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DYNAMICS OF CHEMICAL PROPERTIES IN THE MINE TECHNOSOLS AFTER SIX YEARS OF RECLAMATION

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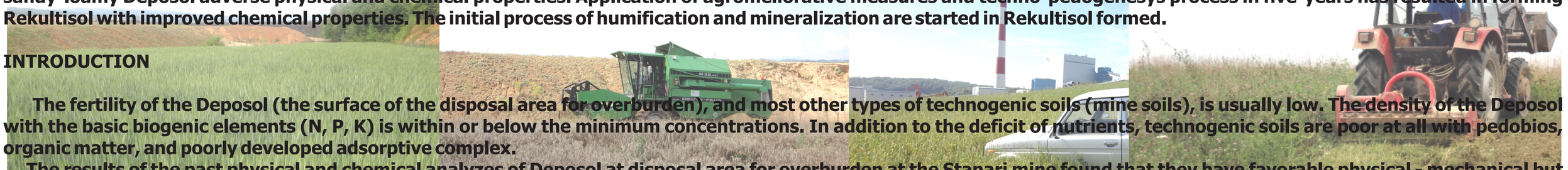
ABSTRACT

The open pit mining results in disturbance of a very large area landscape. The research of agro-technical and biological phases of soil reclamation by seeding and growing different agricultural crops was conducted on technogenic soil in Stanari coal basin. The aim of this survey refers to implementation of reclamation of technogenic soil in Deposol–plant–Rekultisol system on plateau at internal disposal area for overburden from Raškovac open pit in EFT – Mine and Thermal Pover Plant Stanari (Republic of Srpska, Bosnia and Herzegovina). The survey task refers to examination of the dynamics of main chemical properties in the technogenic soil through six-years period reclamation (2011–2016). The analyzed chemical properties in technogenic soil are as follows: organic matter content, humus content, N, P_2O_5, K_2O. Biological reclamation is carried out by establishing the vegetation in two directions: seeding perennial grassland, and growing of annual arable crops. The research was conducted in a direct type of reclamation of the sandy-loamy Deposol adverse physical and chemical properties. Application of agromeliorative measures and techno-pedogenesys process in five-years has resulted in forming Rekultisol with improved chemical properties. The initial process of humification and mineralization are started in Rekultisol formed.



INTRODUCTION

The fertility of the Deposol (the surface of the disposal area for overburden), and most other types of technogenic soils (mine soils), is usually low. The density of the Deposol with the basic biogenic elements (N, P, K) is within or below the minimum concentrations. In addition to the deficit of nutrients, technogenic soils are poor at all with pedobios, organic matter, and poorly developed adsorptive complex.

The results of the past physical and chemical analyzes of Deposol at disposal area for overburden at the Stanari mine found that they have favorable physical - mechanical but unfavorable chemical properties (Malić, 2015; Malić and Marković, 2012; Malić, 2010). The same authors state that, based on the content of organic matter, the researched Deposol belong to the class of low and medium content, while there is no pure humus and nitrogen. According to the content of P_2O_5 and K_2O in the Deposol, they are classified as very poorly secured by these elements. The Deposol is characterized by a non-carbonate substrate, a strong unsaturation with base cations, a medium and highly acidic chemical reaction. For technogenic soils, one of the most important active factors is anthropogenic activity. This activity with reclamation measures can significantly direct and accelerate the processes of pedogenesis.

Geological series of roof coverings of coal layer on the surface mine Raškovac at the Stanari mine are mostly mixed sandy-pebbles, and clay zones and layers. These materials represent poorly bound and unbound sediments. The roof cover thickness varies from 10 to 60 m. The sandy material is a quartz mineralogical composition and of such low fertility.

MATERIAL AND METHODS

The coal basin Stanari is located between 44°40' and 44°50' north latitude and 17°45' and 18°00' east longitude, in the northern part of the Republic of Srpska and Bosnia and Herzegovina (Fig 1). Research on biological reclamation of a direct type was carried out in an experimental field (y: 6.486.822.33, x: 4.957.645.63, z: 220 m) at the internal disposal area for overburden of the excavation from the surface mine Raškovac in the lignite coal basin Stanari. Part of the disposal area for overburden site where the experimental field is located was formed during 2010.

