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Small-Scale Heterogeneities of Nutrients in a Floodplain′s Aquifer

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After reducing point sources, diffuse nutrients entering from groundwater into surface water have become a more important factor of eutrophication. In this context the floodplain of a river is of primary importance, because it is the reactive interface between terrestrial and aquatic habitats. However due to their genesis floodplains have usually a very heterogeneous structure, which is a challenge for investigations and for drawing general conclusions.

Therefore the present study aims to identify the relevant processes in the floodplain′s aquifer and thereby give an explanation for the distribution patterns of nutrients in the aquifer. The investigated floodplain is situated at the river Spree and is bordered by a reopened meander and an artificial canal due to straightening of the watercourse. Former groundwater investigations along a transect by temporary piezometers have shown high spatial heterogeneity (scale: meter) of the concentrations of phosphate, ammonium and dissolved iron, whereas the temporal variation is negligible. We hypothesize that the reason for the spatial distribution of nutrient concentrations is the meander′s movement in the past. To identify the area, where the movement took place ground penetrating radar images were used, which show the lateral and vertical accretions of former point bars. Additionally, the small scale topography of the floodplain which consists of ridges and swales (meander scroll bars) is an indicator for former meanders. These show different densities and types of vegetation. We assume that different infiltration patterns and the different availability of organic matter lead to the observed heterogeneous nutrient concentrations in the aquifer. The investigation was conducted with temporary piezometers for three ridges and swales each with six piezometers in an area, where the meander scroll bars are situated close to each. The aforementioned assumption is supported by the results. The concentrations of phosphorous and ammonium differ significantly between ridges and swales, whereby they are higher below the swales. The concentrations of dissolved iron do not show any correlation to the surface structure. This suggests that the nutrient delivery to the groundwater is dominated by the degradation of organic material.

According to that, the extent of vertical nutrient dislocation in dependency of groundwater level fluctuations was estimated. Investigations were conducted by multi-level-piezometer, which allow sampling with a spatial resolution of 10 cm from 24 different horizons. The vertical distribution is characterized by near-surface peaks of phosphate, ammonium and dissolved iron. The upper part of the peak seems to be influenced by seasonal nutrient uptake by plants. Below the peak the concentrations are constantly low. Hence there is a stratification of the aquifer, which is influenced by organic degradation and nutrient disposal processes.

In conclusion the distribution of nutrients in a floodplain′s aquifer should be examined with a high vertical and horizontal resolution. The vertical heterogeneity is effected by sediment and water level. The horizontal heterogeneity is influenced by vegetation, land use, soil type and small scale topography.