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HEAVY METALS IN THE SOILS FROM SOME REGIONS OF THE LUBLIN PROVINCE

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A b s t r a c t. In the study, the content of heavy metals such as Pb, Cd, Ni, Cu, Zn and Mn in the soils collected from various regions of the Lublin Voivodeship was examined. The examined soils were light medium soils. Content of individual elements was determined by the AAS method in the extracts of 1 M HCl. The analysed soils were poor in copper and manganese. Their concentration and the concentration of lead, cadmium and nickel was in the lower realms of the range natural for light soils formed from sands. Only the content of zinc was fairly high in the above soils, frequently as high as the first degree of contamination.

K e y w o r d s: heavy metals, soil, natural content, Lublin region.

INTRODUCTION

A map of the world soils degradation published by UNEP/ISRIC [9] in 1990 presents the area of Poland as heavily degraded. Spread of public knowledge of this information brought fairly serious economic consequences such as constraints in the sale of Polish farm products on the foreign markets.

A significant criterion for the evaluation of soil ecological state is heavy metals content [1,3,5,7,8].

Imission of heavy metals into cultivated soils is related mainly to such elements as cadmium, lead, nickel, zinc and copper [1,6]. Heavy metals uptake by plants and their transportation rate into the trophic chain of soil-plant-man depends on many factors. Soil and fertilizers are of high priority on the list of these factors [1,3,7]. Phytoavailability of heavy metals is not related to their total content in soil as much as to the quantity of their active forms [2]. Numerous solutions are used to form extractions of active forms [2]. In this study, 1 M HCl was applied to perform metal extraction.

The Lublin Voivodeship covers the areas of central-eastern Poland and includes the regions of Parczew, Chełm, Zamość. These are typical, agricultural areas with a high degree of industrialisation. In this area, emitters located in Belorussia or Ukraine can potentially be the source of environmental pollution. The Metallurgical Plant "Ursus" in Lublin, car factory "Daewoo", heating-electric power stations as well as other industrial plants located in the centre of the region can be listed as emitters of pollutants.

MATERIAL AND METHODS

In middle of the 90-ties, in the Institute of Soil Science and Plant Cultivation (IUNG), Puławy, natural and toxic levels of heavy metals and sulphur content were determined for the soils of Poland. The concept of soil classification according to the level of their pollution was worked out [5,7,8]. In the present research, one experimental spot represented the area of about 400 ha. In order to learn on the variability in soil contamination with heavy metals in the Lublin Province, especially at the eastern border, research work was initiated in the Agricultural University in Lublin in 1994-1995. During the experiment, 50 soil samples were collected from potato fields in autumn. Plantations were situated on the light soil formed from clayey sands of the Parczew district as well as on the medium soils formed from sands or loess in the districts of Chełm and Zamość and in the central part of the Lublin Province (Fig. 1). The soil samples were collected from the ploughing layer of 0-2 cm. The soil samples were then averaged, screened and dried, then extracted with 1 M HCl with the proportion of soil : solution of 1:10 [2]. The content of Cu, Zn and Mn was determined by the AAS method directly in this solution. After APDC was complexed and transfered to the MIBK organic phase, the contents of Pb, Cd and Ni were determined.

RESULTS

The content of copper, soluble in 1 M KCl, in the examined soils changed from 1.6-8.6 mg/kg soil (Table 1). Exceptionally little copper was found in the soil samples from the Parczew district (2.3 mg/kg, on the average). Higher copper concentrations (7.8-8.6 mg/kg) were found in a part of soil samples from Jakubowice and Abramów near Lublin and Horyszowa in the Zamość district (Fig. 2).

The content of manganese in the soils of the Lublin Province varied from 8.2 to 36.9 mg/kg soil (Table 1). Low contents of manganese was characteristic of the

