IOP Conference Series: Earth and Environmental Science

PAPER • OPEN ACCESS

Waste heaps in the urban environment as negative factors of urbanization

IOP Conf. Series: Earth and Environmental Science **915** (2021) 012001 doi:10.1088/1755-1315/915/1/012001

Waste heaps in the urban environment as negative factors of urbanization

V Popovych[1], A Voloshchyshyn[1], P Bosak[1] and N Popovych[2]

[1]Lviv State University of Life Safety, 79007 Lviv, Ukraine
[2]Lviv Department of the National Ecological Center of Ukraine, 79005 Lviv, Ukrain

E-mail: popovich2007@ukr.net

Abstract. Urbanization in Ukraine has led to the development of the Lviv-Volyn coal basin. One of the main negative factors in the operation of coal basins are mine dumps. In addition to environmental hazards, waste heaps of coal mines violate the attractiveness and aesthetics of towns. The wastewater from waste heaps is a secondary factor in reducing the environmental safety of the coal-mining region. These waters are concentrated at the foot of landfills forming the man-made reservoirs. The research presents the negative factors of mine dumps and the results of physical and chemical analysis of subtericone wastewater and its impact on environmental pollution. It is established that the most polluted is the wastewater from waste heaps of the Mezhyrichanska mine which is caused by its operating process. The man-made polluted wastewater from heaps is a secondary factor in reducing the level of ecological danger of the coal-mining region. These waters are concentrated at the foot of landfills in the form of man-made reservoirs. The aim of the research is to indicate the negative factors of urban waste heaps by studying the physical and chemical properties of underspoil waters within the cities of Chervonograd and Novovolynsk.

1. Introduction

Urbanization in the 1950s led to the exploitation of the Lviv-Volyn coal basin. Its operation caused a violation of the architectural, planning and aesthetic principles of Chervonohrad and Novovolynsk due to the emergence of embankments of waste rock in their territory i.e. dumps [1, 2]. Phytomeliorants have transformative functions: reclamation (forest crops, planting and sowing of plants on reclaimed lands), sanitizing (forests, sanitary protection strips), recreational (parks and forest parks), engineering and protective (field and erosion protection), architectural planning (urban landscaping system), ethical and aesthetic (spiritual education) [3-5]. An important place is given to vegetative reclamation of devastated landscapes – eroded lands, quarries, landfills, heaps. Taking into account the transforming functions, the following vectors of vegetative reclamation are formed:

- engineering and protective – counteraction to lateral geophysical flows: a) wind and snow; b) wind-dust-sand; c) wind-dust-smoke; d) wind-water-sand; e) water; f) water-soil;
- sanitizing – oxygen release, filtering, release of phytoncides, ionization of air, noise absorption;
- reclamation – forest crops, planting and sowing of plant seeds on reclaimed lands;
- ethical and aesthetic (phytodesign) – spiritual uplifting, developing the sense of beauty in external space and interiors;
- architectural and planning – design and creation of integrated green areas in localities;
- recreational – the use of vegetation for recreation [6].

Some important issues of vegetative reclamation of devastated landscapes are not sufficiently studied. Such issues are the research on phytocenotic structure of vegetation of different types of dumps and the influence of environmental factors on the development of vegetation. It is extremely important to investigate phytogenic fields in devastated landscapes, where plants experience significant man-made pressure due to human activity. Also unresolved are the issues of reducing the toxicity of underspoil waters. Waste heap of Novovolynsk mining districtis shown in Figure 1.

Figure 1. Waste heap of mine № 4 near the central part of Novovolynsk.

The works of Prof. Kucheryavyy (2000) [7] are devoted to the negative factors of urban landscapes and the problems of vegetative reclamation. He drow up a classification of successions of the biogeocenotic cover of the urban ecosystem, which can be used to improve the monitoring and forecasting of the ecological condition of localities. According to Kucheryavyy, phytomeliorants are divided into three groups: 1) special, the function of which is of leading importance (parks, protective strips, forest parks, etc.); 2) productive, designated for obtaining products, and vegetative reclamation is of secondary importance (forests, fields, meadows, orchards, vineyards, etc.); 3) ruderal (weeds), the reclamative functions of which are spontaneous.

