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

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EGU24 HS2.1.1 - 19/04/2024

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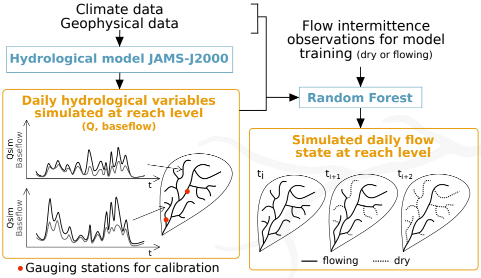
Flow intermittence model (HS2.1.1 PICOA.5)



Projections of flow intermittence under climate change scenarios

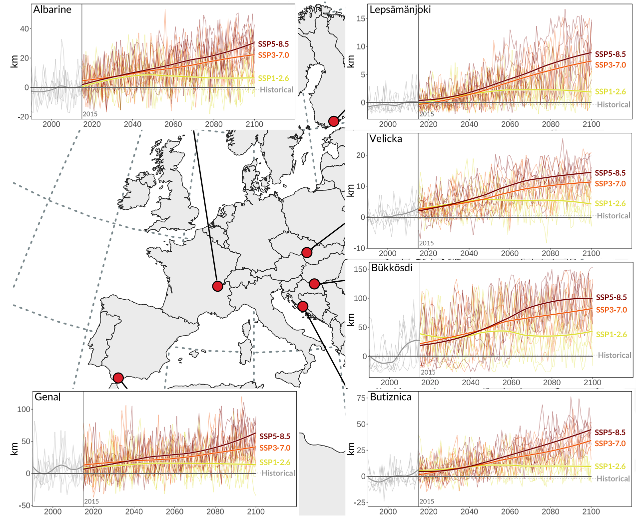
Step 1: Application of the model on 6 European drying river networks

Step 2: Reconstruction simulation under past/present climate (1960-2021)

Step 3: Projections under climate change (1985-2100) : 5 GCMs x 3 SSPs

Step 4: Computation of flow intermittence indicators for the study of the impact of climate change on freshwater ecosystems

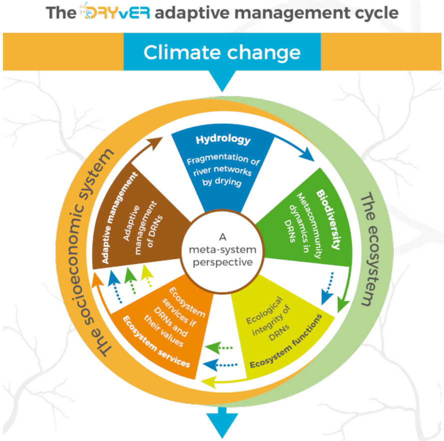
Evolution of the river length with zero flows. Anomaly in comparison with 1985-2014



- **Results** on future changes in
  - the spatio-temporal patterns of flow intermittence
  - the characteristics of drying events
  - the flow regimes of the river sections (perennial or non-perennial)
  - the intensity of extreme drying events
- **Interactive web application DRYvER-Hydro**
- **Examples of applications to ecological studies**

PICO A.11

This study is part of a multi-disciplinary project **DRYvER on drying rivers and climate change** (Datry et al., 2021)



Adaptive management of drying river networks

Objectives of the project:

- Studying the impact of climate change on drying river networks
- Evaluating the consequences of drying on biodiversity and ecosystems

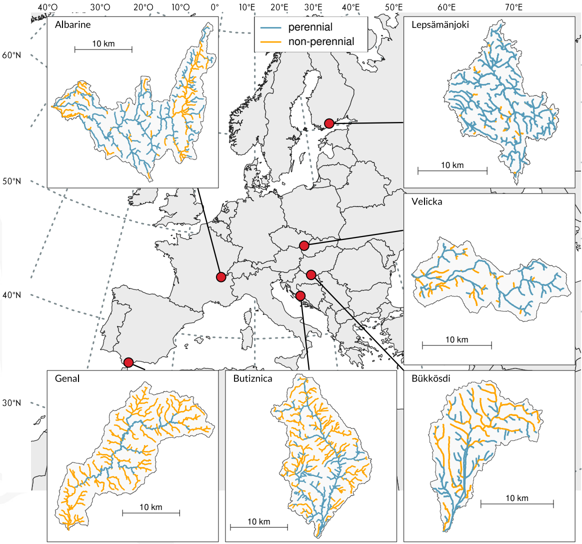
Objectives of this study

Analysis of possible evolutions under climate change scenarios of:

