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Varved sediments of Lake Oeschinen, NW Alps: filling the gap in the flood frequency-precipitation relationship for the last millennium

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The global climate is warming, which is leading to changes in the hydrological cycle. What are the impacts of these climatic changes on the occurrence and magnitude of extreme flood events? Are these changes simultaneous or independent? These are key questions for future flood-risk predictions.

In Europe, regional climate models do not show robust results for the future occurrence of precipitation extremes, which is mainly due to the difficulty in resolving precipitation events and the limited temporal coverage of instrumental data. To overcome this issue, considerable effort has been put forward by the paleoclimate community to produce millennial-long flood proxy records from natural archives. This has led to a more comprehensive understanding of flood events in relation to climate variability. However, while there is an increased consensus in the long-term flood–temperature relationship, still very little is known about the role of precipitation changes on flood frequency and magnitude. This is largely due to the lack of long-term and high-quality precipitation records.

Here we present a millennial-long precipitation reconstruction together with a flood-frequency record obtained from the same natural paleoclimate archive. This allows, for the first time, the direct comparison between the two climate variables in the Alps. We used the varved (annually laminated) sediments of proglacial Lake Oeschinen (1580 m a.s.l., NW European Alps) to reconstruct warm season (MJJA) precipitation and summer flood frequency back to AD 884.

Our results support recent findings from an increasing number of studies in the Swiss, German, French and Austrian Alps showing that floods were consistently more frequent during cool periods over the last Millennium. While the relationship between flood frequency and inferred moist climate has remained speculative, our precipitation reconstruction allows for a direct comparison and shows that flood frequency also increased during wetter conditions. These patterns were found for 7 out of 8 multi-decadal periods. Unlike other periods with frequent flood events, the 13th century is enigmatic in the sense that phases with high flood frequency coincided with very warm summers and relatively dry conditions. Interestingly, this flood peak was also found in sedimentary records of the Swiss, Austrian and French Alps, and seems to be associated to a regional phenomenon. Therefore, it is suggested that different synoptic-scale weather systems with more intense convective rain might have triggered floods during this warm and relatively dry period of the Medieval Climate Anomaly.

From this research, we conclude that: (i) the comparison between sediment flood records and flood-inducing weather situations merits particular attention; and (ii) more investigations are required to further resolve the details of long term floods and climate conditions.