The experimental field is without inclination. The first factor of research is year (factor A), with six treatments: a_1 - 2011, a_2 - 2012, a_3 - 2013, a_4 - 2014, a_5 - 2015, and a_6 - 2016 year.

The second factor of research is system based vegetation, or different plant species within the framework of agro-technical and biological reclamation (factor B), with two treatments. Treatment b_1 is a seeding grassland based on the sowing of complex grass-leguminous mixtures, with the following species: Festuca arundinacea Schreb., Festuca rubra L., Dactylis glomerata L., Phleum pratense L., Poa pratensis L., Trifolium repens L., Trifolium pratense L., and Medicago sativa L. Treatment b_2 encompassed the crop rotation of the following annual arable crops: Sorghum bicolor (L.) Moench., Sorghum sudanense Pers., Secale cereale L., x Triticosecale Wittmack, and Triticum aestivum L.

The analysis of the technogenic soil included the examination of the following parameters: content of organic matter, humus, total N, P_2O_5 and K_2O. For the purposes of laboratory pedological research, the average samples of the Deposol were taken before the study at the beginning of reclamation, and the samples of Rekultisol at the end of the vegetation in 2012, 2013, 2014, 2015 and 2016 (Fig 2). The samples were taken from a depth of 0-20 cm.

According to the soil classification in Bosnia and Herzegovina, the newly discovered soil mines belong to the class of technogenic soils (types: Deposol and Rekultisol). The researched Deposol and Rekultisol are of a silicate subtype. According to the WRB classification (2014), these soils are determined as technosols (Epiarenic and silicit material).

The average rainfall for the six-years period (2011-2016) amounted 1086 mm. The average annual air temperature for the same period was 12,5 °C.

Fig 2 Rekultisol profiles

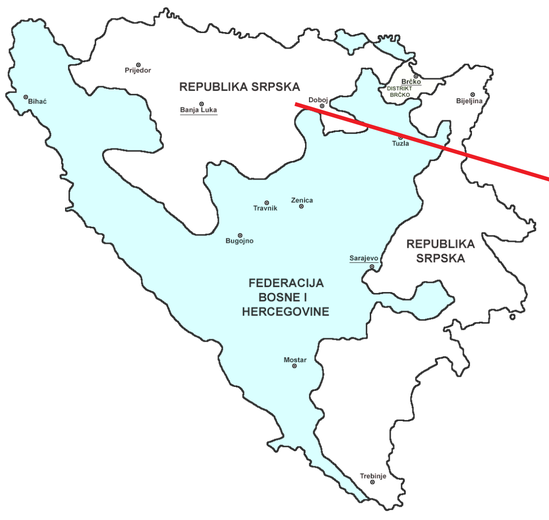
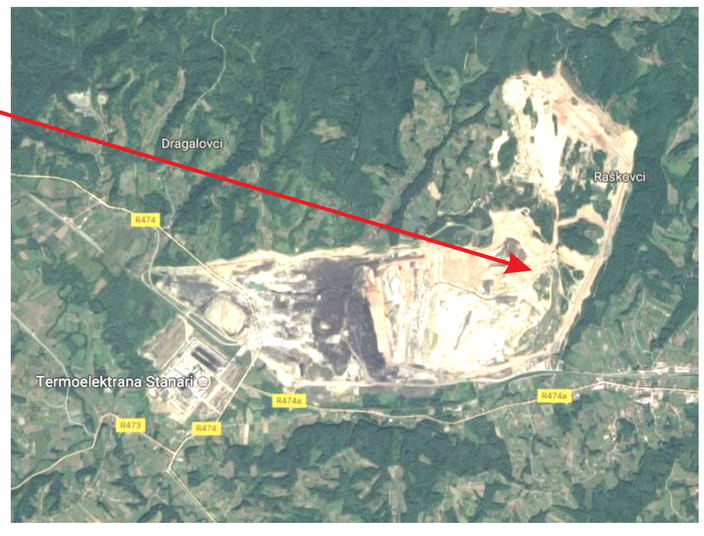
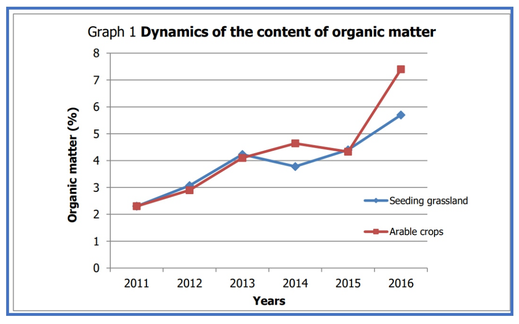


