

Impact of Cement Dust on Some Soil Properties Around the Cement Factory in Kirkuk Governorate – Iraq

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Abstract

Twelve sampling locations were determined on a traverse 6 km long (500 m apart), in order to collect soil samples from surface (0-5 cm) and sub surface (5 – 30 cm) for each location.

It is worth mentioned, that the sampling were undertaken in the direction of the prevailing wind direction away from the vicinity of cement fabric in Kirkuk. At each site, samples were collected at two soil depth, these soil samples were air dried and sieved through 2mm, analysed for their some chemical and physical properties as well as their total heavy metals content. The results indicated that the soils of the studied area are calcareous in nature having 20.8 to 36.8% sandy clay loam to sandy loam in CaCO₃ texture and moderately to slightly alkaline (with mean pH 7.7). CaO percentages were found to be high (24.1%), especially in the surface soil samples taken near the cement factory. The soils were heavily contaminated with Cd and Co in comparison with other heavy metals which the results showed none polluted. The most contaminated sites area found within the 0 to 2.5 Km of the cement factory.

Key Words: Cement Dust, Soil Properties, Cement Factory and Kirkuk

أثر غبار الاسمنت على بعض خواص التربة حول مصنع الاسمنت في محافظة كركوك – العراق

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الخلاصة

حددت مواقع اخذ العينات وعددها 12 نموذج وذلك بطول 6 كم وبمسافة 500 م بين عينة واخرى حيث أخذت عينات من السطح بعمق من صفر – 5 سم وكذلك تحت السطح بعمق 5 – 30 سم لكل موقع.

منطقة الدراسة اخذ بنظر الاعتبار اتجاه الرياح بعيداً عن محيط مصنع أسمنت في كركوك مصدر الانبعاثات .

جفت النماذج هوائياً ونظمت بمنخل قطر فتحاته 2 ملم. و حللت النماذج لدراسة الخصائص الفيزيائية

والكيميائية بالإضافة الى محتويات التربة من العناصر الثقيلة

اشارت النتائج الى ان التربة في منطقة الدراسة هي ذات طبيعة جيرية (كلسية) حيث احتوت ما بين 20,8% -

36,8% من كاربونات الكالسيوم وهي ذات نسجة تراوحت ما بين (مزيجية طينية رملية – مزيجية رملية) . وذات

pH متوسطة الى قلوية قليلاً (7.7 pH) .

أن نسبة اوكسيد الكالسيوم كانت عالية حيث بلغت 24,1% . وخصوصاً للنماذج المأخوذة من السطح قريباً من

معمل الاسمنت ، اي بمعنى ان الترب كانت ذات مستوى عالي من التلوث بمعادن الكاديوم والكوبلت ، مقارنة

ببقية العناصر الثقيلة التي اشارت النتائج عدم تلوث التربة بها .

ان اغلب مساحات المناطق الملوثة محصورة بين صفر – 2,5 كم من مصنع الاسمنت .

الكلمات المفتاحية : غبار الاسمنت ، خصائص التربة ، مصنع اسمنت و كركوك .

