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[1]**Olga Shtyka,** Postgraduate
[2]**Tetiana Bilyk,** Assoc. Prof.

INVESTIGATION OF HEAVY METALS CONCENTRATION IN SOILS IN FORMER AIRPORT ZONE

National Aviation University
[1]E-mail: Olga_Shtyka@gmail.com
[2]E-mail: larus_2010@ukr.net

The problem of soil contamination in the zone of former airport is currently the object of considerable attention in present publication. Received results of investigation concern heavy metals concentrations in soils were analyzed. Thus level of territory contamination is considered to be moderate due to defining zonal pollution of soils with heavy metals as Pb, Cd and Cu.

Keywords: airport, heavy metals, soil pollution.

Розглянуто проблему забруднення ґрунтів на території, що раніше використовувалася для потреб авіаційного транспорту. Наведено результати оцінки вмісту важких металів у ґрунтах. Виявлено зональне забруднення ґрунтів важкими металами Pb, Cd, Cu. Території віднесено до помірно забруднених.

Ключові слова: аеропорт, забруднення ґрунтів, важкі метали.

Introduction

In the environment soil serves as one of the repositories of various anthropogenic contaminators of which pesticides, oil products and heavy metals etc. Last time the problem of significant accumulation of heavy metals in soils becomes relatively serious and more widespread in the near future [1].

Heavy metals are introduced into ecosystems as a consequence of urbanization and different industrial processes, aviation transport industry is not exception. Metals are able to penetrate into the soils due to carrying out different technological processes in the zone of airport or other enterprises of aviation industry. Nevertheless the system of heavy metals concentration control in soils is not function completely. Again a great deal of airports is closed and ecological situation of such territory has not still defined.

Thus it is necessity to make assessment of heavy metals accumulation in soils on the territory of former airports to estimate possibility of territory reusing.

The researches and publications analysis

The problem of soils contamination with heavy metals is examined in a set of recent publications.

Mainly accumulation of previously mentioned pollutants at roadside environments has been studied [1; 2; 3]. The ecological state of urbanozems in the industrial cities and levels of their contamination with metals are reviewed [4; 5; 6; 7; 8]. Thus in some cases soils ambient roads with intensive traffic have almost the same concentration of pollutants as soils in the industrial regions [1; 2; 4].

Information concerning a complex soils contamination assessment under anthropogenic load with different intensity is also represented [9].

The influence of heavy metals on soil biological and chemical properties was revealed in some works [10; 11; 12]. It was defined that pollutants are able to cause slowing of growth and reproduction speed of microorganisms in the soil, decreasing of biological activity and prevailing of microorganisms with higher resistance to heavy metals [10]. In other publication *Streptomyces* resistance to the different levels of anthropogenic contamination with Mn, Cu, Zn and Co was studied [12]. Thus in general the aspect of soils contamination with heavy metals within industrial and urbanized regions and its influence on the environment (deterioration of soils quality, depression of microorganisms development and vegetation cover etc.) is researched actively in framework of different scientific projects.

The results of the present study demonstrate that the physical and geochemical characteristics of soils in the zone of former airport have been investigated and represented [13].

Whereas the problem of soil contamination with heavy metals in the zone of former airport is not completely researched and examined in scientific publications.

Purpose

Therefore the investigation work focuses on estimation of soils contamination with heavy metals in the zone of airport with the purpose to elaborate further a technology for territory remediation.

Characteristic of investigated object

The object of investigation is soils in the zone of former airport (farther – airport). The subject is heavy metals concentrations in the soils.

The airport is situated in Khmelnyzkyj region, in the moderately continental climatic zone with mild winter and warm summer (average annual temperature is 6.8–7.3°C). The northwesterly and northeasterly wind directions are dominant during year. Annual amount of precipitation is enough (530–670 mm).

The territory of former airport borders closely with agricultural areas and residential zone (20 m), moreover, is situated near the railway station and the national highway.

A great deal of the territory (near 92 %) is covered with herbs mostly weeds, other is under bituminous concrete cover.

Soils of territory is classified as typical chernozem, the soil texture is heavy loam. The level of pH is close to neutral and equals 6.9, nevertheless, zones with pH 5.94–6.00 (slightly acidic) were also defined. Humus contain equates to 4.6 % in average. Nitrogen contain in soils of territory is approximately 145 mg kg^{-1}.

Heavy metals contain assessment in soils

The territory of airport was divided into 46 similar regions. The topsoil samples (0–20 cm) were taken at various locations within the airport zone in accordance with DSTU 4287:2004 [14].

The analyzed metals were Cd, Pb, Co, Zn, Mn and Cu in accordance with adopted standards [15; 16; 17; 18; 19].

