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New insights on historic droughts in the UK: Analysis of 200 river flow reconstructions for 1890-2015

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Hydrological droughts of the last 50 years in the UK have been well characterised owing to a relatively dense hydrometric network. Prior to this, observed river flow data were generally limited in their spatial coverage and often subject to considerable uncertainty. Whilst qualitative records indicate the occurrence of severe droughts in the late 19th and early 20th centuries, including scenarios which may cause substantial impacts to contemporary water supply systems, existing observations are not sufficient to describe their spatio-temporal characteristics. As such, insights on drought in the UK are constrained and a range of stakeholders including water companies and regulators would benefit from a more thorough assessment of historic drought characteristics and their variability.

The multi-disciplinary Historic Droughts project aims to rigorously characterise droughts in the UK to inform improved drought management and communication. Driven by rainfall and potential evapotranspiration data that have been extended using recovered records, lumped catchment hydrological models are used to reconstruct daily river flows from 1890 to 2015 for more than 200 catchments across the UK. The reconstructions are derived within a state-of-the-art modelling framework which allows a comprehensive assessment of model, structure and parameter uncertainty. Standardised and threshold-based indicators are applied to the river flow reconstructions to identify and characterise hydrological drought events.

The reconstructions are most beneficial in comprehensively describing well known but poorly quantified late 19th and early 20th century droughts, placing the spatial and temporal footprint of these often extreme events within the context of modern episodes for the first time. Oscillations between drought-rich and drought-poor periods are shown not to be limited to the recent observational past, providing an increased sample size of events against which to test a range of airflow and oceanic index patterns as potential drivers of streamflow drought. The quantification of changes over time in both the mean and the variability of drought frequency, duration, severity and termination benefits from the temporal extent of the river flow reconstructions, assessing the temporal variability of drought over more prolonged timescales than previous drought trend studies. When considered alongside complimentary reconstructions of rainfall and groundwater levels, the characteristics of propagation from meteorological to hydrological drought are analysed to an extent not previously possible.

The unprecedented spatio-temporal coverage of the river flow reconstructions has yielded important new insights on historic droughts in the UK. It is hoped that this more robust assessment of the historical variability of hydrological drought in the UK will underpin enhanced drought planning and management.