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ASSESSMENT OF HEAVY METAL POLLUTION FROM THE INDUSTRIAL DUST ON THE REFORESTATION OF PINE (*Pinus halipensis* MILL) IN THE TELL SETIF (NORTH - EAST, ALGERIA)

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ABSTRACT

The present work aims to analyze heavy metals in the cones, bark and needles of Aleppo pine in 05 stations in the area of Ain El Kebira in order to evaluate pollution level and impact on reforestation. Analysis of heavy metals showed that the concentration of lead rose to 1.61 mg/l at the station of the BCR which is above the accepted international standards of 1mg / l. Fe concentrations are at the upper limit of the WHO standards of 1.5 mg / l at the station on the edge of the forest ranging from 1.03 to 1.65mg/l against the cement between 1.36 and 2.21 mg / l and the BCR between 1.31 and 2.19 mg / l are the most polluted. It is noted that with the exception of the BCR is to say that the industrial zone where the values found on analysis of copper are too high between 1.11 and 2.59 mg/l and far exceed the required standards set 1 mg / l. The levels of zinc at the station of the BCR and are highest between 3.05 and 6.47 mg / l where the required standards are 5 mg / l. We can infer from our results that urgent care should be initiated to preserve the national park above the Babors bordering our study area and is ranked world reserve.

Keywords: Aleppo pine, pollution, reforestation, industrial dust, heavy metals, Ain El Kebira.

INTRODUCTION

Fort used today, the term refers to all air pollution releases of toxic compounds released by humans into the atmosphere [1]. Over the last thirty years, the concept of air pollution has greatly been subject of deep interest on behalf of public authorities under pressure of citizen and civil society. We are observing changes scale, including all phenomena ranging from global to local, from climate change to pollution, indoor [2]. Among the pollution factors, trace elements are important contributors and they are components of mineral and organic-minerals released as fine dust in the air, which settle on the leaves, stems and fruits [3, 4]. Atmospheric deposition in industrial areas and cities are dominated by trace elements [5]. Spillages of cement kiln dust have always constituted a potential danger to the environment [6, 7]. The deposition of cement dust containing heavy metals not only alters the activity of soil but also inhibits plant nutrient resources to be submitted to necrosis and severe poisoning of plants sensitive to these compounds [8, 7]. This would indirectly reduce the transport of soil resources and vegetation cover in particular water [9]. The cement industry plays an important role in the economic development of Algeria. Cement is considered a strategic commodity because it is upstream of any construction activity and building infrastructure. Domestic production of cement has tripled over 25 years [10]. In developing countries, the control mechanisms of chemical pollution in particular are considered, having negative impact on the ecosystems while the level of pollution is not yet fully evaluated.

The highland of Setif is a mountainous region defined by a terrain represented by reforestation considered in Algeria as the only alternative in the forestry policy. These plantations are weakened by periodic pest infestations, with a very poor soil organic matter (predominantly limestone) and a semi-arid climate [11]. So is the Aleppo pine (*Pinus halipensis*) is considered the species which best suits the climate and soil conditions of our study area [8, 14]. In this context, work is devoted to the assessment study of heavy metals (Pb, Cu, Fe and Zn) level from the cement dust emissions and the other industries around like Surface Treatment and Metallurgy named hereafter BCR in the region of Ain el Kebira located 30 km North of Setif and still in the highland.

MATERIALS AND METHODS

Study area

Ain El Kebira site is located between latitude 36° 36'N and longitude 5° 5'E in the mountains of Tell Atlas. Its population is estimated at 56,703 inhabitants spread over an area of 19,592 sq. km with a density equal to people 2.89hab/Km². Annual rainfalls are around 600 mm. It is a mountainous region that is experiencing a steady snowfall during the winter with about 16 snow days / year. The annual average is estimated at 47 days of frost per year. The winds coming predominantly from the west end can be very cold during winter, spring and summer; the region underwent southerly winds dry and warm. Thus, the Sirocco is common in summer and absent in November to February, it is characterized by abnormally high temperatures and humidity very low. Ain El Kebira is known for its industrial activity, very important for the

region of Setif, represented by two units: the cement (RERC) and the unity of fasteners, cutlery and valves (BCR). It is a reforestation of pine Aleppo established in 1954 in an area of 300 hectares Figure-1 card.

