All Sciences Proceedings
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1st International Conference on Scientific and Innovative Studies
April 18-20, 2023 : Konya, Turkey



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# Microbial and Heavy Metal Presence and Impact on Soil Pollution for Central Albania

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***Abstract*** **–** This scientific study was undertaken by presenting data on the presence of microorganisms (bacteria) and heavy metals found in the underground layers of Elbasan city. From the obtained results, it was judged whether the presence of bacteria and chemical elements is at such levels as to be considered as a soil pollution factor.

The main purpose of this scientific paper is to provide the possible correlation between chemical and microbial soil pollution, which directly or indirectly affects the health of the city's residents.

To achieve this goal, five soil samples were taken by digging to a depth of 0.5 m, during March 2023. Mainly, the Elbasan area has been at the center of criticism over the years and is considered an area with significant atmospheric pollution, of a chemical and microbiological nature. We have obtained results that prove chemical and bacterial data that can be considered as a soil pollution factor.

In conclusion, based on the analysis of the results and compared with the permitted rates of pollution, the level of chemical pollution of the soil from the nickel element appears, which is in the amount of about 2 and a half times more than the standards determined by the relevant Regulatory Acts of the EU.

Based on the study and monitoring that was done to the Elbasan city, we think that soil pollution is mainly dedicated to the activity of the farmer in the misuse of organic and chemical fertilizers, the mismanagement of wastewater by the relevant authorities, and especially the abusive activity to the detriment of nature carried out by industries that operate in the city.

*Keywords – Microbial, Heavy Metal, Pollution, Nickel, Heavy Industries, Elbasan.*

## I. INTRODUCTION

Heavy metal study contamination in Elbasan industrial facilities, mines and enrichment plants has been and continues to be the research subject for a wide range of researchers from academic institutions and research centers in the country.

Heavy metal contamination in soil surrounding industrial areas has proved devastating for both agricultural land, forests, and pastures.

Accumulations of Cu, Ni, Zn, Pb, Co, Cd, Cd and Arsenic in forest ecosystems and agricultural land near industrial sites have drastically changed the plant community.

Heavy metals are natural components of the Earth's crust. Examples of heavy metals include Lead (Pb), Mercury (Hg), Cadmium (Cd), Arsenic (As), Chromium (Cr), Selenium (Se), Nickel (Ni).

Heavy metals are toxic at low concentrations. They cannot be degraded or destroyed. In small quantities they pass through the body through food, drinking water and air, leading to toxic effects on living organisms [1]-[3].

Like trace elements, some heavy metals (e.g., copper, selenium, zinc) are essential to maintain the

metabolism of the human body, support living life [4], [5].

At high concentrations, above recommended rates the presence of heavy metals can lead to poisoning.

Various diseases such as tuberculosis, typhoid, influenza and various fungal diseases of plants or animals are easily spread through the air [6], [7].

Heavy metals are dangerous because they tend to bio-accumulate [6].

Bioaccumulation is an increase in the concentration of chemical elements in a biological organism over time, as opposed to its concentration in the environment [6], [8].

In the natural environment, their concentration is low. Whereas high concentrations of heavy metals in the case of contaminated environments result in environmental and public health impacts [3], [8].

In general, industrial processes, in addition to primary production, also produce secondary products, solid, liquid, and gaseous, in the surrounding environment for which there must be continuous control and monitoring [3], [8].

Heavy metals damage the cell membrane of plants, inhibit the normal development of roots and shoots, reduce $CO_2$ plants assimilation, and reduce stomatal conductance and transpiration [3], [8].

Heavy metals have low solubility in normal soils. The concentration of metals in the soil depends on parameters such as pH, redox potential, organic matter, and total metal content in the soil [9], [10].

This paper gives important information about the soil pollution in some areas of the Elbasani town during March 2023 period.

For the analysis of the microbial and heavy metal level pollution in Elbasan, 5 monitoring points have been determined in the north, east and southwest direction of the industrial facility.

