SULFUR POLLUTION OF SOILS LOCATED INTO THE INFLUENCE AREA OF COAL-FIRED POWER STATION ROVINARI

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Abstract

The coal-fired power stations are particularly complex, important polluting agents. The chimneys for evacuation of burning gases represent the high polluting sources on the environment, while the ash dumps – low sources. The Rovinari coal-fired power stations has an installed power of 1720 MW, including several energetic groups built in 1972-1979 period and it use as a fuel the lignite extracted by surface mining in the respective area.
From the geomorphological viewpoint, this area 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 dealing with the loading degree of soils in the territory affected by the emissions from the Rovinari coal-fired power station. In this, soil samples have been collected from 40 main soil profiles oriented to all the cardinal directions. These soil samples have been analyzed in order to know: pH, base saturation degree, humus, total nitrogen, mobile phosphorus and potassium and sulfur. Within the zone influenced by the Rovinari coal-fired power station, the main pollutants are sulfur dioxide, coal dust and the ash which contains carbon as well as silicon dioxide, aluminium oxides, and alkaline and alkaline earth metals (Ca, Mg, K), pollution which affects the normal contents of soil, on the one hand, and the concentrations in plants and the human health, on the other hand.

Key words: pollution, soil, coal-fired power station

The studied area covers 18000 ha on both sides of the Jiu river. In the center Rogojel is located, in the NW, Câlnic, in the SW, Brădet, and in the SE, Vlăduleni, in the E we have Moi and in the NE, Cîrbeşti.

From the geomorphological point of view this area belongs to Getic Piedmont, and it is bordered to the west by Motrului Piedmont and in the east by Bran Hill, being crossed NW-SE by the Câlnic-Câmpul Mare Depression, which has at Rovinari 150 m altitude.

In order to analyze the effects of the emissions from the coal-fired power station Rovinari and dissipation from the ash dumps, soil samples were collected from 40 sites in eight different directions starting from the coal-fired power station. The sites are 1.5 km away one of each other for each direction, the last being 7.5 km away from the power station

The system allows the analysis of the dispersion of pollutants emited bythe cooling towers or from the ashes dumped into the air. The Rovinari coal-fired power station has an installed power of 1720 MW with several energetic groups developed in 1972-1979 period. The termo electric power station Rovinari are using the lignite as combustible, extracted by the mining industry.

MATERIAL AND METHOD

The carrying out of this work needed field studies for soil sampling and observations on materials representing slopelands and terraces around the Rovinari fired-coal power station. Soil samples have been collected for 0-20 cm and 20-40 cm depths, in several georefferenced sites. The 40 collected soil samples have been collected along the cardinal directions, and the soil samples were analyzed for: pH, base saturation degree, humus, total nitrogen, mobile phosphorus, potassium and sulfur (as SO_4^{2}).

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,

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Forests and Environmental Protection (Order No. 756/1997) have been applied (Lăcătuşu R., 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 (Lăcătuşu R., 2002).

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 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, N., Munteanu, I., 2003).

The analyzed data emphasize that, generally, the sulfur in the Rovinari zone present normal or slight loading, excepting some site where the determined values show high contaminations. The higher values are, generally, due to some particular characteristics of soils met along the eight directions for location of sites, but also due to the reducing of the distance to the power station or due to the location on the Spolic Entianthrosols resulted by the surface mining.

Mean coefficients exceeding the maximum normal contents for sulfur (Figure 1) at different distances show higher values at 1.5 km (1.66) and 7.5 km (1.56) other values being smaller than the site (1.40).

Soluble sulfur content in (**S-SO_4, mg.kg^{-1}**) determined in 0-20 cm layer in the range of normal values-values close to the caution threshold sensitive (112 mg.kg-1-346 mg.kg -1, to 450 mg.kg-1), with the average load indicating weak to moderate. The values are higher at sites 3, 21, 26, 29, 35 and 36, situated at varying distances and different from the directions of CET, namely:

No. sit	Distance and position	Content S-SO_4, mg.kg^{-1}	pH
3	4,5 km NE	337	6,1
21	7,5 km E	329	6,6
26	1,5 km N	321	7,5
29	4,5 km S	302	8,1
35	1,5 km SE	305	7,0
36	1,5 km NE	346	8,4

There is moderate values of S-SO_4 in the sites 26, 35 and 36 located 1.5 km from CET, situated in the directions N, SE and NE, but also from more distant sites 3, 21 and 29 situated at 4.5 km NE, 7.5 km S and E respectively.

In the case site 3, with pH = 6.1 Luvisol typical and V = 82% in the 0-5 cm layer, acidification clearly stands 20-40 cm soil layer at pH 5.5 and V = 66% is relatively normal for this type of soil.

