ASSESSMENT OF HEAVY METAL CONTAMINATION OF SOIL SAMPLES COLLECTED FROM THE AREA AROUND AL-MARQUB CEMENT PLANT

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Abstract

Soil samples were collected from and around Almarqub cement factory, AL-Khums city, Libya. These samples were collected from four different sites M1 (inside the factory), M2 (150 m from the factory), M3 (350 m from the factory) and M4 (60 km away from the factory as the control samples. The study was conducted to determine the heavy metal concentration in the soil. Organic matter, pH and water content value were determined according to the method described by Chaturvedi and Sankar (2006). Metals were determined by Atomic Absorption Spectrophotometer. The results obtained for the examined physiochemical properties of soil in the area studied prove that cement dust from the Almarqub cement factory has had a significant impact on the soil. The affected soil properties are pH and total calcium content. These properties were found to be higher than those in similar soils from the same area unpolluted. The increase of soil pH in the same area may be a result of precipitation of cement dust over the years. Metal uptake from cement to soil and plants. Metals determined in contamination soil indicated high concentrations in M1 inside cement factory compared to soil samples as control. Results of the analysis have shown that there are signs of slight impact of soil properties arising from the cement dust on the soils, especially at location inside the factory. Recommendations were offered to monitor the dust falling on the soils through trapping and utilizing the dust emissions of cement.

Keywords: Contamination, Heavy metals, Soil, Almarqub cement factory– Libya.

Introduction

The effect of the atmospheric pollution on the ecosystems was evinced at several times (Bliefert and Perraud, 2001). Human activities such as industrial production, mining, agriculture and transportation, emission of high amounts of heavy metals into surface water, ground water and soils. Some of the metals found in the dust releaseed from cement factory such as arsenic, cadmium, lead, mercury and thallium (Chang, 1996). Aluminum, beryllium, chromium, copper, manganese, nickel, lead and zinc among others (Schuhmacher et. al.,

2002). Cement dust can diffuse over big areas through wind and rain and is cumulatived in and on soils (Demir et. al., 2005). The particles can step inside soil as dry and humid deposits and can undermine its physiochemical properties (Hosker and Lindberg, 1982). Similar studies have revealed that atmospheric particles can lead to the decrease of biodiversity in soil. Environmental contamination by heavy metals has been in increase in recent times. Heavy metals take place naturally in the soil environment from the pedogenetic processes of weathering of parent materials at levels that are regarded as trace less than 1000 $mgkg^{-1}$ and seldom toxic (Kabata and Pendias, 2001). The raw materials of the cement have mainly the following constituents: 75% limestone ($CaCO_3$), 20% - 25% clay (Al_2O_3 + Fe_2O_3), 5% sand (SiO_2) and 2% Ferric oxide (Fe_2O_3). Cements are mineral materials, basically hydrated silicate and portlandite [$Ca(OH_2)_2$] for the ordinary Portland cement (Perfettini et. al., 1991). Many Studies indicated that changes in soil properties have been connected with environmental alteration resulting from human activity (Ibanga et. al., 2008). Cement contacts the soil surface and its constituents usually change the physical and chemical constituents of the soil. Cement has high carbonate content, the dust tends to be highly alkaline. Thus, it is detected that soil polluted by cement will have high pH. Khan and Khan (1996) reported that the biological, physical and chemical properties of soil, such as electrical conductivity, pH and water content, were all found to be influenced when treated by dust of cement. The impact of the activities on the ecosystem components (air, soils, water and vegetation) (Amore et. al., 2005). The unrest and acceleration of nature's slowly occurring geochemical cycle of metals by human being, most soils of rural and urban environments may accumulate one or more of the heavy metals, will cause risks to human health and ecosystems (Adefila et.al.,2004). The main objective of this study was to assess the impact on soil of cement dust emitted in the area around Almarqub cement factory. To investigat pH, moisture, and heavy metals content in the polluted soil, comparing the findings with those for soil samples taken from an unpolluted area.

