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Quantifying the Importance of Seepage Erosion: Recent Advances in Laboratory Experiments, Field Measurements, and Numerical Modeling

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Abstract Text:

There exists an incomplete understanding of one of the basic mechanisms governing sediment transport: erosion by concentrated lateral, subsurface flow or seepage erosion. The importance of subsurface flow induced erosion, a term generally referred to as seepage or sapping, is not well understood at this time. This research hypothesizes that seepage erosion is important in promoting bank failure and sediment loading to streams in numerous geographical locations. Recent research on seepage erosion will be presented highlighting recent advancements in the following: (1) understanding and predicting seepage mobilization of sediment in two-dimensional and three-dimensional laboratory lysimeter experiments, (2) measuring the magnitude and duration of seepage flow and erosion through field research at two streambank sites in Northern Mississippi, and (3) utilizing and updating numerical bank stability models to simulate seepage erosion undercutting and its impact on bank stability. This research has demonstrated that the loss of supporting material brought about by seepage undercutting can be a major cause of slope instability and may be of equal or greater importance than the impact of increased soil-water pressure on soil strength. Field research measuring seeps have documented the first detailed measurements of seepage flow, erosion, and bank undercutting in-situ and demonstrated that streambank stratigraphy and layering were important in controlling seepage flow. This work also highlighted that undercutting occurs not only due to seepage through a conductive, noncohesive streambank layer, but can also occur when seepage erosion undercuts less cohesive layers underneath the conductive layer. The laboratory and numerical modeling research highlights the need to incorporate the dynamic process of seepage erosion into integrated subsurface flow and streambank stability models, which has been performed with the USDA-ARS Bank Stability and Toe Erosion Model.

Impact Statement:

This research has verified that the propensity of streambanks to fail during the recession limb of hydrographs may be the combined result of seepage erosion undercutting the streambanks and the reduced apparent cohesion of the bank. Improved bank stability tools have been developed for future use in river restoration design that better account for site-specific bank failure processes.