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Advances in catchment scale bank erosion modelling – quantifying the improved representation of temporal and spatial variability

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Channel bank erosion processes are influenced by numerous factors resulting in high spatial and temporal variability of sediment production. The representation of channel bank erosion is overly simplistic within most catchment models, despite its significance to catchment sediment budgets. Within this study, the physically-based distributed SHETRAN model is modified to incorporate bank vegetation and channel sinuosity factors that influence spatial and temporal bank erosion rates.

The modified model simulates the temporal variation of bank erosion in response to high magnitude events with the potential to remove bank vegetation and de-stabilise banks, thereby increasing erodibility. As vegetation re-establishes, simulated bank erodibility decreases. During the recovery period, banks have increased vulnerability to further high magnitude events that will result in increased bank erosion. This enables the model to represent the impact of flood clustering on sediment generation. The modified model also represents the spatial variation of bank erosion as a result of varying channel planform. Channel geometry has also been linked to bank erosion rates as a result of flow circulation within channels. Channel sinuosity shows a non-linear relationship with bank erosion, with bank erosion increasing up to a threshold value of sinuosity and decreasing as sinuosity increases above this point.

The original and modified models have been applied to the Eden catchment in north east England. Bank erosion data derived from a GIS overlay methodology covering 150 years has been used to validate the models, indicating annual sediment generation from bank erosion processes within the catchment is 410-4500 t yr-1, equivalent to 2-11% of the catchment sediment budget. Comparison of the original and modified models highlights the improved ability of the modified model to simulate annual variation of bank eroded sediment production; annual sediment production from the original model ranged between 1239-2527 t yr-1 whereas for the same time period the modified model simulated between 677-3142 t yr-1. The modified model provides greater accuracy of spatial variability of bank erosion throughout the catchment when compared with observational data, enabling identification of areas naturally susceptible to erosion, and providing an indication of where protection measures will be most effective. The new channel bank erosion component enables SHETRAN to provide a more complete representation of sediment generation processes at a catchment scale, which will assist successful management of diffuse pollution issues.