Materials and Methods

Almarqub cement factory is located in AL-Khums town which is situated 160 km east of the capital Tripoli Figure (1). Soil samples were collected from four different sites M1 (inside the factory), M2 (150 m from the factory), M3 (350 m from the factory) and M4 (60 km away from the factory as the control, to examine heavy metals, pH and water content of unpolluted soil (control) and soil that had been continually exposed to cement dust. at depth of 1 - 15 cm and four samples from each site, Sampling distances of 150 m and 350 m for polluted soil. A total of 16 soil samples were collected at four locations in the study area. Soil samples collected from the field were air-dried, grinded and sieved to remove materials larger than 2mm diameter. The collection sites for contaminated soil were to the east of the cement factory because of prevailing winds from the west. The probability of dust deposits is larger at any other direction around the cement factory. The distance between stations at the same site was 10 m. Organic matter, pH and water content value were determined according to the method described by Chaturvedi and Sankar (2006). The pH was measured with pH meter.

The pH meter was calibrated with buffer solutions at pH 4, 7 and 9. Metals were determined according to the standard methods of AOAC (1984) by Atomic Absorption Spectrophotometer (180-30 Hitachi). All the studies were carried out in Advanced laboratory for chemical analysis Tripoli. Analysis of variance (ANOVA) and Pearson correlation were performed on the data using SPSS (10.0) for Windows for significant variations and inter-element relationships. Results were presented as the mean ± standard error.

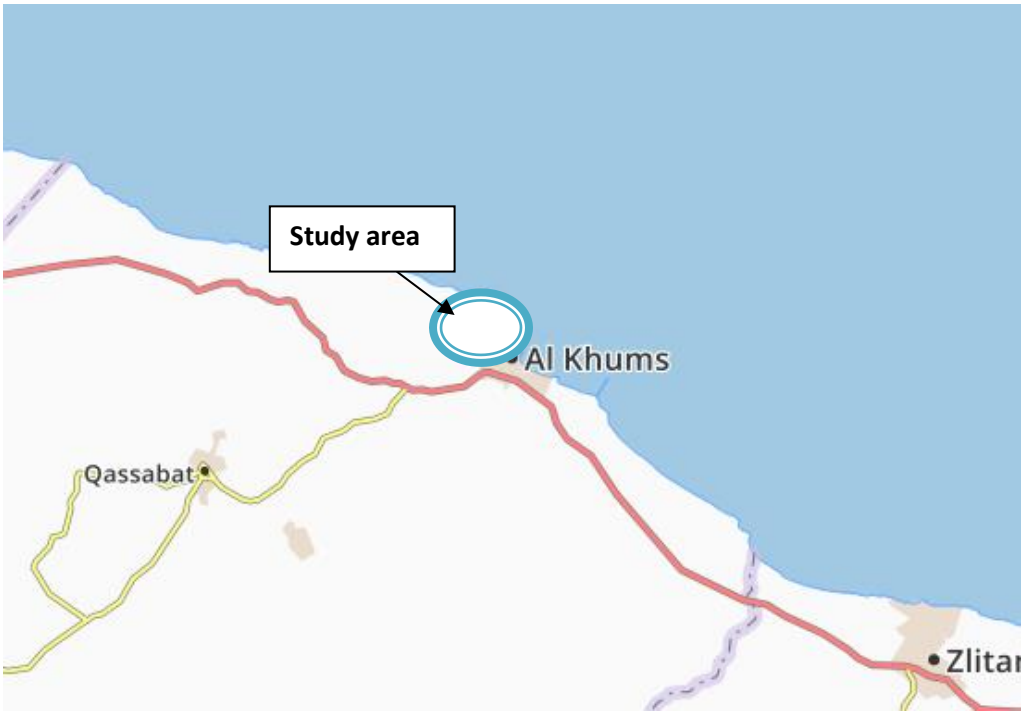


Figure (1): Map Showing the Study Area.

