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River bank erosion processes interaction and effects of riparian vegetation

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The aims of this research are: (1) to investigate the interaction between fluvial erosion and mass failure at the scale of single flow events; and (2) to quantify the main effects of riparian vegetation on bank stability.

A series of numerical simulations in which fluvial erosion, seepage, and mass failure models are fully integrated were performed for a monitored bank located along the Cecina River (Tuscany, Central Italy). Three significant flow events monitored during the period 2003-2004, representative of the typical range of annual hydrographs, were simulated. Each hydrograph was divided in a series of time steps, and then simulation of bank retreat included the following components for each time step: a) hydrodynamic modelling to calculate near-bank shear stresses; b) fluvial erosion and consequent changes in bank geometry; b) finite element seepage analysis; c) stability analysis by limit equilibrium method. Three main processes (fluvial erosion, cantilever, and slide) interacting during the three events were identified, allowing for understanding their mutual role and quantifying their contributions to the sediment delivery.

In the second phase of this research, some of the main effects of vegetation influencing mass failures were included in the numerical model. These factors include: (a) surcharge; (b) increase in soil strength induced by the presence of the root system; (c) main hydrologic effects (interception and changes in pore water pressure distribution in the root zone). A series of simple and preliminary scenarios were used with two main aims: (1) to test the potentiality and sensitivity of the model in including these effects; and (2) to define the parameters (i.e. tree size, position, density) and their critical values in determining beneficial or adverse net effects on bank stability.