EGU General Assembly

SMHI

Why is large sample hydrology important in hydrological forecasting?

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Read more

- Girons Lopez, M., Crochemore, L., & Pechlivanidis, I. (2021). Benchmarking an operational hydrological model for providing seasonal forecasts in Sweden. Hydrology and Earth System Sciences, *25*(3), 1189–1209. https://doi.org/10.5194/hess-25-1189-2021
- Pechlivanidis, I. G., Crochemore, L., Rosberg, J., & Bosshard, T. (2020). What are the key drivers controlling the quality of seasonal streamflow forecasts? Water Resources Research, 56, e2019WR026987. https://doi.org/10.1029/2019wr026987

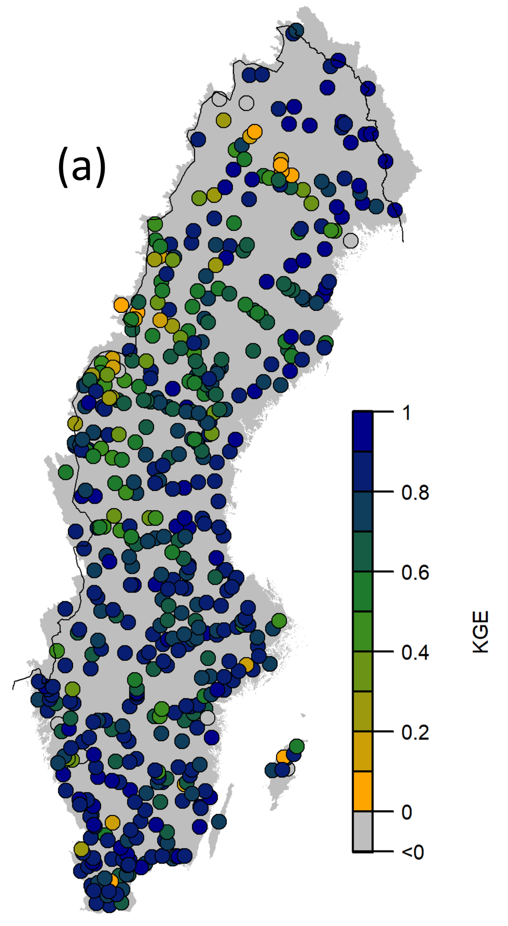
Objectives

- Evaluate the seasonal streamflow forecasts in Sweden and Europe as a function of lead time and initialisation month
- Understand the spatial and temporal distribution of forecast quality and the coupling with catchment characteristics
- Use machine learning to attribute forecast quality to physiographic and hydroclimatic descriptors

The HYPE model setups

The Swedish and pan-European setups of the HYPE model (named S-HYPE and E-HYPE) were designed to provide water information to society (e.g. environmental and climate assessments) at high spatial resolution including making capabilities for making predictions for ungauged basins and using a range of different data sources. The S-HYPE and E-HYPE operational models have an average spatial resolution of 10 and 215 km^2 respectively; while they can provide hydrological information at about 39,500 and 35,400 sub-basins respectively.

(a)



(b)

