

ASSESSMENT OF AEROTECHNOGENIC POLLUTION OF SOILS IN AREA OF INDUSTRIAL ENTERPRISES ACTIVITY OF PAVLOGRAD CITY

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The main sources of soil pollution in Pavlograd and suburban territories are mine tailings, heat supply companies, operating in Western Donbass coal, other industrial enterprises and transport. The coal and mine rocks contain significant amounts of heavy metals and rare earth elements, lead, zinc, vanadium, manganese, cobalt, chromium, germanium, cerium, bismuth and others. Settling on the earth's surface, they form insoluble compounds and accumulate in the upper parts of the soil cover. There are 32 industrial enterprises with more than 600 organized sources and emit more than 1,000 tons of pollutants (including more than 350 tons of carbon monoxide, 130 tons of oxides of nitrogen, 280 tons of suspended solids). **Purpose.** Environmental assessment of soil technogenic pollution in the area of industrial enterprises in the Pavlograd city. The Pavlograd is located between Samara and Vovcha rivers. The most common soils are typical chernozem and saline soils. Soil samples were taken to determine the effect of airborne technogenic pollution in Pavlograd. Soil samples were collected in the vicinity of each enterprise to detail the impact of the main environmental pollutants in Pavlograd. Enterprises as emission sources of air pollution in Pavlograd are following: chemical plant (PCP), mechanical plant (PMP), the machine factory and foundry plant (PalMash). **Methodology.** The definition of the content of acid-soluble forms of heavy metals in the collected samples was performed by atomic absorption spectrophotometry. Assessment of soils ecological quality was given by the degree of soil contamination with HM regarding exceeding the MPC, as well as on the total index of pollution. According to the results of determination of the granulometric composition of the vast number of analyzed soil samples (63 %) is characterized as loam. The rest – sand (33%), and clay soils (4%). **Results.** The results of detection of the reaction of the aqueous extract of the vast number of analyzed soil samples (95 %) were weakly acidic at 6.3 and 6.8. As a result of consistent mapping of pollution in the city of Pavlograd six heavy metals was obtained corresponding GIS map. Follow to the analysis of the GIS map, it becomes possible to select multiple halos increased density of total soil contamination of Pavlograd city with heavy metals. Mostly they are concentrated in the Southeast and West of the city. Sources of emission in the South-East has Pavlograd mechanical plant, the machine factory, and foundry plant. The high density of soil contamination with heavy metals in the West of the city may be associated both with the activities of the Pavlograd chemical plant and the weathering of coal mine tailings. The total pollution index of multipollution level of soil contamination was calculated for generalization of the obtained results. For most of the analyzed samples, according to the above gradation, the environmental situation of the contamination of soils by heavy metals is changed from "moderately threatening" to "threatening". Therefore the necessary arrangements to predict of the development of ecologically dangerous situation of environmental pollution in the area of industrial enterprises of the city. *References 6, tables 1, figures 3.*

Key words. environment situation, technogenic pollution, air, soil, heavy metals.

ОЦІНКА АЕРОТЕХНОГЕННОГО ЗАБРУДНЕННЯ ҐРУНТІВ В ЗОНІ ДІЇ ІНДУСТРІАЛЬНИХ ПІДПРИЄМСТВ МІСТА ПАВЛОГРАД

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Основними джерелами аеротехногенного забруднення ґрунтового покриву у місті Павлоград та приміських територіях є шахтні відвали, підприємства теплопостачання, що працюють на вугіллі Західного Донбасу, інші індустріальні підприємства та автотранспорт. У вугіллі та шахтних породах знаходяться значні кількості важких металів і рідкоземельних елементів. Вони утворюють важкорозчинні сполуки і накопичуються у верхніх частинах ґрунтового покриву, осідаючи з повітря на земній поверхні. Мета досліджень – екологічна оцінка техногенного забруднення ґрунтів в зоні дії індустріальних підприємств міста Павлоград. Більша кількість аналізованих проб ґрунтів у місті Павлоград характеризується як суглинністі та мають слабо кислу реакцію в межах 6,3-6,8. Виділені декілька ореолів підвищеної щільності сумарного техногенного забруднення ґрунтів м. Павлоград важкими металами. Переважним чином вони обумовлені дією індустріальних підприємств, які сконцентровані на південному сході та на заході міста. Екологічна ситуація забруднення ґрунтів важкими металами змінюється від «помірно загрозливої» до «загрозливої».

