EVALUATION OF THE DEGREE OF POLLUTION WITH HEAVY METALS OF SOILS OF TIMISOARA TOWN

Stela URUIOC2, Mariana ALBULESCU1, Cristian Stanco BADEA2, Costina Roxana URUIOC2

West University of Timisoara, Chemistry, Biology & Geography Faculty, 1Department of Chemistry, 2Department of Biology

ABSTRACT
Timisoara town as other urban centres is exposed to some possible dangers that soil and plant contamination with heavy metals can produce. The our studies has been realised on ten soil samples and three plant samples gathered from important areas regarding pollution with heavy metals of Timisoara city. The samples have been analyzed through atomic absorption spectrometry with a device type Varian 2, that has a double beam. The content in cobalt, copper, manganese, zinc, cadmium, nickel, lead, magnesium and iron from soil is changeable under maximum admission. The content in iron, manganese, copper, lead, cadmium from Tilia cordata leaves is situated in normal limits, but higher than in soil.

KEY WORDS: heavy metals, pollution, soil, Timişoara, Romania

INTRODUCTION
Urban environment pollution with heavy metals caught the attention of many researchers because of his complex problems that this phenomenon represents (Duris, 1999; Lăcătuşu et al., 2001; Adomaitis et al., 2003; Panaiotu et al., 2005, 2006). Heavy metals are one of the most dangerous pollutants of urban locality (Mîrlean et al., 1993). Development of industry and transports leads to an excessive growth of heavy metals concentrations from big throngs. Large growth of vehicles leads to the evacuation of big quantities of lead.

In the big industrial cities, in most of the cases, heavy metals concentrations overpassed the alert limit, reaching to alarming toxicity levels. Heavy metals are pollutants, with low toxic potential even to reduced levels of exposure ( Şenilă et al., 2006). Heavy metals represent one of the pollutant category with the most important effects regarding environment quality (Har et al., 2005). Pollution level monitorisation and the impact produced by metallic elements represents an important purpose for environment studies in Timişoara and near it.

Thus, Ţărău et al. (2002, 2006, 2007) brings up studies regarding soil pollution by Termoelectrica Timişoara and environment conservation in the periurban area. Borza et al. (2005) emphasis the impact of economic and social activity over soil quality from periurban area Timisoara. Ianoş (2006) realises a study regarding soil vulnerability of heavy metals pollution from Timisoara town.

The aim of this paper is to obtain new information regarding evaluation in Timisoara town of some possible dangers that soil and plant contamination with heavy metals can produce and their impact over environment.
MATERIAL AND METHODS

For evaluating the level of soil pollution with heavy metals samples soils have been collected from ten points spread in characteristic areas of Timisoara town (Fig. 1). A soil sample has been constituted of 25 partial samples prelevated from 0 - 5 cm depth. Also, samples of *Tilia cordata* leaves have been collected from 3 important areas of the town (Fig. 2).

Collection points were established in order to avoid the eventual dangers that heavy metals contamination can produce regarding the main pollution sources. For placing the collection points for soil and plants samples we used as topographic base the map from Timisoara Town Guide. The collected soil and plant samples were mineralised and disintegrated in OSPA Timisoara laboratories.

![Figure 1. The prelevation points of the soil samples](image)

The prepared samples were dried at 110°C then roasted in oven at 500°C and finally at 600°C. The dross from the crucible has been treated with regal water (HCl:HNO3 in pertained to 3:1) and held 30 minutes 70°C on water bathroom, and then diluted, filtered on paper with filter that has medium porosity and brought to sign in a flask of 20 ml containing hydrochloric acid 1 N. The content in Co, Cu, Mn, Zn, Cd, Ni, Pb, Mg, Fe from soil and also the content of Fe, Mn, Cu, Pb, Cd from plants has been determined through spectrometry of atomic absorption with a device Varian 2, with double beam. Before this, were assigned the standard curves for the analyzed metals.

Soil and plant samples were processed and analyzed after national standards and norms that were consented by the Standardization Association from Romania (A.S.R.O). Data interpretation and processing, and also the naturalistic characterisation of the researched area have been done according to Elaboration Methodology of Pedologic Studies (MESP) that has been elaborated by ICPA Bucharest 1987, and being completed with elements from The Romanian System of Soil Taxonomy (SRTS, 2003).

