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Is this a knickpoint or just a data artefact?

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Knickpoints along river profiles may reflect changes in climatic and tectonic forcing as well as differences in bedrock erodibility. Their analysis has become an important tool for studying the topographic evolution of mountain belts and deciphering changes in climate and tectonic processes. Data on longitudinal river profiles are usually derived from digital elevation models (DEM). However, DEMs often have problems accurately representing valley bottoms, in particular in steep relief landscapes. Hence, data artefacts and errors are common problems in analyses of longitudinal river profiles and render the identification of knickpoints difficult.

Here we present a probabilistic approach that allows characterizing relative elevation errors in longitudinal river profiles. We use a nonparametric quantile regression with monotonicity constraints, which can be applied to entire river networks. The monotonicity constraint ensures that river elevations are always downstream decreasing while quantile regression provides a comprehensive estimate of the local uncertainty along the profile. We combine this approach with a novel knickpoint identification algorithm that iteratively reconstructs the longitudinal river profile by piecewise strictly concave upward segments. The degree of adjustment is dictated by local uncertainties as identified by the quantile regression.

Our new approach reliably detects knickpoints in diverse topographic settings and with data affected by artefacts. It complements previous approaches such as channel steepness or chi-analysis and can be used to map knickpoints along longitudinal river profiles. Our approach requires only two parameters that define the degree of smoothing and the fitting tolerance, and relies solely on the assumption that steady state profiles follow a concave upward profile. In contrast to previous approaches the probabilistic assessment allows objective assessment whether kinks in river profiles are true knickpoints or merely data artefacts.