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Climate driven variability and detectability of temporal trends in low flow indicators for Ireland

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Observational data from hydrological monitoring programs plays an important role in informing decision makers of changes in key hydrological variables. To analyse how changes in climate influence stream flow, undisturbed river basins with near-natural conditions limited from human influences are needed. This study analyses low flow indicators derived from observations from the Irish Reference Network.

Within the trend analysis approach the influence of individual years or sub-periods on the detected trend are analysed using sequential trend tests on all possible periods (of at least 10 years in length) by varying the start and end dates of records for various indicators. Results from this study highlight that the current standard approach using fixed periods to determine long term trends is not appropriate as statistical significance and direction of trends from short term records do not persist continuously over entire record and can be heavily influenced by extremes within the record. The importance of longer records in contextualising short term trends derived from fixed-periods influenced by natural annual, inter-annual and multi-decadal variability is highlighted.

Due to the low signal (trend) to noise (variability) ratio, the apparent trends derived from the low flow indicators cannot be used as confident guides to inform future water resources planning and decision making on climate change. Infact, some derived trends contradict expected climate change impacts and even small changes in study design can change the outcomes to a high degree. Therefore it is important not only to evaluate the magnitude of trends derived from monitoring data but also when a trend of a certain magnitude in a given indicator will be detectable to inform decision making or what changes might be required to detect trends for a certain significance level.

In this study, the influence of observed variance in the monitoring records on the expected detection times for trends with a fixed magnitude are presented. Depending on the indicator selected, the sample variance and trend magnitude very different detection time estimates are obtained and in most cases not within the time required for anticipatory adaptation in the water resources sector.
Additionally, the minimum changes in low flow indicators required to be detectable are large and changes are unlikely to be statistically detectable for many years. This means that water management and planning for anticipated future climatic changes will be required to take place without these changes being formally statistically detectable.Waiting for these trends to become formally detectable with the traditional statistical methods might not be an option for water resources management.

Within the monitoring network, a considerable difference is apparent between stations in terms of detection times and changes required for detection. The existence of flow monitoring stations showing short detection times for specific indicators confirms the potential for identifying stations that may be first responders to climate induced changes. Identifying sentinel stations can increase the ability to more effectively optimise the deployment of resources for monitoring the influences of climatic change in a hydrometric reference network.