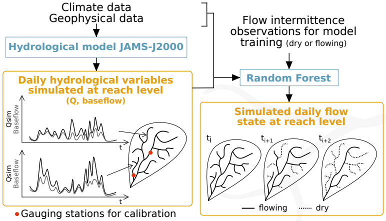
- the spatio-temporal patterns of flow intermittence
- the characteristics of drying events at the reach scale
- flow intermittence regimes (transitions from perennial to non-perennial)
- intensity of extreme drying events

6 studied European drying networks

Flow intermittence regime (historical reconstruction 1985-2014)



Flow intermittence model (HS2.1.1 PICOA.5) (Mimeau et al., 2024)



Step 1: Application of the model on 6 European drying river networks

Step 2: Reconstruction of flow intermittence under past/present climate (1960-2021):

- ERA5-land reanalysis

Step 3: Projections of flow intermittence under climate change (1985-2100):

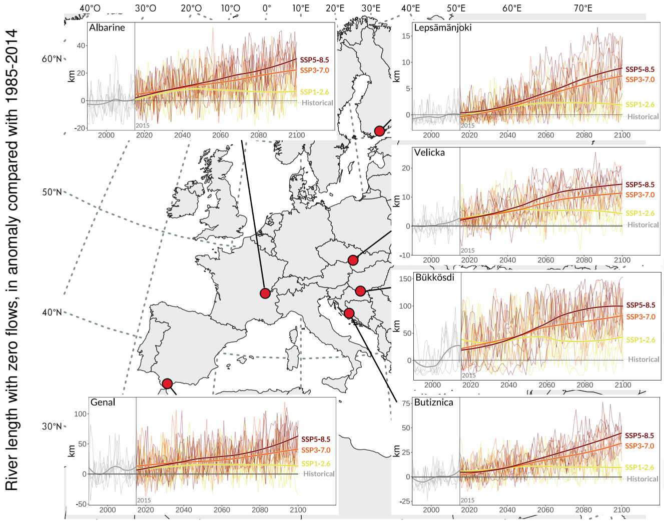
- 5 General Circulation Models (GCMs) (CMIP6 from ISIMIP project)
- 3 socio-economic trajectories (SSP1-2.6, SSP3-7.0, SSP5-8.5)
- Multivariate downscaling by analogy (Devers, Lauvernet, and Vidal, 2023)

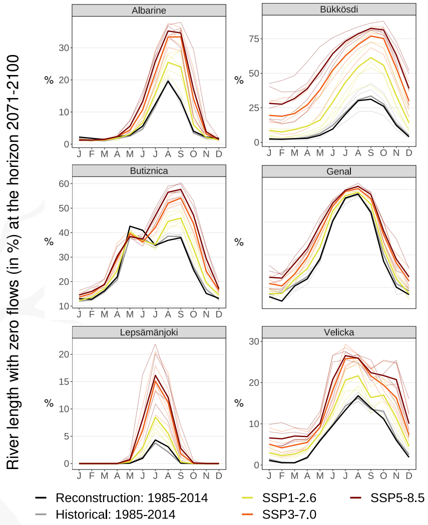
Step 4: Computation of flow intermittence indicators for the study of the impact of climate change on freshwater ecosystems (Künne and Kralisch, 2021)

- Indicators at the **network scale**:
  - proportion of river network with dry conditions [% and m]
  - proportion of river network with changing flowing conditions compared to adjacent downstream river section [%]
- Indicators at the **reach scale**:
  - number of days with dry conditions
  - number of drying events (consecutive days with a dry condition)
  - duration of drying events [days]
  - julian day of the first drying event per year [1-366]
  - number of days to last drying event
  - baseflow proportion of discharge [%]

