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Hydrochemical properties of artificially drained catchments: Results from a six-year study

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Artificial drainage is a common practice to improve moisture and aeration conditions of agricultural land. It shortens the residence time of water in the soil and may therefore contribute to the degradation of peatlands as well as to the still elevated level of diffuse pollution of surface water bodies, especially if flow anomalies like preferential flow cause a further acceleration of water and solute fluxes.

To evaluate the environmental impact of artificial drainage on surface water bodies, it is especially important to understand how the tile drain discharge and its solute signal translate to the larger scales, i.e. to ditches and rivers. As most tile drainage studies so far merely focused on the plot scale, a hierarchical water quantity and quality measurement programme was initiated in the federal state Mecklenburg-Vorpommern (North-Eastern Germany). The core of the monitoring programme (2001-2007) in the pleistocene lowland catchment were automatic sampling stations at a collector drain outlet (I, 4.2 ha catchment), at a ditch draining arable land on mineral soils (II, 179 ha), at a ditch mainly draining grassland on organic soils (III, 85 ha) and at a brook with a small rural catchment (IV, 15.5 km^2).

Precipitation and discharge totals ranged from 447 to 934 mm and from 52 to 318 mm, respectively. The discharge showed a synchronous behaviour at all sampling stations except for the grassland station which reacted with a delay of one day. Nitrate-nitrogen concentrations - on average 11.8 mg/l (I), 8.8 mg/l (II), 9.8 mg/l (III) and 4.3 mg/l (IV) - frequently exceeded the drinking water guideline of 11.3 mg/l and often fell within the worst water quality class in Germany. As the discharge, synchronous

nitrate-nitrogen concentrations at all scales showed the importance of the tile drainage for the catchments' hydrochemical behaviour. Nitrate-nitrogen concentrations generally increased with higher discharge rates. High solute losses of all measured substances (Na, K, Mg, Ca, Cl, N, P and S) always occurred at high flow rates, and, in the case of nitrate-nitrogen, a certain increase of the flow rate evoked a disproportionately high increase of the solute load. Annual nitrate-nitrogen losses ranged from to 4 to 55 kg/ha and were not related to nitrogen balance surpluses. Except for the wettest year, the contribution of the summer period to the total losses was low. Overall, tile drainage of arable land (N) and ditch drainage of peatlands (N and P) have been identified as the key factors for the diffuse pollution of artificially drained lowland catchments and need to be addressed when intending to reduce the diffuse pollution of lowland landscapes.