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Contamination of Soils with Heavy Metals in the Industrialized Region of Western Ukraine: Western Podole Upland

1. Introduction

Opole (Podolsk horbohir'ya) – is the name of the western part of Podolia Upland, one of the highest and most dissected parts of it. It is located in the east part of the city , within Lviv, Ivano-Frankivsk and Ternopil regions. To the east is washed by the Zolota Lipu River, in the west by the Vereshchytsia River, in southern approaches to the Dniester, in the north – to Lviv plateau, Gologory and Peremyshliany lowland. Opole is divided into natural regions: Rohatyn, Prydnister, Khodoriv, Lviv, Burshtyn and Galich. Rohatyn Opole is devoted to art, 350–400 m above sea level and is dissected by rivers: Svirzh, Gnula Lupu, Narayivka (all – left tributaries of the Dniester River). Here dominate common beech and oak forests on gray forest soils. Significant pilgrimage plowed densely populated.

In a broad sense Opole (a word of Slavic origin) used in a number of geographical places and towns in Belarus, Poland, Russia and Ukraine, where naturally combined treeless areas of arable land with forested and grassy areas of gray forest soils, which studied by the author in 2011.

1.1. Method

The area located 815 km^2 profiles of 80 Geoenvironmental polygons (Fig. 1), which selected and analyzed soil samples for eight chemical elements – heavy metals (Tab. 1). The results of the analyzes are summarized in a computer database, counted as background and anomalous contents and izo-concentrate that while further research will build environmental techno-geochemical maps showing the distribution in soils in the district area major pollutants – heavy metals.

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Table 1. Database showing chemical elements in soils within the Rogatyn region, according to atomic-adsorption analyzes provided by the Ivano-Frankivsk regional sanitary-epidemiological station (2011)

No. *n*	No. sample	Georeferenced	Chemical elements [mg/kg]								The total rate of pollution ORP* ORP = 8/*n* = 1Ci/Cph
			Co 5.0	As 2.0	Cu 3.0	Ni 4.0	Hg 2.1	Pb 32.0	Zn 23.0	Cr 6.0	
1	13	Profile I-I Pidbire	0.05	0	0.05	0.01	0	1.82	0.35	0.26	0.684916903
2	14	Yaglush	0.07	0	0.09	0.06	0	2.64	1.65	0.34	1.330342215
3	15	Voroniv	0	0.06	0.04	0.09	0	3.32	1.84	0.44	1.560079771
4	16	Lupivka	0.04	0.09	0.1	0.07	0.03	1.46	2.35	0.51	1.978200605
5	17	Profile II-II Dolunjanu	0.21	0.21	0.21	0.46	0.12	6.85	3.82	1.64	5.607391456
6	18	Benkivzhy	1.45	0.47	0.59	1.44	0.44	15.42	8.46	2.55	14.86199289
7	1	Pidkamine-1	0.08	0	0.06	0.02	0.01	0	0.44	0.46	0.749859935
8	19	Ruda	0	0	0.04	0.09	0	0	1.61	0.24	0.741489899
9	20	Klishivka	0	0.03	0.01	0.07	0	0.41	2.42	0.35	1.051892027
10	21	Pograbivka	0.03	0.01	0.05	0.05	0	0.62	2.45	0.56	1.266059368
11	22	Profile III-III Knjagunuchy	1.13	0.52	0.64	0.95	0.44	12.85	6.84	2.68	13.58710419
12	57	Degova	0.19	0.21	0.24	0.46	0.16	7.44	4.46	1.84	6.178680476
13	23	Preozerna	0	0.01	0.02	0.08	0.01	0.25	0.88	0.18	0.58435377
14	24	Chercha	1.63	0.42	0.55	1.49	0.36	18.41	9.66	2.88	15.31180106
15	25	Pidgorodja	0	0.02	0.09	0.03	0.02	0.28	0.94	0.18	0.837713113
16	26	Stratun-1	0	0.01	0.06	0.09	0	0.41	1.35	0.44	0.959922879
17	27	Stratun-2	0.03	0.05	0.04	0.07	0	0.34	1.64	0.35	1.091235473
18	11	Profile IV-IV Lukovezh	0.12	0.16	0.16	0.25	0.12	5.21	3.44	1.21	4.30571338
19	28	Shyravsk	0.16	0.21	0.24	0.36	0.16	6.35	3.66	1.38	5.420258199
20	4	Grygoriv-1	0.32	0.19	0.25	0.44	0.15	7.24	4.85	1.45	6.05919117
21	58	Voskresenzy	0.24	0.16	0.16	0.35	0.15	5.42	3.55	1.41	4.906159109

The total amount in database is 80 samples.