In the case the other sites, with the reaction between 7 and 8.4 high the degree of base saturation determined noxes acids buffering.

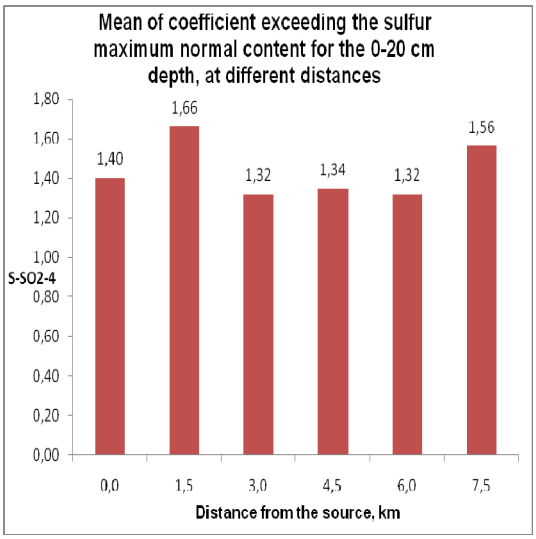

Figura 1 **Variation of mean coefficient exceeding the sulfur maximum normal content in soils in the zone affected by the influence of emissions coming from the Rovinari coal-fired power station**

Mean coefficients exceeding the maximum normal contents at different distances variation least (1.32 to 1.66) compared to site (1.40), remarking though is a slight the maximum site and its vicinity and the second 7,5 km distance.

The directions are comparable variations not exceeding a site is in the no the alert coefficient (2.65).

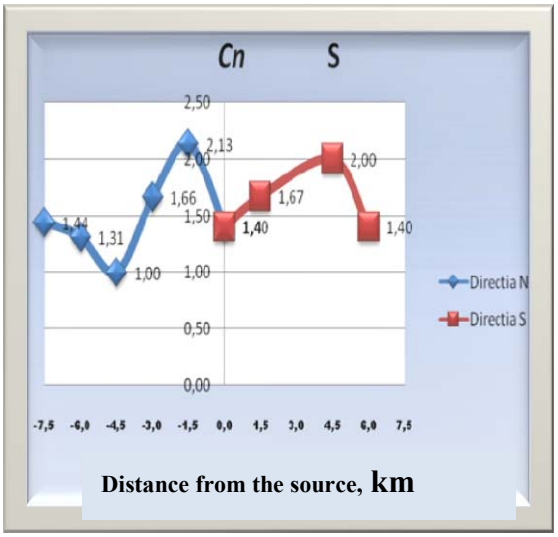

Figure 2 **Variation of coefficients exceeding the maximum normal values of sulfur on the N-S directions**

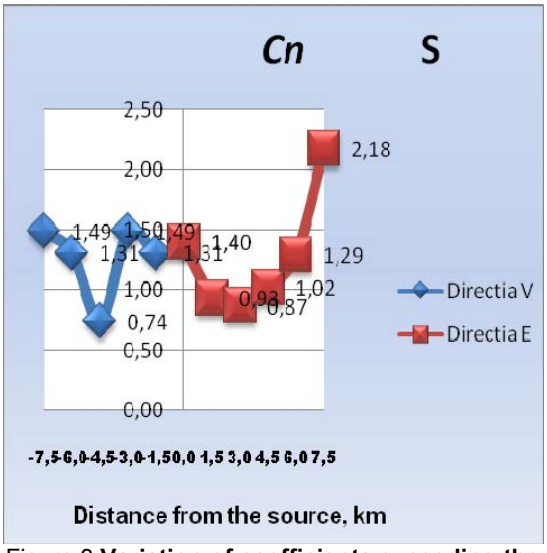

Figure 3 **Variation of coefficients exceeding the maximum normal values of sulfur on the V-E directions**

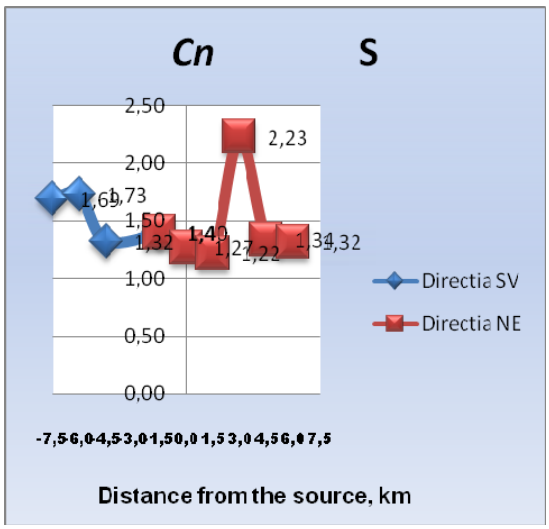

Figure 4 **Variation of coefficients exceeding the maximum normal values of sulfur on the NE-SW directions**