Introduction

Air pollution has become a serious problem in recent time due to rapid growth of thermal power stations, cement factories, steel and coal industries. In comparison to gaseous pollutants, relatively little is known about the effects of particulate pollutants, on vegetation, soil microbial population and other soil properties (Iqbal and Shafiq 2001; Kaeq and Bolat 2007; Zargri and Shoar 2008). The impact of the cement dust on soil properties and plant production has been investigated by some researchers (Saralabai and Vivkanadau 1995). The determination of soil chemical and physical properties and heavy metals component are very important parameters in monitoring environmental pollution. In this respect, Ibanga *et al.* 2008 and Xiaoyu., *et al.*, 2012) reported that moderately to high exchangeable Ca contents ($3.02-7.44 \text{ cmol}(+) \cdot \text{Kg}^{-1}$) was found on the cement affected sites. Furthermore, medium to high exchangeable Na ($0.27-138 \text{ cmol}(+) \cdot \text{Kg}^{-1}$) in the soils a round the cement factory in Nigeria. Morghom, *et al.*, (2000) studied the effect of cement dust after a period of 25 years of cement production on soil physiochemical properties. This study showed that exchangeable Ca, Na, H, Mg as well as soil organic matter were significantly higher in the affected soils than in the non-affected soils. In Tunis, Loeppert and Suarez (1996) reported an increase of Ca, K and Fe on the surface of surrounding soils of cement factory and they suggest that the values of Si, K and Ca could be used as an indication of environment pollution in the vicinity of the cement factory. Zerrouqi, *et al.*, (2008) reported in their study on soil surrounding cement factory in Morocco that Calcium oxide and Sulfur oxide are the principle component of pollution. While Al-Khashman and Shawabkeh (2006) revealed that Lead, Zinc and Cadmium have the highest level in area

close to cement factory in Southern Jordan.

To study area comprises the vicinity of cement factory in Al-Has an Oasis, Saudi Arabia. Al-Omron and El-Maghraby (2011) and Martin, *et al.*, (2006) indicated that the soils of area are Calcareous in nature, and according to accumulation index, the soils could be classified as moderately to heavily contaminated with (As, Cd, Pb and Ni) and heavily contaminated with Cr, while the soils were moderately polluted with Zn. Xiaoyu, *et al.*, (2012) analyzed the heavy metal concentration of (Cu, Zn, Pb, Cd, Ni and MN) in the surface soils in industrial area in NE, China. The data reveals a remarkable change in the content of these heavy metals. Both the correlation analysis and geostatistical analysis showed that Cu, Zn, Pb and Cd have a very similar spatial pattern and come from the industrial activities, while MN mainly caused by natural factors, with recommendation need to make great efforts to control the industrial emission. The Kirkuk cement factory was established (built) at 1983, therefore, it is believed that a large quantity of dust, commonly known as cement kiln dust has been produced during the production of cement in the last 30 years, making it necessary to evaluate the effect of cement dust on the environment, with the main objective to evaluate physiochemical properties caused by the cement dust over 30 years.

Materials and Methods

Soil samples collected and Analyzed in June 2012, twelve sampling point were limited from a transect 6 km long in the direction of dominate winds at the area (500m apart), at every site two composite samples for 0-5 cm and 5-30 cm) depth were collected using a stainless steel shovel. Soil samples were

stored in plastic bags, so they were air dried and gently crushed and sieved through a 2mm sieve and stored in closed plastic containers for chemical and physical analysis, calcium carbonate was determined according to method Soil pH and EC values were determined in soil paste extract using a pH-meter and EC-meter, particale size distributions were analyzed according to (Sparks, *et al.* ,1996), organic matter was measured according to the method described by (Sparks, *et al.* ,1996) .

Soil samples were digested with a mixture 5:2:3 of HNO₃ :HClO₄: HF, the digested solutions were analyzed for total , concentrations of Cu , Zn , Pb , Cd , As , Cr and Ni and Mn by the Atomic emission spectroscopy apparatus according to the methods in Zerrouqi and Shoar (2008).

Statistical Analysis

Statistical methods were applied to process the data in terms of its distribution and correlation among the studied parameters. The commercial statistics software package spss version 17.0 for windows was used for statistical analysis in present study. Basic statistical parameters, such as mean, median, standard deviation (SD), coefficient of variation (CV). To identify the relationship among heavy metals in soil and soil parameters, person's correlation coefficient analysis were performed.

