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Development of biological soil crusts and their influence on soil hydrology in the recultivation area of lignite open-cast mining district in Lower Lusatia (Germany)

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Cyanobacteria, green algae, mosses and lichens are often the first colonizers of substrate and initial soil surfaces. They are an important factor of initial soil formation as they stabilize the substrate and decrease erosion processes. Biological soil crusts accumulate the initial soil organic matter and provide nitrogen fixation. Once settled, the crusts influence the soil water regime by delaying or limiting infiltration through enhanced water repellency. Aim of this study was to compare the influence of biological soil crusts on soil hydrology under conditions on various substrates and of different ages in recultivated areas of the open-cast mining district of Lower Lusatia (Brandenburg, NE Germany) with various recultivation aims.

In Brandenburg (NE Germany), where the climate is transitional between oceanic and continental and the summers are characterized by generally low of precipitation (mean annual rainfall 559 mm, mean annual temperature 9.3˚C) open landscapes provide ideal conditions for biological soil crusts, e. g. on mobile sand dunes in former military training areas and in recultivation areas related to open-cast mining with initial soil development. Here biological soil crusts are commonly found (Spröte et al., 2010). At five study sites in recultivation areas with different reclamation approaches (natural development, pine reforestation, birch reforestation) we defined four types of biological soil crusts: i) cyanobacterial and green algae crusts on the soil surface with no vegetation where dominating sand grains were physically stabilized in their contact zones by this crust type (type 1), ii) cyanobacteria and green algae partially filled in the matrix pores and enmeshed sand grains between sparse vegetation cover (type 2), iii) biological soil crusts with mosses which covered most of the surface between the vegetation (type 3) and (iv) with soil lichens (type 4).

We investigated the development of the amount of chlorophyll a which is an indicator for biomass productivity and depends from the species composition and crust type, and the water repellency index which shows the influence of biological soil crusts on hydrological parameters. Additionally, organic matter content (dry combustion) as well as soil pH (soil: H_2O = 1:2.5) were determined. Texture was analysed by wet sieving and fractionation pipette method.

At all study sites and for all crust types soil pH ranged between 7.2 to 4.7 and decreased from type 1 to type 4. Soil organic matter and chlorophyll a concentrations ranged from 0.3 and 1.7% and from 0.95 to 16.44 mg m^{-2}, respectively, and increased from type 1 to type 4. With few exceptions, water repellency indices ranging between 1.0 and 1.85, followed this trend. Constrarily, infiltration rates decreased from type 1 to type 4. The cause for limited infiltration is the swelling of extracellular polysaccharides in the biological soil crusts (Fischer et al., 2010) and the influence of the particle size distribution and porosity of the substrate with a relatively high content of silt and clay at some study sites.

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