An automated model to design optimal check dam systems in erosion-prone areas

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The effect of check dams on a catchment's sediment yield is generally studied with process-based models, such as Soil and Water Assessment Tool (SWAT), Sediment Distributed Delivery (SEDD), or Soil Erosion and Sediment Delivery Model (WaTEM/SEDEM). A limitation of these models is their inability to simulate how the storage capacity of check dams varies with time. This is an important information for decision-makers: knowing the expected life expectancy of check dams can help determine their number, size, and location. To overcome such limitation, we propose a modelling framework consisting of two components, namely (1) WaTEM/SEDEM, and (2) a network-based model of check dam storage dynamics, which receives the initial sediment input from WaTEM/SEDEM. The framework is combined with a global optimization algorithm to determine the ideal configuration of check dam systems. In particular, the algorithm determines the location and size of check dams that optimize the catchment's sediment delivery ratio and two metrics related to the expected life expectancy of check dams. The model is tested on various areas of Chabagou catchment (Loess Plateau, China). Results show that alternative check dam deployments could have improved the life expectancy and sediment delivery ratio of the existing check dam systems.