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Reconstruction of soil erosion and flood variability from Lake Arreo watershed (Northern Spain) during the last millennium

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Mountain regions from Southwestern Europe have been extremely vulnerable to land degradation and soil erosion due to climate factors (summer soil water stress, high storminess and extreme flooding) and to a long history of human use of land impacting these terrestrial ecosystems. The short-time span of instrumental monitoring datasets limits our ability to obtain a full depiction of the long-term drivers controlling soil erosion in Mediterranean watersheds. Here we have applied a novel methodology based on detailed microfacies analyses on lacustrine sediments from Lake Arreo, located in the headwaters of the Ebro Basin (NE Spain), to reconstruct flood variability, annual sediment yield and denudation rates in a mountainous Mediterranean watershed during the last 1400 years.

The Arreo lake record shows that the lowest flood frequency took place during the 6–7th and 10–15th centuries, while higher flood frequency occurred during the 8–9th centuries and the last 500 years. The reconstructed frequency of high-magnitude flood events from the lake record is coherent with the historical cold-season floods from Basque rivers. Fluvial and lacustrine paleoflood records and documentary evidence show abrupt and large increases in extreme flood frequency during the termination of the Little Ice Age (1830–1870 CE) and mid to late 20th century, both periods of Rapid Climate Change (RCC).

The sediment yield values estimated in this study agrees reasonably well with soil erosion rates monitored in Mediterranean experimental watersheds supporting the validity of this methodology to assess the soil erosion and sediment production from a long-term perspective. The highest soil erosion rates correspond to an interplay between increased frequencies and magnitudes of heavy rainfall and intensive agropastoral and forestry activities in the lake's watershed. This study highlights the potential of lacustrine archives to adequately evaluate the environmental drivers and mechanisms controlling land degradation at decadal to centennial time-scales in vulnerable areas to Global Change such as the Mediterranean region.

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