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Improved Assessment of Subgrid-scale Stream Bank Erosion for Two-dimensional, Depth-averaged River Restoration Modeling

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ABSTRACT

The near-bank region of a river, where the streambed and streambank meet, is often characterized by large spatial gradients in the river's geometry resulting in complex flow patterns and sediment transport rates and directions. In addition, the grain-size distributions and resistance-to-erosion properties of the bed and bank materials can be quite different. These processes result in lateral (bank) erosion rates that can be orders of magnitude greater than the rate of vertical adjustment of the riverbed. This discrepancy in erosion rates is often observed in natural meandering, braided, or anastomosing river systems. But, they can also be characteristics of disturbed streams and adversely impact floodplain infrastructure and resources, therefore requiring bank protection measures or stream corridor restoration. Multi-dimensional computer models of river morphodynamics used in stream restoration have either neglected or used overly simplified conceptual models of riverbank erosion, limiting them to studies of riverine environments where banks do not move, small time scales, or rather qualitative evaluations of the river's morphology. Though, riverbank erosion processes are relatively easy to implement into one-dimensional computer models, such as the US Department of Agriculture CONCEPTS channel evolution model, their incorporation into multi-dimensional computer models is rather complicated. Researchers at the US Department of Agriculture, University of Pittsburgh, and Electricity de France (EDF) have incorporated CONCEPTS' riverbank erosion algorithms into EDF's TELEMAC-2D/SISYPHE computer models of river morphodynamics. Whereas current multi-dimensional computer models use highly simplified bank geometry (e.g., vertical bank) and erosion mechanics (e.g., only fluvial erosion), the bank erosion simulation of the improved model is based on actual bank geometry and bank erosion processes. Further, it is tightly integrated with the simulation of river hydrodynamics and sediment transport processes using a porosity approach. The dynamic capabilities of the new model are highlighted by applications to the Goodwin Creek, Mississippi.