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Knickpoints and their perturbing factors in an Alpine context, Stura Valley, Maritime Alps (North-Western Italy)

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Knickpoints are widely recognized in the river networks of natural catchments. In alpine catchments the origin and genesis of knickpoints, seen in the present morphology, is the result of the interactions of different factors such as faults, quaternary glaciations, river captures, variable lithology and base-level changes. We analyzed the longitudinal profiles of river channels in the Stura di Demonte Valley (Maritime Alps) in order to identify the knickpoints of such an alpine catchment and to characterize their origins. Abrupt changes in the gradient of the longitudinal profiles are observed in the main channel and in the tributaries of the Stura di Demonte river network, representing single knickpoints or wider knickzones. More than 90 knickpoints presenting different amplitudes, slopes and positions ranging from relatively small steps of just a few meters to outright falls or convex segments had been mapped within the Stura drainage system.

We classified half of these knickpoints into four different categories, representing each a different factor responsible for their origin. The other half of the knickpoints has most likely multiple, possibly interacting factors of their genesis (superimposed tectonic uplift, erosional contrasts and glacial processes). Base-level drops are a further potential mechanism responsible for knickpoint formation, especially in the lower Stura valley.

We investigate the distribution of knickpoints using X-analysis of the river network. The distribution of knickpoints in X-space is multimodal. This suggests that a common causative process of most knickpoints is unlikely. However, knickpoints attributed to glacial landforms and fluvial terraces show quite pronounced peaks in their distributions and found at low X-values thus close to the main trunk river. Knickpoints related to lithological changes and faults reveal several minor peaks, the expected pattern for these origins.

We demonstrate with our analysis that even in a regionally small alpine catchment perturbations of river profiles are caused by multiple factors. Thus, (automatically)-extracted knickpoints require a careful analysis of their origin in order to avoid incomplete interpretations of catchment evolution. The recognition of both regional scale phenomena such as recent tectonic activities or climatic changes as well as local controls such as lithology or fluvial captures can be based then on the identification and analysis of the Stura valley knickpoints. Even if knickpoints in some environments might be the signal of a general incision pulse, the effect of different local controls should not be ignored, especially in the investigation of alpine basins. This study confirms that, although knickpoints can provide significant information on incision signals - especially for large scale analysis - local controls are an important aspect in their genesis, and should be taken into account in the study of fluvially dissected landscapes.