# COPPER ACCUMULATION IN SOILS AND VEGETATION OF POLLUTED AREA COPŞA MICĂ

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***Abstract***
*The study carried out in order to estimate the distribution and accumulation of copper in soils and vegetation from Copşa Mică area used a radial network centered in the source of pollution – S.C. SOMETRA S.A. Copşa Mică. Soil and plant samples taken from the radial nodes of the network were analyzed to determine the content of copper. Values of copper content in plant ranged between 4.2 mg/kg and 97 mg/kg. Based on these results has been obtained a regression equation that estimates the copper content in plants as function of the total copper content in soil. The spontaneous vegetation developed in the investigated area includes plants belonging to the following species: Amaranthus retroflexus, Artemisia vulgaris, Asclepias syriaca, Calamagrostis epigeios, Calamagrostis pseudophragmites, Cynodon dactylon, Daucus carota, Equisetum arvense, Phragmites australis, Picris hieracioides, Setaria glauca, Sinapis arvensis, Verbascum phlomoides and Xanthium strumarium. The copper pollution doesn't represent a major problem in Copşa Mică area.*

Keywords: copper, accumulation, soil, plant, Copşa Mică

## 1. INTRODUCTION

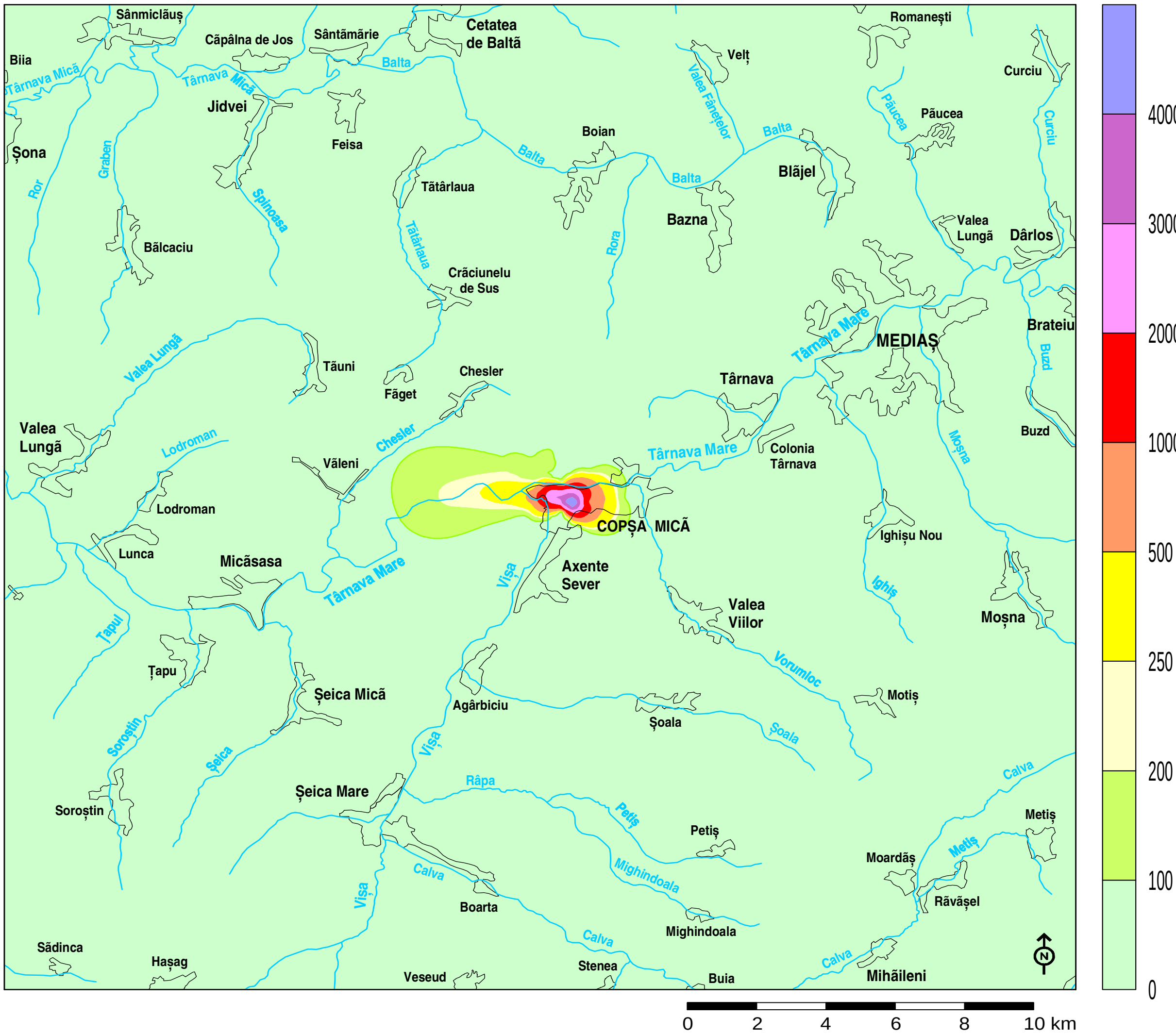
Extensive industrial production is usually connected with the emission of various pollutants to environment. Heavy metal contamination of soil affects the quality of crops, which very often reduces and sometimes disables the production of valuable food and animal feed [2].
There are in Romania, three areas (Copşa Mică – Sibiu County, Zlatna – Alba County and Baia Mare – Maramureş County) highly polluted with heavy metals, caused by non-ferrous ores extraction and metallurgical processing. The intake of heavy metals can lead to altering of human and animals health [3].
Copper is one of the pollutants identified in the area. This element, like zinc, is an essential metal for normal plant growth and development, although it is also potentially toxic. Nevertheless, either deficient or in excess, Cu can cause disorders in plant growth and development by adversely affecting important physiological process in plants [4].
The objective of this study was to estimate the distribution and accumulation of Cu in soils and vegetation from polluted area Copşa Mică. The estimation of Cu accumulation and distribution in plants was achieved by means of the power regression curves.

