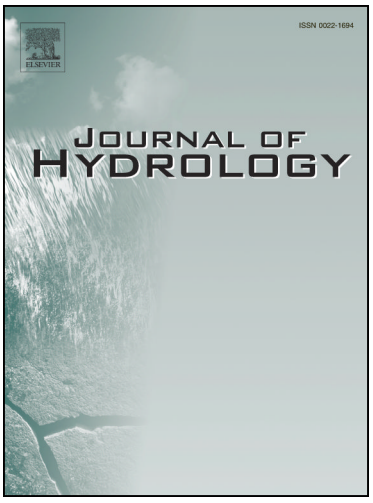

Research papers

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Groundwater dynamics at the hillslope – riparian interface in a year with extreme winter rainfall

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Abstract

Water movement in hillslopes is determined by the subsurface characteristics that control flow paths connecting precipitation to stream flow generation. The hydrological response of hillslopes is notoriously non-linear and non-stationary; with the relative importance of vertical and lateral flow paths also depending on event characteristics and antecedent conditions. In northern boreal regions, climate change projections indicate that wetter and warmer winter conditions are likely to generate more extreme flood events. Here, we report a study from an upland catchment in northern Scotland where a monitoring year provided an opportunity to contextualise observations during the hillslope response to a winter rainfall event that locally caused the most extreme flooding for over 200 years. Monitoring the hillslope water table, soil moisture and isotopes in precipitation, groundwater and stream flow provided invaluable insight into hillslope – riparian coupling. Groundwater with a shallow water table (<0.05 m deep) in poorly drained valley bottom drift deposits maintained almost fully saturated and stream-connected peat soil profiles in riparian areas. In the wettest periods, the groundwater beneath the peat was artesian. On steeper hillslopes, soils were drier and the water table was generally deeper (0.5 to 1 m below ground level), though the profile could fully saturate and groundwater levels reach the surface during the wettest period. Groundwater in deeper wells typically showed an anti-clockwise hysteresis compared to stream flow, and peak levels typically lagged behind the stream by a few hours in the valley bottom and >1