2. Methodology

One of the most acceptable methods to increase the aesthetics and reduce the man-made impact of waste heaps in the urban environment and eliminate their negative factors is vegetative reclamation. For non-natural vegetative reclamation is necessary to carry out the mining stage, which involves leveling the surface for planting forest crops. Such attempts were made within the waste heap of the Mezhyrichanska mine (Chervonohrad). After selecting and laboratory analysis of subtericone waters from different mines, it was found that their greatest hardness is inherent in the area of influence of the mine "Mezhyrichanska"Sampling was carried out during 2017-2020 followed by analysis of the content.

The investigation of the selected samples was carried out in the Laboratory of Environmental Safety at the Lviv State University of Life Safety (Ukraine) Certificate of conformity of the measurement management system № PA127/17 from 14.11.2017, valid until 13.11.2021. The regulations are developed on the basis of the normative document: “Procedure for voluntary assessment of the measurement management system. The premises and the environment of the laboratory meet the sanitary norms, rules and requirements of labor protection. Testing and auxiliary equipment, measuring equipment and materials of the environmental safety laboratory meet the requirements of regulatory documentation. Statistical data processing was performed using Microsoft Excel 2010. For modeling of pollutants spread the Surfer software was used.

3. Results and discussion

Chervonohrad is located in the northern part of Lviv region, at a distance of 80 kilometers from the regional center and 70 km to the border with Poland. Area – 21 km^2 (Chervonohrad - 17.8 km^2; Sosnivka - 2.0 km^2; Hirnyk - 1.2 km^2). Administrative-territorial division - Chervonohrad, Sosnivka, Hirnyk. Population - 80.5 thous. people. (as of 01.02.2020) - (Chervonograd - 66.5 thous., Sosnivka - 11.1 thous., Girnik - 2.9 thous.).

Population density - 3833 people/ km^2. It is an industrial region. Processing and mining industries prevail here. The city of Chervonohrad is located in the Western Ukrainian forest-steppe zone and Maly Polissya, at the confluence of the Solokia and the Rata rivers to the Western Bug. Chervonohrad is located in a humid, moderately warm agro-climatic zone, there is sufficient soil moisture. The climate is temperate continental, characterized by mildness and high humidity. Main natural resources: Zabuzka and Mezhyrichanske coal deposits. The region uses 2,097 hectares, including 1779 in Chervonohrad, 198 in Sosnivka, and 120 in Hirnyk.

Waste heaps of coal mines in the Chervonohrad mining district are the factors of negative consequences of urbanization. In addition to environmental hazards, waste heaps of coal mines violate the attractiveness and aesthetics of cities is shown in Figure 2.

Figure 2. Waste heap and reservoir with wastewater.

The wastewater from waste heaps is a secondary hazard factor of the environmental risk of the coal-mining region. These waters are concentrated at the foot of landfills forming the man-made reservoirs. After selection and laboratory analysis of subtericone waters from different mines, it was found that their greatest water hardness is inherent in the influence area of the mine "Mezhyrichanska" (25.3 mg.eq / dm3), "Zarichna" (26.8 mg.eq / dm3), "Forest" (26.6 mg.eq / dm3), MAC is 7 mg.eq / dm3. The transparency of wastewater is 18 cm is shown in Figure 3.

The dry residue of salts exceeds MAC (1000 mg/dm3) on waste heaps of mines "Mezhyrichanska" (6941 mg/dm^3), "Stepova" (1119 mg/dm^3), "Zarichna" (1865 mg/dm^3), "Lisova" (3842 mg/dm^3), "Chervonohradska" (3814 mg/dm^3). The calcium content in the wastewater samples was in the range of 52-474 mg/dm^3 is shown in Figure 4. In the samples aluminum and chromium are detected. The chromium content doesn't exceed 0.01 mg/dm^3 in all samples. The aluminum content is 0.04 mg/dm^3 for all investigated wastewater, except for the waters of waste heaps of the Mezhyrichanska mine, where its values reached 1.58 mg/dm^3.

