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ZINC POLLUTION OF SOILS LOCATED INTO THE INFLUENCE AREA OF THERMO-ELECTRIC POWER STATIONS DOICEŞTI AND ROVINARI

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Abstract

Some of the most complex polluters of the environment are thermo-electric power stations that are using coal as energy source. There are two types of environmental pollution sources: the main are baskets exhaust gases of coal combustion, so called high sources, and the secondary sources that are ash dumps resulted from the coal combustion activities, so called low sources. Thermo-electric power station Doicesti, located in the area of Sub-Carpathian hills, on Ialomiţa Valley, is a major source of environment pollution with sulphur, since 1952 when was built. By geographically point of view, the studied territory can be included into Sub-Carpathians' Curvature, more specify in the Prahova's Sub-Carpathian subunit.
Pedogenesis factors: rock, topography and parent matherial, have led the evolution of isolated, lythomorphic soils. In the investigated territory four soil classes: Luvisols, Cambisols, Vertisols and Protisols were identified, each of them with types and subtypes mentioned in the paper.
From the geomorphological viewpoint, thermo-electric power stations Rovinari belongs to the Câlnic-Câmpul Mare inter-hilly depression whose altitude, at the Rovinari, is 150 m. The soil forming factors causing the soil evolution have been the rock, parental material and relief, all of them determining the evolution of lithomorphic zonal soils. The soils in the analyzed area represented by the classes: luvisols, hydrisols, cambisols and protisols.
The subject of this paper is to analyze the loading degree of copper of the soils affected by emissions from thermo-electric power stations Doiceşti and Rovinari. Soil samples collected soil profiles distributed in all cardinal directions, were analyzed for pH, zinc contens.
In the investigated area, zinc pollution of soils, caused by zinc emissions from thermo-electric power stations Doicesti and Rovinari, were recorded. The zinc pollution phenomenon gathering way by changing the normal content of soil, plant, and consequently, could affecting the health of the inhabitants of this territory.

Key words: *pollution, soil, thermo-electric power station, zinc.*

INTRODUCTION

Zinc in the flue gases finally reach the soil and vegetation, as aerosols or acid rains. So far, expeditionary field research conducted in the area of main power stations could not show significant changes in soil reaction caused by emissions from coal-fired power plants. This fact is due to greater height of the flue chimneys, which allow distribution of gaseous pollutants on large land areas. Secondly, many soils developed in the area influenced by emissions are buffered, calcium carbonate reserves annihilating leaching and debazification processes (Dumitru, 1992).
Establishing of soil loading is very difficult given the fact that every soil is a separate entity characterized by specific chemical properties. However, large quantities of copper in burned coal are often found in the A horizon of soils in the area influenced by the emissions from the power plants.
The Doiceşti thermo-electric power station is located in the Subcarpathian hills, Ialomiţa Valley. At south of the Pucioasa city, the valley widens, its width exceeding 2 km in Doiceşti area. The Doiceşti, Cornetu and Brăneşti hills have various sizes and orientations, their height ranging between 375 and 518 m. Most of the peaks have heights lower than those of the power plant flue chimney, could be seen from the Pădurea Bălteanu slopes, located on the second line of hills, behind the Doiceşti hill.
In the case of the Rovinari thermo-electric power station, 189 ha have been lost from the economic land use until 2004 and other 110 ha land after 2004 being occupied by the ash Cicani and Beterega dumps.

In order to analyze the effects of the emissions from the Rovinari thermo-electric power station.

Along each direction, the sampling sites are located at every 1.5 km distance in between, the last sites being at 7.5 km far from the thermo-electric power station. This spatial distribution of sites permitted to analyze the dispersion of pollutants coming both from the emission of chimneys and the ash dumps, as well as their contents in the sterile dumps.

MATERIALS AND METHODS

Development of the present study needed field investigations field to collect soil samples and observations on materials constituting slopelands and terraces surrounding the Doiceşti and Rovinari thermo-electric power stations. Sampling was made on the 0-20 cm and 20-40 cm depth. Soil sampling points were located on the map. 24 soil samples have taken, from Doiceşti and 40 soil samples from Rovinari they being subject to the following set of analyses: pH and copper (Căpitanu et al., 1999).

In order to facilitate the interpretation of loading degree of potential pollutants and make a comparison between the contamination intensities of each pollutant element, an excessive coefficient of maximum normal content (Cn), proposed by Lăcătuşu 1995 and Florea 2003, has been calculated for each individual element. This Cn coefficient is defined as the ratio between the respective element content and the maximum normal content of that element. As concerns the potential polluting substances, the reference contents established by the Ministry of Waters, Forests and Environmental Protection (Order No. 756/1997) have been applied (Lăcătuşu, 1995).

The value 1 of this coefficient means the lack of a contamination, according to the official rules. Sub-unitary values mean a low geological background for the respective element, while the over-unitary values may mean a contamination with the respective element due to the pollution source, so much the higher as the value of this coefficient is higher.

