EGU24-12911, updated on 24 Mar 2025
https://doi.org/10.5194/egusphere-egu24-12911
EGU General Assembly 2024

Flow intermittence patterns in European river networks under climate change: Assessing temporal and spatial changes

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Climate change is driving a global shift in river hydrology. Future climate projections estimate that global warming will result in more frequent and intense hydrological droughts in certain regions of the world, including Europe. However, there are currently very few studies investigating the impact of climate change in non-perennial rivers, which are home to a rich aquatic biodiversity and may be particularly vulnerable to an increase in droughts. To comprehend the impact of climate change on drying river networks and its consequences on biodiversity, functional integrity and ecosystem services, it is paramount to model and project flow intermittence under climate change.

In this study, we assess flow intermittence patterns and transitions in six distinct European River Networks from the DRYvER project case studies (Datry et al. 2021), situated in diverse biogeographic regions including Spain, France, Croatia, Hungary, Czech Republic, and Finland. Encompassing watershed areas ranging from 150 km² to 350 km², we employed a hybrid modeling technique to predict spatio-temporal patterns of flow intermittence (Mimeau et al. 2023). Climate projection data were used to force the hybrid models, enabling an evaluation of future changes. Additionally, flow intermittence indicators reflecting impacts on ecological processes were jointly developed in the DRYvER project and computed to assess changes and trends in recent years from 1960 to 2021 and for projected periods up to 2100.

Results indicate that projected drying patterns expand temporally and spatially. Temporally, the increase is related to a higher frequency of ceasing streamflow, but also to prolonged individual drying events. Shifts in the seasonality of flow cessation were also observed, with flow intermittence occurring in atypical seasons, such as winter, and typical drying maxima in summer transitioning to an earlier onset in spring with later ends or second maxima in autumn. Spatially, the increase is related to both, the overall river length affected by flow intermittence and the increase of connected reaches affected by flow cessation, which in turn increases the patchiness of the river network. All streamflow intermittence indicators simulated for the six case studies in

the past and future projections can be explored on the interactive web application DRYvER-Hydro (https://dryver-hydro.sk8.inrae.fr/). Besides, the calculated indicators can be utilized by other DRYvER partners for further ecological analysis and modeling. For instance Vilmi et al. (2023) used these indicators, among other data, to assess algal, fungal, bacterial, macroinvertebrate, and fish metacommunities.

This research provides valuable insights into the dynamic interactions between climate change and river hydrology, emphasizing the urgent need for adaptive strategies to mitigate the consequences on water resources, biodiversity, and ecosystem services in European river systems.

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