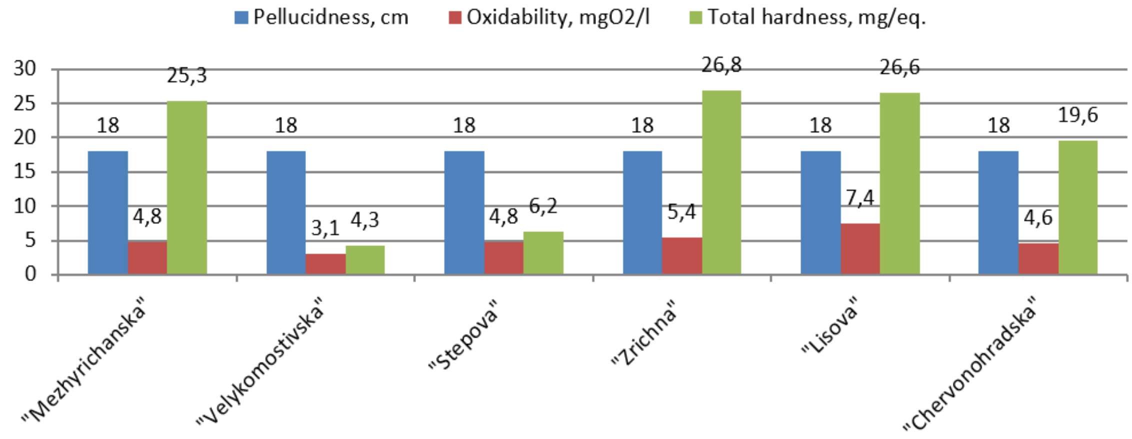


Figure 3. Indicators of transparency, oxidation and hardness of subtericone wastewater.

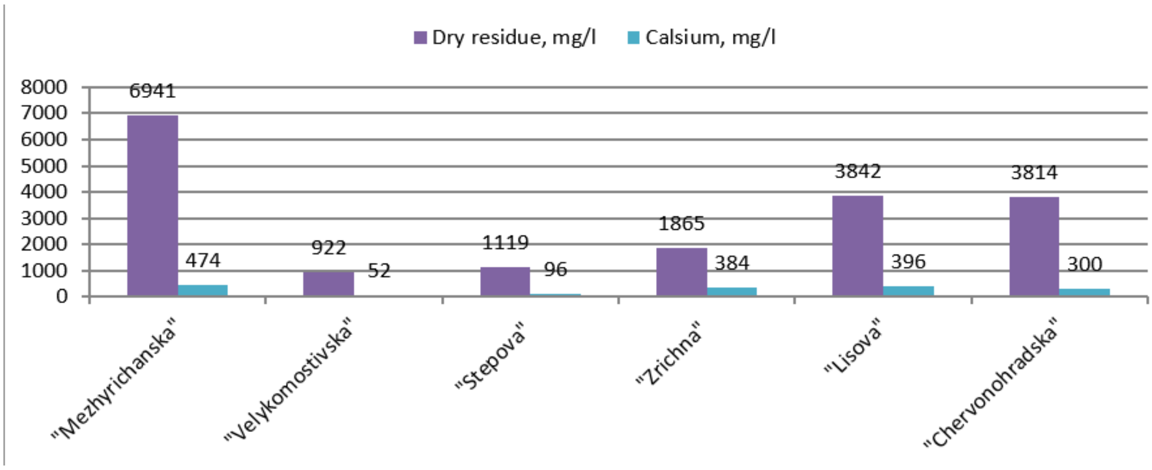


Figure 4. Dry residue and calcium content in subtericone wastewater.

The aluminum content is due to its subsequent ingress from the subsoil, as the mine is still in operation. The aluminum and chromium content in the subtericone wastewater of the studied mines is shown in Figure 5.

