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Quantifying the evolution of transient storage in river restoration schemes

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River restoration has emerged as a policy-driven multibillion dollar industry that aims to return degraded river systems to improved structural and functional states, with the hope of subsequent ecosystem rehabilitation. Traditionally, design and monitoring of restoration schemes has focused purely on physical complexity to improve river appearance or fish habitat. However, it is now widely accepted that the ultimate success or failure of restoration is dependent on how well the physical complexity of the scheme supports biogeochemical function and stream ecosystem productivity. A key concept in this regard is transient storage, often defined as zones in a river corridor, such as surface pools and the hyporheic zone, where water is temporarily stored prior to returning to the stream at some later time. Temporary storage of water within the river corridor acts to slow the passage of a flood wave, thereby reducing flood impacts downstream. Increased contact time between stream solutes and reactive sediment media is also important for organic matter and energy cycling and contaminant transformation. Improvements in transient storage should therefore be seen as a key and desirable outcome of river restoration.

We apply a one-dimensional transient storage model (OTIS) in conjunction with a field-scale tracer injection in order to quantify hydrologic parameters (advection, dispersion, transient storage) affecting water transport in a river restoration scheme in Swindale Beck, Cumbria, United Kingdom. Eight separate tracer injections were conducted over a control (unmodified) reach and three restored reaches in 2016 and 2017. The tracer breakthrough curves were sampled at two locations in each reach allowing modelling of transient storage parameters in each discrete reach. Analysis of the tracer breakthrough curves suggests differences in transient storage between the control and restored reaches suggesting greater water storage and habitat diversity in the restored reaches. There was also considerable variability in transient storage parameters within the restored reaches which may relate to the geomorphic diversity of the scheme. On-going work aims to: (a) monitor the evolution of transient storage as restored reaches move towards hydro-geomorphic equilibrium, (b) establish the relative contribution of surface versus subsurface storage zones to transient storage, and (c) establish if there are spatial and temporal differences in nutrient assimilation between restored and unrestored reaches.