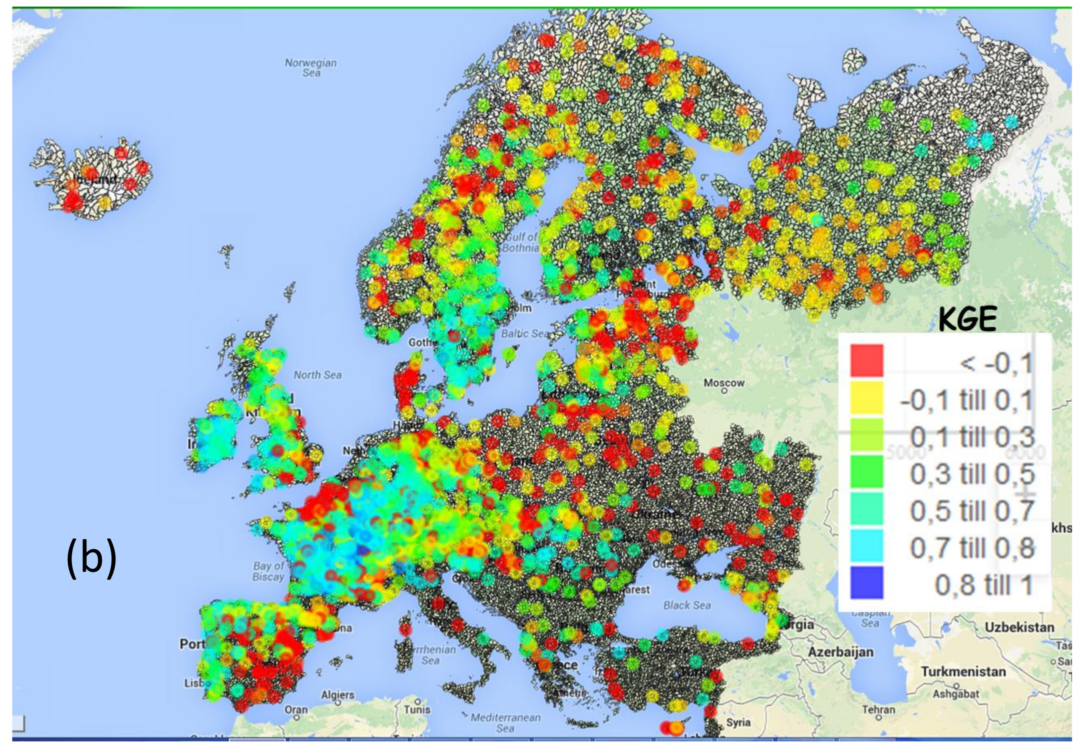


Fig. 1. Kling-Gupta Efficiency (KGE) for: (a) S-HYPE and (b) E-HYPE.

Experimental setup

Swedish assessment

Ensemble Streamflow Prediction (ESP) methodology:

- 1981–2015 analysis period
- 25 ensemble members (-3 years window around current year)
- Initialisation 4 times a month
- 7 months lead time, weekly aggregation

Pan-European assessment

GCM-based using the ECMWF prediction system (SEAS5):

- 1993–2015 analysis period
- 25 ensemble members
- Initialisation every month
- 7 months lead time, monthly aggregation

Driving reference data

Swedish assessment

We use a spatial interpolation product of daily precipitation and temperature covering the whole of Sweden at a resolution of 4x4 km^2 (PTHBV) to produce the series of ESP hindcasts.

Pan-European assessment

Seasonal predictions of daily mean precipitation and temperature were taken from ECMWF's seasonal forecasting system (SEAS5) available at a grid spacing of approximately 36 km. The forecasts were bias-adjusted using a quantile mapping method and the HydroGFD2.0 dataset (precipitation and temperature) as reference.

Evaluation metrics

We evaluate the forecasts on the model reality using the Continuous Ranked Probability Score (CRPS) and its skill score (CRPSS) to evaluate the performance and skill of the hydrological forecasts.

$$CRPS = \int_{-\infty}^{\infty} \left[CDF_{obs}(x) - CDF_{fcst}(x)\right]^2 dx \qquad CRPSS = 1 - \frac{CRPS_{fcst}}{CRPS_{clim}}$$

