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Post-fire changes in sediment rating curves in a wet Eucalyptus forest in SE Australia

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Empirical power law sediment rating curves of the form C = aQb (where C is the sediment concentration, Q is the discharge rate, and the coefficient a and exponent b are fitted parameters), or the alternative form given by log(Qs) = log(a) + (b+1)log(Q) (where Qs = CQ is the sediment delivery rate) are widely used for characterising sediment transport across a broad range of spatial and temporal scales. Fire frequently has a large effect on erosion rates and sediment delivery. We investigate the temporal changes in the coefficient a and exponent b for 3 years following a wildfire between Feb 2003 and Apr 2006, for two South Eastern Australian Eucalyptus forested catchments (136 and 244 ha) with mean annual rainfall of 1900 mm/h. Storm-event integrated sediment loads and discharges were calculated for each of 596 storm events using stage-discharge control structures and in-situ turbidity measurements at 15 min intervals which were converted to sediment concentrations using regression relationships developed from storm activated water auto-samplers. The analysis identified: (i) strong negative linear relationships between the rating coefficient log(a), and the rating exponent b, reflecting sediment rating curves that "pivot" around a common fulcrum point in log-linear space, (ii) a systematic shift in this linear relationship between b and log(a) as a function of time since fire, (iii) maximum values of b of ca. 2.5 (i.e. maximum non-linearity in the relationship between discharge and sediment delivery) immediately following the fire, declining rapidly and monotonically by a factor of 10 to ca. 0.25 in the first 8 months, attributed to declining rill and interill erodibility, (iv) irregular patterns in the value of b during the vegetation recovery period (8-24 months after the fire), and (v) annual cycles in the value of b in the recovered state (24-38 months after the fire) ranging from a minimum of ca. 0.5 in the dry season to a maximum of ca. 1.5 in the wet season. The results provide a robust quantitative perspective on the magnitude and temporal variability of the sensitivity of catchments recovering from wildfire.