One point is taken about 70 m from the facility while another has about 2500 m.

The analysed data showed that the concentrations of zinc, arsenic, cadmium, chromium, cobalt, copper, and lead are below the critical EU - determined values, except for nickel only at levels 2.5 times higher than the defined criteria.

All the soils sampled are planted with crops. They are mainly cultivated with fodder products, wheat, maize, and fruit trees [6].

Our scientific research through the survey of the bacteria and heavy metal's presence taken on analysed soil samples of Elbasan, attempts to provide preliminary information on possible impacts and factors that have led to soil pollution.

## II. Materials and Method

Five soil samples are taken at a 0.25 to 0.5 m of depth during March 2023 period in Elbasan area. For the speciation analysis, determinations in water soil extracts were carried out by applying the colorimetric method diphenyl carbazide [3], [11].

Afterwards, 2.5 g soil samples were shaken with 25 ml of demineralized water for about two hours.

After centrifugation for 10 min at 3500 rpm, the water was filtered through a 0.45 μm Millipore filter [9]. Instantly after extraction, the sample was acidified with a drop of concentrated ultrapure $HNO_3$ to bring the pH < 2.

Soil pH (after standard calibration at pH 4-7) in a suspension of 10 g of soil in 25 ml demineralized water, after magnetic stirring for 30 min, followed by 5 min sediment settling [11].

Various studies showed that the soils sediments consisted of more than 90% of silt to sand fraction. The clay fraction was about 8%.

The analysis of the grain size performed by taking 10 g of sample were treated first with HCl to remove the calcareous material, then oxalic acid for iron release and $H_2O_2$ for organic release.

## III. Results

After laboratory analyses and statistical and analytical processing, it is found that the soil samples taken during the period of March 2023 in the Elbasan area show that there is a significant microbial presence, but soil pollution above the allowed rates is observed only in the nickel element. The data of each of the five samples are grouped together, to correctly judge soil pollution progress, always compared to the basic rates.

Table 1 shows the soil microbial presence, also data of *Enterococci* and Coliform bacteria presence are presented.

Table 1. Summary microbial analysis for the five stations.

| No. | Microbiological index | | Average per 100 g *of dry soil weight* | | Total % | |
|---|---|---|---|---|---|---|
| 1 | Coliform bacteria | Coliform bacteria - *without E. coli* | 50028 | **60890** | 64 | **78** |
| | | *E. coli* | 10862 | | 14 | |
| 2 | *Enterococci* | | **16985** | | **22** | |
| *Total groups of Bacteria* | | | **77875** | | / | |

Table 2 shows the presence of heavy metals in March analysed for the five stations, as well as the recommended content.

Table 2. Average value of soil heavy metals for five stations.

| No. | Heavy metals | Recommended content (mg/kg) | Average (mg/kg) |
|---|---|---|---|
| 1 | Cadmium (Cd) | 3 | 1.2 |
| 2 | Arsenic (As) | 30 | 0.5 |
| 3 | Cobalt (Co) | 75 | 28 |
| 4 | Nickel (Ni) | 75 | **182** |
| 5 | Copper (Cu) | 140 | 31 |
| 6 | Chromium (Cr) | 200 | 48 |
| 7 | Lead (Pb) | 300 | 52 |
| 8 | Zinc (Zn) | 300 | 69 |

Except for nickel which appears in values much higher than the allowed rate, all other elements are below the allowed norm.

*Cadmium* (Cd) in the amount of 0.1 mg/kg is included in the normal soil content while for 3-8 mg/kg the soil is called toxic; it is in the value of 1.2 mg/kg of 3 mg/kg constituting the limit permitted by the EU, so its presence can be considered almost *normal*.

*Arsenic* (As) for 5 mg/kg quantifies normal soil type and for 20-40 mg/kg soil is classified as toxic, currently it is measured at 0.5 mg/kg from 30 mg/kg constituting the permissible limit of European directives, so its presence can be considered *normal*.

