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Modelling interactions between hydrologic dynamics and biogeochemical processes in a riparian wetland of a low-order stream

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Abstract Low order streams often show complex, nonlinear relationships between hydrologic conditions in the riparian zone, streamflow generation and the chemical signature of the stream water. Dynamic surface and subsurface flow paths create a mosaic of biogeochemical conditions that affect the transformation and export of solutes. These relationships are explored in a virtual modelling study of a riparian wetland that links an integrated surface–subsurface flow model with a stream tube approach for biogeochemical reactions along individual flow paths. It is shown that the interplay between water table depth and surface micro-topography in the riparian zone results in distinct shifts between surface and subsurface flow dominance and the development of specific surface flow connectivity. Distinct nonlinear relationships between water table depth and stream discharge that reproduce relationships observed in the field were found. Simulated hydrologic dynamics and the resulting flow paths result in biogeochemical patterns in the riparian zone that are congruent with patterns observed in the field.

Key words hydrologic modelling; groundwater–surface water interactions; biogeochemical processes; micro-topography; riparian wetland