Results and Discussion

The results obtained by examining some physicochemical properties of soils from and around Almarqub cement plant have indicated a strong influence by this plant dusts that have settled on the soil from the cement plant. It can be concluded that the effect of dust on organic matter, water content and pH of soil depended not only on period of exposition to this dust. Results are shown in Figure (2), (3) and (4). The pH values not significant difference at all areas, ranged from at M4 area site about 8.42 to 8.75 in M2 showed in Figure (2). The organic matter was low in soil samples, ranged from 0.14 to 0.30 gm at M2 and M1 respectively Figure (3). Since all samples contained very low amounts of organic matter this result is consistent with other finding of studies on Libyan soils (Hmad et. al., 2006). On the other hand, water content ranged from 2.08% in M4 to 4.32% in M1 Figure (4). The results show that the soil samples from different areas differ in their metals content and the metal concentrations inside the factory samples were higher than others. The Cu concentrations was higher (0.42 ppm) in soil

samples M1 inside the cement factory while in soil samples M2 (150m from the cement factory) concentrations was lower (0.09 ppm) than other samples showed Figure (6). The Cd concentrations in soil samples ranged from high in M1 and low in M4about 0.22 ppm and 0.05 ppm respectively Figure (7). The Pb concentrations was higher (0.23 ppm) in soil samples M1 inside the cement factory while in soil samples M4was about 0.03 ppm Figure (8). The Al concentrations in soil samples ranged from high in M1 and low in M2 about 7.14 ppm and 3.10 ppm respectively Figure (9). While the highest amounts of Ca concentration in the location inside the factory. There were significant differences in soil metals content between first location inside factory and unpolluted samples ($P < 0.05$). Pollution of soil by heavy metals occurs due to different sources such as industrial wastes, application of fertilizers, corrosion of sheeting, wires, pipes, burning of coal and wood, and fuel hydrocarbons. Overall, heavy metals were generally toxic to soil microbial (Mlitan et. al. 2013).

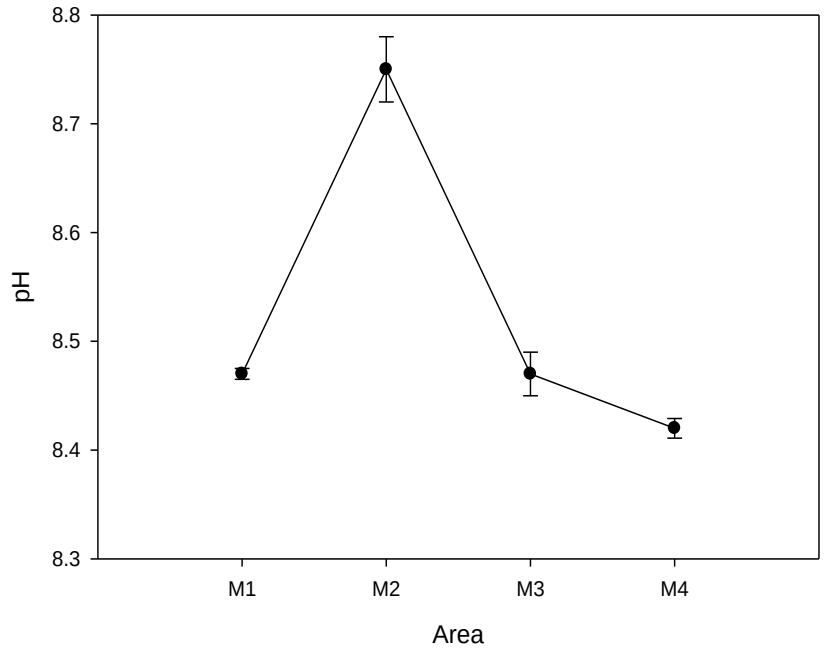


Figure (2): pH Value of Different Locations from The Cement Factory.

