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Morphometric Analysis of Major Catchments Draining the Adriatic Indenter

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Topography and relief in collisional orogens such as the European Alps result from the interplay of uplift driven by plate convergence and crustal shortening, and erosional surface processes that act along evolving topographic gradients and counteract topography formation. Due to ongoing indentation of the Adriatic indenter into the Eastern Alps, the eastern segment of the Adriatic indenter is one of the tectonically most active zones of the Central Mediterranean region. The region is characterized by numerous earthquakes, distinct spatial gradients in recent uplift rates and exhumation level, and active faulting. However, the predominance of carbonaceous lithology hindered low-temperature thermochronology and cosmogenic nuclide dating, so that timing, rates and drivers of south-alpine topography development are still not well constrained. Further on, a systematic morphometric analysis of rivers draining the south-alpine indenter is still missing.

In this study we fill this gap and investigate the interplay of tectonics and climate by a morphometric analysis of drainage systems of the eastern segment of the Adriatic indenter. We systematically extract a variety of characteristic channel metrics of four major drainage systems (Adige, Brenta, Piave, and Tagliamento) of this domain and interpret the morphometric results in terms of (a) lithological effects such as erodibility contrasts and karstification, (b) spatially variable uplift rates, (c) base level lowering caused by glacial erosion and possible Messinian preconditioning, and (d) the migration of drainage divides.

We find a clear correlation between the normalized steepness index (k_{sn}) and bedrock type. k_{sn} - values are systematically increased whenever rivers incise into the basement of the south-alpine indenter. However, the outcrop of the basement indicates a high level of exhumation and thus the highest overall uplift of the domain such that both increased uplift rates and low rock erodibility may be reflected by high k_{sn} values. Despite local disturbances attributed to (a) glacial base level lowering of channels possibly preconditioned by the Messinian and (b) active faults causing vertical and horizontal off-sets, high and low k_{sn} - values correspond to high and low uplift rates measured by GPS-stations. This suggests that uplift rates based on short GPS - time series are representative for trends in the long term landscape evolution of the eastern segment of the Adriatic indenter. On catchment scale, we observe a clear west to east trend from highly disturbed (e.g. Adige Catchment) to overall well graded channels (e.g. Tagliamento Catchment) and explain this observation by the vertical velocity field and bedrock properties. Results from the χ transform of river profiles reveals evidence for a northward shift of south-alpine drainage divides and that the drainage system of the entire Eastern Alps is dynamically reconfigured.