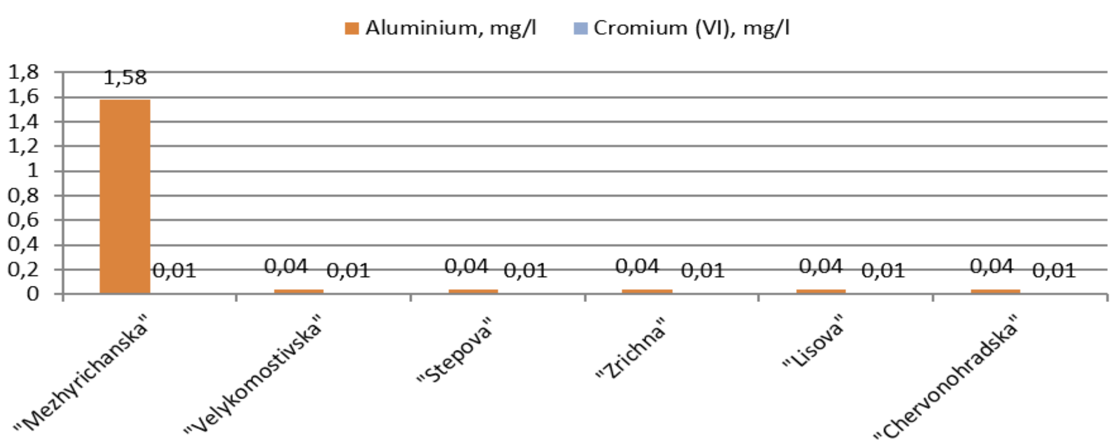
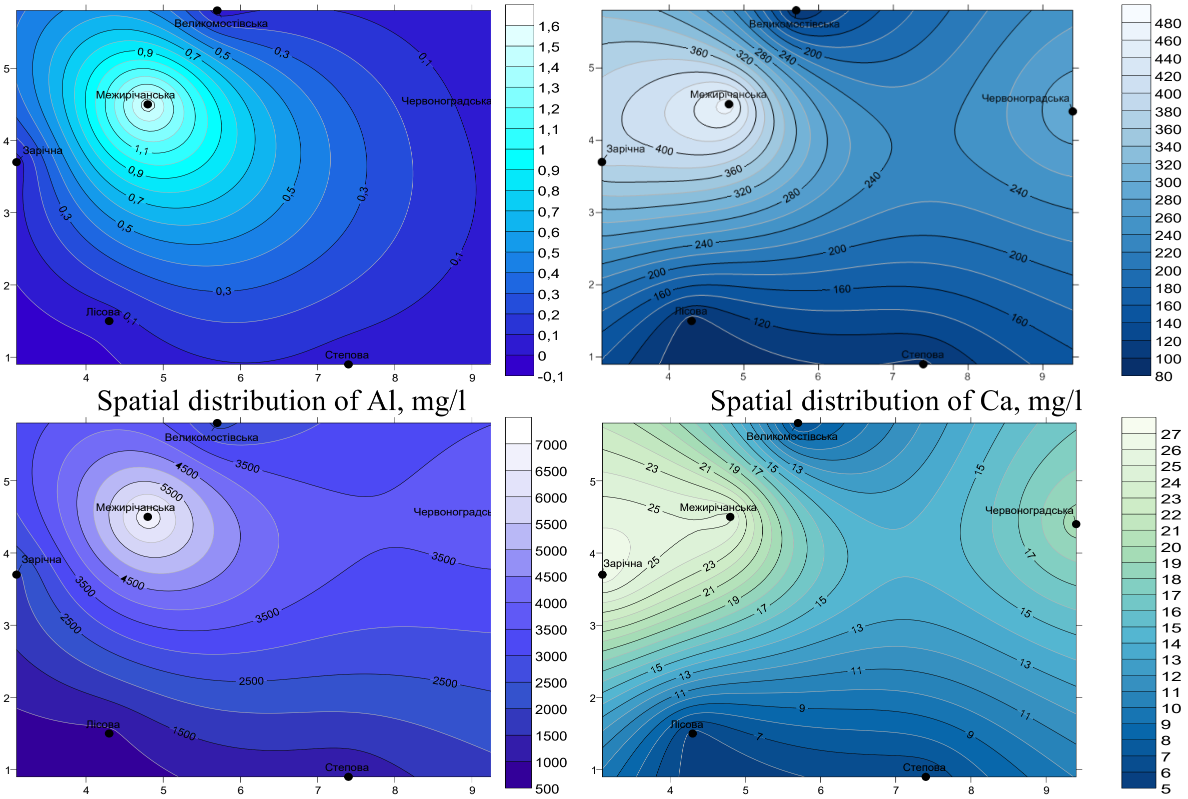


Figure 5. Aluminum and chromium content in subtericone wastewater.

Taking into account the aforementioned indicators of the pollutants content in subtericone wastewater, we have simulated the distribution of pollutants in the mining region is shown in Figure 6.



