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On the influence of debris flows and river restoration on cosmogenically derived catchment wide denudation rates

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Catchment averaging denudation rates obtained by cosmogenic nuclides assume steady state in geomorphic processes and their respective nuclide concentrations in all (sub)parts of a catchment. The denudation signal may then be contained in a well mixed river-sand sample at a particular sampling site. Known and evaluated derivations from these assumptions are e.g., landslides. Perturbations of the cosmogenic depth profile (anthropogenic effects or shallow soil processes), which otherwise allows the establishing of such denudation rates, are assumed to be minor on the final calculated denudation rate. In a current effort we test these assumptions for an Alpine catchment (upper Aare, central Switzerland) over a time series of 3 consecutive years, by keeping the sampling site constant. Three spring and three fall samples as well as a monthly summer 2010 samples have been taken and analyzed for their cosmogenic produced in-situ 10Be concentration. The summer 2009 and even more the summer 2010 were especially high in debris flows events, resulting in large episodic mass transports that in turn resulted in river restoration in order to protect a small town in the late summer of 2010. The obtained 10Be concentrations are higher by up to 60% amongst the seasonal samples between 2008/2009 and 2009/2010, with the monthly samples of 2010 currently processed. This suggests that a careful catchment analyses and a recherché on recent catchment processes has to be performed (i) when catchments reveal signs of non-steady or episodic processes, (ii) when denudation rates are compared to other catchments and (iii) when denudation rates are correlated to other geomorphic parameters. The resulting average denudation rates of about 1mm/yr of the 2008/2009 season are typical for cosmogenically derived Alpine catchment denudation rates [1], have a similar magnitude as obtained by reservoir sediment budget analysis [2] but are 3 times higher than suggested from postglacial lake sediment budgets [3] or modern sediment discharges [4], pointing to huge discrepancies in methods, records and observed time intervals. At the conference we will present a more detailed analysis and interpretation as well as cosmogenic 14C measured on the same samples, that may reveal potential storage and complex erosion scenarios.

[1] Wittmann et al. (2007), JGR-ES, 112, doi:10.1029/2006JF000729
[2] Anselmetti et al. (2007), Aquat. Sci. 69, 179 – 198
[3] Hinderer (2001), Geodin. Acta 14, 231–263
[3] Schlunegger & Hinderer (2003), Terra Nova 15, 88-95