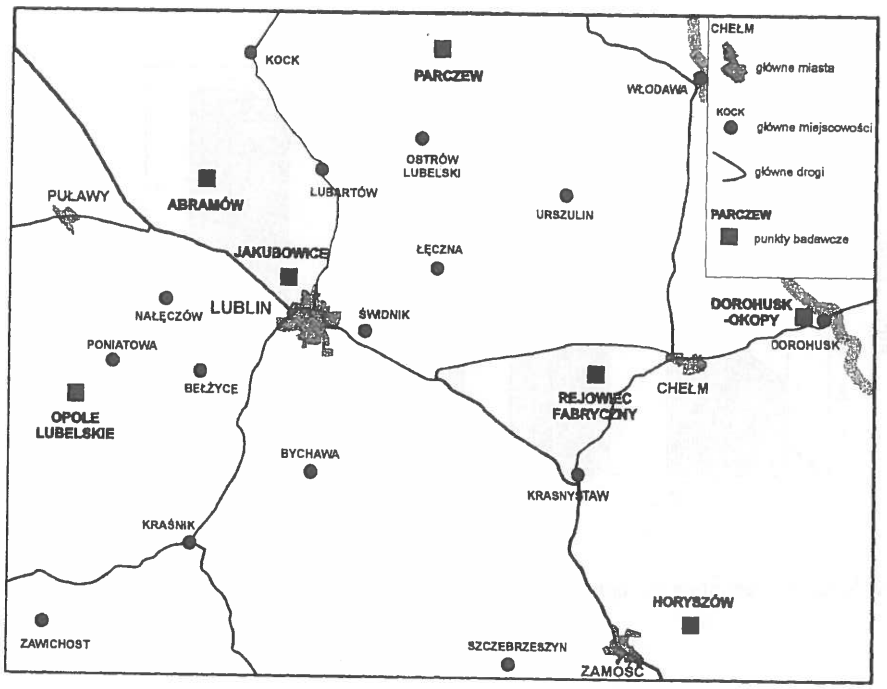

Fig. 1. Distribution of the experimental points in the region.

Table 1. Copper, manganese, zinc, lead, cadmium and nickel content in the soils of Lublin Province (mg/kg)

District	Cu	Mn	Zn	Pb	Cd	Ni
Parczew	1.9-2.2	11.9-14.7	53.9-77.8	5.70-8.60	0.08-0.11	0.052-1.25
Chełm	1.6-5.8	8.2-31.4	46.9-118.5	2.62-10.72	0.04-0.16	0.44-1.86
Lublin	2.6-7.8	25.1-36.9	36.1-101.1	1.53-12.35	0.06-0.13	0.60-2.96
Zamość	4.1-8.6	18.3-33.5	53.3-82.2	1.35-12.86	0.06-0.14	2.07-3.56
$\bar{x}$	1.6-8.6	8.2-36.9	36.1-118.5	1.35-12.86	0.04-0.16	0.44-3.56

Parczew (11.9-14.7 mg/kg) and Chełm soils (8.2-16.1 mg/kg). Only in the soil from the two experimental points in the Chełm district, from the fields of Okopy in the vicinity of the Ukrainian border, the content of manganese was slightly higher: 18.7-34.0 mg/kg. The medium soils from the Lublin and Zamość regions had Mn content of 18.7-36.9 mg/kg soil (Fig. 3).

The zinc content in the examined soils was the highest among all the determined elements, i.e. 36.1-118.5 mg/kg soil (Table 1). The mean content of this element was higher than described by Dębowski and Kucharzewski [1] in the soils

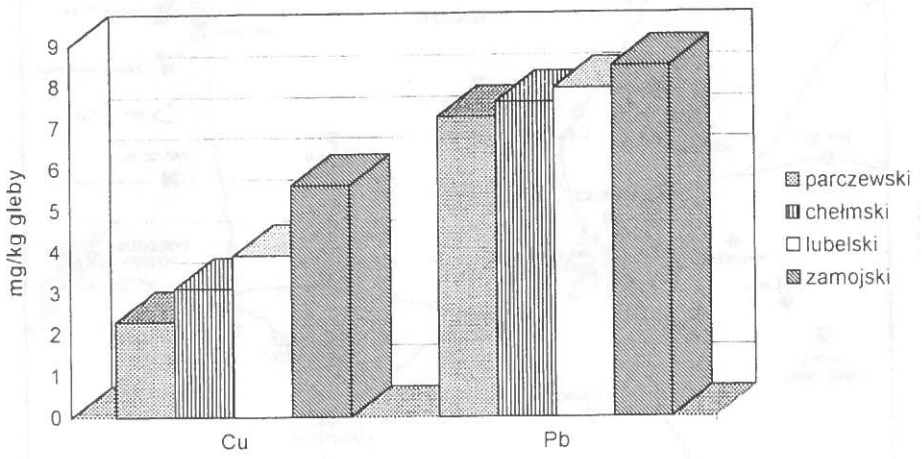

Fig. 2. Mean concentration of copper and lead in the soils of the Lublin Province (mg/kg soil).

