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Soil and sediment microbial structure and function in intermittent stream corridors after a decade of catchment succession

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Large-scale resource exploitation by open-cast mining severely alters landscapes and impairs key ecosystem properties such as soil and sediment structure and function. Understanding the ecological recovery processes starting from an initially bare landscape generated by destructive land-use is extremely limited. Here we took advantage of a 6-ha experimental catchment to assess microbial community structure and function in soils and stream sediments after 3 and 13 years of catchment succession. The catchment (Chicken Creek) was created in 2005 by depositing quaternary sands from a lignite mine forefield in northeastern Germany and has since been left to develop under undisturbed conditions. In the initial stage, 3 years after catchment construction, rills and small streams had formed and the sparse vegetation cover mainly consisted of forbs. Over the next 10 years, the geomorphology, hydrology, and vegetation structure underwent a major transformation. A nearly full vegetation cover established, including various tree, shrub and grass species. Increased evaporation lowered the shallow groundwater table and led to stream intermittency. These changes were accompanied by large modifications in the structure and function of the microbial communities in sediments and soils. Initially, microbial structure and function were strikingly disconnected, whereas linkages had established 10 years later, although some functions still remained disconnected. Potential enzymatic activities increased vastly over the course of 10 years and also became much less variable across seasons. Cyanobacteria, predominant in soils and sediments during the early successional stage, declined to become a minor component of the microbial community. Moreover, despite distinct flow intermittency of the streams, microbial structure and function distinctly differed between sediments and adjacent soils. These results demonstrate a rapid succession of microbial communities during a decade of ecosystem development, suggesting that undisturbed succession is a feasible catchment restoration strategy.