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Natural ponds in an agricultural landscape: External drivers, internal processes, and the role of the terrestrial-aquatic interface

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Keywords

Ponds; kettle holes; water quality; land use; hydrogeomorphic type; shore vegetation

Abstract

The pleistocenic landscape in North Europe, North Asia and North America is spotted with thousands of natural ponds called kettle holes. They are biological and biogeochemical hotspots. Due to small size, small perimeter and shallow depth biological and biogeochemical processes in kettle holes are closely linked to the dynamics and the emissions of the terrestrial environment. On the other hand, their intriguing high spatial and temporal variability makes a sound understanding of the terrestrial-aquatic link very difficult. It is presumed that intensive agricultural land use during the last decades has resulted in a ubiquitous high nutrient load. However, the water quality encountered at single sites highly depends on internal biogeochemical processes and thus can differ substantially even between adjacent sites.

This study aimed at elucidating the interplay between external drivers and internal processes based on a thorough analysis of a comprehensive kettle hole water quality data set. To study the role of external drivers, effects of land use in the adjacent terrestrial environment, effects of vegetation at the interface between terrestrial and aquatic systems, and that of kettle hole morphology on water quality was investigated. None of these drivers was prone to strong with-in year variability. Thus temporal variability of spatial patterns could point to the role of internal biogeochemical processes. To that end, the temporal stability of the respective spatial patterns was studied as well for various solutes. All of these analyses were performed for a set of different variables. Different results for different solutes were then used as a source of information about the respective driving processes.In the Quillow catchment in the Uckermark region, about 100 km north of Berlin, Germany, 62 kettle holes have been regularly sampled since 2013. Kettle hole catchments were determined based on a