## 2. MATERIALS AND METHODS

The sampling of soil was done on a radial network of 103 collection sites. Plant samples were harvested from the same points with the soil samples. The plant samples were collected from agricultural crops, pastures, meadows and spontaneous vegetation.
The total copper content was measured with flame atomic absorption spectrometer in hydrochloric solution resulted by digestion of soil samples in $HClO_4$-$HNO_3$ mixture.).
The map representing mathematical modeling of content values was obtained using the program Surfer, version 8.
The power regression curves were used to estimate the accumulation and distribution of copper in plant.

## 3. RESULTS AND DISCUSSIONS

The estimation obtained by interpolation of content values indicate that the area affected by pollution, where copper content in soil exceeds the alert threshold for copper (in 0-20 cm layer) covers about 1600 ha (*Plate 1*). Exceeding of intervention threshold established for sensitive use of land (200 mg/kg) was reported on 760 ha.




| Total copper content ( mg/kg ) | Estimated area ( ha ) |
|---|---|
| ≤ 100 [a] | 94500 |
| 101 – 200 [b] | 840 |
| 201 – 250 [c] | 200 |
| 251 – 500 [d] | 200 |
| 501 – 1000 | 120 |
| 1001 – 2000 | 80 |
| 2001 – 3000 | 80 |
| 3001 – 4000 | 40 |
| > 4000 | 40 |

| Total copper content ( mg/kg ) | Estimated area ( ha ) |
|---|---|
| > 100 [a] | 1600 |
| > 200 [b] | 760 |
| > 250 [c] | 560 |
| > 500 [d] | 360 |
| > 1000 | 240 |
| > 2000 | 160 |
| > 3000 | 80 |
| > 4000 | 40 |

[a] – alert threshold for sensitive use of land
[b] – intervention threshold for sensitive use of land
[c] – alert threshold for less sensitive use of land
[d] – intervention threshold for less sensitive use of land

**Plate 1 Spatial distribution of copper in soil estimated by interpolation of values obtained in the nodes of a radial network (0–20 cm layer, Copşa Mică, 2005).**

The area where the values of copper content in soil are higher than intervention threshold for less sensitive use (250 mg/kg) covered about 560 ha, located around the pollution source. It was identified an area of about 360 ha where the soil copper content exceeded the intervention threshold for less sensitive use (500 mg / kg).
The highest value of total copper content in soil was determined in sample collected from site located approximately 0.5 km East of the pollution source.