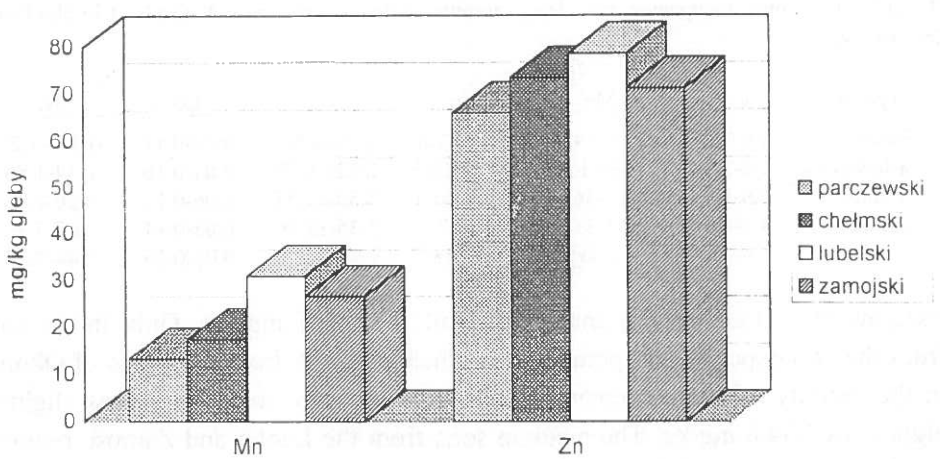

Fig. 3. Mean concentration of manganese and zinc in the soils of the Lublin Province (mg/kg soil).

of the Legnica and Wrocław Provinces. No significant regional soil differentiation in the zinc content was observed. The soils of the agricultural border regions and the regions with more developed industry in the central parts of the province contained similar quantities of zinc (Fig. 3). Only the soil of the Okopy in the Chełm region may be numbered among the soils with the primary degree of pollution [7].

Lead content in the examined soils varied from 1.35-12.86 mg/kg (Table 1). Its mean content in the soils from different regions may be presented in the following sequence: Parczew<Chełm<Lublin<Zamość (Fig. 2).

The content of cadmium soluble in 1 M HCl in the soils of the Lublin Province varied from 0.04-0.16 mg/kg (Table 1). Irrespective of the place of sampling, its concentration in these soils was much similar (Fig. 4).

Nickel content in the soils of the Lublin Province varied from 0.44 to 3.56 mg/kg soil (Table 2). The least nickel was found in the Parczew soils (0.85 mg/kg, on the average); less than in the regions of Chełm, Lublin and Zamość (2.72 mg/kg, on the average) (Fig. 5).

DISCUSSION

In all the examined soils, copper content was at the level assumed by Kabata [3] and Terelak *et al.* [7] as natural for the soils of Poland. The range of variability in the total copper content stated by Terelak *et al.* [7] was 0.2-29.3 mg/kg soil, and its mean content was 6.7 mg/kg. According to Kabata-Pendias and Pendias [4], Polish sandy soils contain 1-26 mg of this element per kg of soil, and its mean content is 8.3 mg/kg. Thus, the examined soils in the Lublin Province may be considered as poor in copper. Significantly higher concentrations of this element were found by Dębowski and Kucharzewski [1] in the soils of the Lower Silesia and by Rostanski [6] in the soils of the Upper Silesia.

On the basis of the threshold values for the Polish light and medium soils [3-5], the examined soils of the Lublin Province may be considered as poor, or, at the most, of medium abundance in manganese. According to Terelak *et al.* [7], low content of this element for light soils does not exceed 21 mg/kg soil, and for the medium soils - 28 mg/kg [3,5].

Kabata-Pendias and Pendias [4] stated that the natural zinc content should exceed the value of 40 mg/kg soil in the soils of Poland. However, Terelak *et al.* [7] were of the opinion that in Polish soils formed from natural sands, the content of zinc does not exceed 30 mg/kg soil. Although in the soils of the Lublin Province such values were even twice as high, yet in most of the tests, they did not exceed

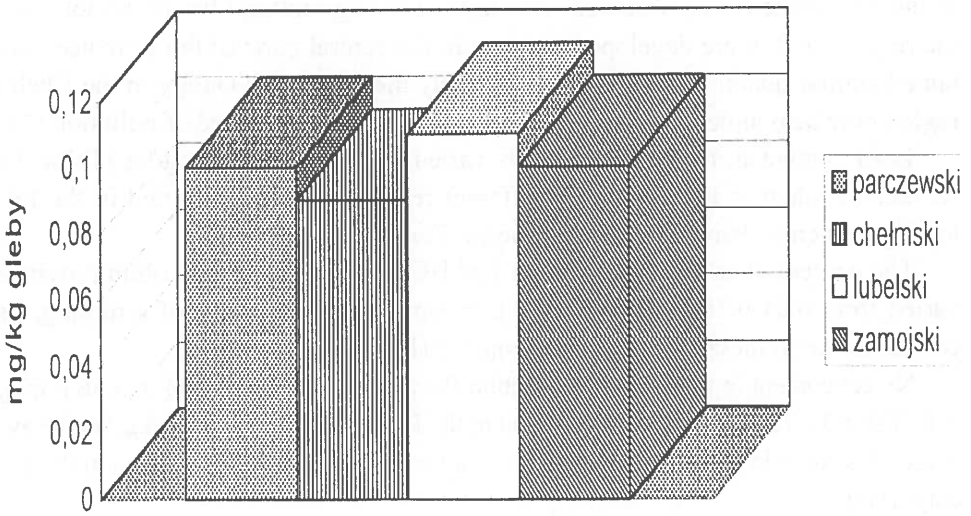

Fig. 4. Mean concentration of cadmium in the soils of the Lublin Province (mg/kg soil).