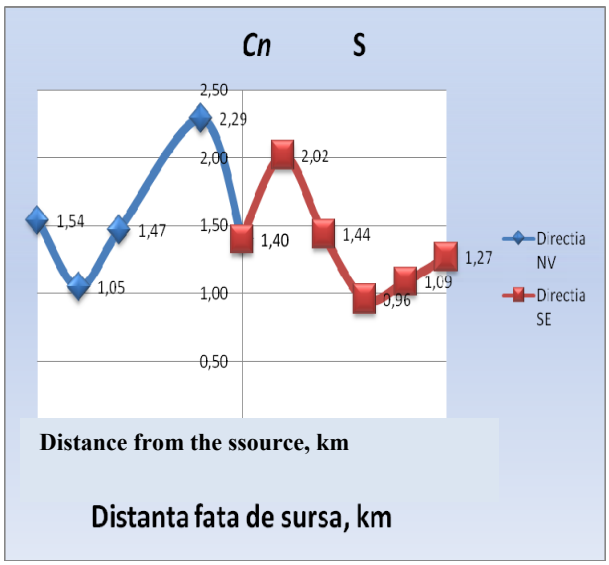

Figure 5 **Variation of coefficients exceeding the maximum normal values of sulfur on the NW-SE directions**

CONCLUSIONS

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

The Rovinari coal-fired 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 coal-fired power station chimneys, especially, dioxide sulfur emissions.

Mean coefficients exceeding the maximum normal contents at different distances variation least (1.32 to 1.66) compared to site (1.40), remarking though is a slight the maximum site and its vicinity and the second 7,5 km distance.

The directions are comparable variations not exceeding a site is in the no the alert coefficient (2.65).

As concerns the pollution of soils caused by the Rovinari coal-fired power station, the following affirmations can be stated: the impact on the soil properties is usually produced in immediate neighborhood of the Rovinari coal-fired power stations; the level of sulfur accumulation and the are of pollution phenomenon extending depend on the age of the coal-fired power stations, installed capacity, technical performances of installation for scrubbing the burning gases, and, finally, the managerial influence; the high capacity coal-fired power stations, like Rovinari, have a great impact on quality of soils, distribution zone of sulfur exceeding 10 km far from the source.

From the viewpoint of the impact of the coal-fired power stations on soils, the following statements should be pointed out:

The energetic sector in Romania is preponderantly ensured by the coal-fired power stations (85%) and less by the primary energy such as hydraulic and nuclear energy. The fuels used indigene coals that have a high content of sulfur, plus some liquid fuels, and gas. Relatively low performance of the energetic sector is caused by the inadequate repairs and maintenances as a result of financing shortage. This sector is one of the branches of the industrial activity potentially generating pollutants.

While the pollution decreases in the last time, especially as a result of the generally decrease of economic activity, the energetic sector, still, remains one of the main source of environmental pollution (and implicitly of soil) with SO_2, NO_x, dust and CO_2.

Besides the economic activity level, the proportion of pollution depends on both the fuel used for producing the electrical and thermic energy and the burning process technology. From this view point, the highly efficient eco-technological systems for burning have a particular importance and can lead to decreasing of the environmental pollution by reducing with about 30% the emissions gases (CO; CO_2; NO_x; SO_X).

The best measure is to prevent the pollution or its decrease. Therefore, it is further necessary to improve, as much as possible, the fuel quality, combustion procedures, sulfur removal technologies, the systems of retaining the dust and noxious substances, to improve the ash transport and deposition. Periodically, an analysis on the coal introduced in the technological process should be made to know the composition and to avoid the maximum potential risk and the element nature.

Also, in this context, the following recommendation could be made: Further monitoring within the area under the influence of coal-fire power station and establishing some sensitive site "sensor sites" to depict in real time the eventual negative evolutions; Further execution of works and studies for development of finished dumps, especially, by their use for forestry or edilitary purposes (recreational parks, lots for parking vehicles, etc.), but also for reclaiming the affected lands and increasing the soil fertility aiming at their as high efficient valuation as possible; In the case of using the dumps for agricultural production, it should be avoided their use for orchards, vegetables and forage plants; under such uses, the soil reaction should be maintained by liming to reduce the solubility of heavy metals, and if the irrigation is applied, the sprinkler irrigation is recommended (to wash the leaves) (Căpitanu V., et al., 1999).

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