The collected soil samples were air-dried and sieved to separate coarse impurities as plants roots, nucleus etc. Then well-mixed soil batches of 10 g each were dissolved with ammonium-acetate buffer solution (pH 4,8). The next stage was shaking of prepared mixture on rotator with subsequent filtration.

Concentrations of heavy metals in each fraction were estimated in prepared extracts by Atomic Absorption Spectrophotometry (AAS).

Quality assurance is guaranteed through double measurements of tree replications. It was used the blanks as a control for correction of background and other possible sources of error.

Statistical proceeding of received data was fulfilled with program Microsoft Excel.

The results of research and discussion

The received results concern these metals concentrations in the soils of the airport zone indicated that territory should be considered to be uncontaminated with Zn and Co and moderately contaminated with Cd, Cu and Pb.

The average concentration of Zn is 0.3 mg kg^{-1} Dry Weight (DW) and ranged between 0.10–0.78 mg kg^{-1} DW (see figure, *a*). The value is considered as relatively very low in comparison with even Maximum Permissible Concentration (MPC) that is equal to 23 mg kg^{-1} DW respectively.

Cobalt concentration ranged between 0.54–1.40 mg kg^{-1} DW (see figure, *b*). The level of pollution with Co is not exceeded MPC (5 mg kg^{-1} DW).

The values of these heavy metals are found within the certain limits there are not sharp deviations.

The concentration of Cu ranged between 0.10–0.24 mg kg^{-1} DW (if samples with exceeded MPC are excluded) and average contain of heavy metal is 0.87 mg kg^{-1} DW (all samples are included).

The values are within the narrow region excepting a set of samples in which Cu concentration exceeds MPC (3 mg kg^{-1} DW) in soils (see figure, *c*).

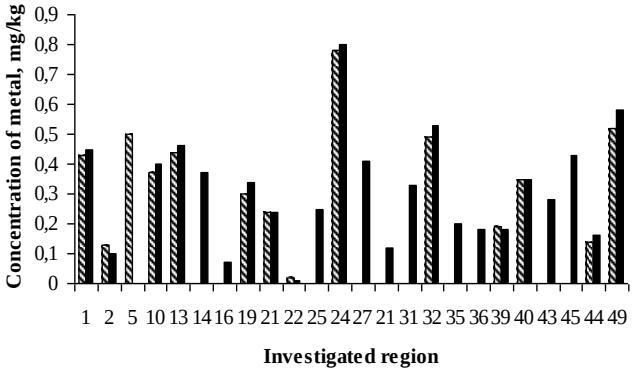
Thus contamination of soils on the airport territory has zonal character.

Average concentration of Cd is 0.21 mg kg^{-1} DW it does not exceed defined norms (MPC is 0.7 mg kg^{-1} DW). The values of concentrations are very different and located in relatively wide range 0.04–0.77 mg kg^{-1} DW (see figure, *d*).

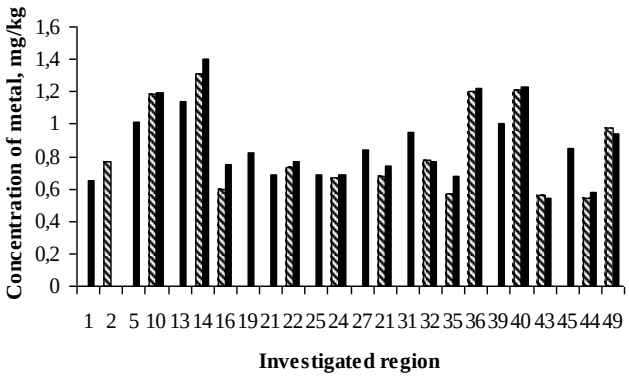
Thus there is the great variation of data. It is observed surplus of Cd concentration in some samples of soil.

Adequately contamination of soils with Cd as in the case with Cu has zonal character on the territory of airport.

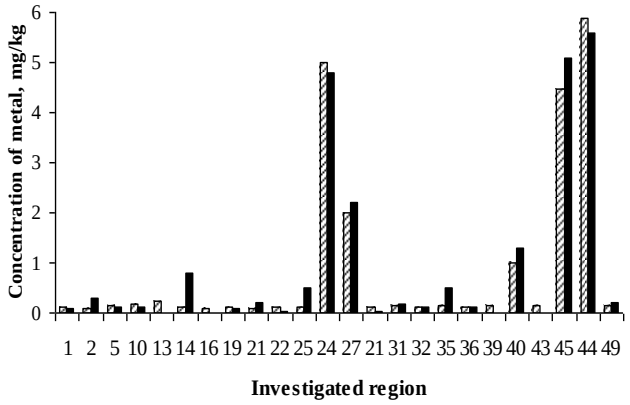
The values of Pb concentrations vary and are in the range 0.15–2.11 mg kg^{-1} DW (see figure, *e*).



