

## Evaluation of the quality of the ground of the lake of Reghaïa in heavy metals and study of their distribution on the surface

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### ABSTRACT/RESUME

**Abstract:** *The Lake of Reghaïa is an exceptional natural heritage in the Algiers area, it underwent a dramatic pollution by its rejection supply due to the close industrial activities. Since the year 1999. That, encouraged us to accordingly take part in order to present an evaluation of the quality of the grounds of the site as regards pollution in MTE (metallic trace elements) heavy metals. We have selected a ground located on western bank of the lake, of a square surface, limited to 2,500 m<sup>2</sup> of a slope of 25%, it is agricultural but not exploited for more than 20 years according to the owner of the ground. That has an advantage of excluding the irrigation by water from the lake. A systematic sampling of triangular grid of thirteen (13) samples with positions GSP (geographical system of positioning) of each point. Quantities of approximately 100g more 1 kg of ground were taken. Analysis by AAS (atomic absorption spectrometry) has shown presence of heavy metals (Ni, Zn, Pb, Cd, Cr, Cu and Hg), which does not exceed the values of reference on selected surface, of the contents of (Ni and Zn and Hg) exceed slightly the values reference in the superior part of surface located at 64 m of bank of lake, and approximately 20 min height compared to the surface of the lake, the pollution of the surface of ground were not noted, however, from the contents of (Cr) go beyond the values of reference in all surface marking higher spades in the medium of surface, On the other hand, accumulation Cu is on the level nearest to the lake. Strong Mn concentrations on all the surface particularly they are high on first line close to lake and the limit superior of analyzed surface.*

### I. Introduction

In Algeria, the period after independence was marked by the effects and the consequences of the development strategies based on industrialization, which started since the beginning of the years 1980, to express their reverses through serious distortions on the whole of the components of the natural environment (receiving mediums, natural resources, etc.).

Since the years 1980, the industrial park of Reghaïa pours its rejections in the sea, passing by a single marsh in the of Algiers area, which is called the Lake Reghaïa. The activity of the zone generates various types of the rejections, transforming a place pleasant

and favorable to the life of fauna and flora and prosperity of the biodiversity into a tank of toxic and dangerous products.

In addition, among pollution induced by the industrial activity, is that related to heavy metals. Moreover, the site of its marshy nature, offers to its vicinities fertile fields with agriculture in direct contact with the edge of the lake.

Any time, within the framework of the development of the Plan of Coastal Installation of the of Algiers littoral, the wetland "Lake Reghaïa" was retained for the control of a pilot project of Management

Integrated of Coastal areas (GIZC). This natural heritage reveals stakes, in ecological matter (wetland), socio economic (agriculture, industry, tourism, habitat,) and policy (administration, land pressure,). A decision taken by the public authorities to set up the wetland in natural reserve testifies to the need for its protection. [1]

The protection and the depollution of the grounds are a delicate operation because each site is specific, several characteristics can intervene in particular geology, topography, the nature of the pollutants, their spatial, their concentrations, and their behaviors with the ground, the latter are essential to the choice of the technique of depollution. [2]

The ground is a nonrenewable resource and the processes of its formation and its regeneration are extremely slow being able to go to several thousands of years, contrary to its degradation, certain human activities can degrade the grounds in a few years or decades.

In this context, and seen that heavy metals present an undeniable health hazard for the whole environment and that the ground is an important vector of transfer of metals of the environment towards the organism, heavy metals are present naturally in the rocks, they are released during the deterioration of those to constitute the geochemical bottom. The natural concentration of these heavy metals in the grounds varies according to the nature of the rock, its localization and its age. [3]

Heavy metals being natural or anthropic in the aquatic mediums are trapped in the sediments [4], and for a significant analysis of a watery pollution or a contamination of the grounds adjacent, one analyzes the ground [5], the great contamination by heavy metals touches the sidements more than the living organisms [6] [7] [8] cadmium and mercury are often found in the anthropic rejections. [9].

We chose this work which consists of the qualitative and quantitative evolution of heavy metals in the periphery of the lake and the establishment of the correlation between the distribution of their concentrations to the surface of the ground and the pH on the one hand and the mineralogical composition of the ground on the other hand. It is important to announce that the ground in question has not been exploited for more than twenty years.