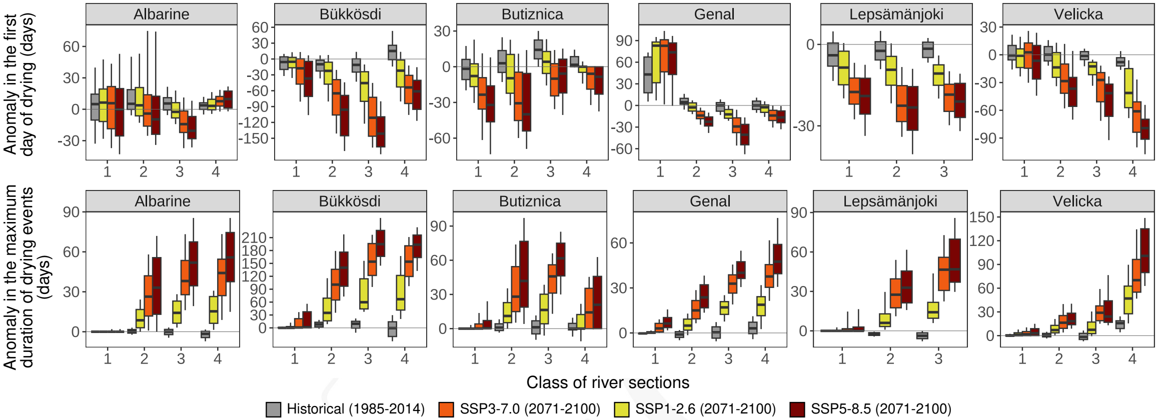
Indicators are provided at monthly and yearly time steps.

Changes in the spatio-temporal patterns of flow intermittence





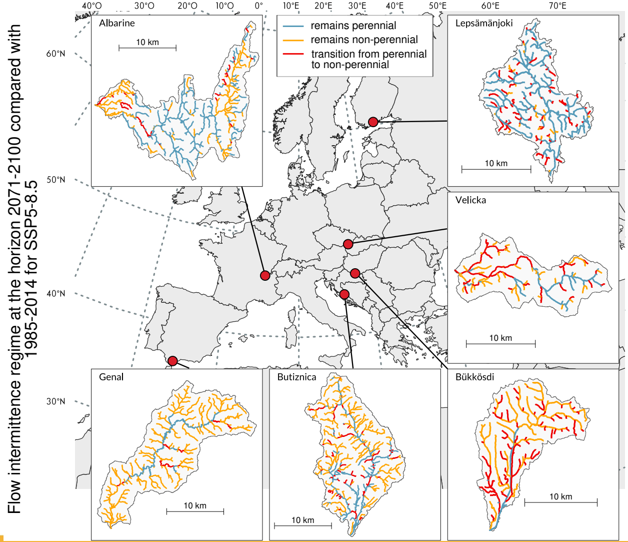
Changes in the characteristics of drying events

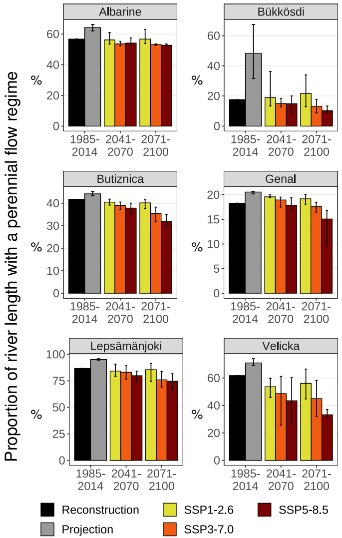


Classes of river sections, based on the average number of dry days/yr for the recontruction simulation (1985-2014)