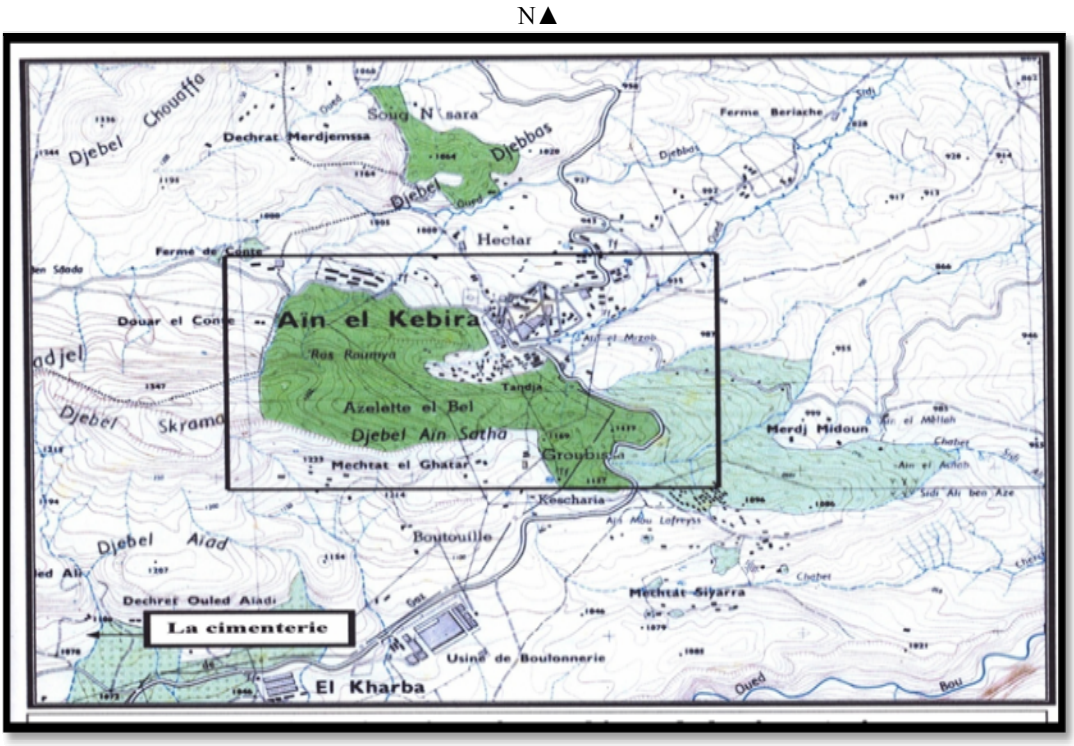

Figure-1. Location of study sites (from topographic map Kherrata to 1 / 25000).

Sampling

Samples were collecting from; Ras Eroumia, Azlet EL BEL, Edges of the road towards Ain El Kebira edge and reforestation, Cement factory and BCR. Needles, cones and bark of five individuals' were recovered and randomly selected in different places from Aleppo pine in the reforestation of El Guettar. The spatial occupation of reforestation is dominated by the Aleppo pine (*Pinus halipensis*) but can find some species such as ash (*Fraxinus angustifolia*), oak (*Quercus ilex*) and cypress (*Cupressus simpervirens*).

Methods of analysis

pH measurement

It is used to quantify the concentration of H+ from the ground which gives it acidic or basic character [7].

The device used is a pH meter WTW pH meter type 521.

Conductivity

Conductivity is the property that has a suspension to facilitate the passage of an electric current. It is due to the mobility of present ions which are able to move under electric field. Under high frequency current (as usually made with market equipments) no electrolysis occurs and then only resistance of the electrolyte is measured. This resistance depends on the nature of the ions (charge and size which is linked to ionic mobility and specific conductivity) and their concentration. Temperature affects the conductivity because the mobility of ions proportional to the temperature [7,16]. Measurement is carried out on InoLab WTW ® Cond 730.

Heavy metals

The samples were dried separately at 120°C for 24 hours and then grounded. One gram of plant material is calcined at 450°C in a porcelain crucible for 6 hours and then dissolved in a 50ml beaker containing 10 ml of nitric acid and 30ml of distilled water. After filtration, the content of the clear solution was adjusted to 50 ml with distilled water. Analysis of heavy metals was carried out using an atomic absorption spectrophotometer type 3110 PERKINELMER brand. ACK After calibration of the spectrophotometer, we measured the concentrations of lead, zinc, copper and iron; the results are expressed as mg / l [7].

RESULTS AND DISCUSSIONS

Soil pH

The results reported in Table-1 show that the pH of soil is between 7.1 and 8.8.

