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Influence of fly-ash produced by lignite power station on humic substances in ectohumus horizons of Podzols

Jerzy Weber (1), Maria Jerzykiewicz (2), Elżbieta Jamroz (1), Andrzej Kocowicz (1), Magdalena Dębicka (1), and Irmina Ćwieląg-Piasecka (1)

(1) Wroclaw University of Environmental and Life Sciences, Wroclaw, Poland (jerzyweber@gmail.com), (2) University of wroclaw, Department of Chemistry, Wroclaw, Poland (maria.jerzykiewicz@chem.uni.wroc.pl)

Literature on fly-ash influence on the environment report mainly on alkalization effect on vegetation and changes in chemistry of forest floor. As far as now soils were examined only for changes in pH in surface horizons, physical properties and heavy metal solubility. Soil properties strongly depend on soil organic matter content and humic substances properties, thus their modification plays a crucial role in soil forming processes and changes in the environment. From the other side, the alkalization effects on podzolization processes and particularly on humic substances have not been recognized. The aim of this paper was to characterize changes in properties of humic substances in ectohumus horizons of Podzols affected by alkali blown out from fly-ash dumping site of power station Bełchatów, central Poland.

The objects of the investigation were Podzols derived from loose quartz sand, developed under pine forest. They surround the dumping site, which was established to store wastes from lignite combustion in Bełchatów power station. The samples were collected from ectohumus horizons in direct vicinity of the dumping site (50 m) as well as in the control area (7.3 km away) in five replications. Determination of elemental composition and spectroscopic analysis (EPR, FT-IR, ICP-OES and UV-Vis) were performed for humic acids, fulvic acids and humines extracted with standard IHSS procedure.

An increase of pH in ectohumus horizons caused by the influence of fly-ash leads to change in humic substances structure. Obtained results showed that humic and fulvic acids from fly-ash affected Podzols indicated higher contents of nitrogen and sulphur, as well as higher O/C and lower C/N ratios. This points out a higher degree of their humification. Also EPR analyses of humic acids and humins affected by fly-ash indicated higher metal ions concentrations. However, the increase of Mn and Fe ions concentration did not affect the Fe(III) and Mn(II) band intensities of EPR spectra. This may suggest the presence of other forms (other oxidation state) of Mn and Fe ions, that are diamagnetic and hence EPR silent. Lower g-factors values of radicals built-in humic substances extracted from fly-ash affected soils are associated with more condensed structures with lower content of oxygen functional groups. Decrease of free radicals concentration in Podzols affected by fly-ash is correlated with an increase of the transition metal ions, such as Mn(II) and Fe(III), which interact (antiferromagnetically) with semiquinone radicals built-in humic substances macromolecules.

Humic acids from fly-ash affected site indicated lower values of E4/E6 ratio, which confirmed higher molecular weight of the molecules. Thus the humic fractions from ectohumus horizon of the fly-ash affected area could be described as having heavier, more complex structure then those from control area.

Above mentioned modification of humic substances may contribute to restriction of the podzolization processes, and transformation of underlying eluvial horizons into transitional AE horizons. Furthermore, due to transformation and translocation of organic components, illuvial Bhs horizons can be transformed into Bs horizons.