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Multi-driver attribution of detected hydrological change

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There is growing evidence that significant links between large-scale climate indices and streamflow over decadal time-scales can be established. However identifying the dominant driving mechanism(s) of detected changes in streamflow (i.e. attribution) at the catchment scale is a challenging task due to the confounding influence of human disturbances such as land-use changes, water abstractions, and river engineering.

This study addresses this challenge by examining the utility of the multiple working hypotheses framework in moving towards more rigorous attribution of changes using the Boyne catchment in the east of Ireland as a case study. Previous research on this catchment found that a large upward change point in streamflow during the mid-1970s corresponded with a shift in the North Atlantic Oscillation (NAO) index towards a more positive phase, bringing increased precipitation, and hence increased risk of flooding. Here, the single-driver analysis is extended to include multiple factors causing change within the catchment (both climatic and internal) in order to establish relative contributions of hypothesised drivers. Rainfall-runoff models were employed to reconstruct streamflow to isolate the effect of climate taking account of both model structure and parameter uncertainty. The Mann-Kendall test for monotonic trend and Pettitt change point test were applied to explore signatures of change.

Results show that the detected increase in annual mean and high flows was not predominantly driven by changes in precipitation as a result of a shift in the NAO index. Rather we assert that the dominant driver of change was arterial drainage and the contemporaneous onset of agricultural field drainage in the 1970s and early 1980s. It is also demonstrated that attribution can be more complex at different time-scales with multiple drivers acting simultaneously. This study emphasises the quantity and range of data types needed for rigorous attribution, especially when substantial human modifications to catchments may be involved. In the face of such complexity, the use of this systematic hypothesis testing framework combined with hydrological modelling helps to avoid confirmation bias and improves overall understanding of dominant drivers of change.