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Unravelling the style and timing of slope-to-channel system morphoevolution in tectonically active landscapes: new insights from the Northern Apennines of Italy.

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Crustal uplift and erosional processes, such as river-valley incision and hillslope denudation, are coupled factors leading the evolution of mountain landscapes. The morphoevolution of the slope-to-channel system has a key role in predisposing mountain slopes to failure. Large and complex gravitational slope deformation can produce stream blockages and/or diversions, vertical-step knickpoints on stream longitudinal profiles, as well as marginal spillways and epigenetic gorges. On the contrary, intensive valley entrenchment due to regional base-level variations can cause even large-sized slope failures because of the generalized increase of topographic stress and the upstream migration of slope-break knickpoints. Therefore, the evaluation of the morphoevolution of slope-to-channel systems must consider the spatiotemporal relations between active tectonics, valley incision and gravitational slope deformations. The Bidente River basin, in the uplifting Northern Apennines (Italy), is exemplar area to explore this topic because of i) high rates of stream incision during Quaternary due to active uplift and climate changes, ii) presence of slope failures of different mechanism, size and state of activity. We applied a combined geomorphological approach based on i) the analysis of the height distribution and along-stream correlation of a well-developed sequence of strath terraces, used as geomorphic markers; ii) the computation of a range of stream long-profiles metrics; iii) the time-dependent, catchment-scale R/SR metrics.
Stream long-profile metrics allowed to identify drainage network anomalies at a range of scales and to unravel their type and origin. Geomorphic markers coupled with the R/SR metrics revealed useful to assess the timing of both base-level variations responsible for the upstream migration of slope-break knickzones and slope failure associated with mass rock creep processes. Overall, the results contribute to define the style and the timing of the late Quaternary slope-to-channel system morphoevolution and the causal relation between active tectonics, valley entrenchment and large slope failures, for the understanding of which the chronological constraints are of crucial importance.
This study provides further insights to the interpretation of landscape metrics in case of the transient response of slope-to-channel systems to both local non-tectonic and regional tectonic-related drainage network anomalies.