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# The ramp or the staircase? A process-hierarchy in post-fire hydrogeomorphology

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Three decades of data show that annual average post-fire erosion rates vary within se Australian forested landscapes over ca. 4 orders of magnitude from <0.01 t ha-1 y-1 to 100 t ha-1 y-1. These differences are currently difficult to predict, and here we propose and explore a new conceptual framework that may assist in post-fire erosion prediction. The dominant erosion processes are observed to depend on infiltration-excess overland flow, and large increases in erosion rates are broadly associated with shifts or "jumps" across erosion process-thresholds. Additional higher- yielding processes are added hierarchically with increased rainfall forcing, starting with raindrop splash, to interill, to rill, to hillslope debris flows, and finally to channel debris flows. In this conceptual framework, the first-order control on the erosion rate results from the combination of system properties and forcing that enables additional erosion processes to be activated in the hierarchy. Second-order controls are process-specific, and explain the remaining variability in erosion rates within each of the processes for a given forcing. Large erosion increases are related to the way in which soil properties, fire severity, hillslope gradient, and channel gradient trigger "jumps" across these process thresholds, which, it is argued, explain the majority of the variability in post-fire erosion rates at headwater catchment scales. The applicability and usefulness of this conceptual framework to erosion prediction in a range of fire affected environments (eg. Western US, Canada, the Mediterranean) will be explored.