*Cobalt* (Co) for of 10 mg/kg is included in the normal soil content while for 40 mg/kg the soil is called toxic; it is in the value of 28 mg/kg of 75 mg/kg constituting the limit permitted by the EU, so its presence can be considered almost *normal*.

*Copper* (Cu) for 2 mg/kg quantifies normal soil type and for 60-125 mg/kg soil is classified as toxic, currently it is measured at 31 mg/kg from 140 mg/kg constituting the permissible limit of European directives, so its presence can be considered *normal*.

*Chromium* (Cr) for 5 mg/kg is included in normal soil content and for the presence of 75-100 mg/kg the soil is considered toxic, currently it is present in the value of 31 mg/kg out of 200 mg/kg which constitutes the limit permitted by the Directives. European, so its presence can be considered quite closes but still *below the permitted limit*.

*Lead* (Pb) in the amount of 10 mg/kg is included in the normal soil content while for 100 mg/kg the soil is called toxic, namely it is in the value of 52 mg/kg of 300 mg/kg which constitutes the limit permitted by the EU, so its presence is *normal*.

*Zinc* (Zn), for 10 mg/kg is introduced into the normal soil contents and for 100 mg / kg the soil is called toxic, in our case it is in the value of 69 mg/kg of 300 mg/kg constituting the limit permitted by European directives, so its presence can be considered *normal*.

*Nickel* (Ni) for 10 mg/kg is introduced into the normal soil content while for 70-400 mg/kg the soil is called toxic. It is present at a value of 182 mg/kg of 75 mg/kg which constitutes the limit permitted by the European Directives; it is *two and a half times higher than the European standard*.

## IV. DISCUSSION

Analysis of soil microbial populations in contaminated areas have shown a significant presence of aerobic bacteria, actinomycetes, fungi and nitrogen-fixing agents and various microbial groups [2], [5], [10]. The soil can be polluted by bacterial factors, due to the discharge of sewage, while from the content of heavy metals, due to the dumping of industrial wastes on the ground.

Heavy metals are released into the environment from technological processes, the smelting and refining industries, metal scrap, the plastics and rubber industry, various consumer products and from the burning of waste containing these elements. They can reach the food chain through potable water supply, air suction and food consumption [12].

High levels of heavy metals in the environment result in heavy exposure of humans and animals to these toxic elements through the food chain, inhaling dust, or direct ingestion.

Feeding animals can get a feed contaminated with heavy metals, and the remainder is excreted from the soil when it is fertilized with organic manure, which comes from animal excrement [9].

Elbasani town has been ranked one of the most polluted cities in Albania for years. We are mainly of the opinion that among the main reasons for this drastic pollution we can list high concentration of population, multiple buildings, loaded traffic, infrastructure, absence of green areas and above all the development of heavy industrial production activity and poor management regarding the technical control carried out by the Albanian state, in disrespect of environmental pollution measures.

We think that this excessive presence of nickel is also influenced by the lithology of the terrain and serves as a fact that nickel pollution is the result of the natural distribution of nickel in the area under study [3], [13], [14].

Meanwhile, it is well known that environmental pollution from nickel comes from traffic [3], [15], [16], but mainly from emissions from refineries and industrial waste.

Elbasani town soil throughout the analysis period results to be contaminated by Nickel.

## V. CONCLUSION

• From the conducted study we conclude that the Elbasan city soil is composed of heavy metals elements, most of which show no level of pollution except the nickel component which is 2.5 times above the standards set by the EU.

• All other heavy metal components are found in almost acceptable conditions.

• Elbasan city is presented with a significant soil pollution, judged by the high presence of bacteria and the high level of nickel, whereas factors we think have influenced the deposits of raw materials on the ground from the production activities carried out by the industries severe, and the misuse of organic fertilizers by farmers.

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