Ключові слова: Екологічна ситуація, техногенне забруднення, повітря, ґрунти, важкі метали.

Оцінка та прогнозування техногенного впливу на довкілля

PROBLEM STATEMENT. The large number of industrial enterprises in the natural-economic region of the Dnieper leads to the formation of technogenic anomalies of atmosphere pollution [1]. Consequently, the residents adjacent to industrial enterprises, residential areas are "hostages" of a certain number of mining and metallurgical industry, fuel-energy complex and patterns of functioning vehicles [2].

The main sources of soil pollution in Pavlograd and suburban territories are mine tailings, heat supply companies, operating in Western Donbass coal, other industrial enterprises and transport. The coal and mine rocks contain significant amounts of heavy metals and rare earth elements, lead, zinc, vanadium, manganese, cobalt, chromium, germanium, cerium, bismuth and others [3]. Settling on the earth's surface, they form insoluble compounds and accumulate in the upper parts of the soil cover. There are 32 industrial enterprises with more than 600 organized sources and emit more than 1,000 tons of pollutants (including more than 350 tons of carbon monoxide, 130 tons of oxides of nitrogen, 280 tons of suspended solids) [4].

The purpose of study – environmental assessment of soil technogenic pollution in the area of industrial enterprises in the Pavlograd city.

EXPERIMENTAL PART AND RESULTS OBTAINED. The Pavlograd is located between Samara and Vovcha rivers. The investigated area belongs to the North-East slope of the Ukrainian crystalline massif and extends along the South-Western side of the Dnepropetrovsk-Donets basin. From the South to the North of the city crossed with Vovcha river (over 2.85 km). Samara river is a natural boundary from the North-East. Two small rivers entitled as Gnyzdka (3.9 km) and Kocherga (2.9 km) cross the territory of the city of Pavlograd as well. The most common soils are typical chernozem and saline soils [5]. Underground fresh and mineral water are essential to the life of the city. The climate is the Atlantic-continent, not humid, characterized by hot summers, with the thaw, dry. The average temperature for the year: 4.4°C. The Number of dry days: 80 (April-October). The priority direction of the wind: a warm period West - 18% of the days; the coldest period of the East - 23% of days. Forest area around the city and in its territory are presented with large tracts of pine trees. Investment potential of the city is characterized, in particular, for existing production facilities relating to various forms of ownership. More than one thousand real estate objects belong to communal property of the city territorial community.

Soil samples were taken to determine the effect of airborne technogenic pollution in Pavlograd. Soil samples were collected in the vicinity of each enterprise to detail the impact of the main environmental pollutants in Pavlograd. Enterprises as emission sources of air pollution in Pavlograd are following: chemical plant (PCP), mechanical plant (PMP), the machine factory and foundry plant (PalMash).

Soil sampling was performed by the method of "envelope". The total number of samples -60. The soil samples were collected in the depth 0-10 cm, 800-900 g of each sample. After that, soil samples were dried at room temperature and powdered, have been removed impurities and particles using sieves with holes of different diameter from 5 to 1 mm. The shredded material is thoroughly mixed and scattered smooth a thin layer in

the form of a square, was divided into four sectors to reduce the mass of the sample. The content of the two opposite sectors was discarded, and the remaining two were again mixed. After multiple repetitions, the sample remained was dried to obtain extracts from the soil. The definition of the content of acid-soluble forms of heavy metals in the collected samples was performed by atomic absorption spectrophotometry.

