Identification of flood-rich and flood-poor periods by using the longest streamflow records in Spain

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- INTRODUCTION
- METHODOLOGY
- CASE STUDY
- RESULTS
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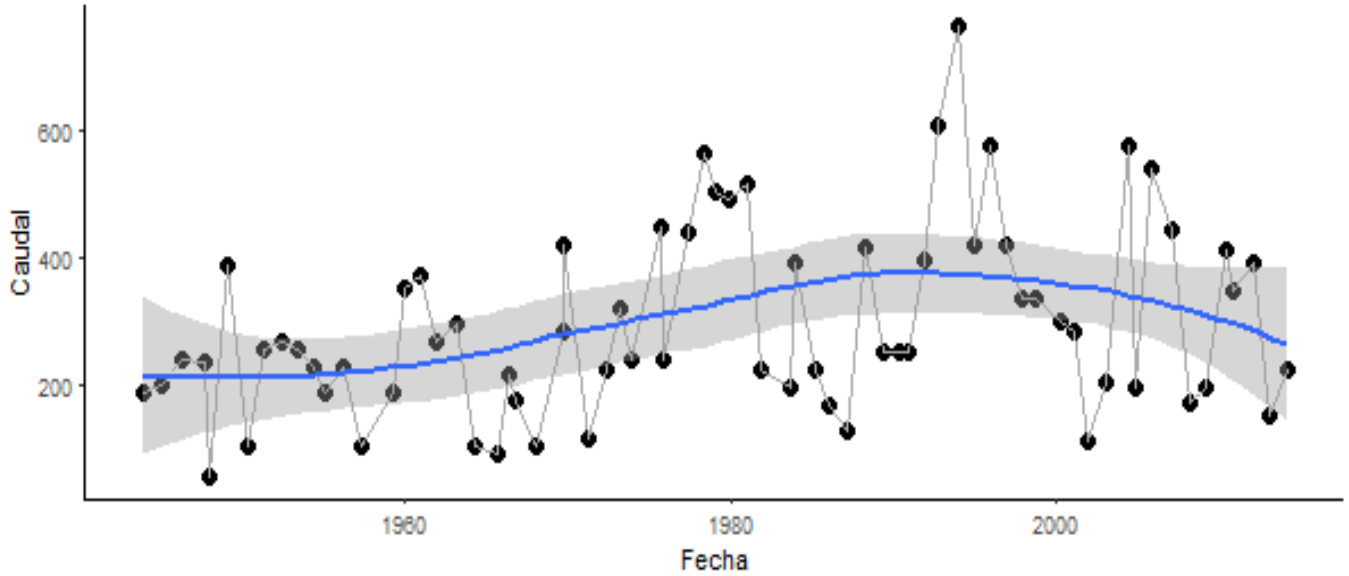
INTRODUCTION

- **In the last decades, there has been general concern about if streamflow series are stationary or non-stationary.**
- **In 2008, Milly et al. stated that '*stationarity is dead*'.**



Source: Suassuna et al. (2018)

INTRODUCTION

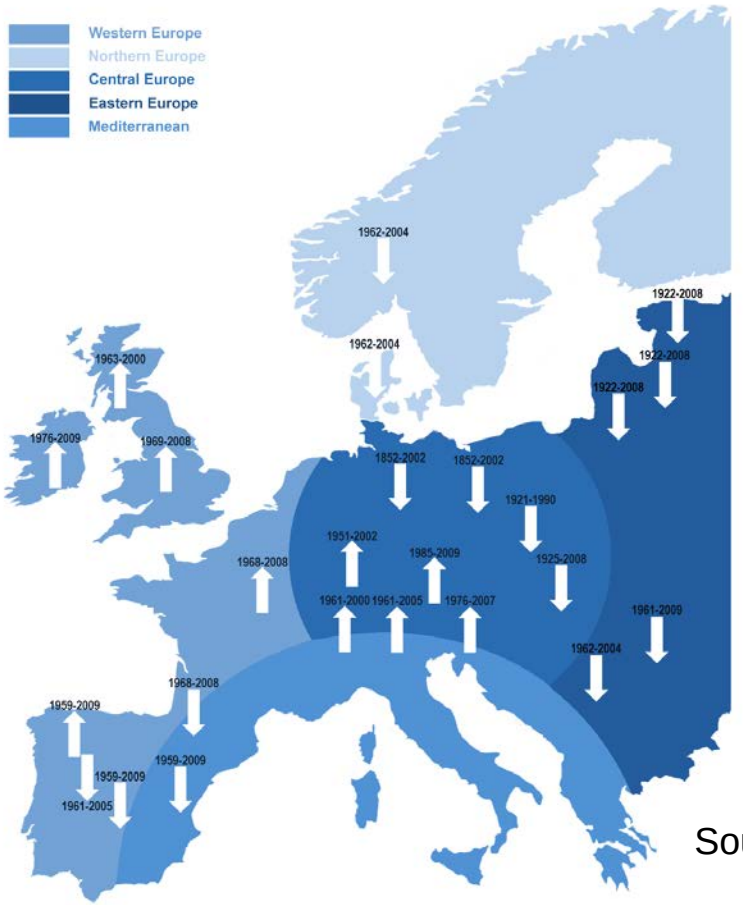
- **Several studies have tried to find temporal trends in flood series, but no clear pattern was found.**

Source: Kundzewicz et al. (2005)

- **However, climate change is expected to change atmospheric pattern circulations.**