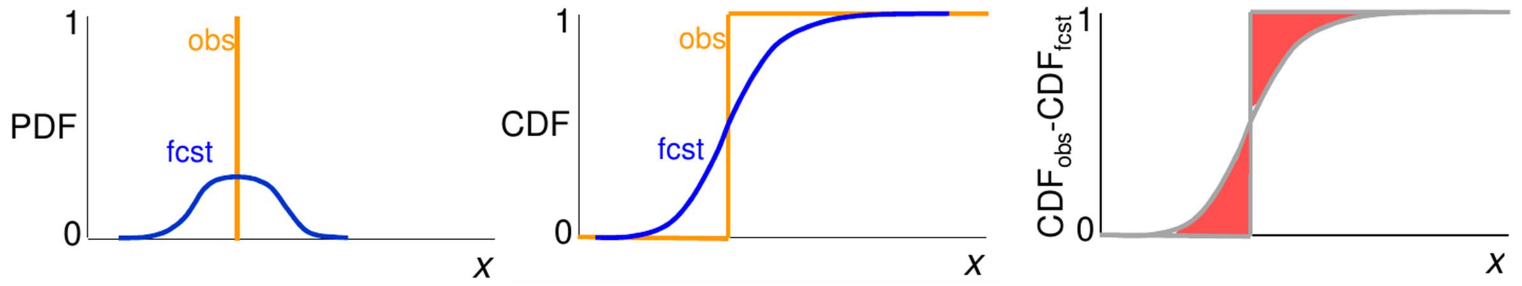


Fig. 2. Schematic representation of CRPS and CRPSS calculation.

Skill distribution - link to catchment characteristics

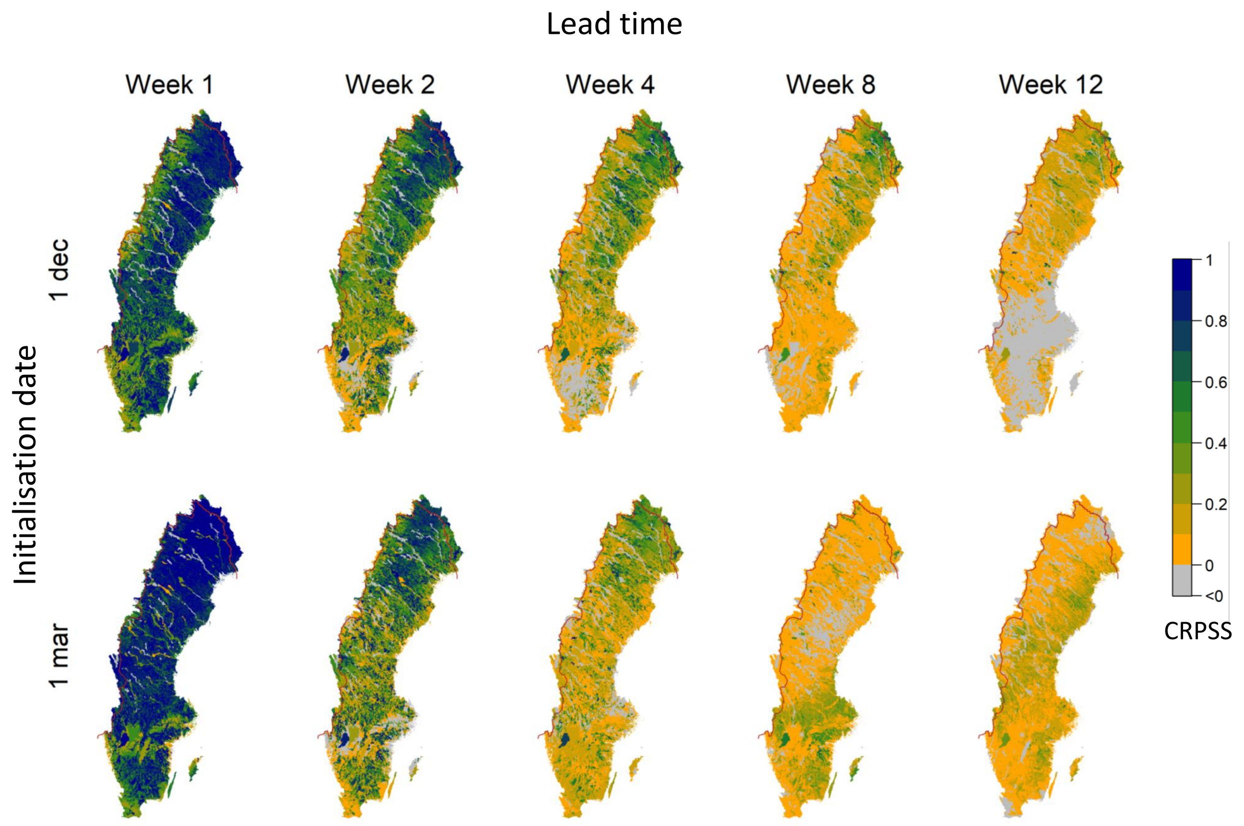


Fig. 3. Skill of S-HYPE ESP forecasts as a function of lead time.

