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## Internal Erosion of Soil Pipes: Still More Questions Than Answers

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Internal erosion of soil pipes can be a very important process in gully erosion as well as other mass failure events such as sinkholes, landslides and levee/dam breaching. Flow through preferential flow paths such as macropores can be rapid enough to exceed the soil critical shear stress and cause detachment of particles from the walls of the flow path, i.e. internal erosion. Development of a soil pipe from enlargement of a macropore results in more rapid flow and thus greater internal erosion, particularly mass failure of aggregates from pipe walls and roofs. If the sediment transport capacity of the pipe is exceeded, the pipe will plug causing back-pressure to build up within the soil pipe, which can foster hillslope instability. However, limited research has been conducted on particle and aggregate detachment within soil pipes as well as transport of sediment through soil pipes. The objective of this paper is to present observations of little known and poorly described processes involved in pipeflow and the resulting internal erosion of soil pipes. Many of the processes involved in internal erosion of soil pipes are assumed based upon processes observed in surface and stream erosion studies but are so poorly quantified for soil pipes that they are yet to be transferable. For example, the role of solution chemistry on sediment detachment from pipe walls has been quantified to a limited extent but little has been done on the effects of seepage forces on particle detachment in pipes and even less done on sediment transport capacity of soil pipes. Recent advances have included: development of suspended sediment and bedload rating curves for soil pipeflows but the results are crude and warrant further study. Quantification of the interactive effects of surface flow in channels with flow through soil pipes below channels on headcut migration and gully widening is in its infancy. Other processes, such as air-entrapment in creating or temporarily plugging pipes, have been suggested as important but lack quantification. These processes and others combine to result in internal erosion of soil pipes but they must be better understood and quantified in order to develop the next generation of soil erosion models and landscape morphology prediction technologies.