## II. Materials and methods

### II.1. Sampling Locations

The Lake Reghaïa is a wet coastal area; located at the North-eastern limit of the plain of Mitidja to 29 km of Algiers. Surface of the lake is of 150 ha, the surface of the lake (water level free) is approximately 75 ha

Geographical coordinates: 3° 19' and 3° 21' east, 36° 45' and 36° 48' North [10]



Figure 1: Localization of the wetland of Reghaïa

### II.2. Methods

We have selected a ground located on western bank of the lake, of a square surface, limited to 2500 m<sup>2</sup> of a slope of 25%, it agricultural is not exploited for more than 20 years according to the owner of the ground. That has an advantage of excluding the irrigation by water from the lake.

The selected zone is in direct contact with the lake without obstacle, the first line of the points of sampling (S1, S2 and S3) were 14 m above the edge of the lake (Figure 2):

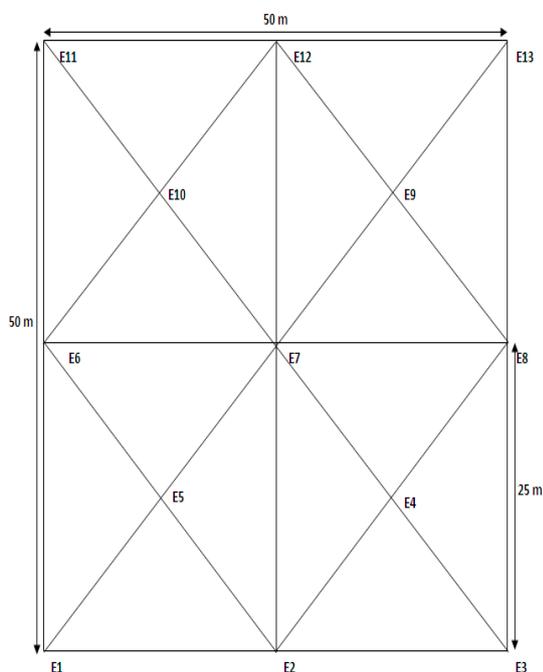


Figure 2: Satellite sight of the zone of sampling

These conditions led successfully to the expected results from this study.

The number of the taken samples depends on the surface and the objective of the study. we are in search of a certain pollution, its distribution on the surface in order to establish a correlation surfaces of it in relation to the distance and the height. On the other hand, surface is 50m x 50m. In order to reveal the required pollution, the remote samples of 25m which compose a rectangular grid were selected to cover internal surfaces. Inside Samples were selected giving a systematic sampling of triangular grid of thirteen (13) samples as indicated in figure 3.

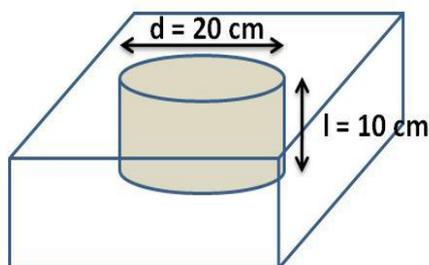
**Figure 3: sampling plan**



This grid covers perfectly the surface presenting of the samples of five (05) levels of distances per report/ratio of the lake:

- S1, S2, S3** : 14m
- S4, S5** : 26.5m
- S6, S7, S8** : 39m
- S9, S10** : 51,5m
- S11, S12, S13** : 64m

This study is directed towards a study of surface, the hollow ones approximately 20 cm in Diameter and 10 cm of depth, as the figure 4 shows. Were carried out.



**Figure 4: Diagram of the hollow one**

The stereo analysis microscope and calculates its pH were carried out before the preparation of the

samples. After that, they were dried in a drying oven at temperature of 40°C (2 days) then crushed coarsely, after sifting was made using tamiseuse (Ballistics department at the Institute Main road of Criminalistic and Criminology of National police NICC/NP) standard Haver EML DIGITAL CUT MORE & BOECKER, programmed for a time of one (01) Min and oscillation of 25 a second, the samples passed by four sieves of 1250,400,160 and 40 µm. Approximately 10 G of each sample obtained whose particles are lower or equal to 40 µm are stored in limp kneaded.

The measurement of the pH was taken on the thirteen (13) samples. The test specimen is of 20 G in a beaker, to which we add 100 ml of pure water; one follows introduces a bar magnet to agitate the solution during 15 to 20 min using a magnetic stirrer. we leave the solutions 30 Min of decantation, in continuation one filters the solution via a filter placed on a funnel this last placed on beaker.

