



Quantifying magnitude and frequency of recent extreme floods using a 600 year lake sediment record from the UK

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Flooding in northwest England has been reconstructed from the coarse grained units preserved in lake sediment sequences at Bassenthwaite Lake, a record that includes the floods of December 2015 (Storm Desmond) and November 2009 and shows they were the most extreme in over 600 years. The inception and propagation of a lake sediment flood event horizon in the aftermath of the December 2015 storms in the UK will be explored. Linking our new sediment palaeoflood series to river discharges, the first assessment of flood frequency and magnitude based on lake sediments for the UK, shows that recent disastrous flooding in northern England was more extreme than revealed by standard hydrological approaches, making these events the rarest (Recurrence Interval >1:10000 years) ever recorded in the UK. Particle size characteristics of flood laminations, after correction for variations in the stability of catchment sediment sources, were correlated on a hydrodynamic basis with recorded river flows. The particle size flood record is underpinned by a robust chronology to CE1420 derived from radionuclide (Pb210, Am241, and Cs137) dating and correlation to the rich history of metal (Pb, Zn, Ba and Cu) mining in the catchment accurately recorded in the sediment geochemistry. The sediment palaeoflood series reveals five flood rich periods (CE 1460-1500, 1580-1680, 1780-1820, 1850-1925, 1970-present), and these correspond with positive phases of reconstructed winter NAOI and other Atlantic circulation patterns. The hydro-climatology of the extreme events (top 1% of floods) in our series, show that 67% of floods have occurred in the 21st Century during a period of prolonged warmer northern Hemisphere temperatures and positive NAOI winter index. Climate model ensemble outputs for the Northern hemisphere forecast increased frequency and magnitude of positive NAOI, and warmer air temperatures; we infer from this that there will also be an increase in the frequency of extreme floods and flooding in general with concomitant impacts on communities and infrastructure.