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INFLUENCE OF TRANSPORT ON CADMIUM, LEAD AND ARSENIC CONTENT IN SOIL

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K e y w o r d s: heavy metals, soil, motorization, traffic.

A b s t r a c t

The purpose of the study was showed the transport effect on cadmium, lead and arsenic content in soil. The research was carried out in Morąg city in the places with high traffic intensity near garden plots, agricultural areas, wasteland and birchen woodland and at different distance from the route, and near Skiertąg lake situated with a long way to roads. There were analyzed pH, granulometric composition and humus, cadmium, lead and arsenic content in soil. It was showed the lead pollution of soil near the busy roads. Moreover, there was more cadmium content, but in the acceptable level.

WPŁYW KOMUNIKACJI NA ZAWARTOŚĆ W GLEBIE KADMU, OŁOWIU I ARSENU

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S ł o w a k l u c z o w e: metale ciężkie, gleba, motoryzacja, natężenie ruchu.

A b s t r a k t

Celem przeprowadzonych badań było określenie wpływu ruchu komunikacyjnego na zawartość kadmu, ołowiu i arsenu w glebie. Przeanalizowano punkty o dużym natężeniu ruchu samochodowego w Morągu. Uwzględniono tereny ogródków działkowych, gruntów użytkowanych rolniczo, nieużytku i młodnika brzozowego znajdujących się w różnej odległości od tras komunikacyjnych oraz położoną w dalszej odległości od dróg okolicę jeziora Skiertąg. Program badawczy obejmował analizę gleb z uwzględnieniem pH, składu granulometrycznego oraz zawartości próchnicy, kadmu ołowiu i arsenu. Stwierdzono, że w pobliżu ruchliwych tras komunikacyjnych gleba była zanieczyszczona ołowiem. W glebie było również więcej kadmu, ale w ilościach nieprzekraczających dopuszczalnych norm.

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Introduction

The estimate of the different factors and processes which influence on soil quality is one of the leading and still topical problem. The physical, chemical or biological soil properties changes for the worse can decide not only about fertility decreased but even about total production excluding. The factors responsible for the degradation of the soil environment include an excessive cumulation of heave metals. They occur as natural component in nature, but belong to particularly dangerous elements, which create a potential risk to the biological environment and decide about human health (CURZYDŁO 1995, ZIMDAHL, SKOGERBOE 1997, GORLACH, GAMBUŚ 2000, BIELIŃSKA 2005, AELION et al. 2009, DOMSKA, WARECHOWSKA 2009). The elements with a very high risk degree counted among others cadmium, lead, copper and zinc, and those of a medium risk degree – arsenic. Mainly, in this problem, the attention is to heavy metals content in the surface area of soil (BIERNACKA, MAŁUSZYŃSKI 2007, NIEDŹWIECKI et al. 2007).

The soil pollution of heavy metals is showing on town areas with the high urbanization degree, near the industrial factories and the communication roads (CURZYDŁO 1995, GAŁKA, SZERSZEŃ 1996, INDEKA, KARACZUN 1999, WIATER 1999, STEINER et al. 2007, CHRISTOFORIDIS, STAMATIS 2009). In this case, the most changes of soil are as effect of human activity, while the natural factors (matrix, climate, landform features) have secondary importance (OLEŚKÓW 2007).

The purpose of our investigation was determination of cadmium, lead and arsenic content in soil area adjacent to the busy route of the Morąg town.

Experimental Procedures

The investigation was carried out in 2007 in the Morąg town near the communication roads with intensity the road traffic (Figure 1). The study sites were on the area of town allotments (sites 1 and 2), cultivated field (sites 3–5), waste land (site 6), birchen woodland (sites 7 and 8) and near Skiertąg Lake (site 9).

Soil was sampled from the surface soil layer about 2 m by the diagonally method and, near the communication road at the distance of 20 and 250 m (sites 1 and 2) and 20, 250 and 500 m (sites 3–5 and 6–8). In mean soil samples (formed by mixing 10 individual samples), the granulometric composition was determined by areometric Bouyoucos method modified by Cassagrande and Prószyński, pH – electrometrically in 1 mol dm^{-3} KCl, the humus content – according to Tiurin, and the contents of cadmium, lead and arsenic