Assessment of soils ecological quality was given by the degree of soil contamination with HM regarding exceeding the MPC, as well as on the total index of pollution [6]. The level of soil contamination with heavy metals is characterized by the coefficient of the anomaly in the concentration of a chemical element:

$$K_c = \frac{C_i}{C_\phi}, \quad (1)$$

where C_i – element content in soil, mg/kg;

C_ϕ – background content, mg/kg.

Index of soil total airborne pollution (TAP) with heavy metals Z_c was calculated with formula [2]:

$$Z_c = \sum_{i=1}^n (K_{c_i} - (n - 1)), \quad (2)$$

where n – elements number.

The threat caused with technogenic pollution is fixed when $K_{c_i} \geq 1$, and $Z_{c_i} \geq 1$, or more detailed as below:

- $Z_c < 16$ – permissible level of soil pollution;
- $16 < Z_c < 32$ – moderate threatening;
- $32 < Z_c < 128$ – threatening;
- $Z_c \geq 128$ – extraordinary threatening.

GIS density map of the total soil contamination with copper, zinc, manganese, cadmium, lead and nickel has been created using the program modul 3D Analyst complex ArcGIS 9.3.

Data percentage distribution of soil samples according to their granulometric composition is shown in Fig. 1.

According to the results of determination of the granulometric composition of the vast number of analyzed soil samples (63 %) is characterized by loam. The rest – sand (33%), and clay soils (4%). Data percentage distribution of soil samples according to their pH is shown in Fig. 2.

The results of detection of the reaction of the aqueous extract of the vast number of analyzed soil samples (95 %) were weakly acidic at 6.3 and 6.8.

As a result of consistent mapping of pollution in the city of Pavlograd six heavy metals was obtained corresponding GIS map (Fig.3).

Follow to the analysis of the map in Fig.3, it becomes possible to select multiple halos increased density of total soil contamination of Pavlograd city with heavy metals. Mostly they are concentrated in the Southeast and West of the city. Sources of emission in the South-East has Pavlograd mechanical plant, the machine factory, and foundry plant. The high density of soil contamination with heavy metals in the West of the city may be associated both with the activities of the Pavlograd chemical plant and the weathering of coal mine tailings.

Оцінка та прогнозування техногенного впливу на довкілля

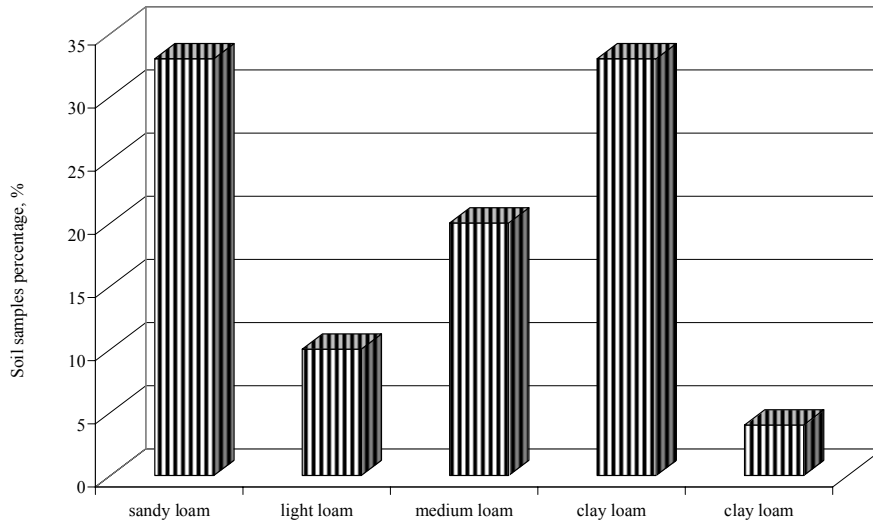
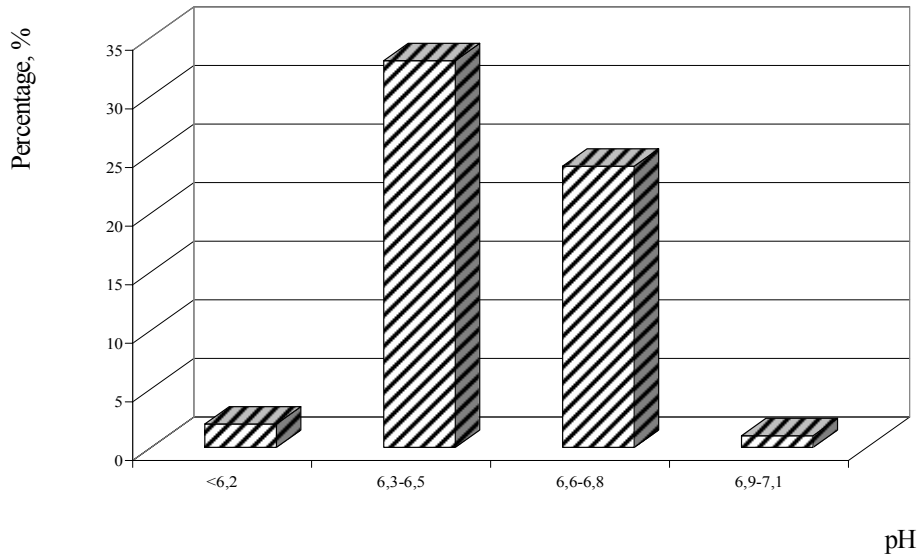