To be able to evaluate the pollution degree, similarly, the coefficients corresponding to the thresholds of "warning" and "triggering", briefly called warning coefficient (Ca) and triggering coefficient (Ci) for each potential pollutant, dividing the value corresponding to warning level and triggering level by the maximum normal content of the respective pollutant.

As the exceeding coefficient of normal content (Cn) of each element is coming nearer to the warning coefficient (Ca) or the triggering coefficient (CI), so the contamination or the pollution of the respective site is more intensive, of course, depending on these values, the adequate measures are taken, consequently.

These relative values for the above mentioned coefficients permit a light comparison of pollution intensities of different chemical elements.

RESULTS AND DISCUSSIONS

The study of pollution of soils in zone of the Rovinari and Doicesti thermo-electric power stations necessitated an ample analysis of soil properties because these form a complex mantle determined by the diversity of relief, groundwater, rock and parent material conditions.

With in the area influenced by the Doiceşti thermo-electric power station, soil samples were taken from 24 profiles, mostly located on both sides of the Ialomiţa river, between the Pucioasa and Târgovişte municipalities and to the west of the Dâmboviţa river between the Izvoare and Drăgăeşti-Ungureni localities and the area of influence of Rovinari thermo-electric power station were taken 40 soil samples at two depths.

Further analysis will be part of the copper for every thermo-electric power station.

As concerns the copper content, it exceeds the normal content within the whole territory in the Ialomiţa floodplain - between the south alignment Teiş-Anina, Brăneşti in the north part and Lăculeţe valley in east part. Maximum values can exceed the normal content of 10 to 20 $mg.kg^{-1}$ content (20 $mg.kg^{-1}$), but well below the alert threshold, so there is threshold, that is there is a slight contamination (loading). In a single site (13 km NNW from the Doiceşti thermo-electric power station), in the 20-40 cm layer, the copper content reached 141 $mg.kg^{-1}$, that is, exceeded the alert threshold, probably as the result of the plant protection treatments applied in grapevine, or a local geochemical anomaly (site ignored in the data interpretations).

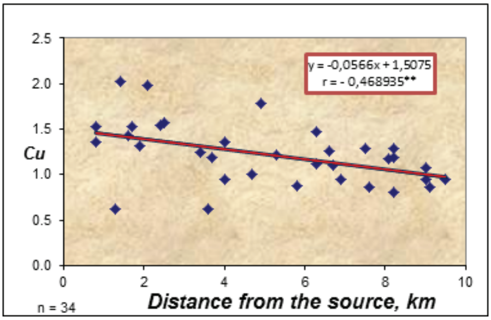

Figure 1. Variation of exceeding coefficient of the maximum normal content of zinc in soils (0-20 cm depth), depending on the distance from the Doiceşti thermo-electric power stations, in the area affected by its emissions (Correlation is distinctly significant)

Coefficient values exceeding the maximum normal content vary between 0.6 and maximum 2.4, being no pollution with copper. The coefficient corresponding to the alert threshold (4.76) is not exceeded.

As regards the territorial distribution (Figure 2), a coefficient exceeding two times the normal maximum content of more than 2 is observed on a reduced area to east of the Doiceşti thermoelectric power station and on an area located along the Ialomiţa valley with this coefficient of 1.25 to 2 which extends to north up to 5 km, and to the south in the dominant wind direction up to 7.5 km.

Thermo-electric power station Rovinari

The study of pollution of soils in zone of the Rovinari coal-fired power station necessitated an ample analysis of soil properties because these form a complex mantle determined by the diversity of relief, groundwater, rock and parent material conditions.

Soils in the analyzed area represent the classes: Luvisols (Typic and Stagnic Preluvosols, Typic and Stagnic Luvosols), Hydric Sols (Typic Stagnolosols) and Protisols (Typic Regosols, Eutric and Entic Alluviosols, Spolic Entianthrosols) (Florea and Munteanu, 2003).

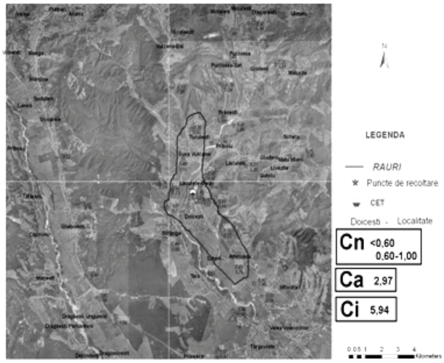

Figure 2. Distribution of exceeding coefficients of the normal maxim content of zinc in the area influenced by the Doiceşti thermo-electric power station

The mean coefficient exceeding the maximum normal contents for zinc, within the power station precinct, is sub-unitary (0.59). At the other distances (Figure 3) the mean of coefficient is over- unitary (between 11.05 and 2.49). The highest values are at 4.5 km (2.49) and 7 km (2.00) far from source.