INTRODUCTION

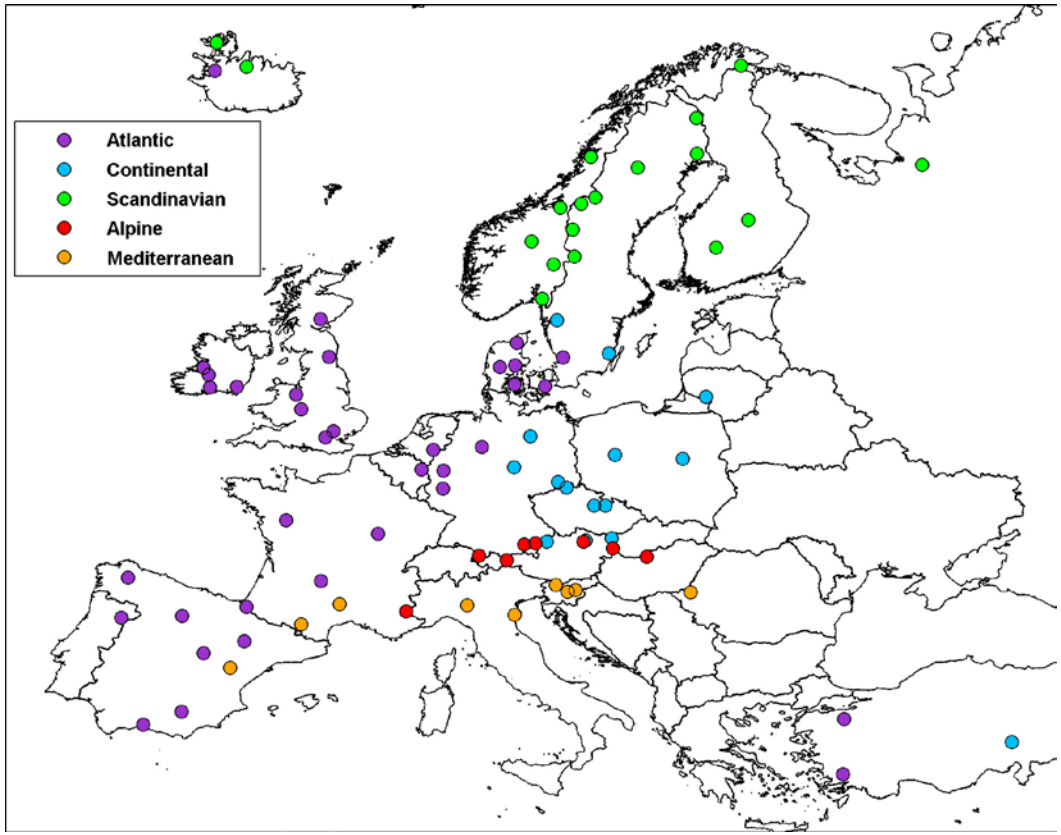
- **In Europe, Hall et al. (2014) offered a summary of previous flood trend studies:**



Source: Hall et al. (2014)

INTRODUCTION

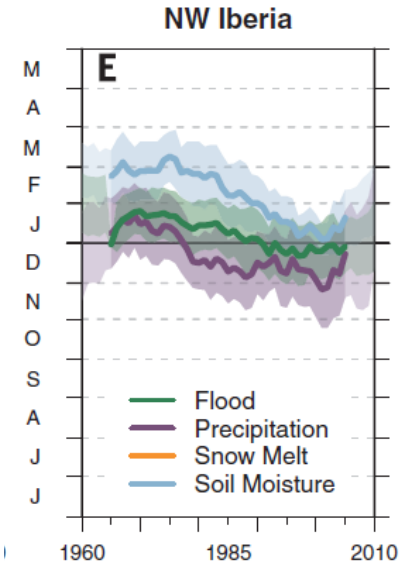
- **Flood trends were also studied at a European scale with the longest available streamflow records (COST ES0901):**

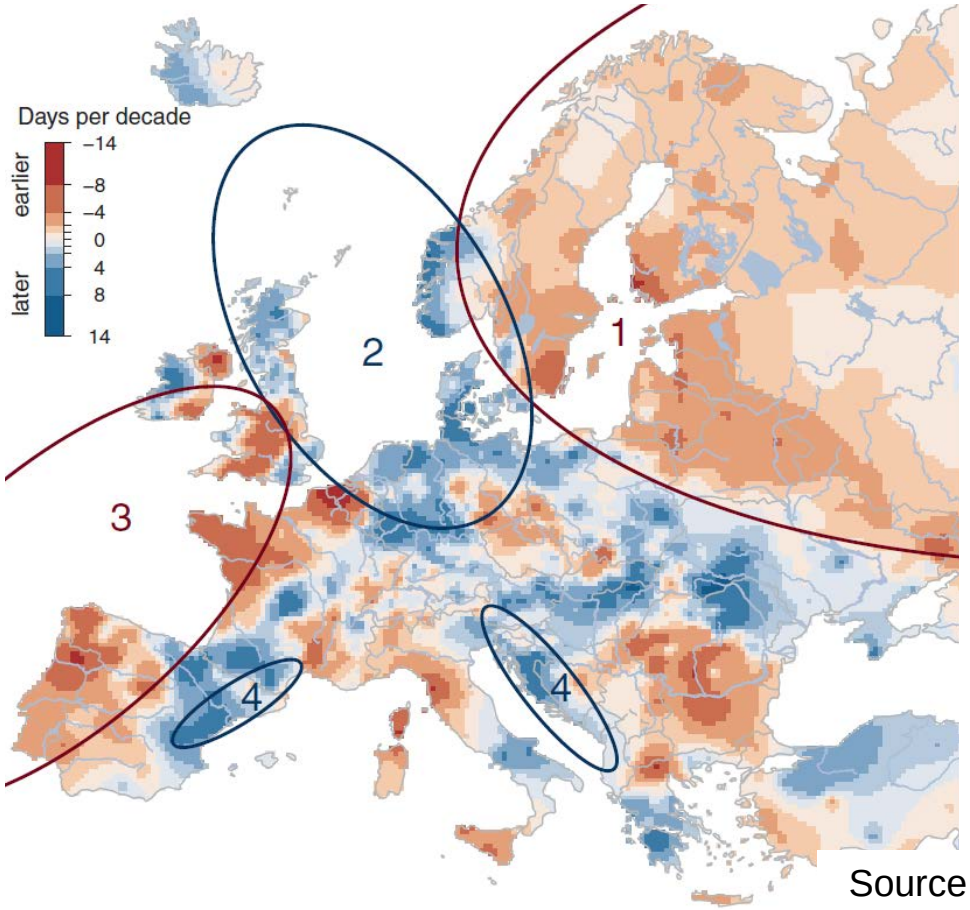


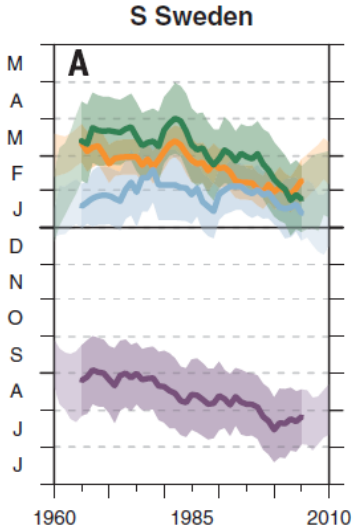
Source: Mediero et al. (2015)