Figure 1 – The distribution of soil samples according to their granulometric composition



pH

Figure 2 – The sample distribution of the soil pH according to the reaction

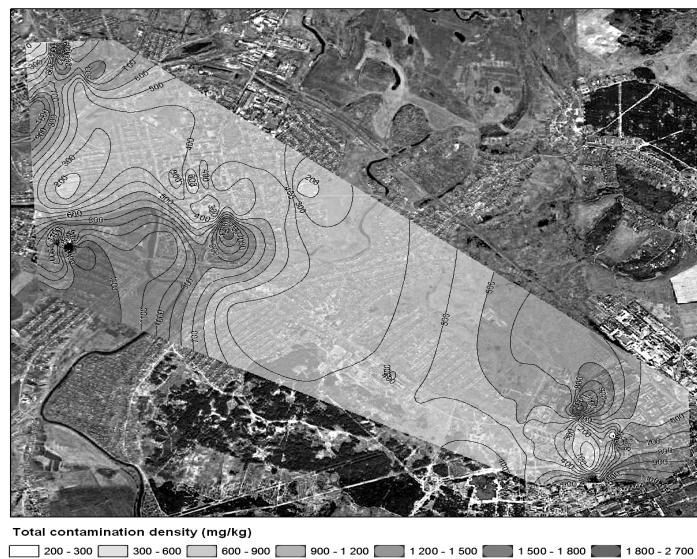


Figure 3 – Map estimates of the total density of soil contamination of Pavlograd city with heavy metals

Оцінка та прогнозування техногенного впливу на довкілля

Follow to the analysis of the map in Fig.3, it becomes possible to select multiple halos increased density of total soil contamination of Pavlograd city with heavy metals. Mostly they are concentrated in the Southeast and West of the city. Sources of emission in the South-East has Pavlograd mechanical plant, the machine factory, and foundry plant. The high density of soil contamination with heavy metals in the West of the city may be associated both with the activities of the Pavlograd chemical plant and the weathering of coal mine tailings.

The total pollution index Z_c of multipollution level of soil contamination was calculated for generalization of the obtained results (table.1).

For most of the analyzed samples, according to the above gradation, the environmental situation of the contamination of soils by heavy metals is changed from "moderately threatening" to "threatening".

