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Solar forcing and atmospheric control of paleoflood dynamics in the Bernese Alps, Switzerland

Lothar Schulte (1), Juan Carlos Peña (2), Francesc Burjachs (3), Filipe Carvalho (4), Jaime Llorca (4), Ramon Julià (5), Johanna Lomax (6), Thomas Schmidt (7), Patricio Rubio (4), Justino Losada (4), and Heinz Veit (8)

(1) Fluvalps Research Group and ICREA, University of Barcelona, Spain (schulte@ub.edu), (2) Meteorological Survey of Catalonia, Generalitat de Catalunya, Barcelona, Spain, (3) ICREA, Catalan Institute of Human Paleoecology and Social Evolution, Tarragona, Spain, (4) Department of Physical and Regional Geography, University of Barcelona, Spain, (5) Institute of Earth Science Jaume Almera, CSIC, Barcelona, Spain, (6) Institute of Geography, University of Giessen, Germany, (7) Schmidt Informations- und Webdesign, Düsseldorf, Germany, (8) Institute of Geography, University of Bern, Switzerland

A multidisciplinary approach provides data from natural, historical, and instrumental time series, for the study of potential effects of climatic changes on alpine floods outside the known range of extreme events. The research focuses on the densely populated Bernese Alps, which are a true "hot spot" of hydrological risk. For the reconstruction of climate variability and floods, interdecadal-resolution alluvial delta plain records were examined. The multi-proxy approach affords insight into alpine flood dynamics of mid-scale catchments during the last three millennia.

Spectral analysis of the geochemical and pollen time series records and climate proxies (δ^{14}C, δ^{18}O isotopes from the Greenland ice, NAO) evidence similar periodicities of 60, 85, 105 and 200 yrs. Thus, the mechanisms of the flood processes are strongly influenced by the North Atlantic dynamics and solar activity. The proxies indicate that cooler climate pulses and transitions from cool to warm climate pulses were an important external driving force of floods. This hypothesis is supported by the reconstructed floods of the Aare and Lütschine rivers from local documentary sources during the last 500 yrs. Flood periods inferred from sedimentary archives (flood layers, geochemical proxies and shifts of river channel) were calibrated by local documentary flood records and compared with the pattern of settlement on flood prone landforms. The generated data series shows also a good correlation with climate proxies, such as the annual temperatures of Europe (Luterbacher et al., 2004), tree ring based summer temperatures of Central Europe (Büntgen et al., 2011) and total solar irradiance according to the model of Steinhilber et al. (2009).

With regard to the last two centuries flood magnitude and frequencies (exact dating) as well as driving mechanisms were reconstructed with more precision. Furthermore, a summer flood index of Switzerland (INU) based on damages recorded from 1800 to 2008 AD was performed. Spectral analysis of the INU index identify the 105yr cycle recorded in the delta plain sediments and the 11-year solar cycle (Schwalbe-cycle). Correlation of the INU with annual temperature of the Alps region since 1800 AD, the δ^{18}O GISP 2 record and the summer NAO indicate that mayor flood activity may occurred during short warm climate pulses (strong positive SNAO) during cold low-frequency periods.