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Impact of artificial freshet releases on channel hydraulics and the hyporheic zone of a gravel bed river.

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The hyporheic zone has been the focus of considerable research and management interest in the last decade. An area of particular interest has been the temporal variability of hyporheic exchange in relation to changing hydrological conditions. Recent studies have shown that the physical and chemical characteristics of the hyporheic zone are highly dynamic, with variations in water chemistry reflecting changing source water contributions in response to changing in-stream hydraulics and water table elevation.. While the implications of natural discharge variability for groundwater-surface water interactions and hyporheic chemistry are increasingly well studied, less attention has been paid to the effects of artificial changes in discharge such as those which occur in regulated rivers. Artificial reservoir releases are now made in many regulated rivers as part of environmental flow regimes. These releases may either be for geomorphic purposes (e.g. to ensure natural geomorphic processes such as sediment transport occur; so-called “flushing flows”), for water quality objectives (controlling stream water temperature or chemistry) or for ecological reasons (e.g. encourage the upstream migration of salmonids). Few studies have assessed whether such releases alter groundwater-surfacewater interactions and hence hyporheic water chemistry in affected reaches. Moreover, it is unclear how changes in post-impoundment sediment transport dynamics affect the physical structure of the hyporheic zone.

This paper describes changes in stream hydraulics, hydraulic head and hyporheic water quality that occurred at sites in the River Lyon (Scotland) during an artificial summer freshet release from a HEP dam. The freshet lasted 12 hours and increased river discharge approximately 4-fold (from 1.2 to 5 m3 s-1). The magnitude of associated changes in velocity varied between riffle and pool habitats, with the maximum increase being from 0.2-0.6 m s-1. There were only subtle changes in streamwater conductivity, alkalinity and temperature during the release. Stream and hyporheic water quality tracked each other during the release indicating surface water dominance of the hyporheic zone. Hydraulic head data taken from piezometer nests showed no clear changes in pressure differential between depths, indicating that local groundwater – surface water interactions were relatively unaffected by the release. Overall, the freshet had a limited effect on surface and hyporheic water quality and hyporheic exchange processes. The only clear effects were on channel hydraulics although these appear to have been insufficient to drive notable changes in hyporheic exchange. However, flow regulation can also have long-term geomorphic impacts on river systems and at one of the sites, physical degradation of the bed appeared to restrict the potential for hyporheic exchange. Larger freshet releases, or releases made at different times of the year, may have different impacts, depending on antecedent hydrological conditions.