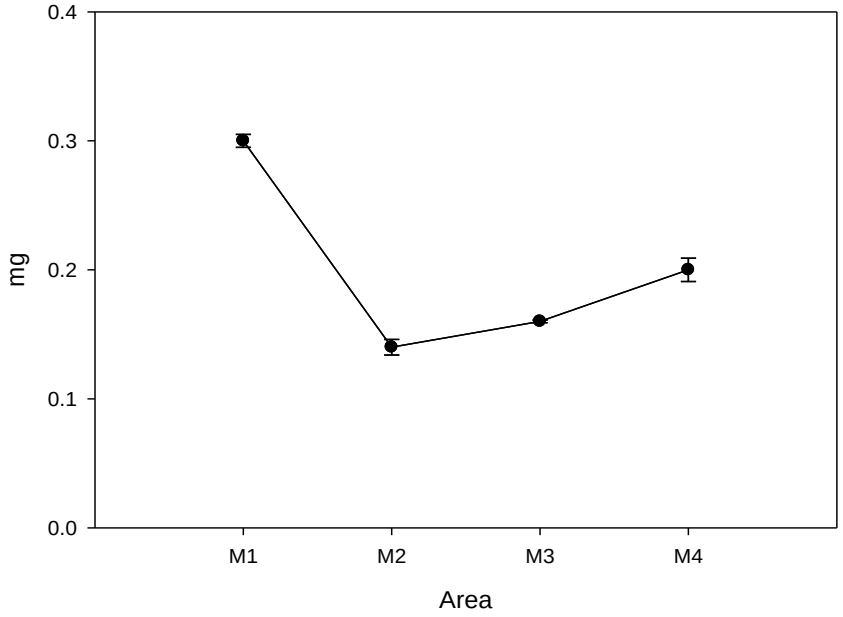


Figure (3): Organic Matter Value of Different Locations from The Cement Factory.

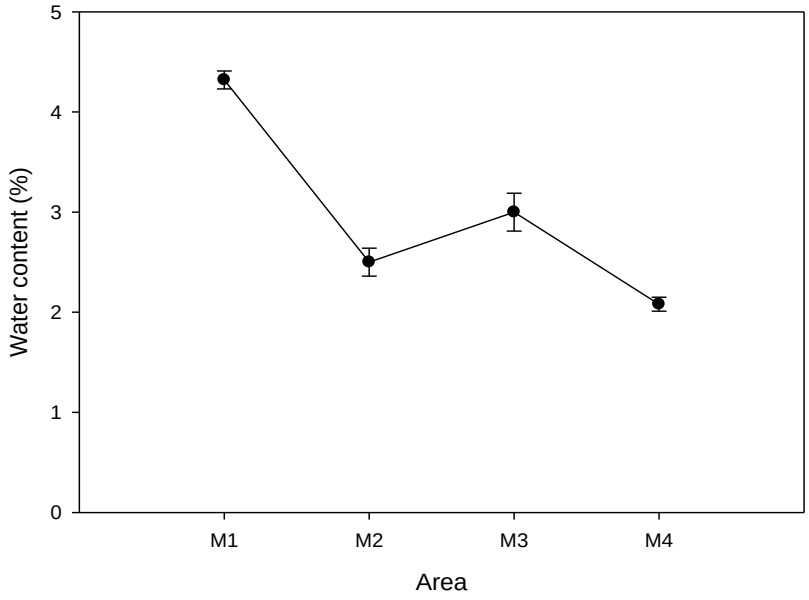


Figure (4): Water Content Value of Different Locations from The Cement Factory.

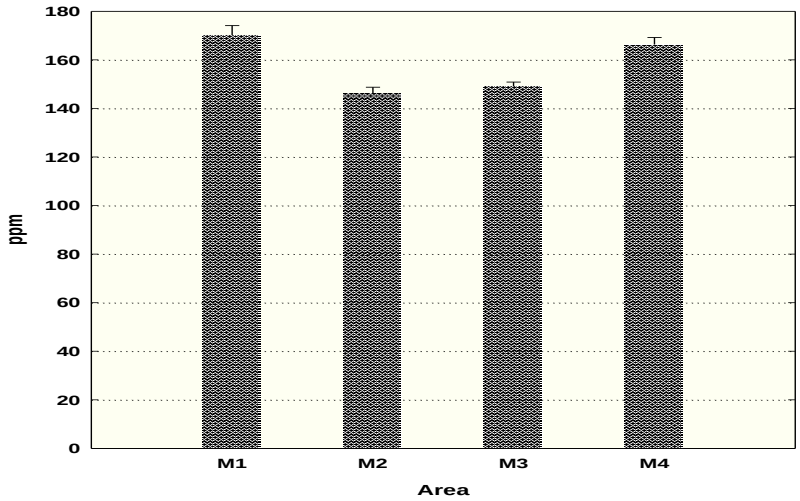


Figure (5): Concentration of Ca in Different Locations from The Cement Factory.

