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Neural network modelling of sediment concentrations and hysteresis loops

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The mechanism of sediment transport in natural streams and rivers is a complex process that is difficult to model in either a traditional or a conventional manner. No direct or indirect empirical model of sediment transport has received universal acceptance and the challenge to discover a superior solution continues. The process of establishing a rating relationship between sediment concentration and fluvial variables equates to a non-linear mapping operation in which earlier statistical methods exploited the recognised relationship that exists between the volume of sediment that is transported and some integrated mixture of past and/ or present fluvial conditions e.g. discharge volumes, discharge velocities or sheer stress factors. The complicated nature of previous formulaic solutions necessitated cumbersome parameterisations and no detailed provision was made to incorporate the 'hysteresis effect'. The sediment concentrations for a given level of discharge in the rising stage of the hydrograph, can be higher or lower than the sediment concentrations for a given level of discharge in the falling stage of the hydrograph, depending on the relative position of the sediment source to the point of measurement and on the amount of sediment that is available for transportation. Traditional or conventional methodologies such as linear or non-linear regression are unable to accommodate such important variations in the relevant processes. The power of a neural network solution to capture this natural relationship has been tested and reported; but the resultant simplifications contained significant underestimations of important sediment-related events. This paper presents some recent findings based on the parameterisation of a self-organising feature map that is used to partition the observed relationship that exists between transported sediment and pertinent fluvial conditions. Hydrological topologies and trajectories are thereafter used to develop a dedicated model that is able to switch between different structural processes and mechanisms and thus offer a suitable construct for the incorporation of trigger

events. The reported findings relate to the Low Moor Gauging Station on the River Tees and are based on 15 minute records for two measurement periods: (1) December 1999 to April 2001; and (2) December 2001 to February 2003.