STRENGTH AND PERSISTENCE OF STREAMFLOW MEMORY ACROSS EUROPE

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What is streamflow memory?

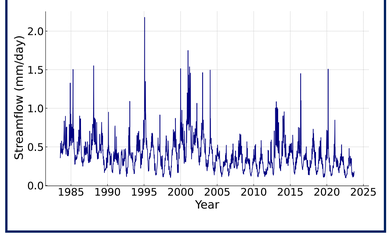
- Streamflow memory characterizes how strongly past catchment conditions influence current and future conditions - *How does a catchment influence itself?*
- *Top-down approach* uses station-based weekly streamflow measurements to analyse catchment dynamics
- Exponential decay effectively characterizes streamflow memory, providing a straightforward way to summarize information at many locations

Why memory?

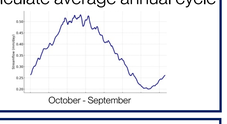
- Summarizes catchment dynamics at monthly to multi-annual timescales
- Characterized by ***initial strength*** and ***persistence***
- Memory displays *distinct geographic patterns*, indicating systematic links with catchment and climate features
- We hypothesize that memory is related to groundwater, and plan to investigate these connections
- Memory calculations come directly from measured data across Europe, and can be used to evaluate how well hydrologic models represent these short-medium timescale dynamics in Europe

Calculating memory for an example EStreams catchment

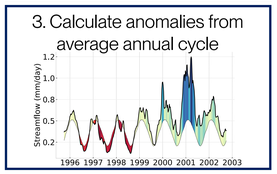
1. Hydrograph with minimum 20 years of data



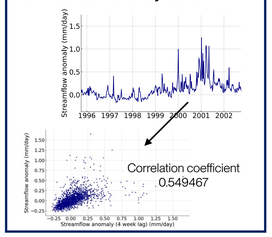
2. Calculate average annual cycle



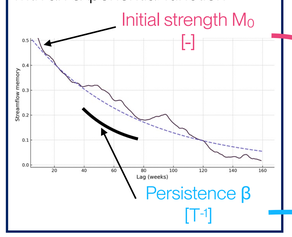
3. Calculate anomalies from average annual cycle

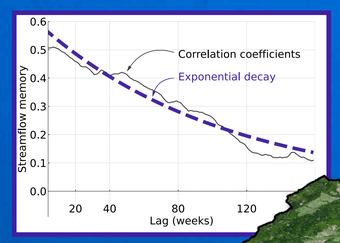


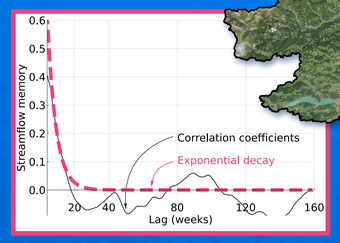
4. Calculate anomaly autocorrelation at lag times from *4 weeks to 3 years*

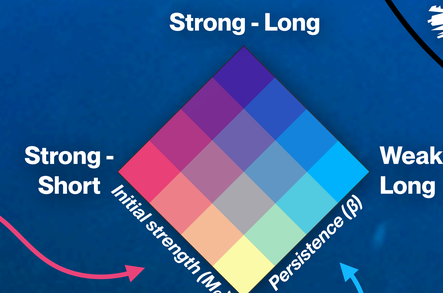


5. Characterize correlation decay with an exponential function



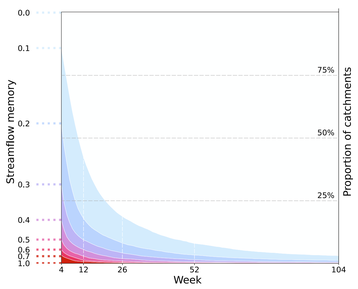


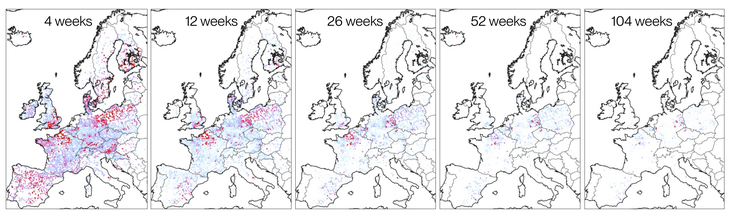




Duration of memory

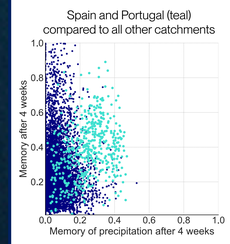
- *Most* catchments show some memory (*correlation > 0.3*) after 4 weeks
- Only *3% of catchments* still display this amount of memory after 1 year
- Memory in areas with large aquifers or deeper bedrock is *more persistent* than in arid regions

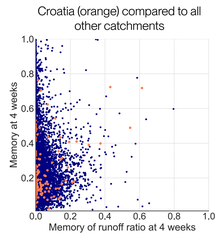


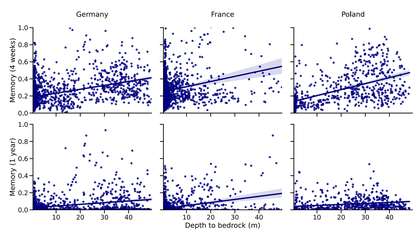


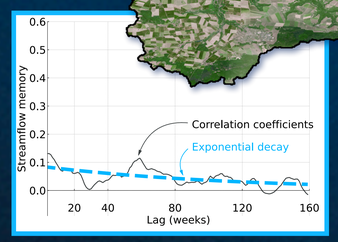
Is memory driven by forcing or by function?

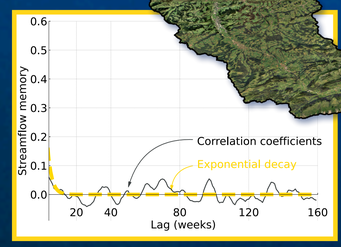
- *Geographically distinct memory patterns* appear regionally linked to landscape:
  - Chalk aquifers in southern England and France
  - Deep bedrock areas in Poland and Germany
- Memory of streamflow is mostly *stronger than memory of precipitation*, indicating that external forcing from precipitation is of low importance
  - Exceptions exist in Spain and Portugal
- Memory of streamflow is also weakly correlated to memory of runoff ratio











Streamflow data from do Nascimento, Thiago VM, et al. "EStreams: An integrated dataset and catalogue of streamflow, hydro-climatic and landscape variables for Europe." *Scientific Data* 11.1 (2024): 879.
Basin map imagery from European Union's Copernicus Land Monitoring Service 2012 and 2021 VHR Mosaics.

Abstract

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