The trend of variation estimated with a power-regression equation indicates that the values of total copper content in layer 0-20 cm decrease below the alert threshold at distances higher then 2 km from the source. The highest values of copper contents in soil were determined for soils located on East direction at distances lower than 1.5 km from source (*Figure 1*).
Approximately 79% of copper content values were below the alert threshold for sensitive uses.

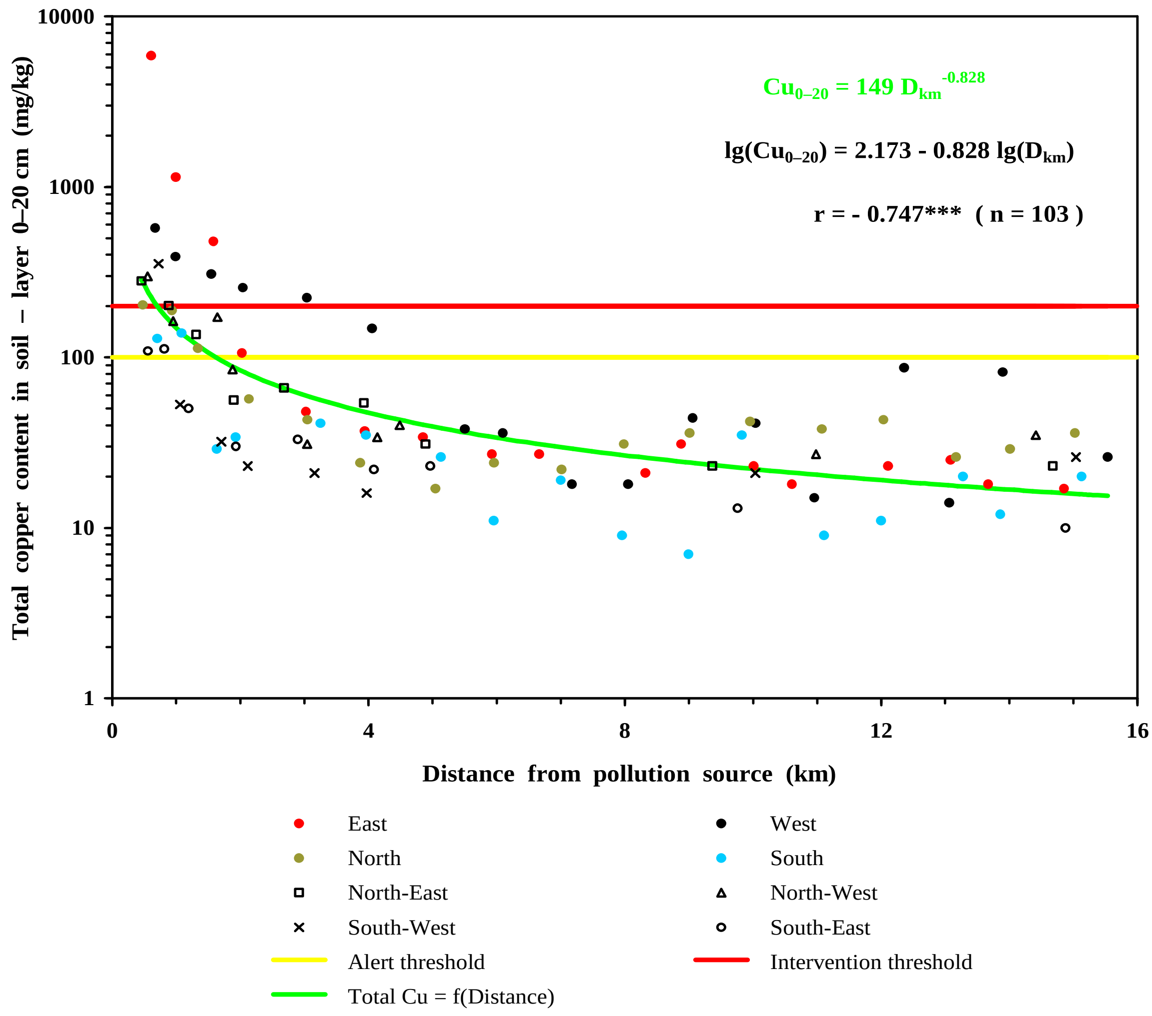



**Figure 1 Total copper content in soil as a function of the distance from pollution source – S.C. SOMETRA S.A. (Copşa Mică, 0–20 cm layer).**