INTRODUCTION

- **Blöschl et al. (2017) found a large-scale pattern of change in flood timing:**



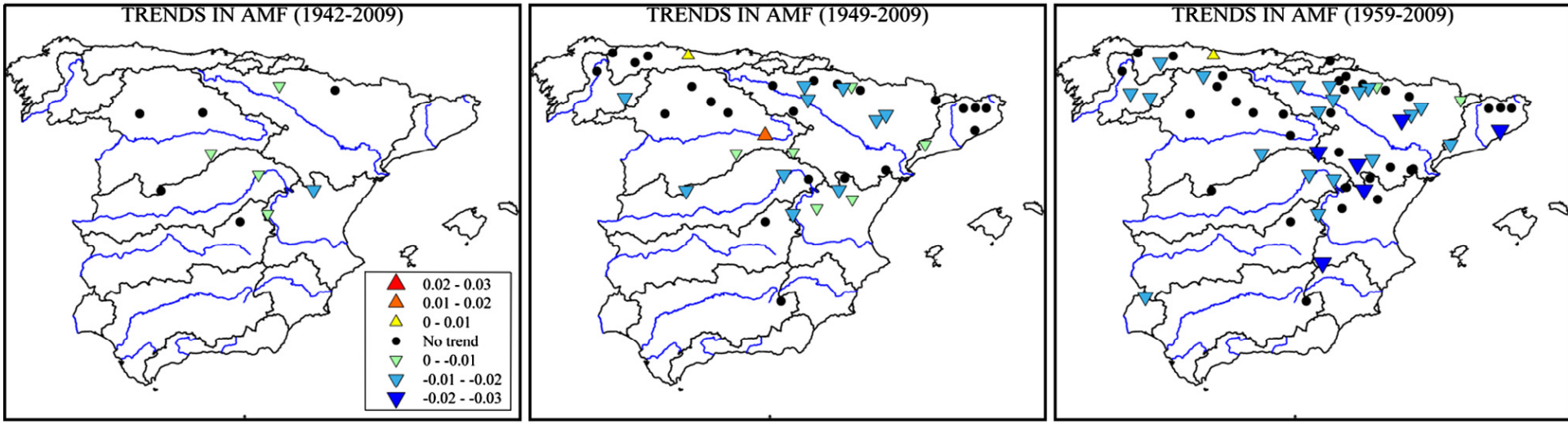




Source: Blöschl et al. (2017)

INTRODUCTION

- **In Spain, Mediero et al. (2014) found a general decreasing trend in flood series, with more notable evidence in the period 1959–2009:**



Source: Mediero et al. (2014)

INTRODUCTION

- **This study aims at conducting a statistical analysis to identify potential oscillations in flood series in Spain.**
- **Such oscillations cannot be identified by the traditional Mann-Kendall test**
- **Temporal oscillations may drive consecutive flood-poor and flood-rich periods.**
- **A methodology has been developed to identify statistically significant flood-poor and flood-rich periods.**

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METHODOLOGY

- **Annual maximum series are usually characterised by an extremal distribution function.**
- **In Spain, a Generalised Extreme Value (GEV) distribution fritted by the L-moment method is recommended.**

$$F(x) = exp\left\{-\left[1 - k\left(\frac{x-u}{\alpha}\right)\right]^{\frac{1}{k}}\right\}$$

- **The expected variability of flood magnitudes under an assumption of stationarity is compared with the actual variability of flood magnitudes in observed flood series.**

METHODOLOGY

- **Flood-poor and flood-rich periods are identified when the stationary hypothesis is not met:**

  1) A GEV distribution is fitted to AMS.

  2) *N* random series of *n* years are generated.

  3) The mean value for each series is calculated.

  4) Upper and lower thresholds are obtained for the confidence intervals (α/2) and (1 – α/2).

- **For instance, if the mean value in *n* consecutive years in the observed series is larger than the upper threshold, the stationary hypothesis is rejected.**

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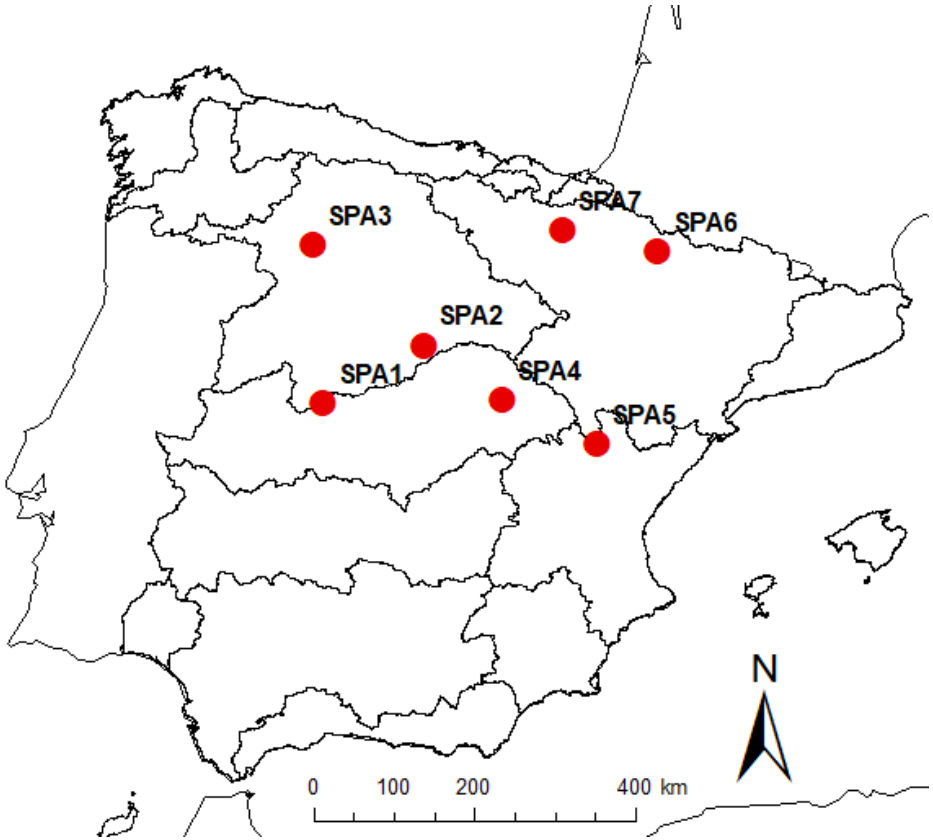
CASE STUDY