Results and discussion

Physiochemical properties of the soil:

The basic physiochemical properties of the collected soil samples were statistically summarized in Table (1)

The texture class of soil was generally ranged from sandy clay loam, to sandy loam in the most cases. In the surface soil samples (0-5 cm) depth the maximum percentages of sand, silt and clay were 63.2, 45.4 and 32.1% respectively, while the respective minimum percentages reached 33.0, 20.3 and 10.4 % respectively. The studying soils were calcareous in nature as the CaCO₃ content in such soils average at 27.4% on the other hand, the pH values ranged from 4.3 to 8.1, while the Ece values ranged from 4.3 to 43.6 ds.m-1 .This means that the studying soils were saline to alkaline affected soils .Total Ca and CaO₃ % ranged from 9.8 to 28.0% and 9.8 -38.3 % respectively .It is worth to mention that the highest values of such parameters were detected in the surface soil samples taken at the 2 km far from the cement factory, followed by a gradual decrease with increasing the distances from the cement factory (Fig.1,2,3 and4)

Table (1) : Statistical Summary for the Major Physical and Chemical Properties of the Study Area

Parameter	0 – 5 cm depth				5 – 30 cm depth			
	Max	Min	Average	S.D	Max	Min	Average	S.D
Sand %	63.20	33.0	53.1	10.3	72.1	30.1	60.3	11.1
Silt %	45.40	20.3	26.4	7.2	36.8	19.8	23.2	7.2
Clay %	32.10	10.4	20.5	6.1	33.1	17.8	16.5	5.2
pH	8.1	7.8	7.9	1.3	7.6	7.3	7.4	1.2
Ec(ds.m-1)	23.6	4.5	11.5	3.8	15.1	4.3	7.8	1.8
CaCo ₃ %	36.8	21.3	27.4	4.6	32.0	20.8	24.6	4.1
Total Ca%	28.0	10.6	21.3	5.1	22.8	9.8	18.6	4.3
Total CaO %	38.3	10.8	16.2	6.8	32.1	9.8	15.2	6.1

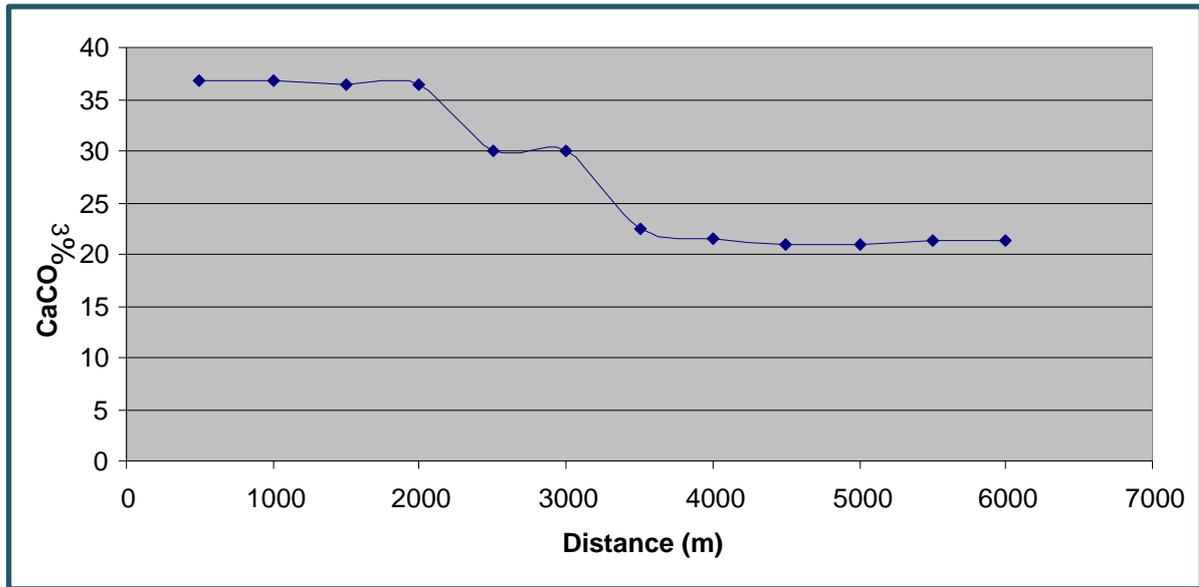


Fig. (1) : Distribution of CaCO₃ % in Surface Soil (0-5 cm) with the Distance Far from the Cement Factory