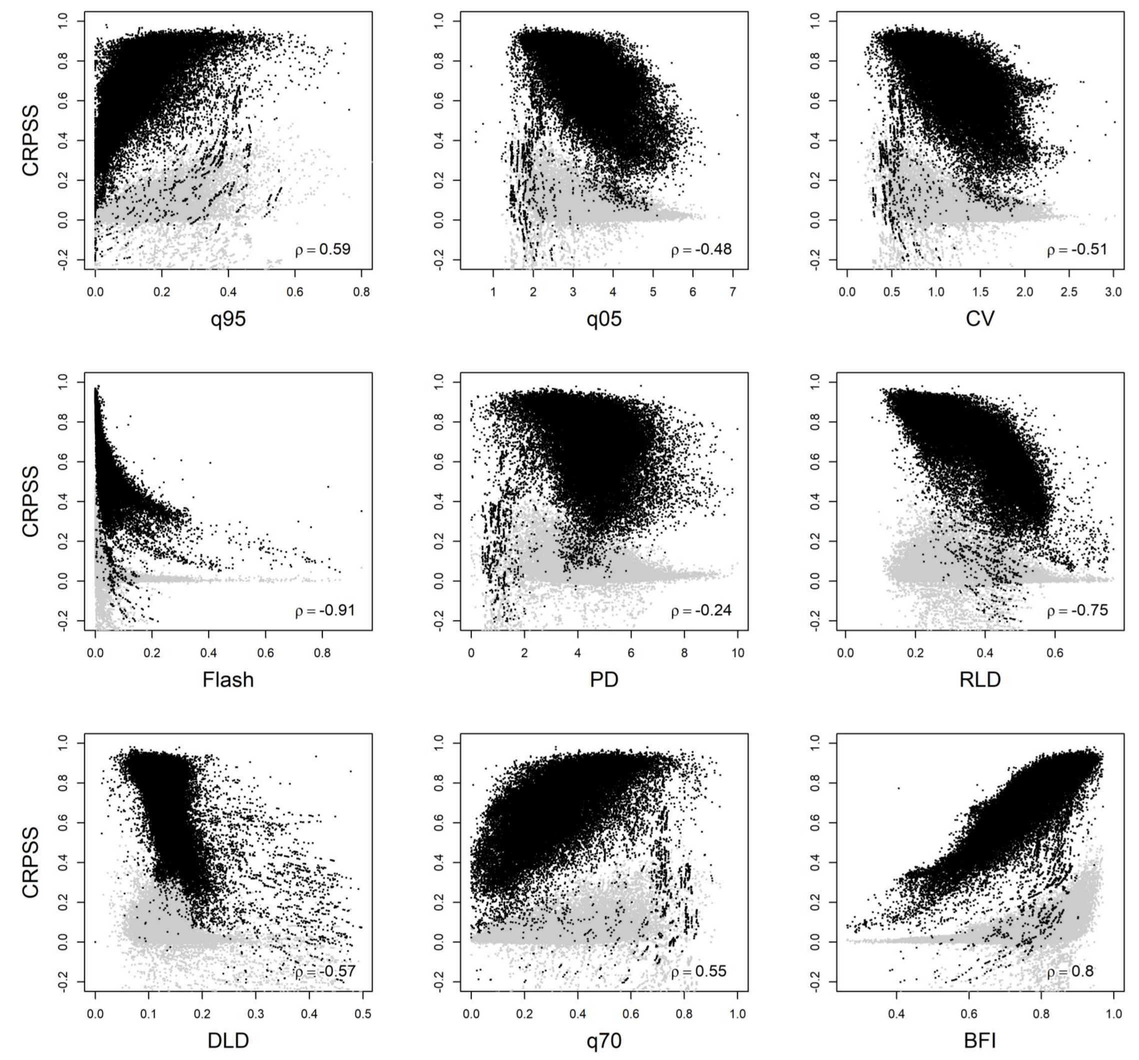


Fig. 4. Forecast skill as a function of a range of flow signatures.