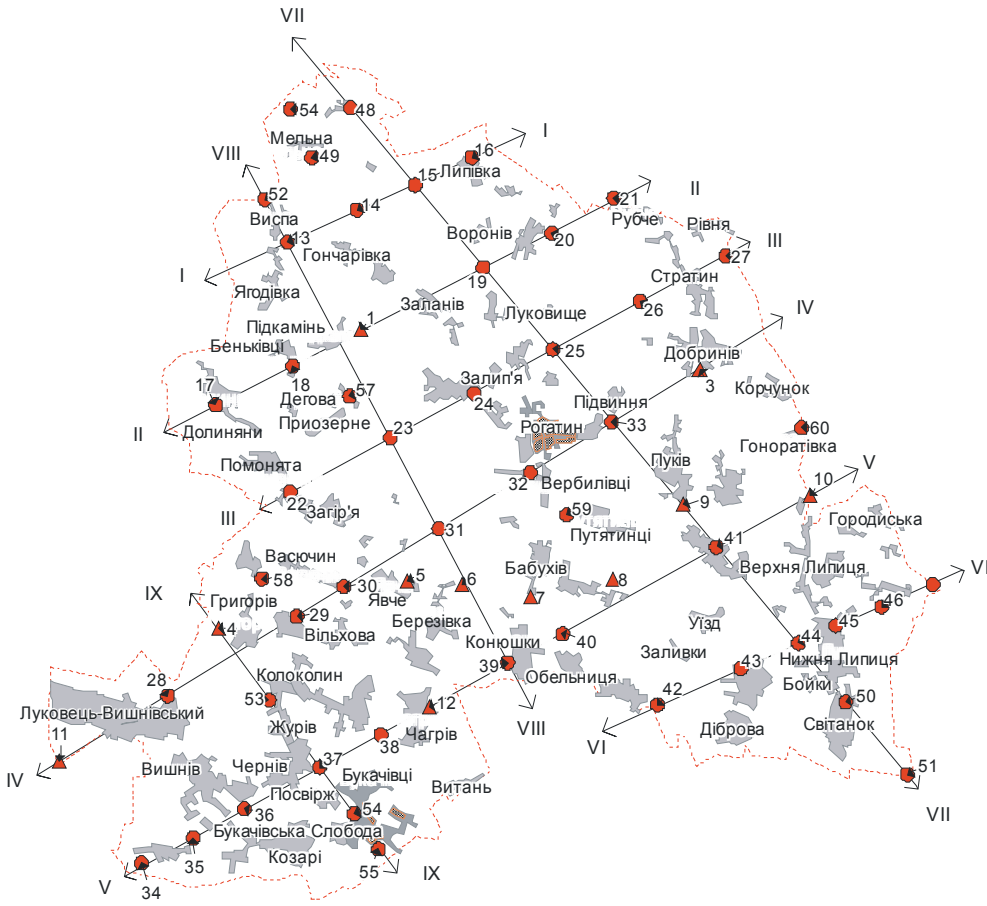

Fig. 1. The map of factual material: geoecological polygons – point sampling

1.2. Research Area

On the territory of the study area Rohatyn Opole there are a number of environmental problems that are waiting for their decision. Regional Council identified priorities for conservation work to improve the environmental situation in the region. First of all it concerns the conservation of soil; reduce air pollution and water, natural disaster prevention and more.

Despite the recession, Rohatyn areas considered environmentally dangerous territory, where the dispersion of emissions of pollutants from Burshtyn TPP enterprises chemistry Kalush.

The use of large amounts of water for production needs, pollution of surface and groundwater sources of industrial, agricultural, municipal and economic return

wastewater and waste management industries bring great harm to water bodies, leading to qualitative depletion of water sources. The main sources of water pollution are sewage treatment plant and sewer network production departments of Housing.