- **7 gauging stations in near-natural catchments with observations in the longest period 1942-2014 are selected:**



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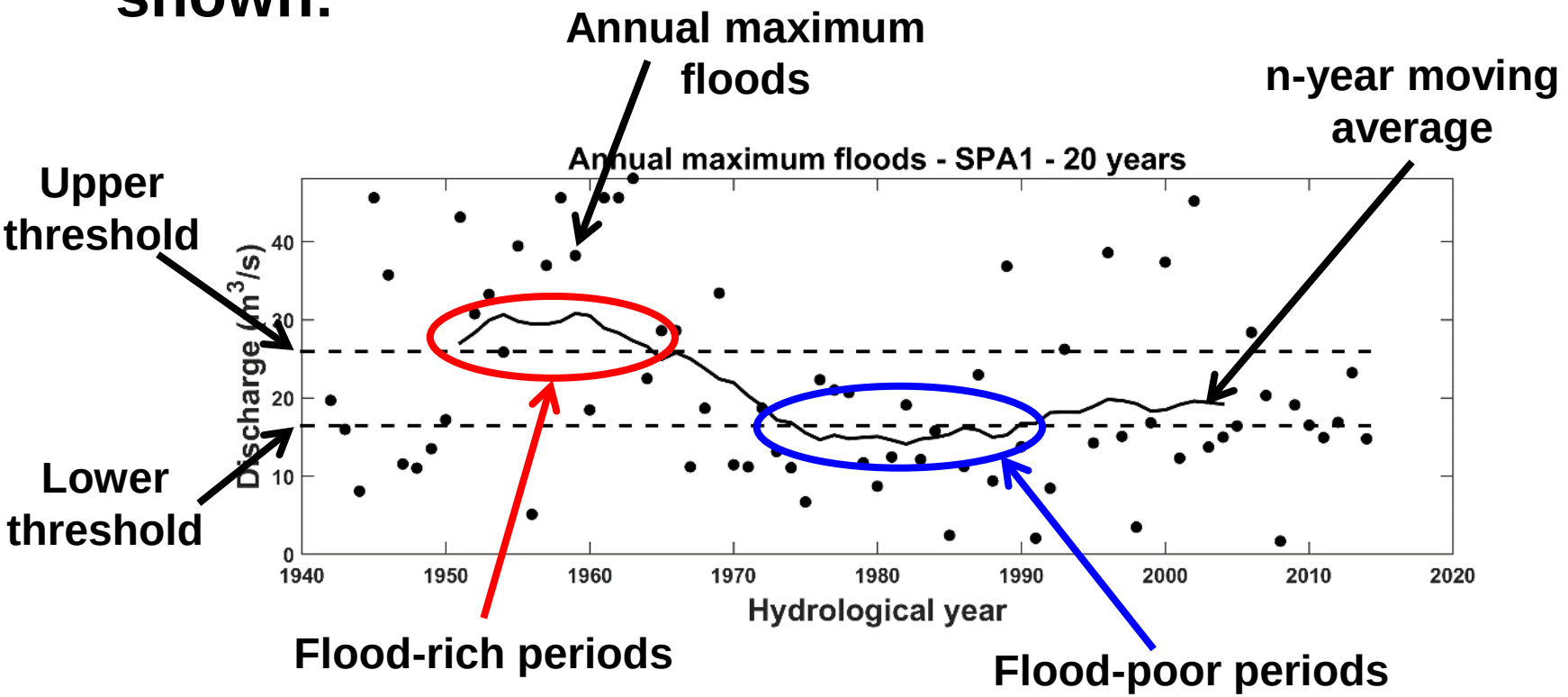
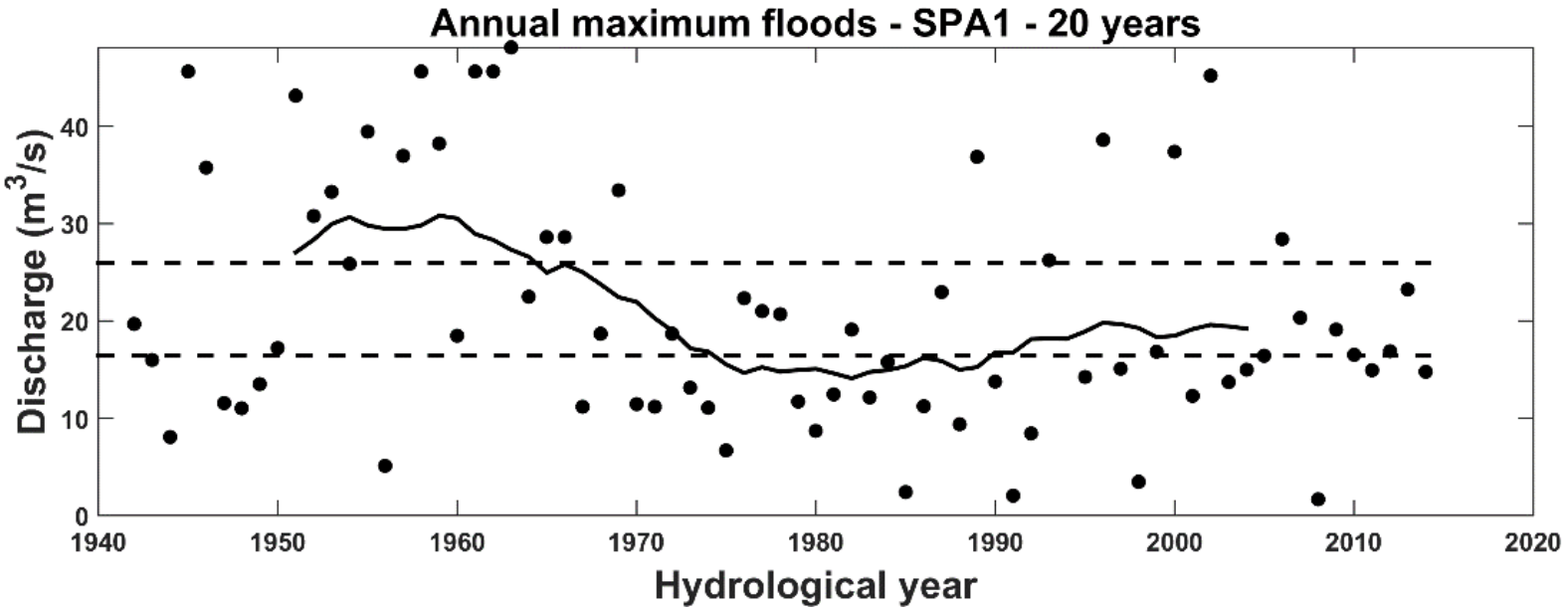
RESULTS