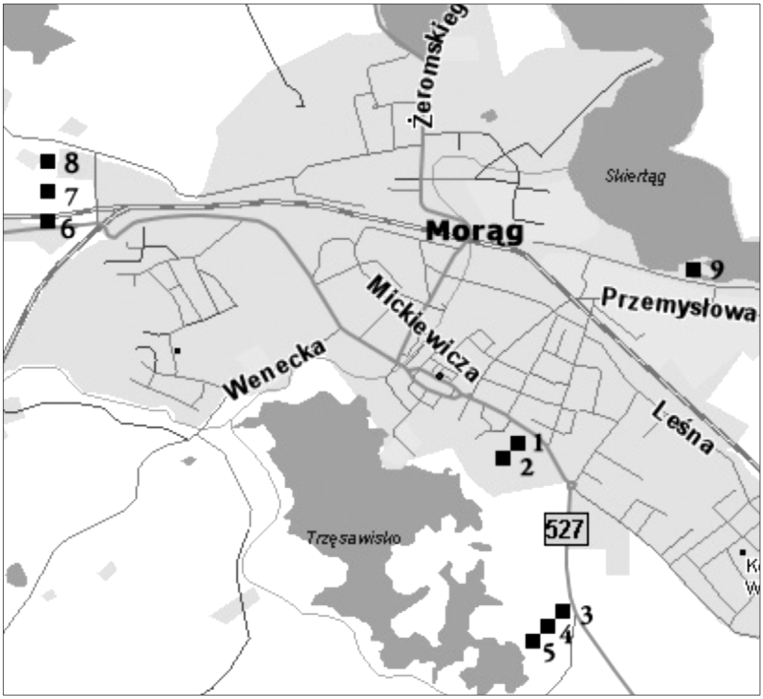

Fig. 1. The research stands: 1, 2 – garden plots, 3, 4, 5 – agricultural area, 6 – wasteland, 7, 8 – birchen woodland, 9 – near Skiertąg Lake

– with the atomic absorption spectrometry technology after a sample mineralization using nitric and hydrochloric acid.

The significance of variations has been calculated using the Tuckey's test, at the level of $p = 0.05$.

Discussion of Results

It has been found out that the study soil samples were not too much different with acidity, which was from pH of 6.5 to 7.0 (Table 1). The soil with a good agricultural fertility was only in an allotment with light loam granulometric composition and with the largest humus content (sites 1 and 2) and soil of cultivated field with strong loamy sand granulometric composition and with lower humus content(sites 3–5). The rest of soils were worse, with granulometric composition of light loamy sand and with small humus content.

Table 1

Some physical and chemical soil properties

Research stands	Granulometric composition	Acidity [1 mol dm^{-3} KCl]	Humus [%]
1	light loam	7.0	0.5
2	light loam	7.0	0.5
3	strong loamy sand	7.0	0.3
4	strong loamy sand	6.5	0.3
5	strong loamy sand	7.0	0.3
6	light loamy sand	6.5	0.2
7	light loamy sand	6.5	0.1
8	light loamy sand	7.0	0.1
9	light loamy sand	6.5	0.2

1, 2 – garden plots, 3, 4, 5 – agricultural area, 6 – wasteland, 7, 8 – birchen woodland, 9 – near Skiertąg Lake

The physical and chemical properties of the study soils, as well as acidity, granulometric composition and humus content, like to BIENIEK (2005) studies, was not favourable for excessive cumulation of heavy metals. However, some authors (BIELIŃSKA 2005) was not showed relation between organic carbon content and granulometric composition with heavy metals content but others (MEDYŃSKA, KABAŁA 2007) think that humus show high abilities of heavy metals absorption, which makes difficult to wash them out of the soil. A high mobility of heavy metals is in the condition of acid acidity and, the soil graining typical of sands and sandy loam indicates a possibility of an occurrence of water permeability and easy migration of pollutions into the soil profile (GORLACH, GAMBUŚ 1992, GONG, DONAHOE 1997).

The cadmium content in the Polish soils amounts from 0.01 to 24.75 mg kg^{-1} s.m., average 0.22 mg kg^{-1}, while the standard norm in the surface soils is from 1 to 3 mg kg^{-1} s.m. (TERELAK et al. 1995).

In the area of study soils the content of cadmium was in natural norm (0^{o}) from 0.09 to 0.81 mg kg^{-1} s.m. (Table 2) of lower standard norms of soil quality (regulation of the Minister of Environment 2002), in amount not higher than acceptability limited content (CZARNOWSKA, BORUCKI 1996). The higher cadmium content was directly near the road to the Olsztyn in soil of the arable areas (site 3). A half lower cadmium content in soil was in a long way from the road (sites 4 and 5), in soil of an allotments (sites 1 and 2) and in soil of wasteland near the approach route to the E7 country road (site 6) depend to a small cadmium content (0.09–0.13 mg kg^{-1}) in soil near this route, but at a longer distance in the birchen woodland and in place with the most distance from the communication roads (near Skiertąg Lake). The obtained results were not showed the clear influence of the communication activity on cadmium content in soil. However, OLEŚKÓW (2007) in the study on an allotments area of the Wrocław has been showed high cadmium content in degree from I to V, not only near communication roads, but also near big industrial plants. By some authors (MEINHARDT 1995), the most source of soil cadmium pollution is the dusts emission from a mill of non-iron metals and dusts from a smelter wastes curried out by the wind. The cadmium content in soil higher than natural values can be also connected with properties of the geological base, applying of the sewage deposits, the higher phosphorus fertilization or as effect the town dumps with industrial and energetic wastes, the remains of paints and lacquers (DOMSKA, WARECHOWSKA 2009).

