Base level changes and landscape response in the Eastern Alps: Tectonics versus Climate

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The landscape of the Eastern Alps is strongly bimodal with two observed landscape types that differ in their morphological appearance. At low elevations, in vicinity to the active valley floors, the landscape is characterized by steep topographic gradients, incised gullies and disequilibrium landforms. In contrast, the second landscape type occurs at high elevations relative to the actual base levels and is characterized by low slopes and gentle channel gradients. The transient state of the landscape between the two described landscape types is characterized by planation surfaces located at distinct levels (relict landscape) dissected by deeply incised gorges (modern landscape).

The bimodality and the transient state of the landscape is commonly interpreted in terms of glacial erosion driven by the climate change during the Pleistocene where large parts of the Eastern Alps (e.g. Salzach catchment) were coined by several glaciation cycles, scouring deep alpine valleys and establishing new erosional base levels. However, it is striking that landscapes in the Eastern Alps with minor glacial impact during the LGM (e.g. Mur catchment), are also in a transient state indicated by similar geomorphic features (non-equilibrium channels, migrating knick points and active hill-slopes) suggesting different tectonic or climatic regimes at different time slices. Recently, these observations were interpreted as reaction of the drainage system on new base levels caused by a large scale pulse of uplift since around 5 my.

To understand the evolution of the landscape during the last 5 my we pose the following questions: a) What is the spatial distribution of old versus young landscapes in the Eastern Alps? b) When did the transition from "old" to "young" landscapes start and what are the process rates? c) What are the driving forces for the formation of the young landscape?

In this study we present first results of a detailed and systematic morphometric analysis of drainage systems covering large parts of the Eastern Alps. We compare catchments covering different lithological units with different glacial impact to understand the modes of alpine landscape evolution due to uplift driven topography and erosion driven relief formation.

The catchment wide analysis of digital elevation models shows several eye-catching anomalies in the hyposmetric curves, in the relationship between surface elevation and topographic gradient, in the stream power pattern of the drainage system and in longitudinal channel profiles. First order anomalies detected by these numerical analyses are consistent with numerous field observations on planation surfaces, incised gullies and knick points and can be identified in catchments with and without glacial impact. Therefore we suggest that recent uplift of the Eastern Alps and subsequent incision is NOT only controlled by glacial scouring but shows also a tectonic signal beyond isotactic rebound due to glacial erosion and unloading.