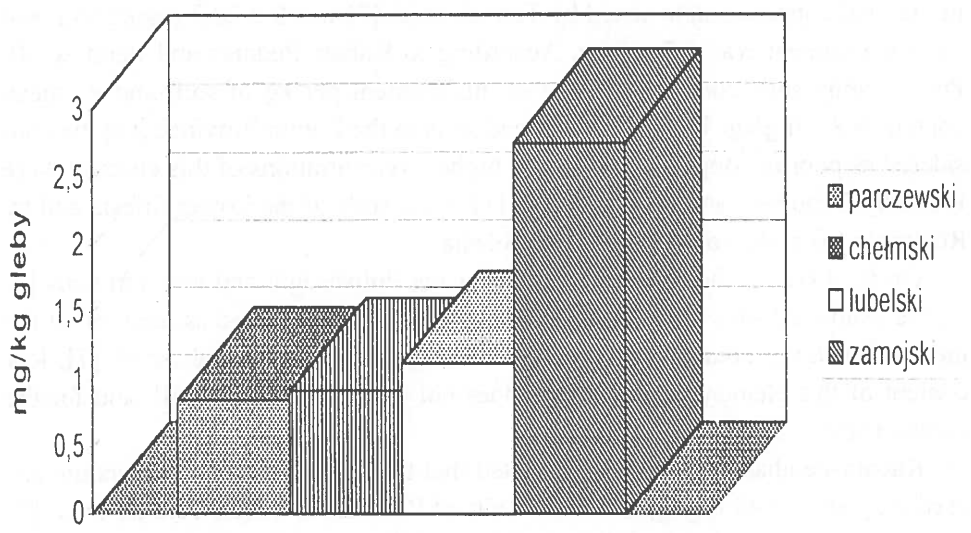

Fig. 5. Mean concentration of nickel in the soils of the Lublin Province (mg/kg soil).

the range proposed by Terelak *et al.* [7] as permissible (100 mg/kg) for the soils with zero pollution level. In the studies by the presnt authors, the values corresponding the first level of contamination (above 100 mg/kg soil) were found only in some samples coming from the region of Chełm and the central part of the province.

Majority of the analysed soils was characterised by the lead content considered by some authors as natural for the soils of Poland [3-5,7], and did not even exceed the mean value (13.8 mg/kg) considered natural for Poland. Kabata-Pendias [3,4] described the range of up to 50 mg of lead for the light soils as a natural content. Terelak *et al.* [7], having examined 15.000 soil samples, determined this value for 70 mg/kg and permissible for the unpolluted soils of Poland. The level of cadmium in the unpolluted light cultivated soils quoted by Kabata-Pendias [3-5] is up to 0.5 mg/kg soil. According to Terelak *et al.* [7], the anticipated range of the total cadmium content variability in the soils is 0.05-1.07 mg/kg, and for the soils with zero contamination, the level may reach even 1 mg/kg soil. The soils examined in this study were characterised by a very low concentration of cadmium (0.10 mg/kg, on the average).

Piotrowska and Terelak [8] as well as Terelak *et al.* [7], when examining various soils of Poland, observed that the total nickel content changed greatly from 0.1 to 173.2 mg/kg soil. The authors determined the mean nickel content for the soils with zero pollution as 6.3 mg/kg soil. Such a degree of pollution with nickel is found in as much as 94.5% of the Polish soils [7,8]. The examined soils ought to be numbered also as unpolluted with nickel.

According to Terelak *et al.* [7], the share of soils with zero pollution level with heavy metals in the studied region was, respectively, 92.6% in the Lublin district, 93.7% in the districts of Biała Podlaska and Parczew, 96.11 % near Zamość and 97.63% in the vicinity of Chełm.

CONCLUSIONS

The analysed samples of the light and medium soils from the border regions of the central-eastern part of the Lublin Province were characterised by:

1. Zero level of pollution with copper, manganese, cadmium and lead.
2. The pollution level of the majority of the examined soils with zinc was also zero. Only a part of the soils from the Chełm district and the central part of the Lublin district showed the first degree of contamination with zinc.

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