Figure 2. The prelevation points of plant samples
1. Civic park, 2. Calea Aradului, 3. Calea Sagului
RESULTS AND DISCUSSIONS
1. Chemicals characteristics of soils
1.1. Soil reaction (pH)
Soil reactions express the way in which the main biochemical processes take place from soil.
Evolution in time of pedogenetic conditions from Timisoara town shows up that the reaction presents some characteristics that indicates inadequate anthropic interventions.
The majority of the analyzed samples presents values (7.4–8.2) that indicate a weak alkaline reaction (Fig. 3).
Knowing the reaction of soil is important because it prevents the specialist towards the measures that he has to undertake, in order to bring up the soil in best condition of reaction (5.8 – 6.8) for plant growth.
Soil reaction also influences indirect the nutrition conditions of plants through pH values influence over the main nutrition elements mobility or some pollutants.

![Figure 3. The pH value in the prelevated soil samples](image)

1.2. The heavy metals content from soil
From the ten soil samples prelevated from the green areas from Timisoara town were determined the following heavy metals: cobalt, copper, manganese, zinc, cadmium, nickel, lead, magnesium and iron.

Now we are going to make an analysis of the concentration of each metal showing up the negative effects that higher concentration in heavy metals have on plants and life generally.

**Cobalt** is an essential element for bacteria that fix natrium. These use cobalt for fixing the atmospheric natrium. The soil content in cobalt is tight...
bounded by the condition of soil formation, by the nature of the parent materials and by the anthopic interventions.

In the case of the analyzed area, the biggest concentration of Co is found in I. C. Brătianu Market (sample 1 = 0.76 ppm) while in General Gh. Domășneanu Market we found the lowest concentration (sample 7 = 0.413 ppm). The values from the other points of collection are relatively similar, being situated between 0.541 ppm and 0.646 ppm. These values situates the analyzed sites in soils with normal content of Co (Fig. 4).

![Figure 4. Variation of cobalt concentrations from soil samples](image)

![Figure 5. Variation of copper concentrations from soil samples](image)
Copper is present in soil in lower quantities than 20 ppm. Quantities that are close to this value or higher lead to the diminution of biological activity from soil. Reaching to plants, in higher concentrations than 20 ppm, copper can become toxic for the animals that consumes those plants (Uruioc, 2000).

Concerning copper concentrations from the studied soils, these are included between 2.224-5.639 ppm, the highest value being at the crossing between Amurgului and Sever Bocu Street (sample 3) and the lowest value on Gheorghe Dima Street (sample 9). Regarding these values, the analyzed soils are among the soils that have normal concentration of copper (Fig. 5).

Manganese is found in soil, in the crystalline structure of clayey minerals, at the surface of colloids organico-minerals (exchangeable manganese), in the soil solution and under the form of activ manganese that is accessible to plants.

In the ten analyzed soil samples, the concentration of manganese overpass little the value 9 ppm. The only value under 9 ppm has been registered in Gheorghe Dosmaneanu Market (sample 7 = 8.64 ppm) (Fig. 6). The results of the analysis show up that these soils have a normal content of manganese.

Zinc is found in soil, in clayey minerals, oxydes, hydrates and in organic material. There is a closed bound between the content of soil in humus and the content in zinc.

The content in zinc of the sites from the analyzed area oscillates between 2.774 ppm and 2.918 ppm. These values situates the analyzed soils to the inferior limit of the normal concentrations (Fig. 7). The lowest values were registered in General Gheorghe Domăşneanu Market (sample 7) and Gheorghe Dima Street (sample 9).

Cadmium is a chemical element that is related to zinc, it is less abundant than zinc and is known because of his toxic effect on plants and animals.

In most of the gathered samples from the investigated area, the content of cadmium is under the limit of detection of the device. Values over 0 have been identified in I. C. Bratianu Market (sample 1 = 0.064 ppm), Marasesti Market (sample 2 = 0.013 ppm), the crossing between Republicii Boulevard and Jiu Street (sample 5 = 0.014 ppm) and the crossing between Cetatii Boulevard and Torontal Street (1 ppm). In all the cases cadmium content is under the normal limit (1 ppm) (Fig. 8).

Nickel is a stainless metal, pollutant for the natural environment and for soils, being related from the geochemical point of view with cobalt.

