CARACTERISATION OF CEMENT'S DUST AND TOTAL HEAVY METALS CONTENT IN SOIL OF SELECTED LOCATIONS AT THE CEMENT PLANT - MEFTAH-BLIDA

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Introduction

As the population of the world increases, the need of housing rises as well. The cement industry grows too. This industry has a major role in the instability of the environment and produces many air pollution hazards [1]. Cement is produced from geological materials that contain CaO, SiO_2, Al_2O_3 and FeO in certain proportions to define the main properties of cement [2]. One of the most critical impacts of cement manufacturing is the dust generated during transport, storage, milling, packing, etc [3]. Atmospheric dust is an important source of air pollution particularly in dry climates, hence air pollution has potentially harmful or nuisance effects on human beings, animals, plants, their biological communities and habitats and on the soil [4]. It has been reported that 1 kg of cement manufactured in Egypt, generates about 0.07 kg of dust in the atmosphere [5].

Previous studies have determined that cement dust falls are enriched in toxic heavy metals such as As, Pb, Ni, Cr, Cu, Zn, Mn, and Cd, [6], which can spread throughout a large area by wind, rain, etc. and accumulate on plants, animals and soil, thus ultimately affecting human health [7]. Heavy metals can cause damage to brain and nervous system, increased blood pressure, affect on gastrointestinal functions and reproduction [8].When considering different kinds of soil pollutants; heavy metals are especially dangerous because of their persistence and toxicity [9]. Al-Khashman and Shawabkeh [10] studied the metal distribution in soils around a cement factory in southern Jordan and found that all of the metals were concentrated on the surface of the soil, and highest metal concentrations were found close to the cement factory.

Therefore, it is of major interest to improve the knowledge on heavy metal sources and their concentrations in topsoil's, as these factors might influence the human population and the ecosystem compartments.

Due to the availability of raw materials necessary for the manufacturing of cement and measures taken by the government of Algeria to encourage and facilitate investments in the country, a cement factory had established in Meftah municipality since 1976 as well to meet the increasing demand for cement. The objective of this paper is to identify and evaluate the levels and sources of dust and heavy metal in agricultural and residential topsoil's in the Meftah vicinity [11]

1. Area of study

The Meftah town is situated at 27 Km North East from the capital of Algiers (fig.1), it is located on the Plio-Quaternary plain of Mitidja at the boundary of Tertiary and Secondary formations constituting the Tellian Atlas of South-eastern Mitidja which contains the deposits of limestones and clays used in the cement manufacturing.

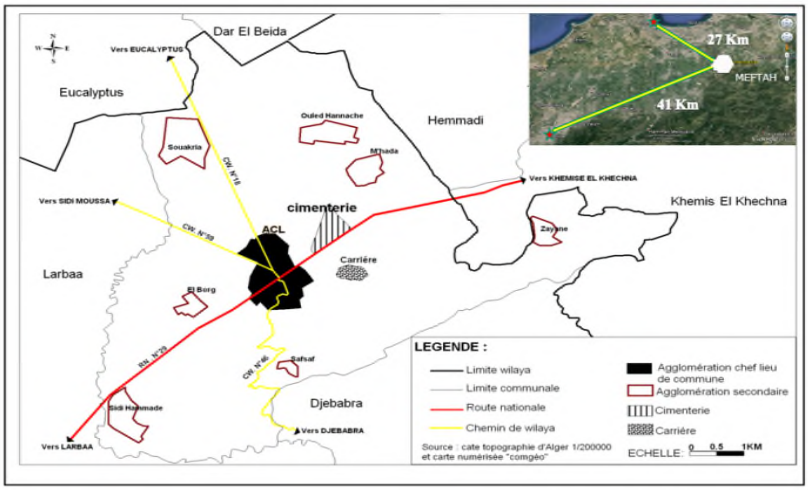

Fig.01. Geographic situation of the studied area

2. Materials and methods

2.1 Sampling procedure

Several visits to the industrial complex, the quarries of limestone and clay, were made in the years 2011, 2012, 2013 and 2014 to describe the pollution apparent degree and to follow its evolution in time. Sampling zone included five areas in Meftah region. Twelve sampling sites were selected in each sampling area, the distance between sampling sites were dependent on land morphology and possible pollution sources, and were separated from each other by at least 300 m.

In total, 72 topsoil composite samples were collected in the study area at a depth of 0–3 cm. The stones and foreign objects are being removed by hand. Topsoil's were kept in plastic bags, then, once in the laboratory, Soil samples are dried in the open air and then screened into various fractions to a sieve analysis. The whole is crushed to 100 microns to be analyzed by atomic absorption spectrometry for the element: Pb, Zn, Cu, Cd.