We carried out measurement by means of an electrode of pH combined and connected to a pH-meter. METTLER TOLEDO of the department National toxicology at the Institute of Criminalistic and Criminology of National police INCC/NP). [11] For the treatment of each sample, we used two types of mineralization:

1. The setting in solution of the ground by floridric, nitric and chloridric acid attacks
2. The setting in solution of the ground by nitric and chloridric acid attacks.

The measurement of the metal concentrations in each sample is carried out by spectroscopy of atomic absorption.

This method of extraction of the setting in solution of the ground by hydrofluoric acid attacks is applied for the dosage of four elements (Ni, Zn, Pb and Cd). Four other elements (Cu, Cr, Mn and Hg) were extracted by the setting in solution from the ground by attack with nitric and chloridric acids.

After mineralization of the organic matter by calcination with 550°C, put in solution in the concentrated hydrofluoric acid, then taken again by hydrochloric acids and acids nitric after elimination of the hydrofluoric acid and silica.

The analyzes of Ni, Zn, Pb and Cd are carried out on a spectrometer of atomic absorption Thermo Electron Corporation series Mr. GF95Z of the department of toxicology/INCC-NP, with the lamp with hollow cathode which emits the wavelength corresponding to the element that we want to analyze. The gases used to generate the flame are a mixture Air/Acétylène. The analyzes of Cr, Cu, Mn and Hg are carried out on a spectrometer of atomic absorption Perkin Elmer Analyst 700 of the national observatory of the environment and sustainable development NOEDD, with the lamp with hollow

cathode which emits the wavelength corresponding to the element that one wants to analyze. The gases used to generate the flame are a mixture Air/Acétyleène.

**III. Results and discussion**

**III.1. Calculate pH:**

The results of the pH obtained from the thirteen samples appear in the following table:

Samp	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13
pH	7.99	8.10	8.16	7.96	7.97	7.88	7.95	7.92	8.03	8.04	7.95	8.09	7.95

Table .1: Values of pH of the samples

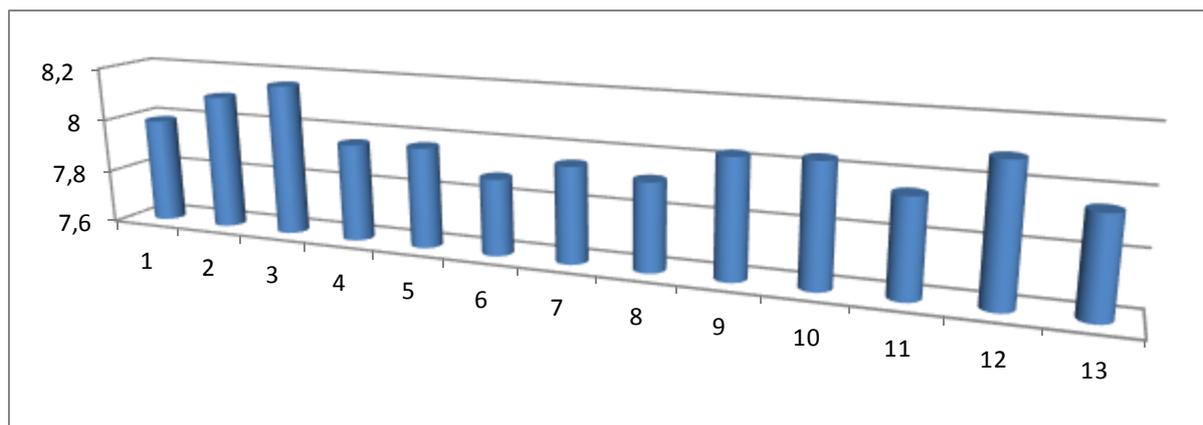


Figure.5: Histogram of the pH

The values of pH obtained are between 7,88 and 8,16 what indicates a stability between the values of pH of the ground on the slightly basic surface. According to the values presented in report BRGM

R 36682 [12] our ground is of texture clay heavy in the pH are close to value 7,75.