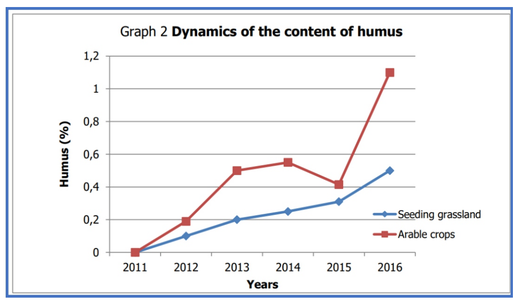
Fig 1 Experimental field location

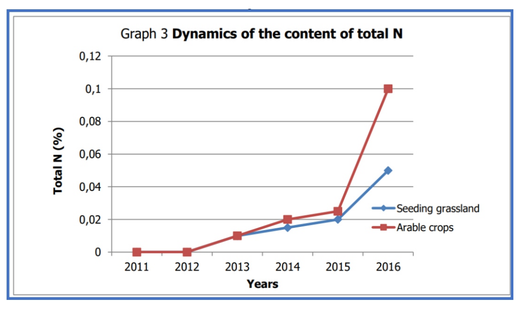


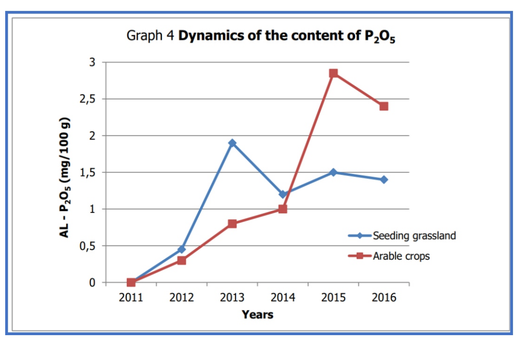
RESULTS AND CONCLUSIONS

The results of the analysis of the chemical properties in the technogenic soil are given on the following graphs (Fig 3).









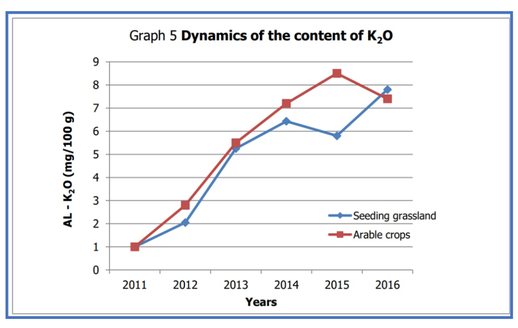


Fig 3 Graphs 1-5 (Dynamics of the content of organic matter, humus, total N, P_2O_5 and K_2O)

The accumulation of unplanned plant residues in the surface of Rekultisol, as an important feature of biological reclamation, resulted in an average increase in organic matter content in the range of values from 5.7% (arable crops) to 7.4% on treatment under the grassllland.

The appearance of humus has been established since the second year of the research, which is evidence of the established humification of organic matter, and as a direct consequence of the efficiency of the applied biological reclamation measures of the Deposol.

Total nitrogen was determined in samples at the end of the third year of cultivation, whose value at the end of the study increased to 0.05% (treatment with seeding grassland), and 0.1% (with arable crops).

The value of plant available phosphorus at the end of the study is 1.4 mg of P_2O_5/100 g of soil, on plots under seeding grassland, and 2.4 mg of P_2O_5/100 g of soil on plots under arable crops.

The value of plant available potassium at the end of the study is 7.8 mg of K_2O/100 g of soil, on plots under seeding grassland and 7.4 mg of K_2O/100 g of soil for the treatment of arable crops.

Under the influence of intensive implemented measures of biological reclamation on the Deposol, forming of the reclamated soil was conditioned, the type of Rekultisol, which indicates improvement of the researched chemical properties.