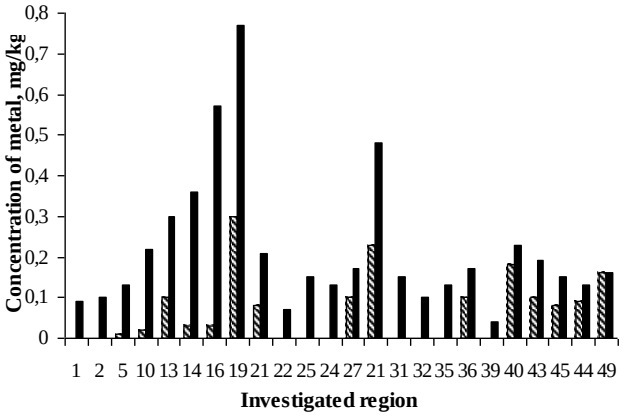
a



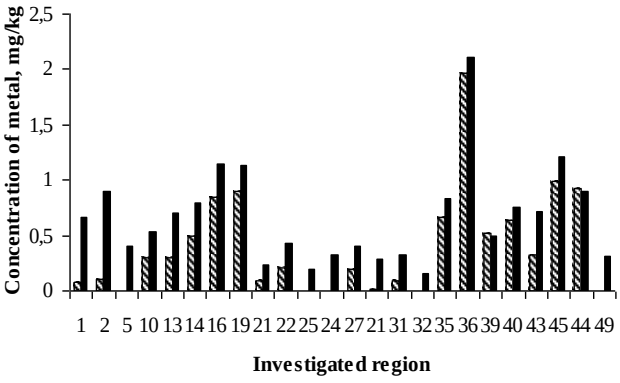
b



c



d



e

Concentration of copper zinc (*a*), cobalt (*b*), copper (*c*), cadmium (*d*), lead (*e*) in soils taken in zone of airport:
black – deep samples;
striped – surface samples

Thus this heavy metal is widespread non homogeneously in soils of airport territory in comparison with Zn and Co.

Soil contamination has partial character because of it was defined exceeding of MPC in a group of taken samples. But in generally the average concentration of Pb in the zone of airport is equal to 0.68 mg kg^{-1} DW that conform acceptable norms.

Analyzing received data it is possible to conclude the soil samples to be taken on depth 20 cm are mainly more contaminated in comparison with topsoil. Exactly exceeding of maximum permissible concentrations in all cases was observed in the deep samples.

Three zones of soils contamination on airport territory were defined in the course of investigation.

The first zone is situated at the ending of taxiway and the beginning of the runway (square 5260 m^2). This zone is characterized with higher concentration of Cu in both topsoil and deep samples and heightened contain of Pb (but not exceeding MPC) only in the deep samples. Received result gives possibility to assume that residual presence of Pb on depth may be result of technological processes and relatively not high values (in the same time close to MPC) may be explained due to metal immigration in deeper layers or extraction and accumulation by plants. Soil contamination with Cu may be considered to be recent and be caused after standing of airport because topsoil samples are also characterized with higher concentration of this metal.

The second zone of contamination was also defined near runway (1560 m^2, on distance 100–150 m from beginning of runway). The higher concentrations of Pb and Cd (exceeding MPC) were observed in soil samples taken on depth.

The third zone of soil contamination was detected 250 m from runway beginning (7590 m^2). This territory is characterized with higher concentration of Cu in both topsoil and deep samples. Taking into consideration that remark, it is possible to presume certainly that soil contamination is not caused due to airport activity.

Thus territory of airport should be considered to be moderately contaminated with Cu, Cd and Pb, but it has zonal character. The concentrations of Zn and Co satisfy adopted standards.

Heavy metals belong to non biodegradable versus carbon-based contaminators. The exceptions are mercury and selenium that can be transformed and volatilized by microorganisms [20; 21].

However, it is rather difficult to eliminate heavy metals from soils and the methods of contaminated soils remediation are extremely expensive.

Thus determination of levels and zones of soil contamination with heavy metals gives possibility to select a profitable remediation technology.

Conclusions

1. The soils on the territory of former airport are classified as moderately contaminated with Cd, Cu and Pb and uncontaminated with Zn and Co.

2. Analyzing received data it is possible to summarize that the soil samples taken on depth 20 cm are considered as more contaminated with Pb and Cd in comparison with topsoil. Higher concentrations of Cu were observed both samples thus the reason is not airport activity.

3. Contamination of soils has a zonal character. In the course of investigation three regions were detected. The first and the third zones are characterized with higher concentration of Cu and the second – correspondingly Pb and Cd. All zones are located near from runway and partially taxiway.

4. Soils in former airport territory are characterized with favorable agrochemical and physico-chemical properties that's why it is high probability to return the territory in use.

5. Taking into consideration data concern soils contamination with heavy metals it is necessary to elaborate the profitable and appropriate soil remediation technology before their returning in use.

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