The microscopic analysis of the samples S1, S7 and E8 is illustrated in the following images whose enlarging is of X60:

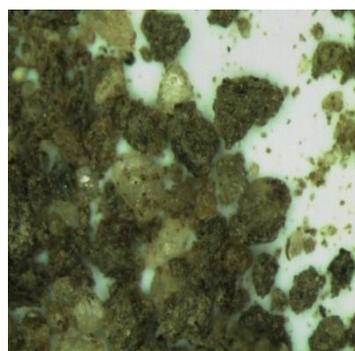


Image of S1

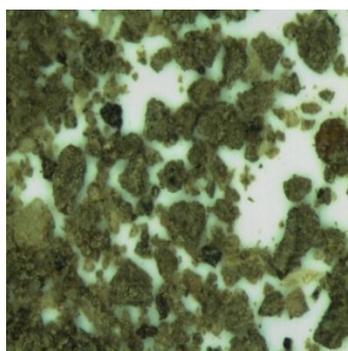


Image of S7

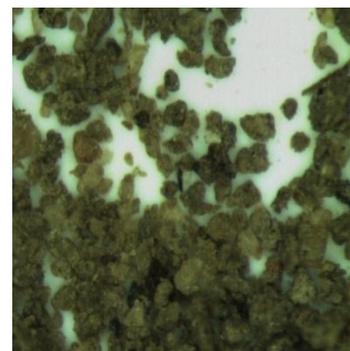


Image of S13

Figure.6: images of stereophony microscope

According to the images with various enlarging's (X12,5, X20, X40 and X60), the samples S1, S7 and S13 result from an arable land which has not been exploited for more than 20 years, according to the owner of the ground, glaze of a spring vegetation of color green, it was taken with distances from approximately 14m 39m 64m of a lake of the marsh type. The ground in place is original and analyzes by

stereophony microscope allowed to conclude that S1 S7 and S13 are an argillaceous topsoil (particles<1µm), from color brown of crust dark, wet and compact. There is a presence of the remainders of vegetation. The particles of the ground have a sub-angular polyhydric structure (polyhydric blunted). It does not have particular odor. The dark color is due to the humus or manganese. [13] [14] [15].

S1; testify the presence to some grains of beige and white color.

S2; Testify the presence of some grains of beige, white and black color.

S3; Testify the presence of some grains of beige and black color.

Our range of calibration of eight (08) heavy metals follows the adequate linear model to the dosage of our heavy metals.

The samples put in solution and supplemented in pure water until 100ml, were analyzed by AAS with flame which gave the results presented in table 2.

These results are expressed in mg/l and µg/l for Hg

	Ni		Zn		Pb		Cd	
	ABS	CC	ABS	CC	ABS	CC	ABS	CC
<b>Standard</b>	0.005	0	0.023	0	0.000	0	0.003	0
<b>S1</b>	0.012	11.146	0.126	46.632	0.004	11.205	0.003	0.275
<b>S2</b>	0.012	11.07	0.129	46.577	0.002	6.673	0.003	0.248
<b>S3</b>	0.012	11.277	0.118	43.217	0.002	4.791	0.003	0
<b>S4</b>	0.011	10.452	0.262	108.307	0.002	5.334	0.003	0
<b>S5</b>	0.013	13.9	0.300	125.442	0.002	5.348	0.003	0
<b>S6</b>	0.013	12.431	0.325	136.959	0.002	4.732	0.003	0
<b>S7</b>	0.013	13.777	0.351	148.761	0.003	8.687	0.003	0
<b>S8</b>	0.015	16.584	0.152	58.213	0.003	9.578	0.003	0
<b>S9</b>	0.014	14.382	0.135	49.729	0.002	6.525	0.002	0
<b>S10</b>	0.011	9.571	0.131	48.46	0.000	0	0.001	0
<b>S11</b>	0.024	32.254	0.616	263.737	0.003	8.67	0.003	0
<b>S12</b>	0.024	32.421	0.248	101.889	0.003	10.787	0.002	0
<b>S13</b>	0.025	34.094	0.279	116.23	0.004	13.358	0.002	0
	Cr		Cu		Mn		Hg	
	ABS	CC	ABS	CC	ABS	CC	ABS	CC
<b>Standard</b>	0.016	0	-0.0086	0	0.0071	0	0	0
<b>S1</b>	0.0125	91.977	0.01125	18.693	0.105	403.471	0.003	< 0,2
<b>S2</b>	0.0145	99.663	0.01025	17.352	0.117	431.733	0.001	< 0,2
<b>S3</b>	0.0145	105.570	0.01225	27.014	0.087	344.224	0.002	< 0,2
<b>S4</b>	0.0145	97.997	0.00925	13.055	0.081	312.033	0	< 0,2
<b>S5</b>	0.0185	134.246	0.00925	30.966	0.092	308.277	0.002	< 0,2
<b>S6</b>	0.0175	122.488	0.00425	17.553	0.088	324.867	0.001	< 0,2
<b>S7</b>	0.0165	122.139	0.00325	14.231	0.082	319.719	0.001	< 0,2
<b>S8</b>	0.0155	104.543	0.00325	12.996	0.096	344.208	0.001	< 0,2
<b>S9</b>	0.0145	103.903	0.00525	13.842	0.083	303.010	0	< 0,2
<b>S10</b>	0.0165	101.940	0.00525	15.524	0.102	331.661	0	< 0,2
<b>S11</b>	0.0145	105.709	0.00425	14.082	0.09	344.675	0.011	0.31
<b>S12</b>	0.0125	89.736	0.00625	22.520	0.076	285.433	0.002	< 0,2
<b>S13</b>	0.0135	92.039	0.00725	21.315	0.112	399.130	0.006	< 0,2

