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A 2000-year palaeoflood record from northwest England from lake sediments

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Greater insight into the relationship between climatic fluctuations and the frequency and magnitude of precipitation events over recent centuries is crucial in the context of future warming and projected intensification of hydrological extremes. However, the detection of trends in flood frequency and intensity is not a straightforward task as conventional flood series derived from instrumental sources rarely span sufficiently long timescales to capture the most extreme events. Usefully, the geomorphic effects of extreme hydrological events can be effectively recorded in upland lake basins as efficient sediment trapping preserves discharge-related proxy indicators (e.g., particle size). Provided distinct sedimentary signatures of historic floods are discernable and the sediment sequence can be well-constrained in time, these lacustrine archives offer a valuable data resource.

We demonstrate that a series of sediment cores (3 – 5 m length) from Brotherswater, northwest England, contain numerous coarse-grained laminations, discerned by applying high-resolution (0.5 cm) laser granulometry, which are interpreted as reflecting a palaeoflood record extending to ∼2000 yr BP. The presence of thick facies which exhibit inverse grading underlying normal grading, most likely reflecting the waxing and waning of flood-induced hyperpycnal flows, supports our palaeoflood interpretation. Data from an on-going sediment trapping protocol at Brotherswater that shows a relationship between river discharge (recorded via short-term lake level change representing flood events) and the calibre of particles captured in the traps lends further support to our interpretation.

Well-constrained chronologies were constructed for the cores through integrating radionuclide (210Pb, 137Cs, 241Am, 14C) dating within a Bayesian age-depth modelling protocol. Geochemical markers of known-age that reflect phases of local point-source lead (Pb) mining were used to resolve time periods where radiocarbon dates returned multiple possible age solutions.

We subsequently build a regression model using the time-window where recorded river discharge and the sedimentary record overlap (1961-2013) in order to reconstruct discharge estimates for the palaeoflood laminations. These quantitative palaeoflood data can thus be inserted into statistical flood frequency analyses and compared with outputs using instrumental data and regional flood information.