Share contaminated water is for nearly 61%. Sewage treatment plants are overloaded, are in poor condition. Most treatment facilities need renovation, repair or restoration.

Rohatyn region differs from other regions of Ukraine by highly dynamic development of subsurface geological environment, due to the influence of both internal (endogenous) forces of the Earth and the external influence of environmental (exogenous) and anthropogenic factors. According to the scheme of seismic zoning district is included in the boundary 4–5-zone scoring.

2. Results and Discussion

Our studies have shown that soil contamination Hg, Ni, Zn, Pb, Cu, Co, as other heavy metals (HM) accumulated mainly in the humus (0–10 cm from the surface) and in subsurface (30–50 cm) horizons of the soil profile. If the studied areas remote from potential sources of contamination (industrial Rogatyn, roads, etc.), then the distribution of heavy metals in the area and in a profile more or less uniform, as illustrated in maps built by us (Figs 2–8). It was also found that the gross contents of Cu, Zn, Cd, concentrated in alluvium and Pb – in humus. Perhaps, a role as a geochemical barrier effect caused by carbonate rocks that uncomfortably overlies the Miocene sands in the form of lenses.

From sample tests it is known that the accumulation of excess Zn has a detrimental effect on the activity of microorganisms that interferes with the formation of organic matter in soils. In addition, contaminated fermentation and decomposition of cellulose changed as physical and physical-chemical properties of soils.

Unlike Cu, Zn, Cd, Pb compounds are concentrated mainly in the upper (humus) horizon. Excess Pb, compared with the background, has a depressed effect on soil microorganisms. This indicates admission Pb in soils by anthropogenic impact [2], which is confirmed high in this element in the upper soil layer. Accordingly, humus and alluvium horizons are sort of geochemical barriers for the deposition of heavy metals.

Some authors [1, 4] believe that Pb enters the atmosphere mainly in oxide form, then it settles on the soil surface, sorbed organic substances migrate through the soil profile, but beyond the soil profile is made in small quantities [4].

Interesting data obtained by mercury Hg. Content – small, but receipt of the pollutant has anthropogenic origin, because it focuses exclusively in the surface layer (0–5 cm). Anomalies of Hg near the village fork associated with the combustion of coal in boiler small businesses. Migration of Hg is possible only for short distances [3].

