration of heavy metals elements for Nyala area from 24 soil selected samples are presented here:

Table 1: Heavy metals concentration (in ppm) using XRF techniques for some selected soil samples from Nyala city.

No	Sample	Depth	Cr	Ni	Cu	Zn	Pb	Co	Fe	Zr	Y	Rb	V
1	S01E	0	0.012	0.007	0.008	0.033	0.008	0.007	2.880	372.820	25.660	92.290	61.590
2	S02E	5	0.022	0.003	0.005	0.011	0.008	0.000	1.314	198.401	10.165	89.321	65.321
3	S05E	0	0.016	0.008	0.007	0.013	0.007	0.000	3.048	200.231	11.289	85.320	60.215
4	S06E	5	0.028	0.002	0.002	0.004	0.003	0.000	1.023	154.254	13.967	88.321	55.321
5	S09E	0	0.019	0.007	0.007	0.005	0.001	0.000	0.842	198.879	14.212	83.001	50.214
6	S10E	5	0.023	0.003	0.004	0.009	0.002	0.000	1.373	198.458	15.154	88.321	27.675
7	S01W	0	0.015	0.007	0.004	0.004	0.002	0.000	2.471	343.733	17.146	90.812	41.761
8	S02W	5	0.017	0.003	0.007	0.004	0.003	0.000	1.212	200.215	14.121	55.658	41.762
9	S05W	0	0.023	0.001	0.002	0.001	0.000	0.000	1.119	197.666	10.089	51.085	39.698
10	S06W	5	0.017	0.004	0.001	0.001	0.000	0.000	1.084	315.635	12.980	4.713	44.226
11	S09W	0	0.025	0.000	0.003	0.001	0.000	0.000	1.119	105.514	9.666	8.0756	41.666
12	S10W	5	0.013	0.003	0.006	0.001	0.003	0.007	2.684	198.401	11.200	154.321	36.108
13	S01S	0	0.016	0.000	0.001	0.004	0.002	0.000	0.059	105.514	13.808	114.300	31.178
14	S02S	5	0.019	0.003	0.002	0.004	0.004	0.000	0.847	198.401	15.128	77.326	29.640
15	S05S	0	9.726	3.106	0.852	0.167	0.000	0.000	29.18	171.760	13.422	68.617	39.698
16	S06S	5	0.024	0.003	0.012	0.003	0.002	0.000	1.182	263.028	15.545	69.604	42.783
17	S09S	0	0.023	0.000	0.051	0.001	0.001	0.000	1.017	213.277	14.321	48.759	29.640
18	S10S	5	0.015	0.002	0.053	0.002	0.002	0.000	1.671	699.122	28.543	56.325	43.175
19	S01N	0	0.014	0.006	0.006	0.021	0.007	0.000	2.791	442.841	29.556	95.088	69.071
20	S02N	5	0.027	0.008	0.002	0.004	0.002	0.000	1.892	295.127	18.947	74.986	52.745
21	S05N	0	0.019	0.005	0.004	0.004	0.002	0.000	1.267	215.350	16.001	56.325	69.071
22	S06N	5	0.018	0.007	0.004	0.004	0.000	0.004	2.894	298.218	17.923	69.084	70.604
23	S09N	0	0.026	0.004	0.001	0.001	0.002	0.000	1.541	858.960	31.22	65.324	52.908
24	S10N	5	0.031	0.003	0.000	0.002	0.003	0.000	1.542	215.35	15.020	56.325	50.654

XRF results for the collected soil samples evident the existence of the following elements: Co, Fe (major) Cr, Ni, Cu, Zn, Pb , Zr , Y, Rb and V (minor).

The average concentrations of heavy metals Cr, Cu, Ni, Pb and Zn for more than one measurements of each of the soil samples presented in part per million (ppm) units are given in Table 1 [10]. It was found that Fe concentrations for all studied sites are very high (2.880 ± 1.160208 ppm), near the values of standard reference materials (SRM) for IAEA. The high Fe value confirms with the fact that the soil is clay. The high concentration of Fe clay soils can not cause any risks, because Fe is not a contaminant element. Fe is important in plant nutrition and an essential crop micronutrient, while most the Cr, Ni, Cu, Zn ,Pb , Co, Fe, Zr , Y, Rb and V concentrations are (0.4245,0.1331,0.0435,0.0127, 0.0027, 0.0011,2.7521 ,277.547 ,16.4618 ,72.6376 and 47.7802) (ppm) respectively