According to WHO standards the normal soil pH is between 6.5 and 7.2 [9]. Apart from the resort of Ras Eroumia, all others are above the standards. This illustrates the homogeneity of the deposits that come from the same source which is the cement plant. Indeed, compounds such as oxides (MgO, Na_2O, K_2O) and lime (CaO) present in the raw material react in an alkaline soil [9].

Table-1. pH of soil evolution for various stations.

Sample locations	Ras Eroumia	Azlet El Bel	Edge of reforestation	Cement factory	BCR
Levies					
L1	6,9	7,4	7,5	8,5	7,6
L2	7,1	7,5	7,5	8,7	7,5
L3	7,2	7,3	7,2	8,8	7,9
L4	7,1	7,5	7,4	8,3	7,6

Electrical conductivity and soil salinity

The electrical conductivity is the capacity of a soil to change the passage of an electric current. It is between 108 and 492 S / cm at 20.1°C (Figure-2). The salinity varies between 70 and 367 ppm.

Proportionality between conductivity and soil salinity is confirmed by the strong mineralization at the station of the cement plant is the source of dust emission (Table-2).

Table-2. The electrical conductivity and soil salinity.

Sample locations		Ras Eroumia	Azlet El Bel	Edge of reforestation	Cement factory	BCR
Levies						
L1	conductivity µs/cm	108	170	222	469	211
	Salinity ppm	70	82	100	330	210
L2	conductivity µs/cm	113	168	217	487	219
	salinity ppm	79	88	109	367	221
L3	conductivity µs/cm	121	179	227	492	229
	salinity ppm	77	87	113	359	224
L4	conductivity µs/cm	143	175	238	502	271
	salinity ppm	80	87	111	352	217

Heavy metals in the Aleppo pine (*Pinus halipensis*)

Lead

Table-3 showed that the level of Pb varied between 0.20 and 1.61 mg / l. Ras Eroumia stations, El Azlet Bel located inside the reforestation and have values between 0.20 and 0.87 mg / l, so substandard that are 1 mg / l. The cement also shows values between 0.25 and 0.91 mg / l, which is below the threshold (1 mg / l). Our three stations are far from sources of pollution Pb [11].

Indicates the edge of the reforestation of values between 1.03 and 1.25 mg / l, therefore above the threshold, the station was influenced by road traffic between the town of Setif and that of Ain El Kebira which leaded gasoline is still used and even the cheapest. Station BCR shows values up to 1.61 mg / l which is above the threshold tolerated.

It is considered highly toxic of the human, flora and fauna characteristic of industrial pollution. It infects the plant surface [11, 14]. The concentrations of Pb in the needles of the trees are higher than in the bark and cones.

Our analysis shows that lead levels in the Aleppo pine vary from one station to another depending on industrial activity and road traffic. But the rates of Saniak (BCR) are the most important and therefore the most polluted of all stations, exceeding two and a half times the accepted norm. Indeed, the results far exceed the standards required by WHO, which seems reasonable due to the disposal of it on the side of the road, releases from the BCR and the Pb concentrates at the surface of plants [11].

Iron

Table-3 showed that the Fe ranges between 0.38 mg / l and 2.24 mg / l.

Fe concentrations are at the upper limit of WHO standards (1.5 mg / l) at the station on the edge of reforestation in the 2nd and 3rd harvest (1.03 and 1.25 mg / l) especially in bark and cones. Station of the cement plant (1.36 and 2.21 mg / l) and BCR (1.31 and 2.24 mg / l) are the most polluted due to the use of iron as addition to cement and fundamental element in the manufacture of bolts and taps.

Our results for iron levels are very large fluctuations depending on the stations [15]. Indeed, compared to the first three stations, we find that the samples of Aleppo pine in the other two stations (BCR and Cement factory has iron levels higher than the standards set (1.5 mg / l).

Table-3. Concentrations of Pb and Fe (mg / l) in the needles cone bark the Aleppo pine.

