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Assessing flow intermittence in France under climate change

Aurélien Beaufort[1,2], Quentin Bottet[1], Guillaume Thirel[3], and Eric Sauquet[1]
[1]INRAE, UR Riverly, Lyon-Villeurbanne, France
[2]Université François Rabelais de Tours, EA 6293 GéHCO Géo-Hydrosystèmes, France
[3]INRAE, UR HYCAR, Antony, France

With climate change, perennial headwater streams are expected to become intermittent and intermittent rivers to dry more often due to more severe droughts, placing additional stress on aquatic life and new constraints for water management.

In this study, we quantify the changes in river flow intermittence across France over the 21st century. Using global hydrological model calibrated on gauging stations is certainly hazardous to assess changes in flow intermittence at a fine resolution (i.e. in headwater streams). Here, we suggest a modelling framework supported by field observations performed on a large number of French intermittent streams:

- we used discrete observations from the ONDE network set up by the French Biodiversity Agency recording summer low□flow levels once a month. ONDE sites are located on headwater streams with a Strahler order strictly less than five and evenly distributed throughout France;

- a model developed by Beaufort et al. (2017) was adapted to simulate the regional probability of drying of headwater streams (RPoD) under climate change. This empirical model is based on regional relationships established between the non-exceedance frequencies of daily discharges and the proportion of drying statuses observed at ONDE sites. Calibration was performed against the discrete flow states available at 3300 ONDE sites between May and October from 2012 to 2018. The model used daily discharges simulated at 568 gauging stations by the GR6J rainfall-runoff model (Pushpalatha et al., 2011).

An ensemble of 26 high-resolution projections has been derived from GCM simulations under RCP2.6 and RCP8.5 emission scenarios, applying an advanced delta change approach (van Pelt et al., 2012). Daily discharge time series at the 568 gauging stations obtained from GR6J with the GCM-driven forcings have been used as inputs of the empirical model to estimate RPoD under future climate conditions.

Characteristics of flow intermittence between May and October have been studied over France divided into 22 Hydro-EcoRegion. Results for the periods 2021-2050 and 2071-2100 show an increase in RPoD with time. The mean RPod over the whole period May–October is 12% at the national scale under the current climate, compared to 20% and 23% on average all RCPs together for the periods 2021-2050 and 2071-2100, respectively. The changes are significant in regions with

historically high probability of drying. On the other hand, no change is detected in the Alps. This last result is debatable since, in these areas and under the current climate, low flows are mostly observed in winter, the ONDE sites are sparse and the model predicting RPoD shows the worst performance.

References:

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