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High-resolution monitoring of fluvial bedrock erosion in a natural gorge

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Morphological evolution of terrestrial and planetary landscapes is of increasing interest in the geosciences. In mountainous regions stream development and stream shape as a consequence of the interaction of uplift and erosion is fundamental for surface formation. Bedrock stream sections are prevalent that are routings for water and sediments. Hence, the correct description of bedrock channel evolution is fundamental for landscape modelling. To analyse how in situ erosion rates depend on factors like discharge, sediment transport and topography, there is a need of highly resolved topographic field data that so far is not available.

Here we present preliminary outcomes of a change detection study from the Gorner Gorge above Zermatt, Switzerland. The outflow of the Gorner glacier (the Gornera stream) is captured most of the time by a water intake for hydropower production. However this intake is flushed twice a day in summer to purge settled sediments. Then the Gornera, charged with erosive bedload, runs along its natural stream bed that cuts through a roche moutonnée. This bedrock section (25m long, 5m wide and 8m deep) was surveyed repeatedly twice a year benefiting from nearly dry bed conditions during water capturing.

A Leica ScanStation C10 was used for capturing high density point clouds (aspired average point spacing 5mm) of the bedrock surfaces. Referencing each of the various scanning positions was conducted using Leica HDS targets attached to fixed anchor bolts in the bedrock, that were surveyed locally with a total station. Resulting DEMs were used to calculate DEMs of difference (DoDs) for the bedrock walls and a huge boulder residing on the gravel bed. Erosion rates are visualised and discussed in respect of to the local spatial arrangement of the bedrock to the stream flow and water level.