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Visualising and quantifying variability in hydrological state along intermittent rivers

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Whilst the ecology of intermittent rivers is an established field of research, their hydrology is less well understood. Adaptations of traditional approaches to characterising flow regime using gauged or estimated flow data are effective in identifying wetting and drying cycles at a given location. However, such approaches are unable to fully characterise the systems because of the limited longitudinal information and the binary classification of hydrological state – flow and no-flow. For characterisation that will facilitate research into the hydroecology of these rivers, and the impact of drought and artificial influences upon them, techniques and data are required that capture both temporal and spatial variability with a more detailed classification of hydrological state.

A major impediment to such research has been the lack of available longitudinal, year-round, multi-year data of this type. Some studies have explored hydrological state at gauging station locations, some have longitudinal but summer-only observations, others present spatial and temporal patterns but using modelled data. In the UK, 20 years of year-round observations have been made along 10 chalk rivers in the south east of England. Techniques are presented for the visualisation and quantification of these data using a fourfold classification of hydrological state; high flow, moderate/low flow, ponded and dry. Heat maps provide visualisation of period of record and average monthly hydrological state, and metrics quantify the composition and configuration along the channel.

The period of record heat maps reveal spatial patterns in hydrological state along the rivers, allowing visual comparison of their behaviour and response to wet and dry years. Marked differences are seen in the fragmentation of hydrological state between the groundwater-dominated and more clay-influenced rivers. Monthly average heat maps provide a picture of the typical behaviour of the rivers and highlight stable artificial influences. The impact of drought years is seen in both composition metrics such as the abundance of dry state, and configuration metrics such as lotic connectivity. The metrics thus provide a method by which to quantify the impact of drought on the rivers in an ecologically-relevant way, for example, in the contraction of channel length available to migrating fish.

The UK data present a unique opportunity to study the spatial and temporal variability of hydrological state in intermittent rivers. The heat maps provide readily accessible ways for the data to be presented to stakeholders for the first time. Since nine of the rivers also have gauging stations, there is the potential to investigate relationships between gauged flow and hydrological state and, by infilling gaps in the monthly dataset, seasonality in the rivers' behaviour. Furthermore, a framework for the derivation of metrics may be proposed and demonstrated that encompasses both metrics of hydrological state and more traditional indices of flow regime.