Spatial distribution of Al, mg/l

Spatial distribution of Ca, mg/l

Dry residue of subtericone wastewater, mg/l

Hardness of subtericone wastewater, mg/l

Figure 6. Modeling of the pollutants distribution in subtericone wastewater within the Chervonohrad mining region.

The Surfer program is designed to interpolate, approximate and visualize the functions of two variables, as well as fields defined at points on a flat area. In the manufacture of maps used the technique of overlaying on the raster basis of the display of the field constructed map. After that the Surfer display for overlay on a raster basis is constructed. If the latter are built in the same dimensions, then they fit exactly to the raster base. Modeling of pollutants distribution gives an opportunity to estimate the distribution index of hazardous substances outside the investigated area basing on digital values. One of the most acceptable methods of liquidation of negative factors of waste heaps of mines is vegetative reclamation. For non-natural vegetative reclamation it is necessary to carry out the mining stage, which involves leveling the surface for planting forest crops. Such attempts were made within the waste heap of the Mezhyrichanska mine is shown in Figure 7.

Figure 7. Prepared for reclamation of waste heap of mine "Mezhyrichanska" (Chervonohrad) - one of the biggest man-made heap.

4. Conclusions

Surface preparation of the disturbed land for further reclamation is carried out in areas where mining is completed. The necessity for surface planning is determined primarily by the choice type of reclamation of disturbed lands. Depending on the type of further economic development, continuous, partial, or terrace surface planning can be performed. Continuous surface planning is carried out mainly for agricultural land development, partial – for forestry needs, terrace – for afforestation and horticulture. Continuous planning involves surface leveling with the slopes available for tillage equipment. The magnitude of the slope depends on the type of biological reclamation and climatic conditions of the area. Partial planning means surface leveling while preserving the characteristic features of the relief of disturbed lands. At partial planning of ridge heaps tops of ridges are cut off, and width of the created platforms has to be not less than ten meters. If the dump has a slightly undulating surface, it can be used without planning for forestry development.

Thus, in order to increase the aesthetics and reduce the man-caused impact of waste heaps in the urban environment, it is necessary to implement recultivation and vegetative reclamation. It will lead to the rational use of lands disturbed by mining and also significantly reduce the man-made impact on environmental safety of the region.

References

[1] Petlovanyi M and Medianyk V 2018 Assessment of coal mine waste dumps development priority. Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu **4** 28–35
[2] Popovych V, Stepova K, Voloshchyshyn A and Bosak P 2019 Physico-chemical properties of soils in Lviv Volyn coal basin area. E3S Web of Conferences **105** 02002
[3] Abramowicz A, Rahmonov O, Chybiorz R and Ciesielczuk J 2021 Vegetation as an indicator of underground smoldering fire on coal-waste dumps. Fire Safety Journal. **121** 103287
[4] Abramowicz A Rahmonov O and Chybiorz R 2021 Environmental Management and Landscape Transformation on Self-Heating Coal-Waste Dumps in the Upper Silesian Coal Basin. Land. **10** 23
[5] Abisheva Z, Karshigina Z, Bochevskaya Y, Akcil A, Sargelova E, Kvyatkovskaya M and Silachyov I 2017 Recovery of rare earth metals as critical raw materials from phosphorus slag of long-term storage. Hydrometallurgy **173** 271–282

[6] Buzylo V, Pavlychenko A, Borysovska O and Saveliev D 2019 Investigation of processes of rocks deformation and the earth's surface subsidence during underground coal mining. E3S Web Conf. **123** 01050
[7] Kucheryavyj V 2000 Phytomelioration (Lviv. Svit) p 520
[8] Cudečka-Puriņa N, Ābele L, Atstāja D and Cudečkis V 2019 The Baltic countries towards the goals of waste framework directive. Landsc. Arch. Art. **14** 102–109
[9] Koval V, Olczak P, Vdovenko N, Boiko O, Matuszewska D and Mikhno I 2021 Ecosystem of environmentally sustainable municipal infrastructure in the Ukraine. Sustainability **13(18)** 10223
[10] Mikelsone E, Atstaja D, Koval V, Uvarova I, Mavlutova I and Kuzmina J 2021 Exploring sustainable urban transformation concepts for economic development. Estud. econ apl. **39(5)**