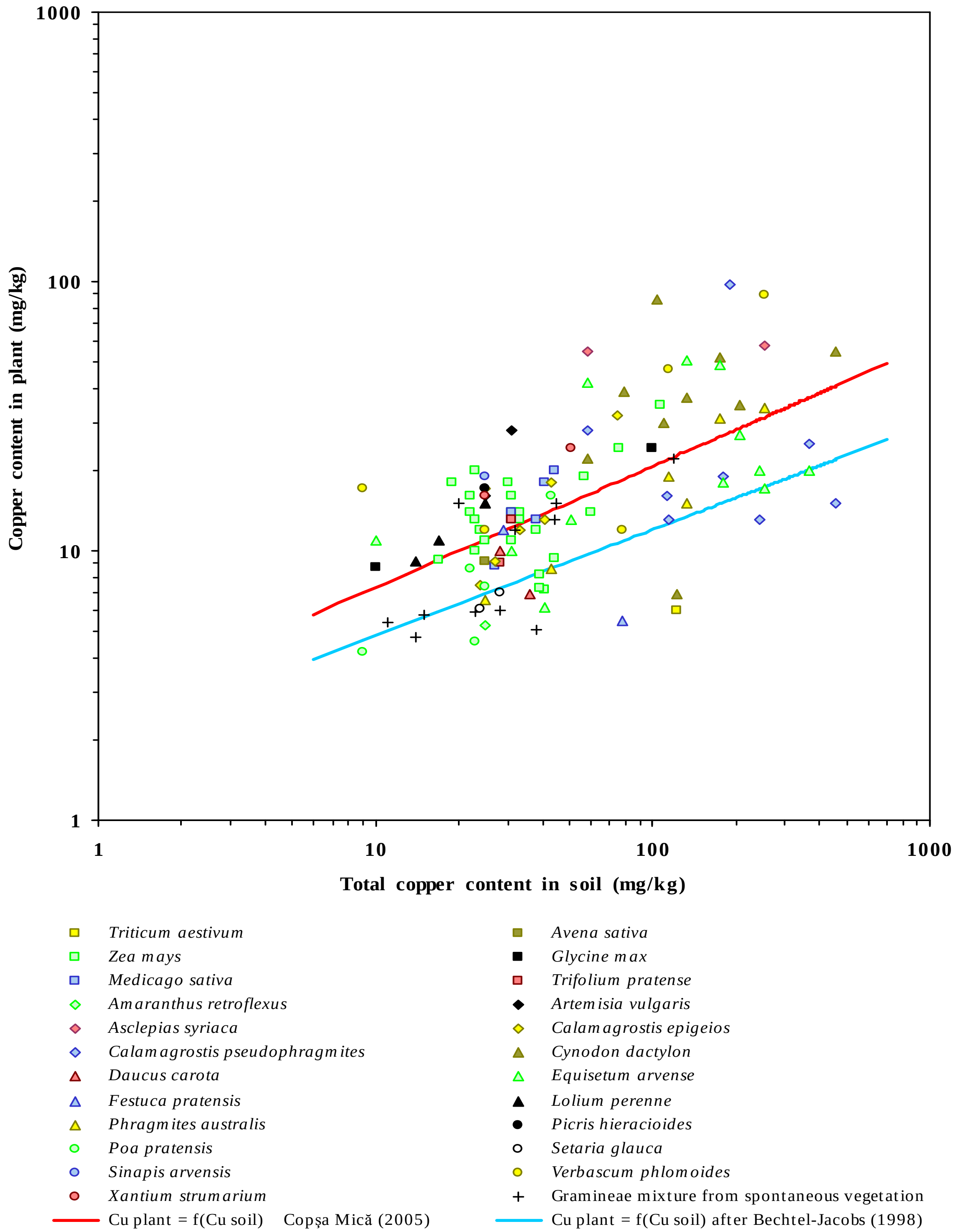



**Figure 2 Log-log diagram for two power regression curves that estimate the stochastic dependency between total copper content in soil and copper content in plant.**

The main crops identified in the investigated area were: maize (*Zea mays*), wheat (*Triticum aestivum*), oats (*Avena sativa*), soybean (*Glycine max*), alfalfa (*Medicago sativa*) and red clover (*Trifolium pratense*). From spontaneous vegetation of Copşa Mică area were collected plants belonging to the following species: *Amaranthus retroflexus,* *Artemisia vulgaris, Asclepias syriaca, Calamagrostis epigeios, Calamagrostis pseudophragmites, Cynodon dactylon, Daucus carota, Equisetum arvese, Phragmites australis, Picris hieracioides, Setaria glauca, Sinapis arvensis, Verbascum phlomoides* and *Xanthium strumarium.*

The regression curve obtained on the basis of determinations made on samples from Copşa Mica (2005) was compared with that obtained from a research study made by [1]. Simple regression equation recommended by Bechtel-Jacobs as a model of copper accumulation is not statistically significantly different to the equation obtained Copşa Mică (*Figure 2*).

Copper content in plants ranged from 4.2 mg/kg to 97 mg/kg. The lowest value of copper content (4.2 mg/kg) was obtained for plants of *Poa pratensis* sampled at 8 km South far away from pollution source. From the same site was harvested plants of *Verbascum phlomoides* and the copper content determined for this plant was 4 times higher than copper content of *Poa pratensis* plants. The highest value was determined for plants of *Calamagrostis pseudophragmites* harvested from 0.5 km NW from the source of pollution. From area where copper content in soil was higher (460 mg/kg) were harvested both plant of *Cynodon dactylon* and *Calamagrostis pseudophragmites*. It notes that the copper content of *Cynodon dactylon* plant was almost 3 time higher than value of copper content determined in *Calamagrostis pseudophragmites* plants.