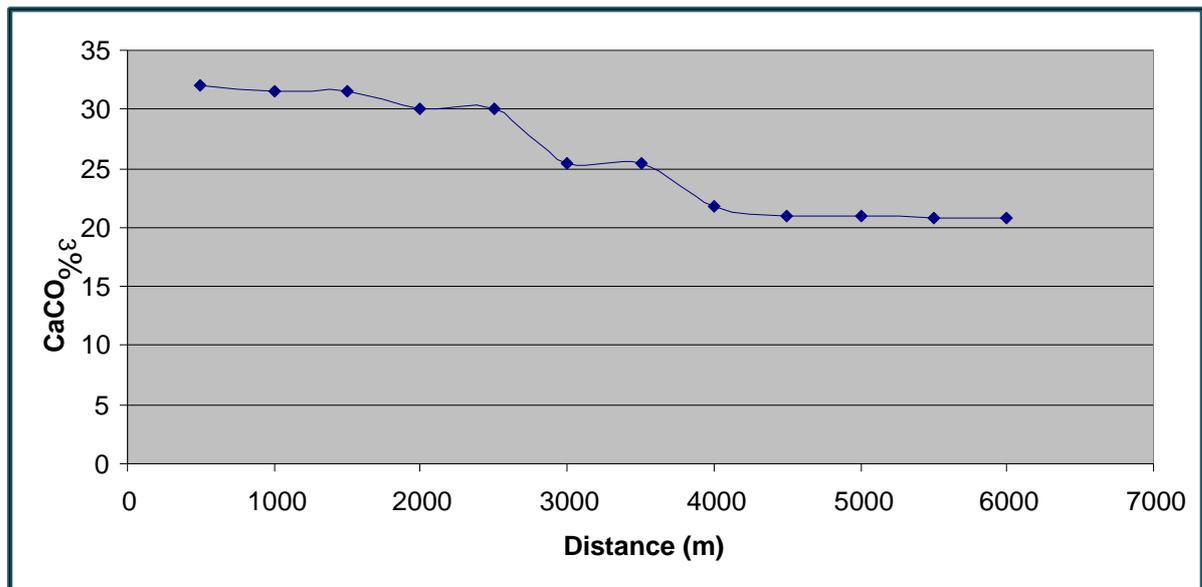


Fig. (2) : Distribution of CaCO₃ % in Sub Surface Soil (5-30 cm) with Distance Far from the Cement Factory