- **N = 100,000; n = 10, 20, 30 years; α = 10%, with 5% in each tail. Only the results for 20 years are shown:**



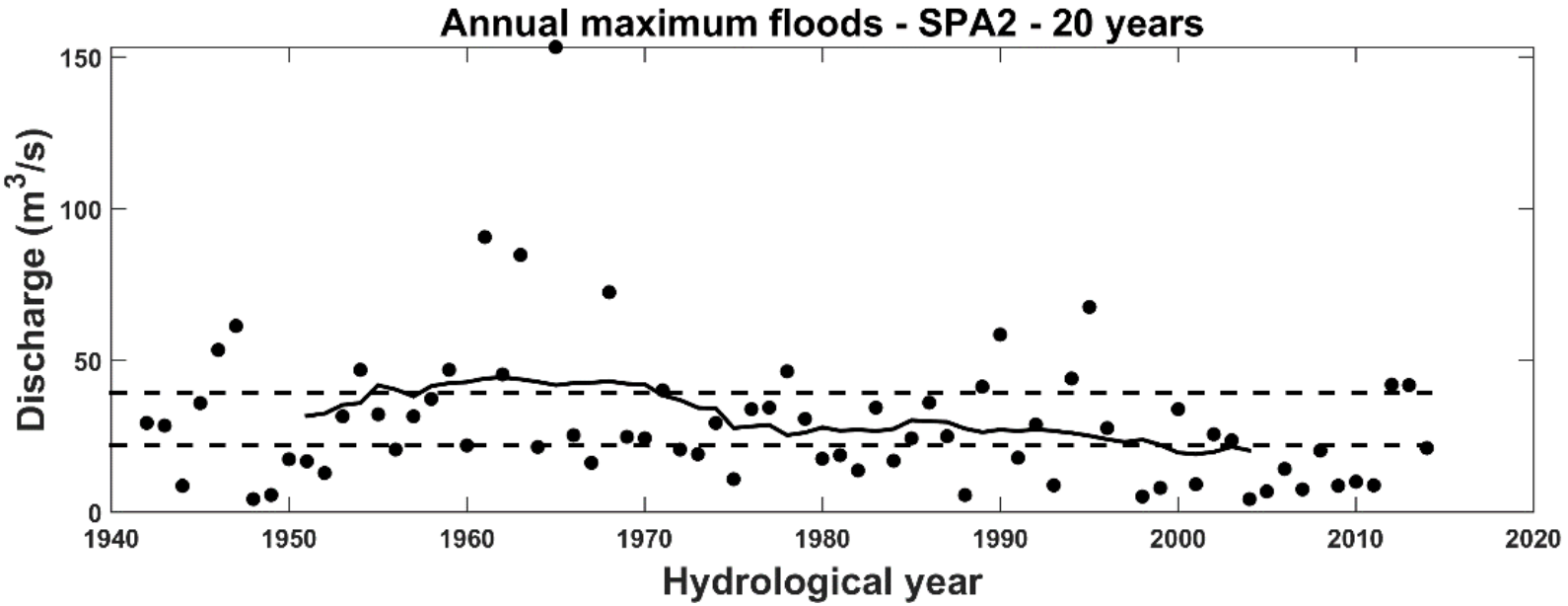
RESULTS

- **In the gauging station SPA1:**
  - **Flood-rich periods: 1942-1974**
  - **Flood-poor periods: 1966-1999**