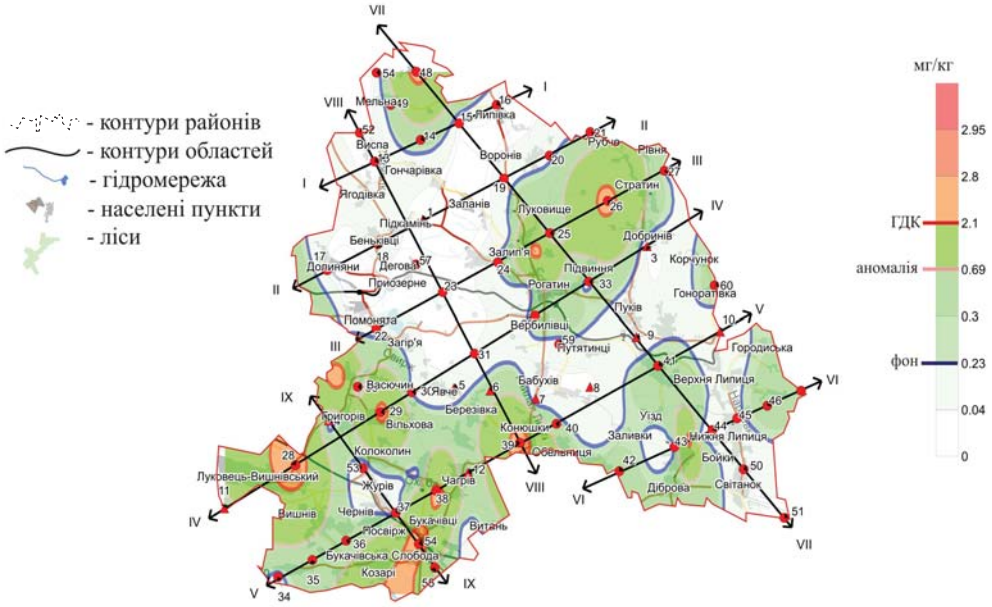

Fig. 2. The distribution of Hg in soils

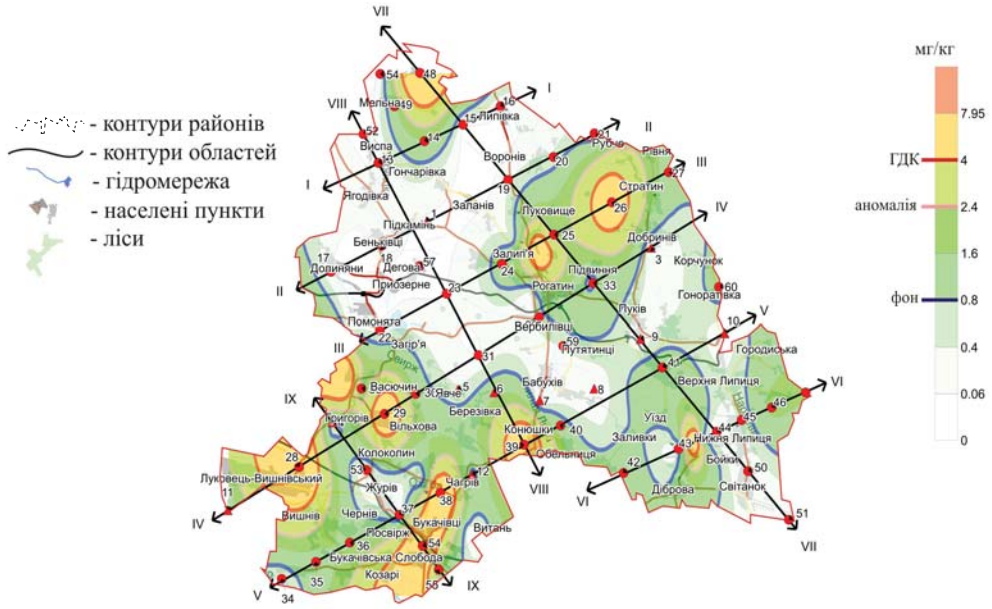

Fig. 3. The distribution of Ni in soils

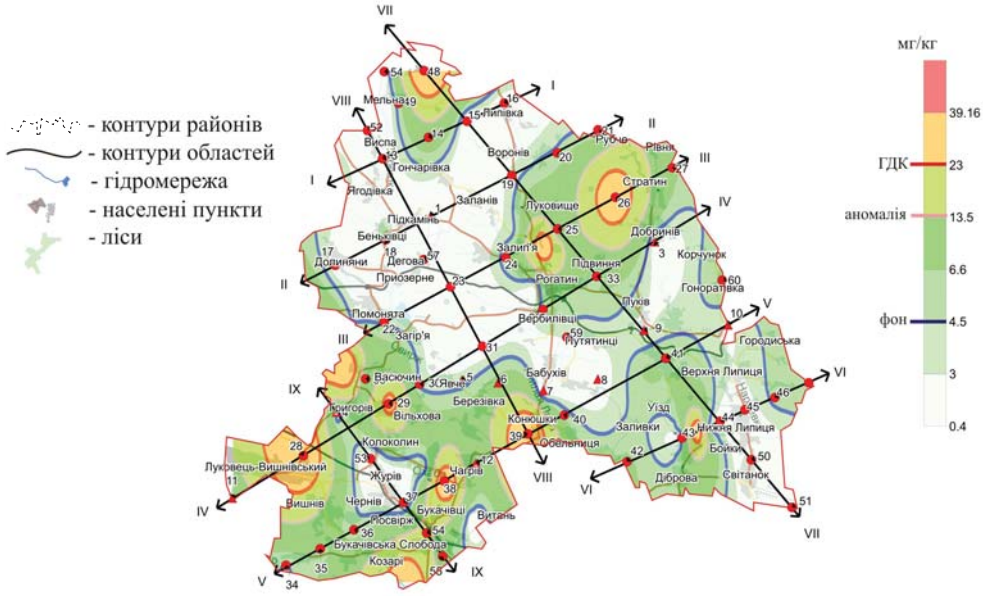

Fig. 4. The distribution of Zn in soils

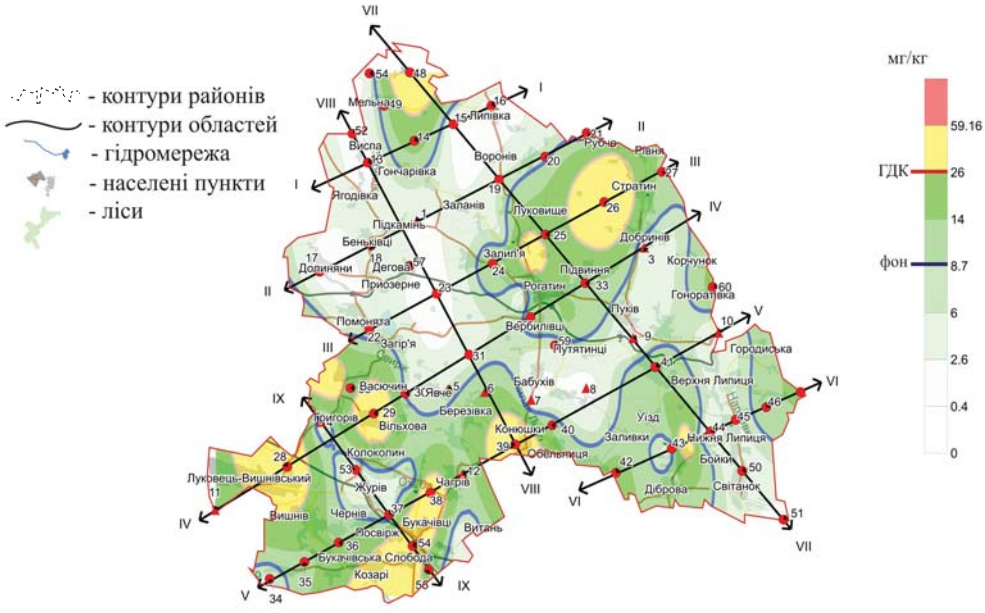

Fig. 5. The distribution of Pb in soils

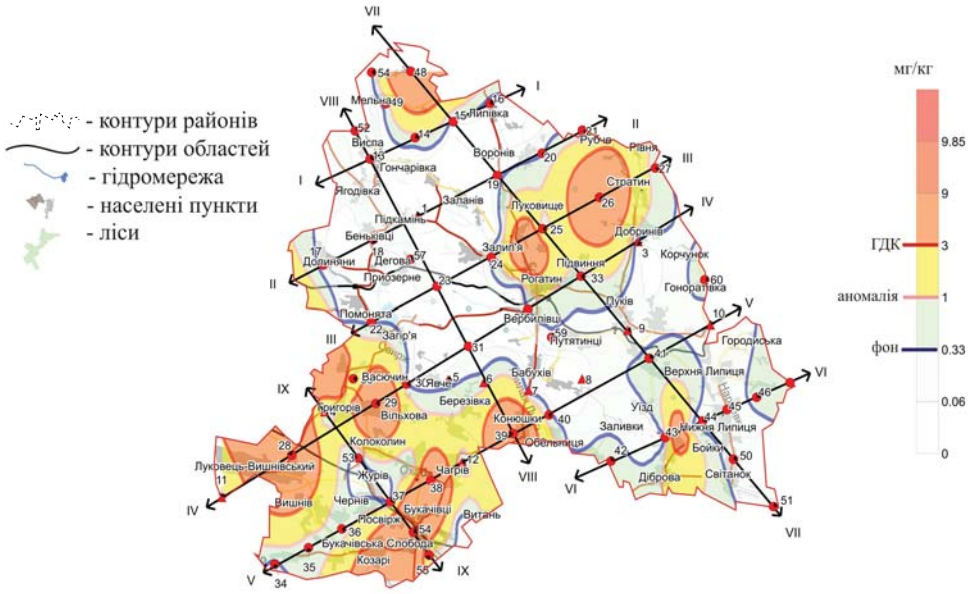

Fig. 6. The distribution of Cu in soils