**Table 2:** Contents of heavy metals in the samples of ground. CC: concentration (mg/Kg)

#### Nickel ;

According to the concentrations of Ni obtained, we notice that the concentrations of S1 S2 and S3 of the level 14 m compared to the edge of the lake vary slightly between 11.146 and 11.277 mg/kg. On the line of 26.5 m, the content of S5 increased reaching a value of 13.9 mg/kg on the other hand the concentration of the S4 sample fell slightly taking value 10.452 mg/kg. On the level of the line 39 m, the concentrations vary towards the rise of the left with right (of S6 with S8) from the 12.431 up to 16.584 mg/kg.

In continuation significant drops of concentration of the sample S10 (9.571 mg/kg) and light for S9 (14.382 mg/kg) of the level 51,5m.

The higher line (64 m) records strong concentrations of the 32.254 to the 34.094 mg/kg which presents the maximum value.

Although the ground is characterized by a slope of 25% and the values of the pH which are generally similar, nickel could migrate of the lower levels close to the lake up to the level highest fascinating of the concentrations raised with fluctuations towards the fall during its advance. The contents are lower by in relation with the values of reference of H, Germany and Japan, but the higher value recorded

arrives at the limit of the value of reference to France (35 mg/kg).

**Zinc;**

The concentrations of Zn start between 43.217 and 46.632 mg/kg on the level of the line 14 m, in continuous increase of 125.442 and 108.307 mg/kg in level 26.5 mg/kg, this increase continues with 39m (136.959 and 148.761 mg/kg) except the concentration of the sample to the S8 right-hand side decreased considerably (58.213 mg/kg) this reduction is recorded on the level 51.5 m from 48.46 to 49.729 mg/kg. The higher level (64m) takes sees an increase in approximately 100% in S12 and S13 and a maximum value in S11 (263.737 mg/kg).

Although the ground is characterized by a slope of 25% and the values of the pH which are generally similar, zinc could migrate of the lower levels close to the lake up to the level highest taking a maximum concentration of 263.737 mg/kg with a remarkable fall in the level 51.5 m and the majority of samples right-hand sides of the ground.

**Lead;**

The concentrations are inferior to the values of reference of Germany and Japan, the maximum concentration of Zn exceeded the reference of the Netherlands (200 mg/kg), this content, and those of line 39 exceeded the values of reference in France (140 mg/kg). Downward values of the S1 left towards the line S3 (11.205, 6.673 and 4.791 mg/kg) in the level 14m, these contents are increased in S4 and S5 (5.334, 5, mg/kg 5.348 mg/kg respectively) of the level 26.5m, they continue to increase in S7 and S8 (8.687 and 9.578 mg/kg respectively) of the level 39m.

An absence of lead in S10 and downward content with 6.525 mg/kg in S9 on the level 51.5 m, then a correction starting from going S11 of 8.67 in S11 to reach the maximum one in S13 (13.58 mg/kg). The concentration of Pb increases proportionally into diagonal right-hand side to reach a maximum in the sample S13 (13.358 mg/kg) with a high value appearing on the line of 14m lake.

The contents are too low compared to the values of reference of Netherlands (50 mg/kg), France (85 mg/kg), Germany (300 mg/kg) and Japan (300 mg/kg).

**Cadmium;**

Cadmium is mainly absent in the ground, an appearance in the level 14m which does not exceed 0.275 mg/kg.

The content is too low in comparison with the values of Netherlands (1 mg/kg), France (0.8 mg/kg), Germany (2 mg/kg) and Japan (5 mg/kg).