Class 1: 0 - 5 **Class 2**: 5 - 30 **Class 3**: 30 - 120 **Class 4**: > 120

Changes in flow intermittence regimes

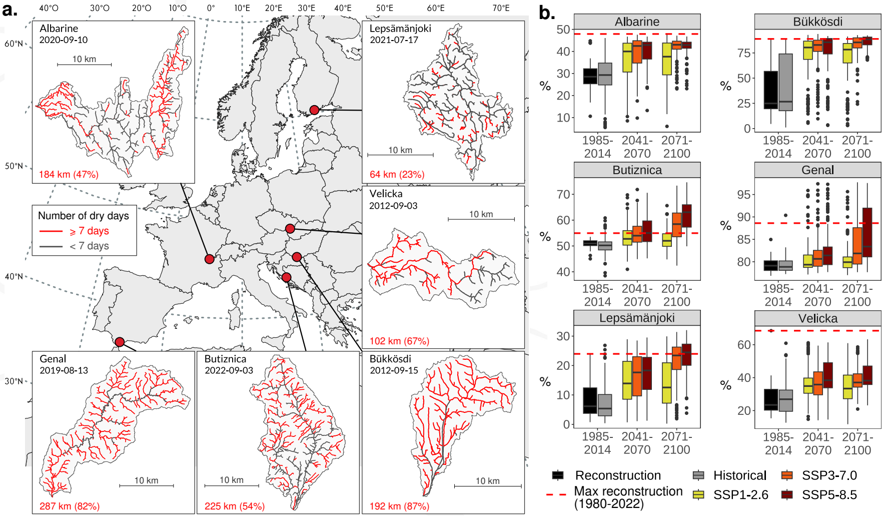


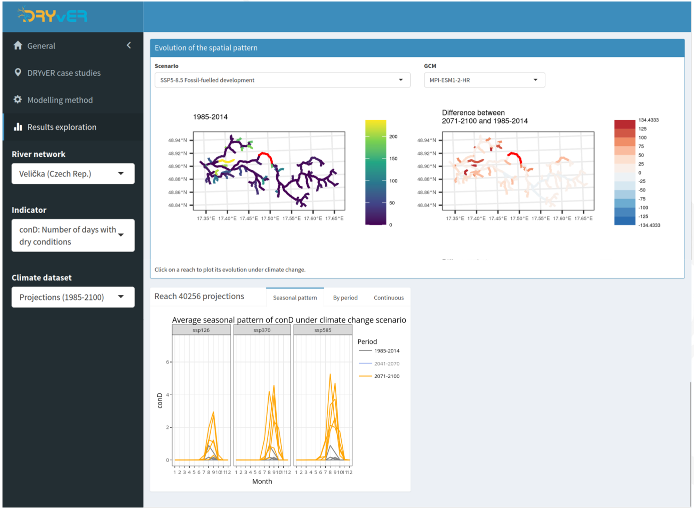


Changes in intensity of extreme drying events

a. Driest 10 days event in the 6 DRNs for the historical reconstruction simulation (1980-2022).

b. Evolution of the annual maximum proportion of dry river length over a 10 day period under the 3 SSP scenarios. The red dashed line shows the driest event of the reconstruction simulation (1980-2022), corresponding to the extreme events in panel a).





Interactive web application **DRYvER-Hydro** to visualise all flow intermittence indicators in the 6 studied river networks.

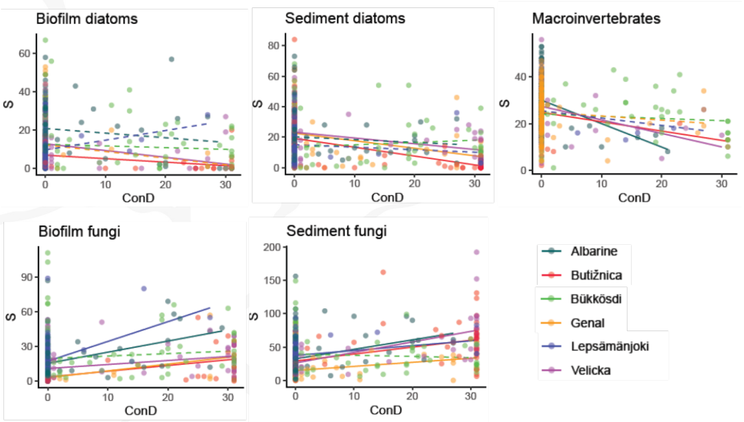
https://dryver-hydro.sk8.inrae.fr/

Examples of applications to ecological studies

- Impact of zero-flows on meta-communities

Longer drought was generally related to reduced diatom and macroinvertebrate taxon richness, but for fungi, richness increased with the duration of drying. Further investigations are now in preparation.

Relationships between taxon richness (S) and number of days with dry conditions within 30 days prior to sampling (ConD). Each colour represents separate drying river network (DRN). Linear regression lines are drawn for each DRN (solid line=significant; dashed line=non-significant).