The plants identified and harvested from areas where the total content of copper in soil (0-40cm) exceeded 200 mg/kg belong to following species: *Asclepias syriaca, Calamagrostis pseudophragmites, Cynodon dactylon, Equisetum arvense*, *Phragmites australis* and *Verbascum phlomoides*. These plants have adapted to stressful conditions induced by excessive levels of heavy metals in soil managing to grow even in such a hostile environment.

The copper content in aerial part of plant is not a good indicator of copper toxicity due to the immobilization of this element in plant roots. With regard to agricultural crops, values of copper content in plant ranged between 7.3 mg/kg and 35 mg/kg. These value are normal for plant. USEPA notes that up to a copper content of 40 mg / kg in maize stalk the plant development process is not affected.

## 4. CONCLUSIONS

In Copşa Mică area soil pollution with copper remains at high levels only in small area. Most of values of copper content determined in soil samples from the 103 sites were below the alert threshold. Even if copper pollution does not pose a major risk for environment, the simultaneous presence in soil of the other heavy metals like Cd, Pb and Zn represents a threat for human and animal health.

In the polluted area were identified plant species able to accumulate copper in tissues in excessive amounts without adverse effects on the general development of the plant (*Asclepias syriaca, Cynodon dactylon, Calamagrostis pseudophragmites, Equisetum arvense*, *Verbascum phlomoides*).

Estimated copper content in plant according to the total copper content in soil using the suggested regression equation is particularly useful in the early stages of a risk assessment in the Copşa Mica area.

## 5. REFERENCES

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