Reducing uncertainty with flood frequency analysis: the contribution of palaeo- and historical flood information

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Key points

Quantifying improvements to flood frequency analysis with addition of paleoflood and historical information

Sensitive analysis to evaluate effects of changing cross-sections on paleoflood magnitude reconstruction

Use of slackwater deposits in semi-alluvial setting for paleoflood reconstruction

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Abstract

Using a combination of stream gauge, historical and palaeoflood records to extend extreme flood records has proven to be useful in improving flood frequency analysis (FFA). The approach has typically been applied in localities with long historical records and/or suitable river settings for palaeoflood reconstruction from slackwater deposits (SWD). However, many regions around the world have neither extensive historical information nor bedrock gorges suitable for SWD preservation and palaeoflood reconstruction. This study from subtropical Australia demonstrates that confined, semi-alluvial channels such as macrochannels provide relatively stable boundaries over the 1000-2000 year time period, preserving SWDs, enabling palaeoflood reconstruction and their incorporation into FFA. FFA for three sites in subtropical Australia with the integration of historical and palaeoflood data using Bayesian Inference methods showed a significant reduction in uncertainty associated with the estimated discharge of a flood quantile. Uncertainty associated with estimated discharge for the 1% Annual Exceedance Probability (AEP) flood is reduced by 50-74%. In addition, sensitivity analysis of possible within-channel boundary changes shows that FFA is not significantly affected by any associated changes in channel capacity. Therefore, a greater range of channel types may be used for reliable palaeoflood reconstruction by evaluating the stability of inset alluvial units, thereby increasing the quantity of temporal data available for FFA. The reduction in uncertainty, particularly in the prediction of the ≤ 1% AEP design flood, will improve flood risk planning and management in regions with limited temporal flood data.

Key words: Flood Frequency Analysis, Palaeoflood Hydrology, Extreme flood, Stable boundary channels, Historical flood information, Sensitive analysis