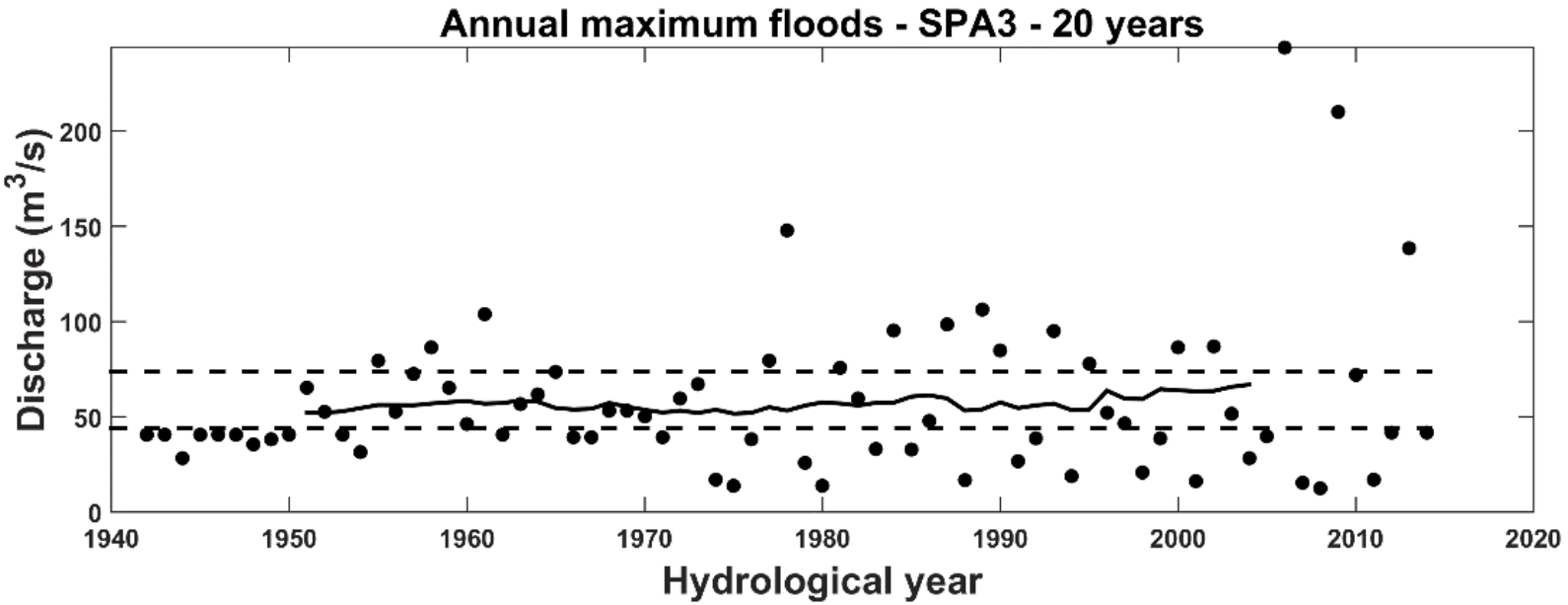
RESULTS

- **In the gauging station SPA2:**
  - **Flood-rich periods: 1946-1980**
  - **Flood-poor periods: 1991-2014**



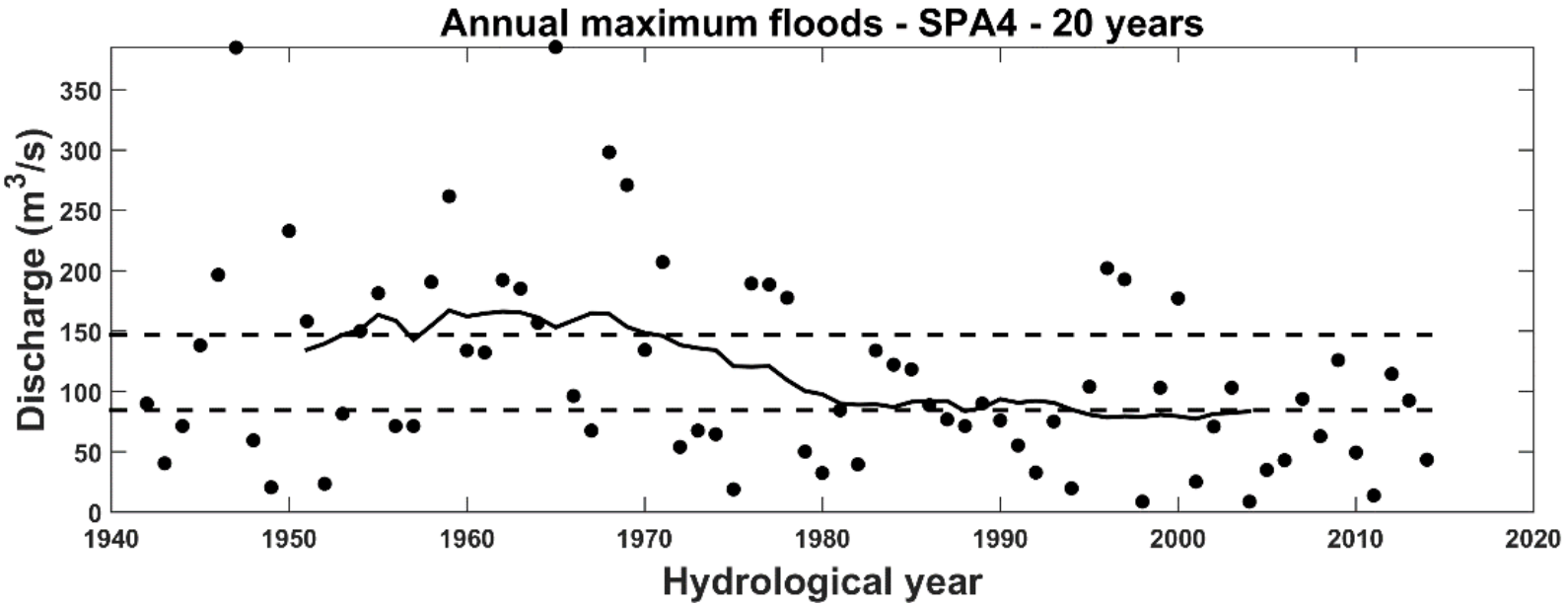
RESULTS

- **In the gauging station SPA3:**
  - **Flood-rich periods: -**
  - **Flood-poor periods: -**