2.2 Physicochemical analysis of topsoil

Determination of pH and electrical conductivity: Before measuring the pH of the samples, the electrode was washed with distilled water and then with the sample. The pH is measured in dust solution with a report dust/water equal to ½.5 [12]. The conductivity cell was thoroughly rinsed with some of the sample. The tube is then filled to the brim, ensuring no air bubble adheres to electrode. Two tubes containing the sample were placed in a water bath maintained at 200°C and allowed for 30 minutes to reach thermal equilibrium. The cell was thoroughly resisted with the first tube and measurement was made in the second tube accordingly.

3. Results and discussion

3.1 Physical inventory of dust pollution in Meftah area:

The results of the average concentrations of dust (PM10) in the ambient air at various distances of the cement works (tab.01) show that the maximal impact is situated at a distance of 700 meters of the fireplace.

The concentrations of dusts decrease gradually from 700 meters of the factory; the values of broadcast dusts (PM10) of the cement plant of Meftah are lower than the Algerian limit standard.

Tab01. Average concentrations of dust (PM10)

Distance	Standard in the ambient air Mg/Nm^3	Electro-filtre walk	Electro-filtre stopped
100	80	0	0
200		0,389	0,900
400		20,15	45,16
700		22,40	50,76
1 000		14,43	32,60
2 000		4,33	9,6
4 000		0,87	2,51
7 000		0,44	1,01
10 000		0,192	0,43

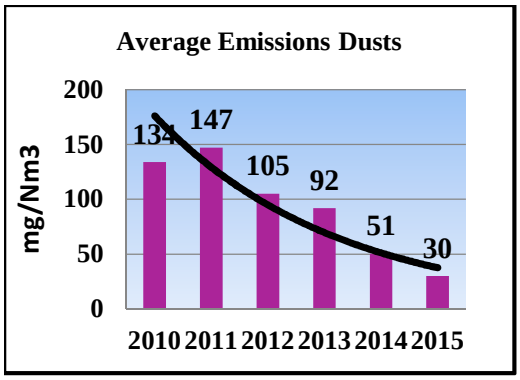

Fig.02.Evaluation of dust concentration in time and distance

Diagram above representing the total dust emission on Meftah area (Fig.02); dust concentration has decreased significantly after the installation of the fireplaces of evacuation in 2010.

3.2 Physico-chemical results:

3.2.1 Analysis of dust

Chimney dust analyses focused on the chemical composition and the morphology of the particles. It was enabled the identification of a typology of these particles which is morphology blocks obtained at the scanning electron microscope, in this morphology three species predominant: calcium, silica and oxygen are more than 25%. Other minor elements are of the order of 1 to 2%. This typology is connected with the various types of sources present in the area of investigation which are the cement works and the quarry.

3.2.2 Geochemical results of the dust

The preliminary results demonstrate that this dust are especially basic (pH= 9.25) and contain a high free lime (42.124 CaO). Grading analysis and analysis by sedimentation show that the included size of dust grading between 0.8 and 0.25 mm present 97.9% rate and 38.5%, which correspond to the class of particles. Further, the results of chemical analyze of dust emitted by the fireplaces of evacuation shows an abundance of calcite and quartz. It’s almost the same in the dust emitted by the fireplaces of

evacuation and mixture of raw materials whereas major element concentrations are low except for SiO_2 and CaO.

Tab02- Geochemical Analyses of the cement dust released by the fireplaces and the raw flour

Designation	Raw flour	Dust released by the fireplaces
SiO_2	13,99	10,34
Al_2O_3	3,98	4,594
Fe_2O_3	2,20	2,558
CaO	42,30	42,124
MgO	0,98	1,054
K_2O	0,61	0,71
Na_1O	0,23	-
SO_3	0,31	0,9297
Cl	-	0,265
P_2O_5	-	0,198

Further and using Atomic Absorption Spectrometry (AAS) methods in this investigation, the ground of samples collected in Meftah vicinity detain a variable contents in ETM (As, Cd, Cr, Cu, Pb and Zn). Cu and Zn are the most spread elements in all the samples. These variations can be explained through the influence of the environment conditions on elements mobility. Whereas, Cd, Cr and Ni are present in the contents more or less low, but susceptible to be source of pollution.

4-Conclusion

It is well known fact that air pollution is hazardous to environment and human health. From this assessment it can be concluded that cement industry causes a great damage to ecology and human health worldwide. The gaseous and particulate emissions from cement plants are degrading air quality and thus creating considerable environmental pollution especially air pollution [13]. The preliminary results of this study show that industrial pollution, especially particulate matter broadcast from cement plant of Meftah, and that are dispersed on soils surrounding the cement plant. Whereas, after substitution of the electrostatic by the handle filter; the level of dust emission decreased significantly in the area surrounding the complex. The results of geochemical analysis on a regional scale have shown that the urban area nears the quarry and cement complex is the most contaminated with cement dust. Moreover, most of the households are located in proximity of the company; hence the population had experienced different health problems related to cement production, especially respiratory illness.

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