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Storylines of UK drought based on the 2010-2012 event

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Spatially extensive multi-year hydrological droughts threaten water resources availability and incur significant environmental and socio-economic consequences. Given the impacts of climate change, the UK is expected to remain vulnerable to future multi-year droughts. Existing approaches to quantify hydrological impacts of climate change are often scenario-driven and may miss out plausible outcomes with significant impacts. Event-based storyline approaches aim to quantify “storylines” of how a singular event with significant impacts could hypothetically have unfolded in alternative ways from plausible changes to its causal factors under present and future climate. This study uses the 2010-2012 UK drought, the most recent period of severe hydrological drought, as a basis, to create counterfactual storylines based on changes to 1) precondition severity, 2) temporal drought sequence and 3) climate change. Model simulations are performed using the GR4J hydrological model and drought characteristics for each counterfactual storyline is calculated using the Standardized Streamflow Index at multiple accumulation periods.

The storylines show that maximum intensity, mean deficit and duration of the 2010-2012 drought were highly conditioned by its meteorological preconditions. Recovery time from progressively drier preconditions reflect both spatial variation in drought characteristics and the influence of physical catchment characteristics, particularly hydrogeology, in the propagation of multi-year droughts. Plausible storylines of an additional dry year with dry winter conditions repeated before the observed drought or replacing the observed dramatic drought termination confirm the vulnerability of UK catchments to a “three dry winter” scenario. Application of the UKCP18 projections at four global warming levels explore the impacts of the drought in a warmer world. Drought conditions of the storylines could have matched and exceeded that experienced in past severe droughts, especially for southern catchments. The construction of storylines based on observed events can complement existing methods to stress test UK catchments against plausible unrealized droughts.