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Controls on seasonal river flow variability across the UK

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Given heightened concerns about climate and human impacts upon hydrology, there is a need to quantify temporal and spatial variability in water availability, and to establish climate-flow associations to predict future water stress. In the UK, most previous climate-river flow research used records with often restricted spatial coverage, sparse density and/ or anthropogenic influences. In addition, it is important to understand the role of basin properties as modifiers (dampen or amplify) of climate inputs. Several UK studies acknowledged basin properties influence on runoff (particular geology); but most often this research does not go beyond consideration of broad national gradients and lacks systematic analysis of a suite of basin parameters. This paper addresses these research gaps by investigating both climate and basin controls on seasonal river flow variability for ∼100 near-pristine catchments across mainland UK.

Daily river flow records were used to derive seasonal flow indices (December-February, March-May, June-July, and August-November means) for the 1975-2005 period. Cluster analysis of indices identified regions with similar river flow characteristics for each season. The number of flow classes varies between six (autumn) and eight (winter). The mapping of classes shows that (in time) basin cluster membership is not static between seasons; and (in space) some classes tend to be contiguous and other classes are more complex to include basins located far apart.

Correlation analyses between climate indices (regional i.e. precipitation, potential evaporation and soil moisture; and large-scale atmospheric circulation i.e. North Atlantic Oscillation) and seasonal flow indices were performed to identify in which regions climate drivers exert the strongest (least) control on seasonal flows. The best regional climate predictors vary depending on the season with rainfall being dominant in winter and its influence decreasing in summer. Significant correlations between NAOI and flow indices were only found for winter (positive) and summer (negative). Regional climate variables were found to have a stronger association with seasonal flows than the NAOI.

A rage of basin properties (related to e.g. elevation, land cover, geology and physiography) were analysed to identify which basin properties exert a significant influence on climate-flow controls. It was found that a given property may have influence for one season but not for another; and many properties have only limited influence on climate inputs.

This study provides an improved baseline assessment of the large-scale hydroclimatological associations in mainland UK. The ability to identify regions and time-periods most susceptible to climate change/variability and anthropogenic influences has implications for water resource management, mitigation of water hazards (floods and droughts) and hydrological prediction/ forecasting.