sample locations parameters Levies		Ras Eroumia		Azlet El Bel		Edge of reforestation		Cement factory		BCR	
		Pb	Fe	Pb	Fe	Pb	Fe	Pb	Fe	Pb	Fe
L1	Needles	0.59	0.48	0.31	0.92	1.06	1.03	0.46	1.45	1.49	1.31
	Cones	0.48	0.81	0.34	1.15	1.10	1.24	0.35	1.89	1.51	1.68
	bark	0.51	1.06	0.20	1.29	1.03	1.41	0.25	2.21	1.59	2.01
L2	Needles	0.63	0.39	0.38	0.85	1.16	1.08	0.52	1.48	1.43	1.53
	Cones	0.58	1.15	0.33	1.37	1.09	1.54	0.47	1.76	1.25	1.61
	bark	0.62	1.25	0.21	1.35	1.13	1.48	0.29	2.12	1.37	2.24
L3	Needles	0.63	0.38	0.67	0.48	1.25	1.19	0.75	1.41	1.49	1.57
	Cones	0.80	1.14	0.76	1.21	1.16	1.29	0,62	1.91	1.37	1.65
	bark	0.29	1.38	0.37	1.39	1.04	1.53	0.59	2.09	1.30	2.19
L4	Needles	0.62	0.95	0.69	0.98	1.19	1.04	0.91	1.36	1.61	1.48
	Cones	0.71	1.15	0.87	1.41	1.14	1.21	0.72	1.95	1.53	1.74
	bark	0.29	1.26	0.41	1.47	1.13	1.65	0.63	2.19	1.49	2.14

Copper

It is noted (Table-4) that with the exception of the BCR is to say that the industrial zone where the values found on analysis of copper are too high (1.11 and 2.59 mg / l) and exceed the required standards set out 1mg / l and can be explained by the use and release of metal in the atmosphere [3]. This confirms that during this period the BCR has manufactured valves in copper [3].

Zinc

The levels of zinc concentrations are indicated (Table-4) below the threshold for all stations except that of BCR, with higher values up to 6.47 mg / l [8]. Moreover, the significant presence of zinc in the BCR, and the levels recorded at this station that are greater than the maximum recommended by the WHO in plants (5 mg / l) is explained by the zinc plating used in the protection taps and bolts [12, 13].

Table-4. Concentration of Cu and Zn (mg / l) in the needles, cones bark the Aleppo pine.

Station parameters Levies		Ras Eroumia		Azlet El Bel		Edge of reforestation		Cement factory		BCR	
		Cu	Zn	Cu	Zn	Cu	Zn	Cu	Zn	Cu	Zn
L1	Needles	0.07	0.53	0.07	0.77	0.07	0.68	0.12	1.34	1.25	3.21
	Cones	0.11	0.60	0.04	0.27	0.07	0.51	0.18	1.71	1.31	3.76
	bark	0.05	0.35	0.04	0.44	0.08	0.68	0.11	0.84	1.71	5.96
L2	Needles	0.08	0.54	0.08	0.78	0.08	0.69	0.16	1.34	1.11	3.05
	Cones	0.14	0.62	0.13	0.35	0.19	0.68	0.18	1.71	1.45	3.49
	bark	0.07	0.41	0.35	0.47	0.32	0.74	0.11	0.84	1.89	5.86
L3	Needles	0.07	0.65	0.14	0.78	0.12	0.73	0.15	1.39	1.45	4.47
	Cones	0.15	0.67	0.13	0.29	0.24	0.67	0.21	1.62	1.72	5.98
	bark	0.07	0.45	0.47	0.48	0.34	0.68	0.14	0.87	2.59	6.27
L4	Needles	0.05	0.66	0.21	0.81	0.45	0.64	0.18	1.06	1.52	4.47
	Cones	0.24	0.69	0.19	0.3	0.76	0.59	1.24	1.79	1.79	6.04
	bark	0.49	0.47	0.08	0.52	0.95	0.72	1.08	0.85	2.51	6.47

CONCLUSIONS

The concentration of heavy metals in our samples is proportional to the distance from the unit production of cement and the BCR. The results show that samples of Aleppo pine in the cement and RCC are the stations most affected because they are not only located within the same units but also on the road Setif-Ain El Kebira. It is noted that there is an increase in the level of heavy metals in the stations of the plant and the BCR in the bark of trees compared to needles and cones.

We have seen that during the sampling, the total absence of lichens, one of the best indicators of organic pollution at the plant and the BCR and the edge of reforestation. An analysis dendrometric complete our study to better track the reforestation and well elucidate the influence of heavy metals in the evolution of reforestation.

Heavy metals occur naturally in plants at trace level, and then increased levels of these metals in plants are wildlife, flora and human health at risk. According to analysis, the concentrations found in different parts of the Aleppo pine showed that the region is facing a real and confirmed phenomenon of air pollution by iron, lead, copper. The highest concentrations come important sources which are cement, BCR and air pollution coming road leaded petrol still on use in the Algerian market. It can be concluded that remediation of this area is now becoming a necessity to prevent an environmental disaster and a progressive death of neighboring ecosystems.

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Annexure-I

WHO standards on plants.

pH	6.5 - 7.2
Fe mg/l	1.5
Pb mg/l	1
Cu mg/l	1
Zn mg/l	5