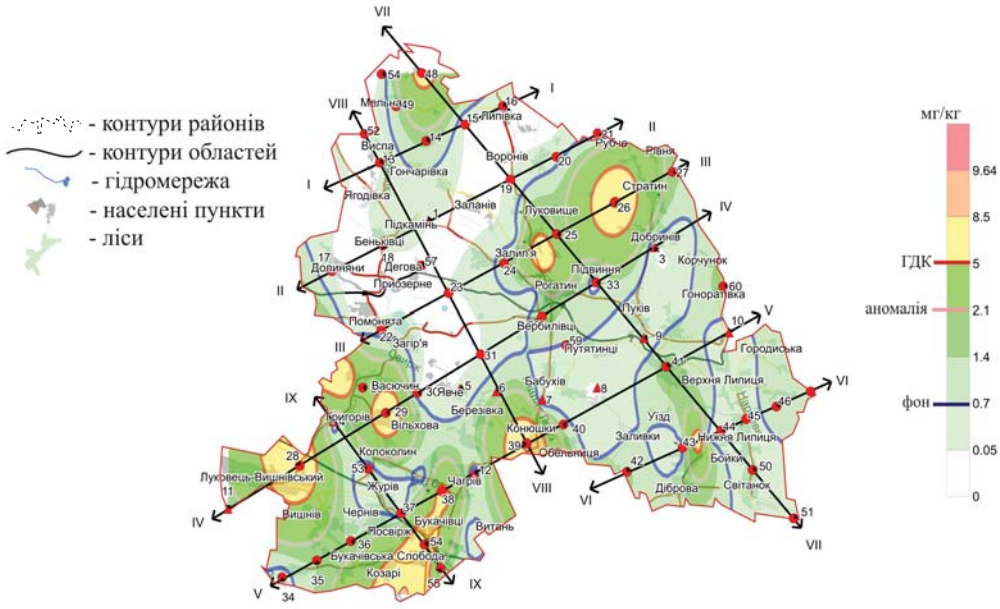

Fig. 7. The distribution of Co in soils

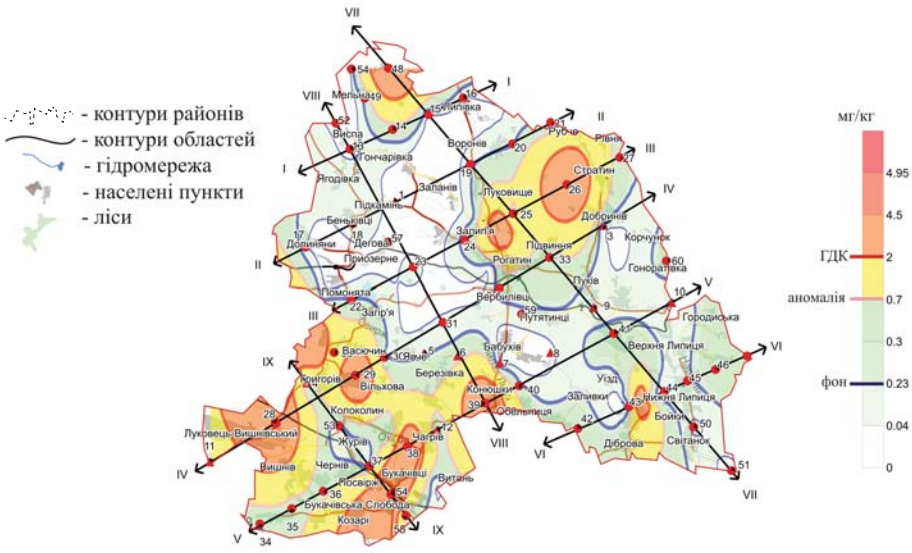

Fig. 8. Distribution of As in soils

3. Conclusions

Distribution of Hg, Ni, Zn, Pb, Cu, Co, As (Figs 2–8) revealed several anomalies. On the map of the total pollution index that combines all previous element wise cards exceeding background abundances confined to urban Rohatyn and further to the northeast of it. Other anomalies are concentrated in the south-west and less in the south-east, where there are high concentrations of settlements. But the final reason identified anomalies should be refined in the further research of other components of the environment – soil and surface water, air and vegetation.

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