**Chrome;**

The majority of surface contains variable concentrations, between 100 and 130 mg/kg. Contents between 89 and 99 mg/kg were observed on the line of 14m and the line of 64m. The maximum has shelter in the positions of S5, S6 and S7 of which the largest is that of S5 (134.246 mg/kg).

In comparison with the reference value of (100 mg/kg) of France and the Netherlands, almost 60% of the surface of our land exceeds it. So, 40% of the remaining surface is within the limit of this value.

**Copper;**

The maximum content of copper reach 27.014 and 30.966 mg/kg in S3 and S5, a decrease of 21.315 and 22.520 mg/kg in S12 and S13, the remaining is approximately between 10 to 20 mg/kg. The minimums are S4 and S9 (13.055 and 13.842 mg/kg).

The reference value of copper is 35 mg/kg in France, which affirms that surface is not touched by Cu pollution. However, values approach S3 and S5 to the position 26m above the bank of the lake.

**Magnesium;**

The recorded maximum content was found in S1, S2 and S13 (403.471, 431.733 and 399.130 mg/kg respectively. concentrations between 303 and 344 mg/kg in the majority of surface. The minimum is located in S12 (285.433 mg/kg)

Give The bibliography does not supply reference values for comparison.

**Mercury;**

Content less than 0.2 mg/kg are recorded on all surface, except for the samples of diagonal of S11, it presents content of 0.31 mg/kg.

The value of S11 is beyond the recommended value in France (0,3 mg/kg)

**IV. Conclusion**

The use of the atomic absorption spectrometry has enabled us to carry out an evaluation of the pollution of the ground with heavy metals. In this study, we established, in the first time, a representative sampling, physicochemical characteristics and thereafter of the classified dosages on eight element as heavy metals including Nickel, Zinc, lead, cadmium, Chrome, Copper magnesium and Mercury.

The characterization of the highlighted ground calculates its pH and morphological composition.

The calculated pH varies between 7.88 and 8.16, this gives to our ground the alkaline character. Morphologically, the ground in place is original and analyzed by stereophony microscope allowed to conclude that it is an argillaceous topsoil whose particles are lower than 1µm, the brown color of crust dark is due to the humus or manganese. The particles of the ground have a sub-angular polyhedric structure (polyhedric blunted).

Insufficient because the interaction ground - substances is a complex phenomenon nevertheless we could establish assumptions and recommendations.

The analysis by AAS of the samples of surface of our ground, put in solution by the attacks of the acids showed the presence of heavy metals (Ni, Zn, Pb, Cd, Cr, Cu and Hg) which does not exceed the values

of reference on selected surface, of the contents of (Ni and Zn and Hg) exceed slightly the values reference in the superior part of surface located at 64 m of bank of lake and approximately 20 m in height above the surface of the lake, the pollution of the surface of ground was not noted, however, from the contents of (Cr) go beyond values of reference in all the surface marking of the higher spades in the medium of surface, On the other hand, accumulation of Cu is on the level nearest to the lake. Strong Mn concentrations on all the surface are particularly high on first line close to lake and the limit superior of analyzed surface. The weak recorded concentrations are due to the formation of a protective coating (a coherent line) around the peripheral of the lake, preventing the heavy transfer of metals in the ground, this characteristic belongs to the ground of heavy clay type when wet. On the other hand, it was noted a migration towards the reaching ground of the levels of cumulate far from the lake for Ni, Zn, Pb and Hg and close to the lake for Cd, Cr, Cu and Mn, this mobility is supported by the alkaline character of the ground, and the capillarity of the particles <math>1\mu\text{m}</math>.

A widened analysis of heavy metals on the surface will be able to argue the assumption relating to the transfer of heavy metals starting from the agricultural terrains used and irrigated by water of the lake polluted with heavy metals, these terrains are located in the heights of our surface in which gravity and rain water support the transfer to the bottom, moreover the phenomenon of illuviation `progressive accumulation in a layer of the ground (or horizon) of various substances deposited by the infiltration of water' will be able to take place.

The results of this study showed that heavy metals are controlled by the physicochemical properties of the grounds in particular the pH, the diameter of the clay particles and mineralogical compositions.

This study could reveal that the pollution of this part of Algiers natural heritage is in extreme cases in relation to recommended values and opens prospects for research on the surface and in-depth of the ground in a widened way, taking in consideration other characteristic parameters.

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