DOI https://doi.org/10.30525/978-9934-26-111-4-3

SUCCESSION TRAITS OF THE TRANSFORMED GRASSL AND VEGETATION IN THE AREA FLOODED DUE TO COAL MINE WORKINGS

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Environmental consequences of underground coal mining are numerous and can affect the relief change and transformation of the vegetative cover of the disturbed areas as well [1]. In the steppe zone of Ukraine, Western Donbass coal basin is the region with intensive underground mine working already for last 50 years. Operation of the coal mines has led today to landscape transformation, subsidence of the soil surface, flooding and formation of the technogenic water bodies [2]. Native vegetation of these areas is replaced by new plant communities that are not typical for the steppe zone, including the wetland species emergence. Unfortunately, the herbaceous vegetation state of the transformed grasslands has become a subject of study only in the last years [3]. We assumed that succession pathway in the area of permanent flooding due to mine workings should differ from both primary successions in technogenic ecotopes and secondary successions that occur after the termination of disturbances. The aim of this work was to reconstruct the possible trajectory of herbaceous communities change during last decades in the zone of permanent flooding.

The study was carried out in 2018–2020 on the territory of former pastures an area near 1 km^2 (48º29'01.9" N 36º02'36' E'), where some technogenic water bodies were formed by groundwater, melt and rainwater

in the sites of surface subsidence. Vegetation study was carried out in three different types of plant habitat: dry (site 1, xero-mesophilic), wet (site 2, mesophilic, and site 3, meso-hygrophilic) and flooded (site 4, hygrophilic). 36 vegetation records were done along 9 transects around 3 technogenic ponds. Vegetation in the adjacent area within a radius of 100 m from the subsidence zone (control site, xerophilic) was studied to account for herbaceous plant species that could be a diasporas source for spontaneous succession.

In total, 83 species of herbaceous plants belonging to 31 families and 66 genera were identified in spontaneous vegetation in the zone and permanent flooding. Of these, 8 families belong to monocotyledons, and 23 families belong to dicotyledons. The greatest similarity with undisturbed vegetation was revealed for site 1 (31.3 % according to Jacquard coefficient), while only 20.7 % in a more saline and humid habitat The species composition in meso-hygrophilic habitat with salt marshes was very different from the undisturbed one (1.4 %), and a complete dissimilarity with the surrounding vegetation was established for hygrophilic habitats near the technogenic ponds. Thus, in the most transformed habitat of flooding zone, species richness and abundance were provided by specialists, while sites with mesic conditions created suitable opportunities for the successful development of both specialists and generalists. A similar species distribution had the natural mosaic vegetation in the zone of spring marshes surrounded by semi-dry meadows [4], which indicates some common features in the vegetation of fragmented territories. Recovery of the target vegetation is not observed in all cases of spontaneous successions [5], and the species composition was not the same as that observed in undisturbed bogs. However, spontaneous successions in the completed workings territory indicate that the target vegetation restoration took place over 25 years [6, 7].

Judging by our work results, restoration of the target vegetation did not occur for 25 years of permanent subsidence and flooding, exacerbating the transformation of the natural environment. Such a direction of succession cannot be expected due to the radical transformation of the landscape, hydrological regime and soil, the result of which is the formation of habitats that do not have similarities with the conditions of target vegetation existence. In addition, the transformed territory has a mosaic character, which contributes to the creation of local plant communities that are different from the neighboring ones: the inhabitants of semi-dry and moist meadows, salt marshes and wetlands are adjacent at close distances. A similar local coexistence of several ecological groups of species was noted on undisturbed grasslands [4] and explained by the variable humidity

conditions, which are accepted by many species, resulting in a species-rich community with a unique species composition. Based on the study results, we built a possible sequence of herbaceous plant synusia on the territory of permanent surface subsidence and flooding (Figure).

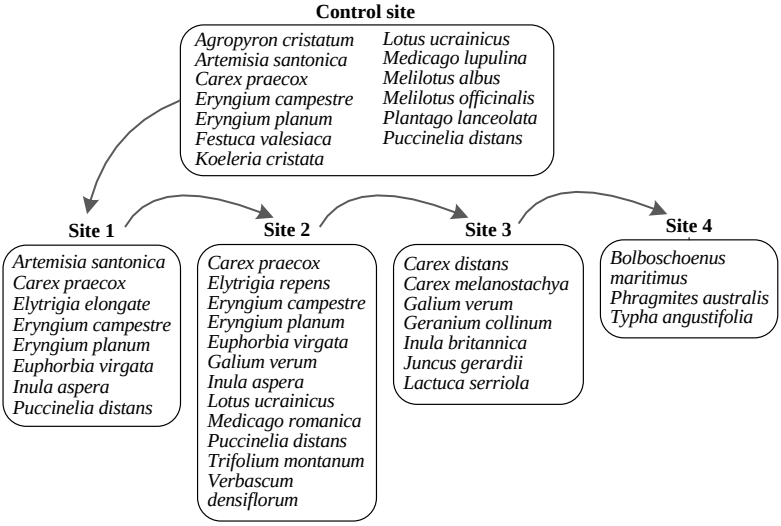

Figure. Hypothetical scheme of the sequential herbaceous plant communities in flooding zone on the territory of Western Donbass coal basin

So, radical change in herbaceous vegetation of the former pastures was determined by disturbance of soil and hydrological conditions in the subsidence and flooding zone. Properties of transformed habitats contributes to the formation of dissimilar grassy communities on neighboring sites, including xerophytic steppe species, mesophytic meadow species, halophytes and wetland plants. Restoration of semi-natural grasslands did not occur during the 25 years of ongoing flooding of the territory. The unusual species composition in the flooded area is complemented by a significant number of rare and endangered herbaceous species that we have discovered. The potential ability of transformed territories to provide valuable habitats, such as wetlands or dry pastures, in combination with the right management methods, points to the prospects of revival the vegetation in studied area of subsidence and flooding zones in Western Donbass.

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