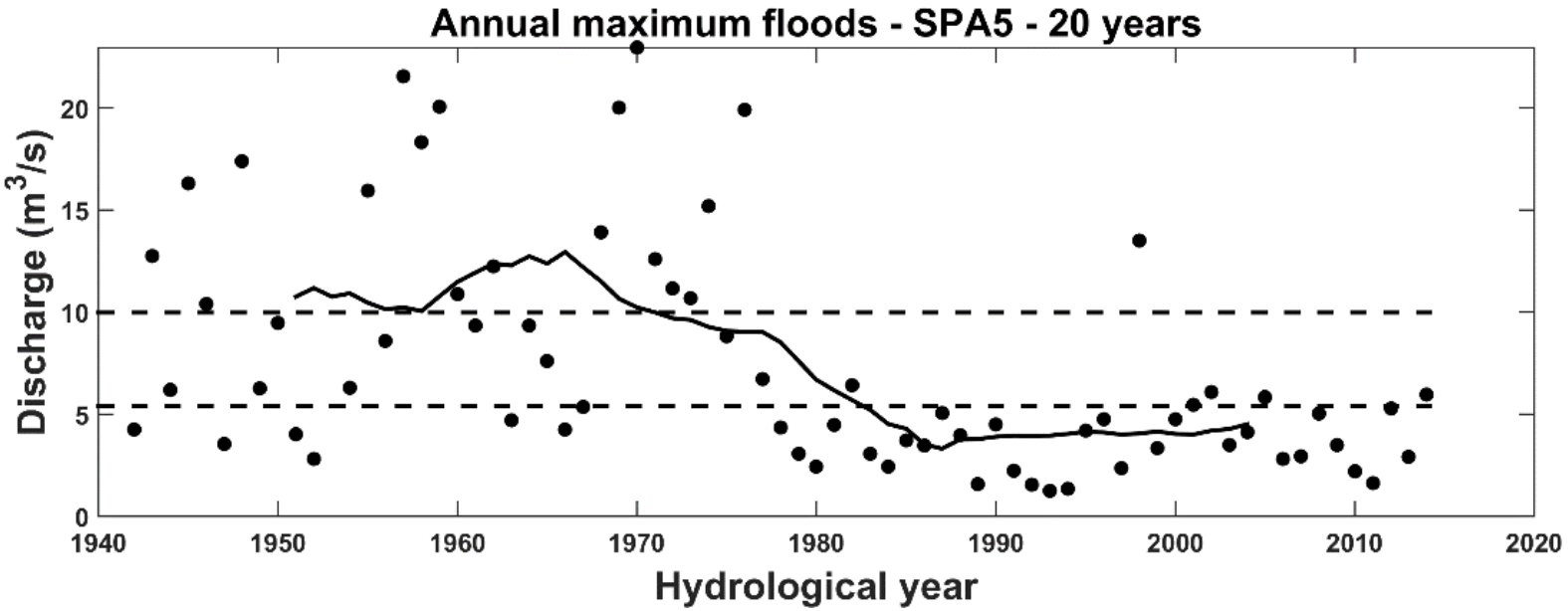
RESULTS

- **In the gauging station SPA4:**
  - **Flood-rich periods: 1945-1980**
  - **Flood-poor periods: 1986-2014**



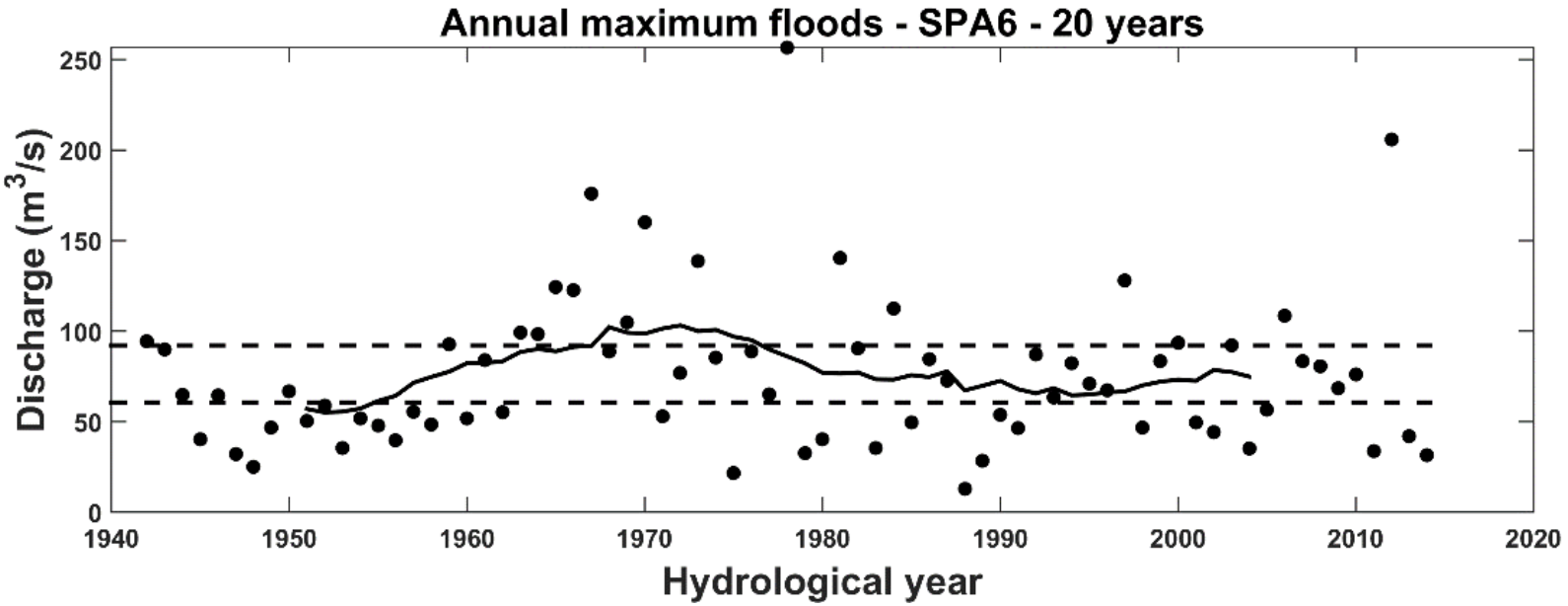
RESULTS

- **In the gauging station SPA5:**
  - **Flood-rich periods: 1942-1981**
  - **Flood-poor periods: 1974-2014**



