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From patterns to processes: understanding channel step formation in steep streams

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Streams with gradients greater than 3% often have bedforms exhibiting step-pool morphologies with steps determining channel stability. As major roughness elements they dissipate the stream's energy. Also, steps are important in the coupling of channels and adjacent hillslopes: step destruction can induce hillslope failure through de-buttressing and thereby drive sustained sediment supply to the channel.
Although step dynamics have been investigated in various modelling and experimental efforts, the processes of step formation and destruction are still under debate. Moreover, we lack a comparison of the proposed mechanisms with the step-pool bedforms observed in the field. To discriminate between dominant processes of step formation, an assessment of step patterns was performed.
Here, we analyze the channel long profile of the Erlenbach, a mountain stream in the Swiss Prealps with a mean slope of 17%. We collected profile data in 2014 and applied a standardized automated algorithm to identify steps. In addition, we surveyed channel width and the positions of large boulders in the field. Using these data, we investigate how principle geometric metrics (e.g. changes of the channel width) reflect the occurrence of steps, and we determine the relevance of the 'jammed state' hypothesis for step formation in the study reach.