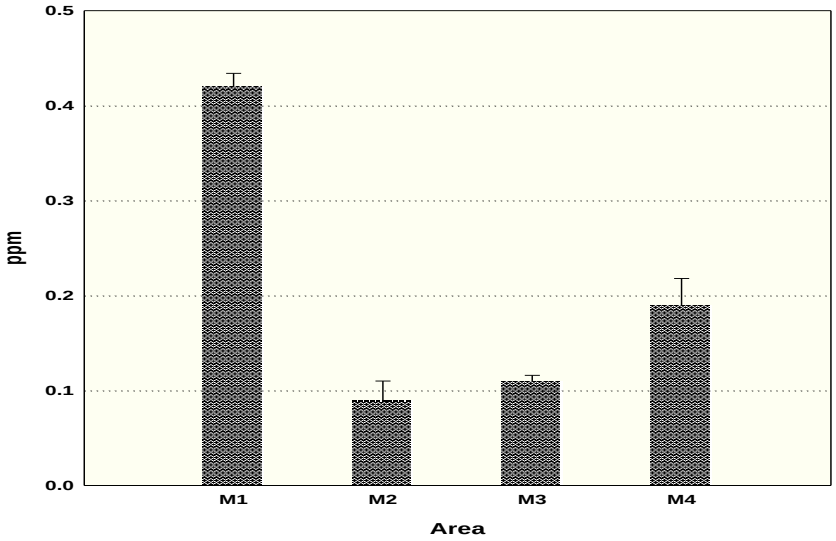


Figure (6): Concentration of Cu in Different Locations from The Cement Factory.

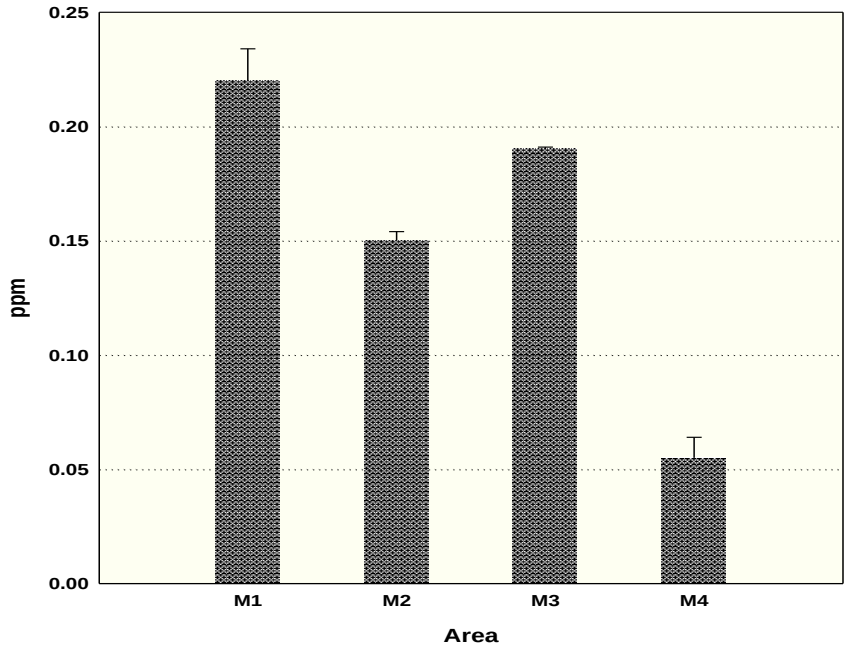


Figure (7): Concentration of Cd in Different Locations from The Cement Factory.