Table 1 – The total pollution index Z_c

Pollution level with technogenous substances	Number of samples	Percentage
Acceptable	20	34,5
Moderate threatening	16	27,5
Threatening	20	34,5
Extraordinary threatening	2	2.5

CONCLUSIONS. The vast number of analyzed soil samples in Pavlograd is characterized as loamy and have a weakly acidic at 6.3 and 6.8. Highlighted are some of the halos in Pavlograd of high density of total soil contamination with heavy metals. Mostly they are caused with impact of the industrial enterprises, which are localized in the South-East and in the West of the city. Environmental situation of soil pollution of heavy metals is changed from "moderately threatening" to "threatening". Therefore the necessary arrangements to

predict of the development of ecologically dangerous situation of environmental pollution in the area of industrial enterprises of the city.

REFERENCES

1. Kryvakovskya R. V. (2013) Mapping of air pollution by dioxides of nitrogen and sulfur in the industrial towns of the region/ G. W. Kryvakovsky, M. M. Khar'ytonov, V. M. Khlopova // *Ecologichna bezpeka*, (16) . no.2. P. 32-35
2. Bakharev V. S. (2012) Study of the status of air pollution in terms of change modern buildings inhabited cities/ V. S. Bakharev, A. L. Korzhova, V. V. Kostyrya, D. V. Marynyn // *Ecologichna bezpeka*,(13) . no 1. P. 43-47
3. Bondarenko L. V. (2010) Ecological and chemical status of urban territories of coal-mining region (on the case of Pavlograd) / L. V. Bondarenko, V. A. Kirichenko, S. A. Kravets, Y. Y. Serdyuk, A. Tyapkin K. // *Scientific Bulletin of national mining University*, 2010. no. 10-11. P. 89-94
4. Tyapkin A. K. (2004) Operational ecological and radio-geochemical assessment of coal-mining towns of the region (on the example of Pavlograd) / O. K. Tyapkin, L. V. Bondarenko, V. A. Kirichenko, S. A. Kravets // *Mining Geology, geomechanics and mine surveying: proceedings of the international. nauch.- tech. Conf. Donetsk*. P. 415-420.
5. Yevgrashyna G.P. (2003) Impact of mining industry on hydrogeological and soil-meliorative conditions/ G.P.Yevgrashkyna. Dnepropetrovsk: Monolit, 2003. 200 p.
6. Gololobova E. A. (2011) Assessment of polielement soil contamination of areas at various levels of anthropogenic stress. *People and the environment. The problems of neo-ecology trend.*, 2011. no. 1-2. P. 118-124.

ОЦЕНКА АЭРОТЕХНОГЕННОГО ЗАГРЯЗНЕНИЯ ПОЧВ В ЗОНЕ ДЕЯТЕЛЬНОСТИ ИНДУСТРИАЛЬНЫХ ПРЕДПРИЯТИЙ ГОРОДА ПАВЛОГРАД

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Основными источниками аэротехногенного загрязнения почвенного покрова в городе Павлоград и пригородных территориях являются шахтные отвалы, предприятия теплоснабжения, работающие на угле Западного Донбасса, другие промышленные предприятия и автотранспорт. В углях и шахтных породах находятся значительные количества тяжелых металлов и редкоземельных элементов. Они образуют труднорастворимые соединения и накапливаются в верхних частях почвенного покрова, оседая на земной поверхности. Цель исследования - экологическая оценка техногенного загрязнения почв в зоне действия промышленных предприятий города Павлоград.

Большая часть анализируемых проб почв в городе Павлоград характеризуется как суглинистые и имеют слабо кислую реакцию в пределах 6,3-6,8. Выделены несколько ореолов повышенной плотности суммарного техногенного загрязнения почв г. Павлоград тяжелыми металлами. Главным образом они обусловлены действием промышленных предприятий, которые сконцентрированы на юго-востоке и на западе города. Экологическая ситуация загрязнения почв тяжелыми металлами изменяется от «умеренно угрожающей» к «угрожающей».

Ключевые слова: экологическая ситуация, техногенное загрязнение, воздух, почвы, тяжелые металлы.