Geophysical Research Abstracts
Vol. 21, EGU2019-3332, 2019
EGU General Assembly 2019

"What's past is prologue": Reconstructing historic flow data to inform management of future hydrological extremes.

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"What's past is prologue", a quote from Shakespeare's "The Tempest", recognises that the past sets the stage for the story of the future. As projections of future hydrology suggest increases in hydrological variability with more severe extreme events, and population and socio-economic demand on water supply continue to grow, understanding the extreme events of the past can help us prepare for the future. However in the UK, river flow data are sparse prior to the 1960s, thus limiting our understanding of the extreme hydrological events of the past.

This presentation describes the methods used to create a spatially and temporally coherent dataset of re-constructed daily river flow data for 303 catchments in the UK, over the 125 year period 1891-2015. The multi-objective calibration approach employed was designed explicitly to optimise the GR4J hydrological model to high, median and low flows simultaneously, as well as taking model parameter uncertainty into account. The modelled data provides good simulations of daily flow when compared to available observations, and show consistently high performance in the earlier record, in catchments where longer term observations were available. Using the Standardised Streamflow Index (SSI), it was possible to assess the ability of the model to simulate extreme events. By comparing the reconstructed SSI timeseries against the observed over the period 1970-2015, it was seen that there was some uncertainty in the extreme high and low flow magnitudes; however, by comparing extracted accumulated deficits of drought events in observed and the modelled data, the timing and the classification of drought events were well simulated.

This research provides a modelling framework that can produce robust model calibrations for use in hydrology across the flow range and at the extremes, allowing for the production of spatially and temporally consistent flow data with extensive applications. Such datasets as the one produced from this work can be applied in quantitative long term analyses of extreme events, as well as trend analyses that have never before been possible. Furthermore, the model calibrations and long term reconstructed data can be widely applied in assessing and contextualising the current water situation, as well as in seasonal forecasting and climate change projections.

This work has been submitted to Hydrology and Earth Systems Sciences Discussions under the title: "A Multi-Objective Ensemble Approach to Hydrological Modelling in the UK: An Application to Historic Drought Reconstruction".