Table 2: Descriptive Statistics Report

	Cr (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Pb (ppm)	Co (ppm)	Fe (ppm)	Zr (ppm)	Y (ppm)	Rb (ppm)	V (ppm)
Mean	0.4245	0.1331	0.0435	0.0127	0.0027	0.0011	2.7521	277.548	16.4618	72.6376	47.7802
Std. Deviation	1.9812	0.6332	0.1728	0.0337	0.0025	0.0026	5.6838	175.198	6.135	30.708	13.148
Variance	3.9250	0.4010	0.0300	0.0010	0.0000	0.0000	32.306	30694.3	37.646	943.013	172.871
Geometric Mean	0.0252	0.0000	0.0000	0.0041	0.0000	0.0000	1.5110	242.873	15.563	61.3784	46.0348
Range	9.7140	3.1060	0.8520	0.1660	0.0080	0.0080	29.1190	753.446	21.554	149.608	42.929
Std. Error of Mean	0.4044	0.1293	0.0353	0.0069	0.0005	0.0005	1.1602	35.762	1.252	6.268	2.6838
Minimum	0.0120	0.0000	0.0000	0.0000	0.0000	0.0000	0.0590	105.514	9.666	4.713	27.675
Maximum	9.7260	3.1060	0.8520	0.1670	0.0080	0.0080	29.1780	858.960	31.220	154.321	70.604

Table 3: Comparison of trace element concentrations (in ppm) for studied samples with other studies in different locations from the world.

Element	Karon Lake*[13]	Wadi El Rayan[13]	Marmara Sea [14]	Gulf of Naples[15]	Saros Gulf[16]	(ISIW) at Romania[17]	Hyderabad, India [18]	Threshold value[19]	Tirana,Sediment sample[20]	Haweja Kirkuk[21]
Cr	26-98	23 - 203	65 - 85	11 - 66	35 - 75	52.9 - 101.3	12.3 - 480.6	10 - 50	-	-
Ni	9-46	14 - 18	35 - 50	0.01 - 26.7	<5 - 75	41.9 - 65.6	12.6 - 132.0	10 - 50	-	-
Cu	34-46	43 - 52	20 - 80	3 - 664	<0.5 - 48	<15 - 52.8	11.1 - 186.6	10 - 40	-	-
Zn	25-90	60 - 145	77 - 1765	25 - 120	.0 - 121.0	40.8 - 882.2	20 - 200	60 - 145	-	-
Pb	u.d-17	-	-	-	-	11.0 - 52.2	42.9 - 1832.5	10 - 30	-	-
Co	-	-	-	-	-	-	-	-	-	36.29
Fe	-	-	-	-	-	-	-	-	4.39	1.55
Zr	79-231	98-737	-	-	-	-	-	-	-	-
Y	11-34	9-38	-	-	-	-	-	100-1000	-	-
Rb	16-51	18-25	-	-	-	-	-	-	-	-
V	7-57	11-17	-	-	-	95.5-110.7	-	30-150	-	-

-Not limited

Table 4: Person Correlation matrix of selected major and trace elements for soils samples-Nyala city

Element	**Cr**	**Ni**	**Cu**	**Zn**	**Pb**	**Co**	**Fe**	**Zr**	**Y**	**Rb**	**V**
Cr	1										
Ni	-.043	1									
Cu	.997**	-.051	1								
Zn	.975**	-.054	.971**	1							
Pb	-.230	-.056	-.235	-.054	1						
Co	-.091	-.090	-.091	-.011	.204	1					
Fe	.990**	-.032	.987**	.982**	-.167	-.030	1				
Zr	-.129	.020	-.105	-.109	.078	.018	-.088	1			
Y	-.106	.085	-.085	-.021	.239	.100	-.056	.874**	1		
Rb	-.029	.017	-.039	.042	.459*	.385	.018	-.073	.077	1	
V	-.131	.080	-.149	-.028	.447*	.110	-.058	.226	.322	.017	1

**. Correlation is significant at the 0.01

4. Conclusions

XRF technique has been employed in order to reveal their mineral composition to evaluate the pollution of soil with heavy metals. The concentrations of studied elements (Cr, Ni, Cu, Zn, Pb , Co, Fe, Zr , Y, Rb and V) in Nyala city were determined. A soil pollution assessment becomes very complex when different sources of contamination are present and their products are variably distributed with time assembling and become toxic. As a result of existance of all these elements, which are not pollutant, we recommend that the measurement of heavy metals in study area are within acceptable levels and doesn't possess any biological risks. The results of this study can be used as a data baseline for preparing a radiological map of the study area, especially at the chosen sites. Existance of toxic elements with different values caused many diseases if reached to human bodies with high ratio [21]. For example, Cr caused carcinoma; Cu caused cirrhosis, nausea, vomiting and diarrhea.

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