Table 2

Cadmium, lead and arsenic content in soil (mg kg^{-1} s.m.)

Research stands	Cd	Pb	As
1	0.42	25.0	1.51
2	0.40	15.0	1.44
3	0.81	45.0	1.31
4	0.40	20.0	1.48
5	0.42	10.0	1.60
6	0.39	30.0	1.61
7	0.09	40.0	1.59
8	0.13	25.0	1.51
9	0.12	20.0	1.54
NIR; LSD$_{p\,=\,0.05}$	0.03	0.08	0.07

* see Table 1

The lead content in the Polish soils amounts from 0.1 to 992.5 mg kg^{-1} s.m. and generally it depend on the mineral and granulometric composition and on the origin of base rocks. The lead availability also depends on soil acidity and in lower degree on humus and sorption properties of soil (TERELAK et al. 1995).

The lead content in the surface soil level of the study area was higher than in GAŁKA and SZERSZEŃ study (1996) of Oleśnica area and it was from 10.06 to 45.05 mg kg^{-1} s.m. (Table 2). In the most cases there was not higher content than limit norm of 40 mg kg^{-1} (TERELAK et al. 1995). The lead content, highest than limit norm, was in soil directly near the busy communication road to Olsztyn (site 3). Similarly, the others authors (GAŁKA, SZERSZEŃ 1996, INDEKA, KARACZUN 1999) have been showed, that the most lead content is near the communication route and it is smaller together from the roadway distance.

The own investigations carried in Morąg were showed the higher lead content, a little lower than the limit norm and near limit norm (30.02 and 40.00 mg kg^{-1}) was near the route to the E7 country road at the distance of 20 and 250 m (sites 6 and 7). By CZARNOWSKA and BORUCKI (1996) in the soils with low pollution, the lead content is from 20 to 50 mg kg^{-1}, so it can found, that in the own study experiments, only in two cases (sites 2 and 5), the soils was not polluted with lead. OLEŚKÓW (2007) has been showed the communication influence on the heavy metals pollution of soils in the study of the Wrocław vicinity and, there was average 70% of lead pollution from I to III scale degree. In the investigation of LASKOWSKI and TOŁOCZKO (1995), near the agglomerations of urbanized and industrial area was showed that lead concentration more depend on kind of the base rock, the granulometric composition or the organic substance content than on the location of the sites research in the land. However, the authors was showed that even a low content of heavy metals can be dangerous with the high soil acidity because it connected with the high participation of the available forms in total content of heavy metals.

The arsenic is element very popular in the environment. It is used in various industry branches and in agriculture as a component of pesticides, moreover is in small amounts in the all food agents (PLAK 2007, DOMSKA, WARECHOWSKA 2009). The anthropogenic sources of arsenic can be from pesticides with arsenic content and also from agents used for wood conservation or paints and lacquers production, but the most dangerous is non-ferrous metallurgy, particularly copper metallurgy and solid and liquid fuel burning (PLAK 2007). In the soil arsenic is absorbed by organic substances, ferric oxides, aluminum hydroxides and manganese compounds, and its content is highly variable and ranges from 0.1 to 95 mg kg^{-1}. The arsenic content is higher in clayey soils and soils rich in organic components, ferric, aluminum and phosphorus compounds, and in the region of the metallurgic and chemical industry, and in large urban agglomeration its concentration in soil can reach the values of as much as 2500 mg kg^{-1} (KABATA-PENDIAS, PENDIAS 1999 by PLAK 2007). The dissolvability of lead in soil and also fhyto-assimilability of its can be depended on the competitive ions content, for instance phosphate ions or iron salts (GULZ et al. 2005).

The arsenic content in soil of the Morąg select area was very low from 1.31 to 1.61 mg kg^{-1} (Table 2). These values were in the range of the acceptable standard norm not more than 20 mg kg^{-1} s.m. arsenic content (PLAK 2007). In the MEINHARDT (1995) study which has been conducted on the Wrocław province and in the Wrocław town was polluted of heavy metals, and also arsenic pollution of soils with the similar granulometric composition (light loamy sand), but with larger humus content (from 2.1 to 4.9%), directly near industrial factors, communication routes and sewage deposits (the Czechnica

Heat and Power Station and slag heap of the Siechnice Mill). Next, SZERSZEŃ et al. (1996) was showed a big influence of wastes on arsenic content in soil the Legnica province, when near of these there was until 29.8 mg kg^{-1} s.m. of its.

Conclusion

1. There was showed that soil located in the direct distance of the busy communication routes (to Olsztyn and E7 country road) in the Morąg town was polluted with lead.
2. In the soil near the study communication routes was also more cadmium content, but in this case, it was not higher than acceptable of standard norms and law regulations.
3. There was not observed of the communication routes influence on arsenic content in soil of the study area.

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