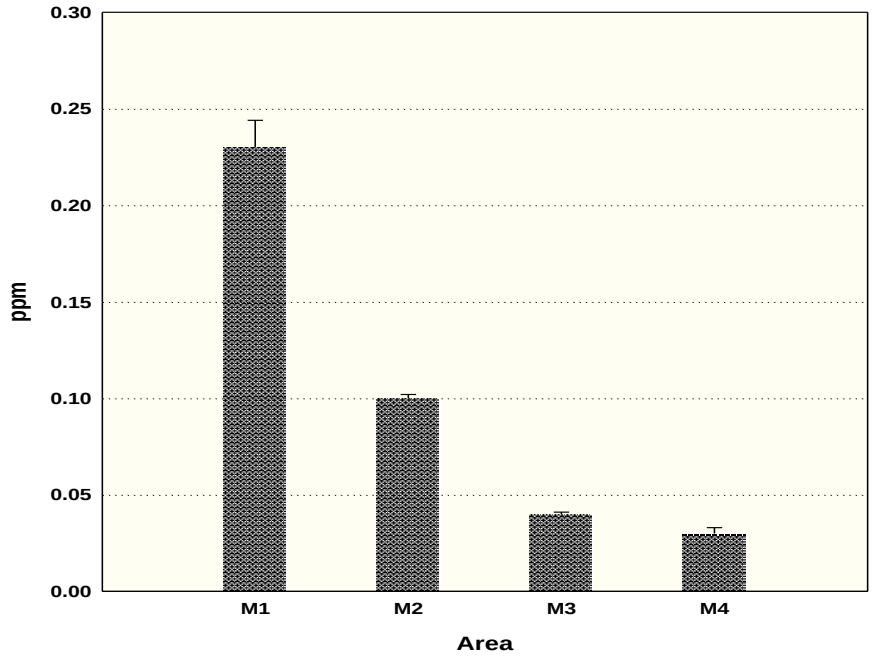


Figure (8): Concentration of Pb in Different Locations from The Cement Factory.

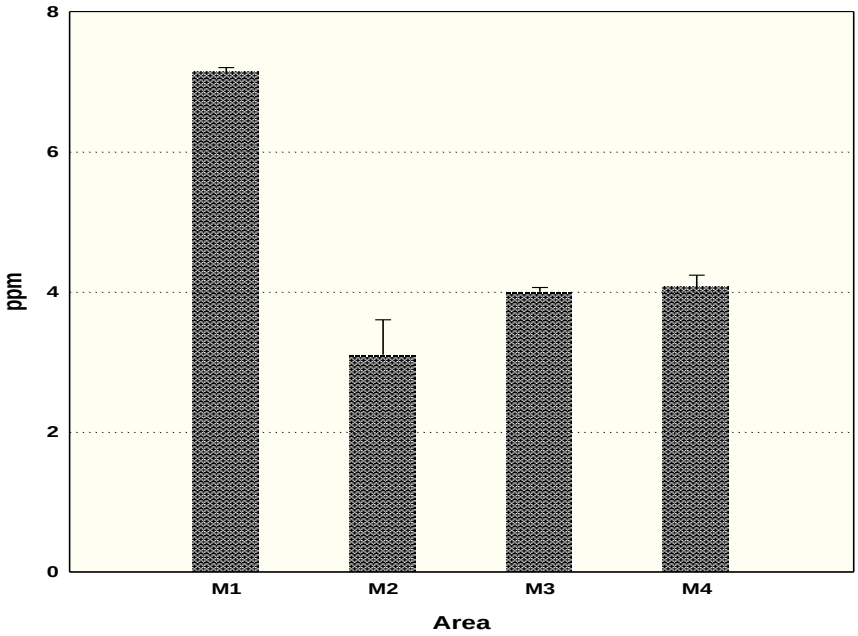


Figure (9): Concentration of Al in Different Locations from The Cement Factory.

Conclusion

From the results obtained, it is concluded that the physicochemical properties of soils such as pH, water content and organic matter in the study area pointed to a strong impact by cement dusts that have settled on the soil from the factory. Metals determined in contamination soil indicated high concentrations in M1 inside cement factory compared to soil samples as control. From other research pointed to higher metals and pH in soil samples lead to the reduction of microbial in polluted soil by cement dust.

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