

Reclamation of Post-Mining Lands by Conversion of industrial waste and combustion by-products into soil covers: A study in Poland and Slovenia

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Abstract:

This paper presents a study of land rehabilitation of coal-mine affected areas with intensely eroded slopes, highly acidic characteristics, and the possibility of subsidence in two post-mining areas (Poland and Slovenia). The primary purpose of this research was to convert coal combustion by-products (CCPs), industrial waste, and organic materials into high-quality artificial soils with parameters for plant growth and development.

Several mineral products including fly ashes, aggregates, sludges, slags, or decarbonization lime with amendments of organic materials (carbon lignite or spent mushroom compost) have been investigated as components of soil substitutes. A series of physicochemical and phytotoxicity tests of the artificial soils and their water leaches showed that the content of valuable nutrients (N, P, K, Ca, and Mg) was adequate for proper plant growth. The concentration of toxic elements (As, Cd, Cu, Cr, Ni, Pb, and Zn) did not exceed the permissible thresholds and may be applied in green areas, including wooded or shrublands.

Furthermore, the possibility of using industrial water from Slovenian lignite mine for irrigation soil substitutes was investigated. The concentrations of ions responsible for salinity (SO_4^{2-} , Cl^- , Na^+ , and K^+) and the content of heavy metals did not exceed the limits for irrigation water.

The results revealed that mixtures of CCPs with mining and organic wastes have great potential for use as soil covers due to their physicochemical properties and negligible environmental risk. Moreover, applying soil substitutes for land reclamation supports the circular economy approach, which aims to minimize waste and reuse.

Keywords: coal combustion by-products, reclamation, heavy metals, artificial soils, circular economy

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