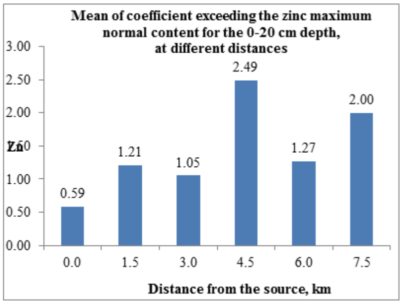

Figure 3. Variation of mean coefficient exceeding the zinc maximum normal content in soils in the zone affected by the influence of emissions coming from the Rovinari thermo-electric power station

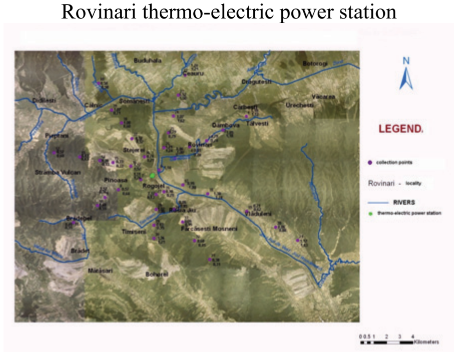

Figure 4. Zinc distribution and location of sites in the thermo-electric power station Rovinari

CONCLUSIONS

The area affected by the Doiceşti thermo-electric power station is located in the Prahova Subcarpations, in the Ialomiţa floodplain wide of 2 km in south part and 1 km north part, respectively.

Pedogenetic factors determined the occurrence of various soils, the most common being Fluvisols, followed by the Eutric Cambisols and Luvisols.

Most soils have a neutral-slightly alkaline reaction, being resistant to pollution with acid contaminants. The soils in the central-eastern area evolved on more acid materials (e.g. the Typical Luvisol site-5 SE).

General formation conditions determined an evident accumulation of small quantities of humus, receiving to some extent organic carbon derived from coal dust, fact illustrated by the C/N ratio, slightly higher than that of normal conditions.

The Doiceşti thermoelectric power station polluted area which extends along the Ialomiţa river south-north direction having as as boundaries Teiş-Săteni, Aninoasa in south; and Brăneşti in north and Glodeni in East. Within the above mentioned territory, soils that are sightly polluted with copper, and moderately-strongly polluted with coal dust and ash, which changed the humus content and texture.

The area of maximum influence of these particulates is located around the Doiceşti thermoelectric power station where the soil particle size distribution are drastically changed on the soil profile.

Self-purification processes are insufficient to ensure the environmental protection. In order to reduce the atmosphere pollution degree, the following recommendations are given:

- to improve the combustion;
- to reduce the sulfur content of fuels and increase the degree of retention of emitted sulfur;
- to increase height of chimneys and improvement of emission conditions;
- to improve capture of pollutants emitted in the form of dust and gas;
- to establish the special protection areas and warning areas.

These measures lead to the reduction or soil mantle contamination or pollution control.

Technologically depleted dumps should be reclaimed especially for forestry, as a measure for the protection of environment and people health.

In the area influenced by the Rovinari thermo-electric power station, some more important aspects have been emphasized.

The Rovinari thermo-electric power station, characterized by installed capacity of 1720 MW, represents a major source of soil pollution, by its sterile dumps provided by surface mining and ash dumps, as well as the gas emissions from the Rovinari thermo-electric power station chimneys, especially, dioxide sulfur emissions, carbon dioxide and nitrogen.

The analyzes show that, according to the coefficients exceeding the normal maximum content, for copper it is found that there are no exceed the alert coefficient.

As regarding the most intensively loaded direction, this is the southern direction, the values due to the wind coming from the northern part, which has a frequency two times higher as compared to the other directions.

REFERENCES

Căpitanu V., Dumitru M., Toti M., Răducu D., Popa D., Motelică M., 1999. Impactul emisiilor termocentralelor asupra mediului ambiant. ICPA Bucureşti.

Cicek A., Koparal A.S., Catak S., Ugur S., 2001. The levels of some heavy metals and nutritional elements in the samples from soils and tree-leaves growing in the vicinity of Seyitomer Thermal Power Plant in Kutahya (Turkey). In: Topcu S., Yardim M.F., Incecik S., (Eds.), Air Quality Management at Urban, Regional and Global Scales, Istanbul, Turkey, p. 157-162.

Dumitru M., 1992. Impactul ploilor acide asupra mediului ambient. În ”Ecologie si protectia mediului”. Călimănesti.

Lăcătuşu R., 1995. Metoda pentru evaluarea nivelului de încărcare şi de poluare a solurilor cu metale grele. Soil Science, Journal of the Romanian National Society of Soil Science, vol. XXIX.

Florea N., Munteanu I., 2003. Sistemul roman de taxonomie al solurilor-SRTS. Bucuresti, Appl. Geochem. 11, p. 25–34.