Resulted in the weak of alteration processes of the primary rocks, in big part nickel remains in solid products of physical-mechanic disintegration, then being transported and stored in the parent material of soils.

What regards the nickel content of soils from the analyzed area, this presents low values and also contents that are between 1.947 ppm (sample 7) and 3.230 ppm (sample 1) (Fig. 9).
Figure 6. Variation of manganese concentration from soil samples

Figure 7. Variation of zinc concentrations from soil samples
Figure 8. Variation of the cadmium content from soil samples

Figure 9. Variation of nickel content from soil samples
Lead is a chemical element, very toxic for live organisms, that it is usually found in rocks and soils in medium quantities of 15-16 ppm (Fiedler et al., 1988). In West Plain lead content is about 15-25 ppm (Lăcătușu et al., 1997). The high values identified in the Banato-Crisana Plain are derived from mountainous massives with metamorphic and acid magmatic rocks (Lăcătușu et al., 1997). Being easily extracted from rocks in alteration processes, the soluble compounds of lead are taken over by pluvial waters or by the drainage from slopes, in this way enriching the areas descended through subsidence.

In the Timisoara area high values of lead are due to the natural background and to the intense road traffic.

These values are under normal limits, that it is 1-20 ppm, with low tendencies of increase in some areas. The only value over the normal limit was identified in I. C. Bratianu Market (sample 1 = 20.379 ppm). In the other tested areas lead contents were between 1.882 ppm and 15.522 ppm (Fig. 10).

Magnesium. In soil magnesium is found under exchangeable form and under soluble form that is taken by plants. As concentration in magnesium come down from the soil solution takes place the transition from exchangeable form to soluble one.

What regards the content in magnesium of sites from the investigated area this oscillates between 2.532 ppm and 2.903 ppm, values that situates the investigated area within the soils with less values of magnesium (Fig. 11).

Iron. The content in iron of the sites within the analyzed area, these oscillate between 17.619 ppm and 18.032 ppm.
These values situates the analyzed sites in the soils with low extractable iron content. The biggest value has been registered at the crossroad between Republicii Boulevard and Jiu Street (Fig. 12). The gathered samples from the central-north part of Timisoara (samples 1, 2, 3, 4, 9, 10) present lower concentrations vis a vis of those gathered from the central-south part of Timisoara.
(samples 5, 6, 7, 8), where there are the main sources of pollution (CET Timișoara) (Fig. 1).

2. The heavy metals content from plants

From the obtained results there can be noticed that in plants are registered higher contents in some heavy metals than in soil. This proves the role that vegetation has (through retention from the atmosphere of different dusts and a significant quantity of pollutants), especially in soil protection and generally in environment.

Iron. In the three areas of prelevation of *Tilia cordata* leaves samples, iron concentrations have been varied: in Civic Park 9400 ppm, in Calea Aradului 8000 ppm and in Calea Sagului the lowest concentration of 6400 ppm (Fig. 13).

Manganese. The highest concentration of manganese has been registered in the leaves of *Tilia cordata* from the Civic Park (62 ppm). The values from Calea Aradului and from Calea Sagului have been similar, that is 28 ppm and 23 ppm (Fig. 14).

![Figure 13. Variation of iron concentrations from the samples of *Tilia cordata* leaves](image-url)
Figure 14. Variations of manganese concentrations from the samples of *Tilia cordata* leaves

**Copper.** In the gathered samples of *Tilia cordata* leaves from the Civic Park and from Calea Sagului have been registered values of copper of 1.9 ppm. In Calea Aradului copper concentrations are reduced to half from the values of others (1 ppm) (Fig. 15).

**Lead.** The highest concentration of lead (0.7 ppm) has been registered in the samples of leaves from Civic Park from the central area of Timisoara. In Calea Aradului lead value of 0.5 ppm and in Calea Sagului the quantity of lead was the lowest, 0.3 ppm (Fig. 16).

**Cadmium.** In the prelevated samples from Calea Sagului cadmium has been under the limit of detection of the device. From the analysis done on *Tilia cordata* leaves from Calea Aradului resulted 0.2 ppm cadmium. The biggest concentration (0.5 ppm) has been identified in the plants from Civic Park, more than double vis a vis Calea Aradului (Fig. 17).