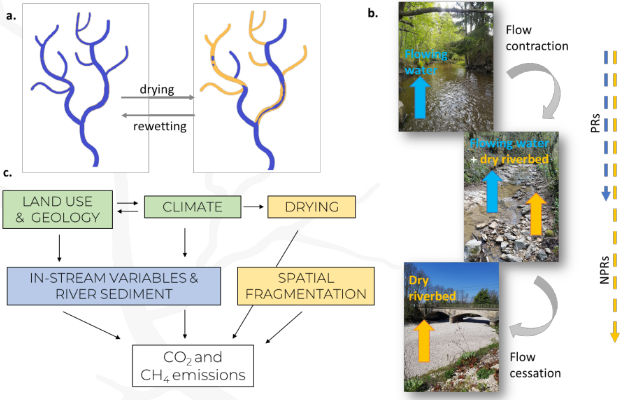


(Vilmi, Snåre, and Mykrä, 2023)

Examples of applications to ecological studies

- Impact of zero-flows on meta-communities
- GHG emissions of intermittent river networks

Taking account of the drying-up and re-watering phases in the calculation of greenhouse gas emissions from intermittent rivers

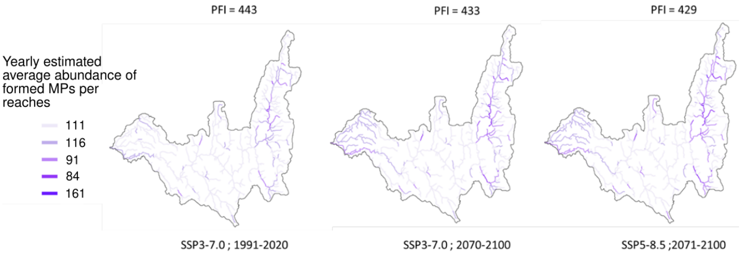


(López-Rojo et al., 2024)

Examples of applications to ecological studies

- Impact of zero-flows on meta-communities
- GHG emissions of intermittent river networks
- Plastic fragmentation in the Albarine river

Estimation of plastic fragmentation according to 2 SSP scenarios based on the climate projections from the MRI-ESM2-0 GCM. PFI: Plastic fragmentation index



(Barthélémy et al., 2024)

Key messages

- There is a **severe intensification of drying** in the 6 study sites by 2100 for the SSP3-7.0 and SSP5-8.5 scenarios
- Simulated drying events in the future period tend to **start earlier** in the year and **last longer**
- Climate change could lead to a **reduction in the length of the network with perennial flow** in the 6 sites
- **Extreme dry spells** observed during the last decade **could become the norm**, or be frequently exceeded depending on the SSP

- The intermittence indicators calculated for the 6 European study cases and their projections under climate change can be viewed on **DRYvER-Hydro**
- The intermittence indicators are used to study the impact of drying on freshwater ecosystems

References

- Barthélémy, N. et al. (2024). "Flow intermittence increases PVC film fragmentation in aquatic ecosystems". In: *Environmental Science & Technology (under review)*.
- Datry, T. et al. (2021). "Securing Biodiversity, Functional Integrity, and Ecosystem Services in Drying River Networks (DRYvER)". In: *Research Ideas and Outcomes*. DOI: `10.3897/rio.7.e77750`.
- Devers, A., C. Lauvernet, and J.-P. Vidal (2023). D1.6 Report on downscaling global climate projections for catchment-scale hydrological modelling. Link to deliverable. INRAE.
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- Vilmi, A., H. Snåre, and H. Mykrä (2023). D2.6: A report on meta-community spatio-temporal models and meta-community patterns across the six focal DRNs in Europe. Link to deliverable. SYKE.

Thank you for your attention !

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Other EGU24 presentations related to the **DRYvER** project:

- EGU24-16251 HS2.1.1 Mimeau et al. Using a hybrid hydrological modelling approach to simulate drying patterns in 3 non-perennial European river networks.
  Fri, 19 Apr, 08:47–08:49 (CEST) PICO spot A | PICOA5
- EGU24-3816 HS2.5.1 Abbasi and Döll Quantifying the potential impacts of climate change on streamflow intermittence in Europe.
  Fri, 19 Apr, 14:45–14:55 (CEST) Room C

start return

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