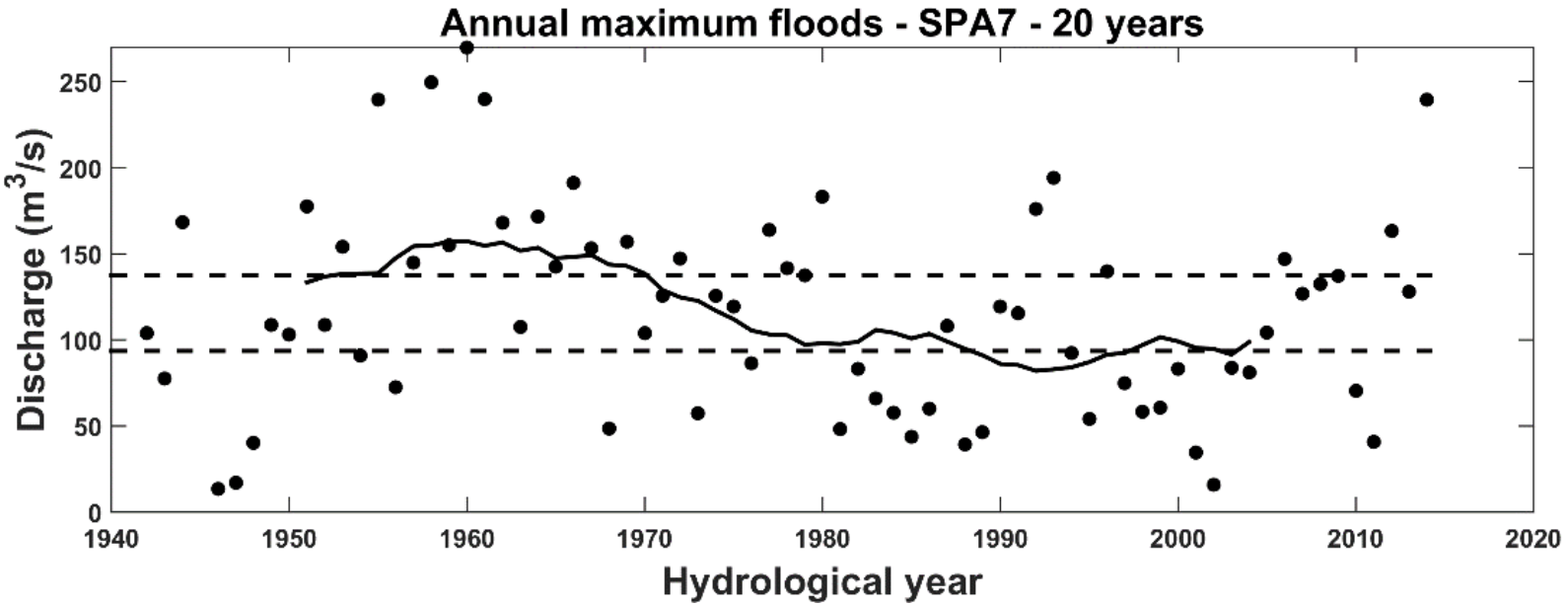
RESULTS

- **In the gauging station SPA6:**
  - **Flood-rich periods: 1959-1986**
  - **Flood-poor periods: 1942-1964**



RESULTS

- **In the gauging station SPA7:**
  - **Flood-rich periods: 1944-1980**
  - **Flood-poor periods: 1980-2007**

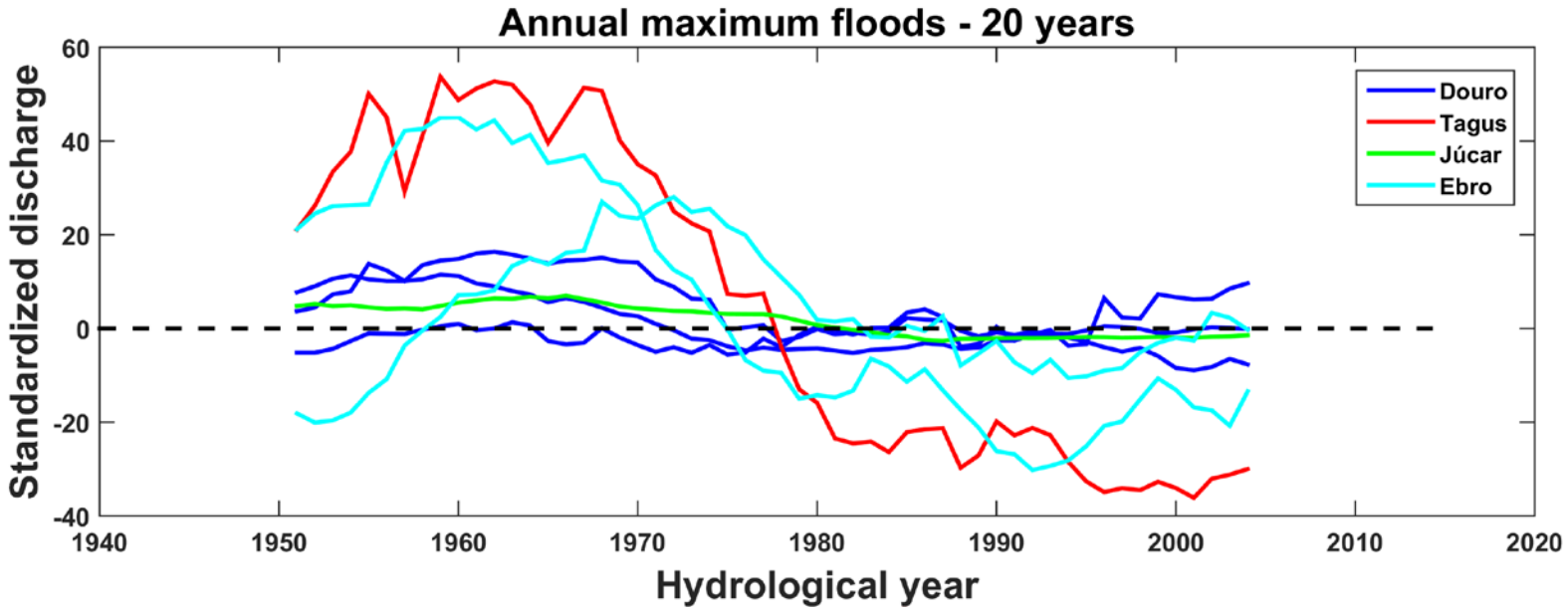


RESULTS

- **In 6 gauging stations, a significant flood-rich period is identified from the beginning of the series to around 1980.**
- **In 5 gauging stations, a significant flood-poor period is identified at the end of the series with a varying beginning year, but most likely finishing at the ending year of the series.**

RESULTS

- **Similar patterns in the 7 gauging stations are found by using standardized discharge magnitudes of annual maximum floods.**
- **Oscillations are larger in the Ebro and Tagus basins than in the Douro and Júcar.**



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CONCLUSIONS

- **A methodology to identify statistical significant flood-poor and flood-rich periods has been presented.**
- **A period with unexpected large consecutive floods, or a flood-rich period, from the beginning of the series to around 1980 has been identified in six of the seven sites.**
- **A period with unusual small consecutive floods under the hypothesis of stationarity, or a flood-poor period, has been identified at the end of the series in four of the seven gauging stations.**

CONCLUSIONS

- **This finding can explain the generalised significant decreasing trend identified in most of gauging stations in Spain previously.**
- **A flood-rich period at the beginning of the flood series followed by a flood-poor period at the end of the series condition the decreasing trends identified by the Mann-Kendall test.**
- **Consequently, the decreasing trend seems to be caused by a natural temporal oscillation in flood magnitudes.**

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