In order to establish some correlations between the heavy metals content from soil and plant, we consider that it is necessary thicken the points of observation from the areas where these substances had higher concentrations.
Figure 15. Variations of copper concentrations from the samples of *Tilia cordata* leaves

Figure 16. Variations of lead concentrations from the samples of *Tilia cordata* leaves
3. Determined factors in heavy metals accumulation in Timisoara town

In the urban area of Timisoara, soil means the crossing of a significant number of pollutants: thrown or deposited solid residuals, residual waters used for the irrigations of some areas, negative dusts thrown up by industrial factors, toxic gases dissolved in rain water and then reached in soil.

The main factors that had an important role in heavy metals accumulation in the soils from Timisoara are: means of transport, industrial agents, the physique condition of soil and the climate.

The means of transport. At least once a day, the atmosphere of Timisoara knows high concentration of gaseous pollutants and sedimentable dusts resulted from the means of transport (Ianoș, 2006).

These are relocated on a area that is conditioned by the environmental factors (relief aspect, wind, turbidity), or urbanistic (assembly of high block of flats, green areas), loading the soil with some toxic elements and pollutants.

The industrial agents. The steriles come from the sterile spoil bank of CET Timisoara is deposited in humid wethers, in the south part of Utvin. As these spoil bank spread up, the impact will be over the phreatic, through pollution of water adduction that dews up the sterile, being charged up with heavy metals (cadmium, lead). After the wethers are dried, the wind spreads on the area dusts loaded with chemical elements that are toxic for the vegetal and animal organisms, producing air and soil pollution.

The climate. The main condition of dispersal of the pollutants is the climate condition, factor that leads and catalyses all the transformation reactions of the pollutants.
The moderate continental-temperate climate with oceanic and mediterranean influences in which Timisoara is located has consequences over the pollutant accumulation through debased reactions acceleration as well as through soluble toxic substances pursuant to an increased pluviometric regime.

CONCLUSIONS
After the analysis of the ten taken soil samples from the characteristic areas of Timisoara town and three leaves of *Tilia cordata* samples from important areas from the point of view of pollution with heavy metals we can conclude the following:

The majority of analyzed soils samples present values that indicate a weak alcalin reaction.

The content in cobalt, copper, manganese, zinc, cadmium, nickel, lead, magnesium and iron from soils is variable even under the maximum limit admitted.

The highest concentrations in toxic heavy metals have been identified in I. C. Bratianu Market; in this point of soil samples prelevation, lead overpasses the normal limit; also, we meet the highest value of cadmium but this doesn’t reach the alert stage.

The lowest concentrations of lead have been identified in General Gh. Domasneanu Market and Gh. Dima Street, in these 2 points cadmium value has been under the detection limit of the device.

The content in iron, manganese, copper, lead, cadmium from *Tilia cordata* leaves are situated in normal limits.

In *Tilia cordata* leaves are higher contents in iron, manganese, copper and cadmium but smaller in lead.

The factors determined in the heavy metals accumulation in Timisoara town are: the means of transport, the industrial agents (CET Timisoara), the climate.

In order to reach to the alert stage through the growth of the pollution stage we recommend: the endowment of the industrial agents pollutant with the adequate filter, reduction of the vehicle traffic, usage of some unpolluting in the case of the means of transport.

We also recommend thicken of the points of observation in order to prepare a plantation programme of some species resistant to pollution: *Acer campestre, Alnus sp, Carpinus betulus, Fagus sylvatica, Juglans sp, Platanus hybrida, Robinia pseudacacia, Abies sp, Pinus nigra*.

According to MAPM 756/1997 order regarding the normal limits of heavy metals from soil and relatively with other towns from the country, Timisoara can’t be considered a polluted town.

REFERENCES

- Borza I., Țărău D., Jarabă, R., Țărău, I. - The impact of economical and social activities on soil quality and use of agricultural lands in the peri-urban area
URUIOC STELA et al.: Evaluation od the degree of pollution with heavy metals of soils of Timisoara town


- ***Ghidul municipiului Timișoara
- *** Ord. MAPM 756/1997
- *** Metodologia Elaborării Studiilor Pedologice (1987)
- ***Sistemul Român de Taxonomie a Solurilor (SRTS, 2003).