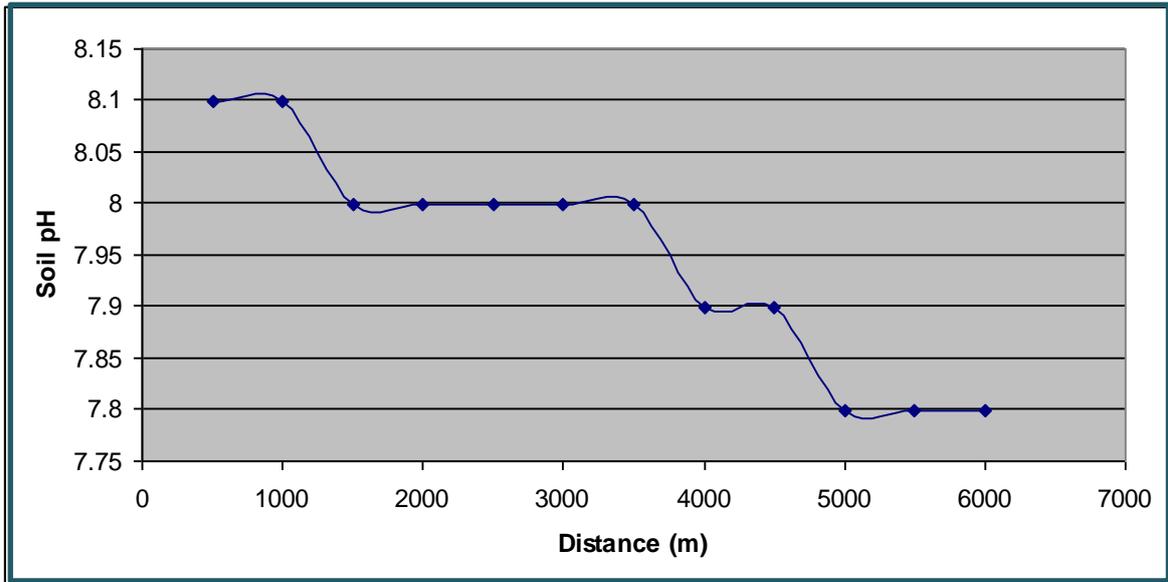


Fig. (3) : Distribution of pH in Surface Soil (0-5 cm) with the Distance Far from the Cement Factory

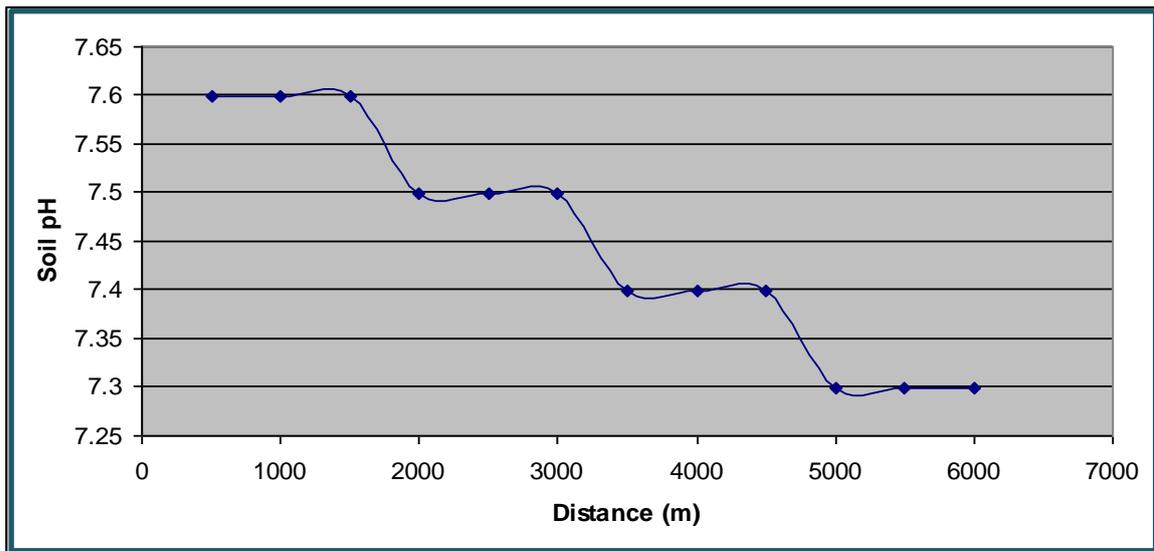


Fig. (4) : Distribution of pH in Sub Surface Soil (5-30 cm) with the Distance Far from the Cement Factory

Heavy Metals Content in the Soil

The values in table (2) shows average concentrations of heavy metals of soil samples along the studied transect compared to the average concentrations and normal ranges in soils reported by Lindsay (1979). The mean values of the metals content in both studied soil depth could be arranged in the following descending order Mn > Zn > Cr > Pb > Co > Cu > Ni > Cd obviously , the levels of Cd and Co were high , where as the

values of the other metals were lowest observed .

