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Temporal variation in sediment budget components for a small incised upland catchment in southeastern Australia

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Temporal variation in process rates, sediment storage and exports can result in substantial changes to components of catchment sediment budgets over both short and long timescales. Quantifying the magnitude of temporal change in sediment budgets is important for interpretation of current and future processes and in understanding landform change. In this study, we develop a fine ($<$63 μm) sediment budget for a 1.64 km^2 gullied upland catchment located in the Central Highlands region of New South Wales in southeastern Australia. The catchment is comprised of steep hillslopes and a low relief ($>$900 m) plateau, with channel incision extending along the valley floor to mid-catchment. Land use is predominantly sheep and cattle grazing of pasture, with unrestricted stock access to channels. Various process-based techniques were used to examine temporal variation in sediment budget components over seasonal timescales (3-4 monthly) for a period of nearly two years. This included monitoring of hillslope and channel bank erosion, channel cross-sectional change, and suspended sediment output in conjunction with USLE-based hillslope erosion modelling and sediment source tracing using ^{137}Cs and ^{210}Pb$_{ex}$.

Over the total study period, the sediment budget developed from these datasets indicated channel bank erosion accounted for an estimated 80% (41.6 t) of total sediment inputs. Valley floor and in-channel sediment storage represented 53% of total inputs and the remaining 47% was exported from the catchment. Temporal variation in catchment suspended sediment exports was largely dependent on the dynamics of sediment supply and storage within eroding channels. This was reflected in the sediment delivery ratios (SDR) for individual measurement intervals, which ranged from 1 to 153%. Bank sediment supply during low rainfall periods was reduced but subaerial processes – including rainsplash and sheetwash, freeze-thaw, and stock trampling effects – continued delivering sediment to channels, resulting in net accumulation on the channel bed with insufficient flow to transport this material to the catchment outlet. Following the higher flow period in spring of the first year of monitoring, sediment supplied to channels during the 3-month measurement interval was removed as well as an estimated 72% of the sediment accumulated on the channel bed since the start of the study period.

The variation in rainfall patterns, pasture vegetation growth, and antecedent soil moisture with seasons and drought conditions contributed to observed hydrological response and sediment flux patterns. Given the seasonal and drought-dependent variability in sediment storage and delivery, the period of monitoring may have an important influence on the overall SDR and interpretation of sediment transfer through catchments. This study also highlighted the potential significance of sediment dynamics in channels for determining contemporary sediment yields from small gullied upland catchments in southeastern Australia, which are widespread in parts of the southern Murray-Darling Basin and appear to represent an important source of fine sediment delivered to lowlands.