Although the results showed that the concentration of studied metals were lowest at the subsurface soil samples compared with the surface samples, because of the semi-arid condition at the studied region and lowest amount of rainfall which not increased more than 200 mm. and we conducted that the concentration of Cd were relatively lower at the subsurface depth samples

(5-30 cm) were very close to the common Cd range illustrated by Lindsay (1979). This may be referring to the higher CaCo₃ content in the studying soils (Table, 1)

It is worth to mention that most of the heavy metals contaminated soil samples were situated more closed to the cement factory .This finding is in agreement with the results reported by Al –Omran and El –Maghraby (2011) for the soil around cement factory in Jordan and Saudi Arabia respectively.

Conclusion

From the determined results it could be conducted that the soil of the studying area could be classified as moderately to heavily contaminate with Cd and Co.

The most contaminated sites were situated in the 0 to 25 km far from the cement factory .Results also suggest that the metals content in the studying soil were positively correlated with the soil PH ,soil organic matter and silt and clay contents . Moreover the Cd and Co were also positively correlated with soil CaCo₃ content (Table 3)

Acknowledgment

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Table (3) Pearson Coefficients between Some Soil Properties and Among Metals in the Study Area

	Cd	Cr	Cu	Ni	Pb	Zn
Clay%	0.20	0.18	0.02	0.16	0.26	0.28
Silt%	0.15	0.32	0.16	0.28	0.08	0.07
Sand%	0.19	- 0.12	- 0.09	- 0.11	0.05	0.17
O.M%	0.32	0.49	0.64	0.11	0.49	0.52
CaCo ₃ %	0.64	0.45	- 0.15	- 0.19	- 0.08	- 0.06
pH	0.22	0.20	0.05	0.04	0.25	0.38

Table (2) Total Heavy Metal Contents (mg.k^{-1}) of Surface Soil (0.5 cm) and Sub-Surface Soil (5-30cm) for from Kirkuk Cement Factory North of Iraq Compared to Common Ranged in Soil

Metal	Total Heavy Metal Contents in the Soil												
	Surface Soil (0 - 5 cm)												Average
	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	
Cr	41.6	40	40	40.5	39	39.5	39.3	39	38.5	38.6	38	38	39.3
Pb	18.3	18.5	58.5	66	59	60	60.3	15.5	16.6	16.8	16.5	16.5	35.2
Cd	3.8	3.8	3.7	3.9	3	3	3.4	34	2.8	2.8	2.7	2.6	3.2
Zn	31	32	48	48.5	50	50.9	53	54	53	60	61	63	50.4
Cu	12.5	12.5	13	15	16.5	16.7	16.8	18	17.3	17.5	19	19.7	16.2
Ni	10	10.5	10.5	11.1	11.2	11	10.5	10.8	10.8	10	10.3	10.2	10.6
Co	23.6	23.5	26	26.4	26.5	30	30.3	30.4	23.8	23.5	23.5	24	25.9
Mn	290	300	300	310	310	290	290	280	280	270	270	260	287

Metal	Total Heavy Metal Contents in the Soil													
	Surface Soil (5-30 cm)												Average	Common Range Soil mg.k^{-1}
	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000		
Cr	36.3	36.2	36	36	35.8	35.8	35	35	35.3	35.3	35	35.2	35.6	100
Pb	4.5	4.5	4.3	4.4	4.4	4.3	4.3	4.5	4.5	4.8	4.8	4.8	4.5	60
Cd	0.3	0.2	0.2	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.2	0.3	0.3	0.6
Zn	6.8	6.5	6.8	7.3	7.5	7.8	7.8	7.9	7.9	8	8.1	8.1	7.5	150
Cu	3.2	3	3	3.2	3.4	3.4	3	2.8	2.8	2.7	2.7	2.6	3	35
Ni	1.3	1.3	1.2	1	1	1.1	1.2	1.1	1.2	1.1	1.2	1.3	1.2	40
Co	7	7.5	8	8.2	8.2	8	8	8.1	8.1	8	8	8	7.9	0.7
Mn	50	55	56	56	50	50	53	35	50	50	50	50	51.9	300

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