Flow signatures

Normalised low flow (q95)	Normalized high flow (q05)
Coefficient of variation (CV)	Flashiness (Flash)
Normalised peak distribution (PD)	Rising limb density (RLD)
Declining limb density (DLD)	Normalised relatively low flow (q70)
Base flow index (BFI)	

Attribution to physiographic and hydroclimatic descriptors

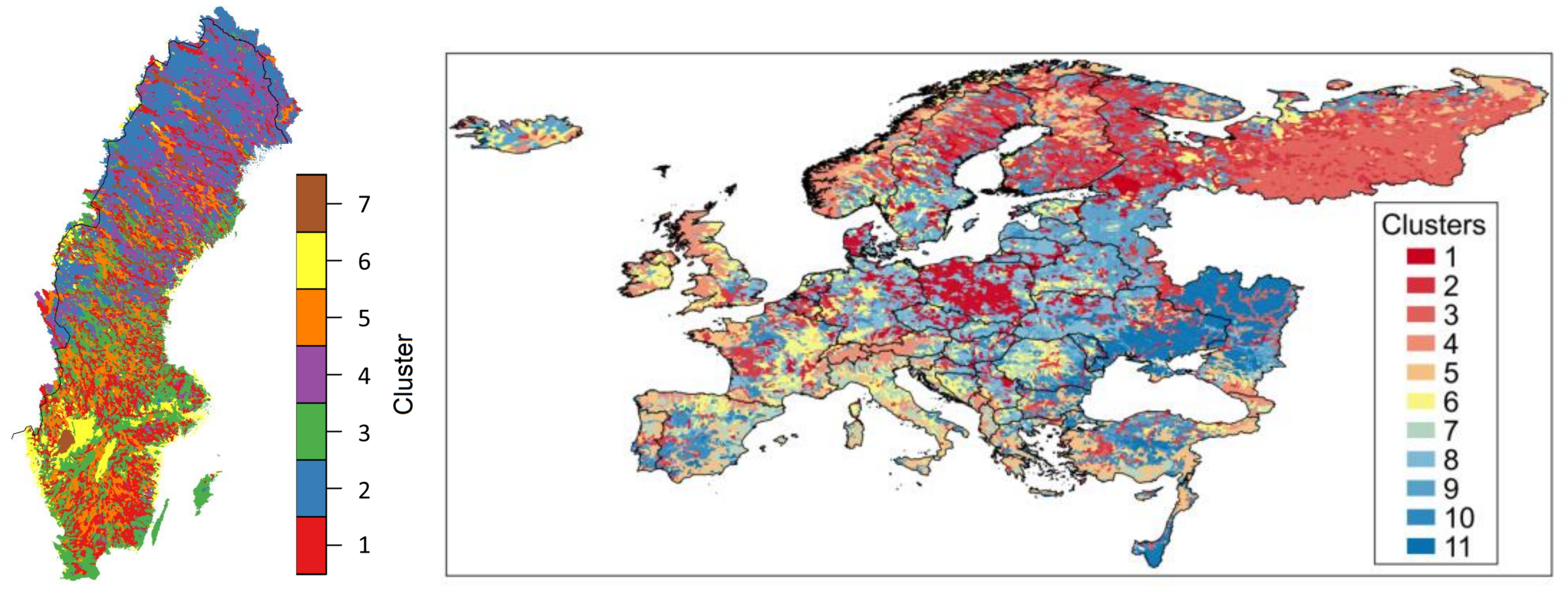


Fig. 5. Spatial distribution of hydrologically similar basins over Sweden and Europe.

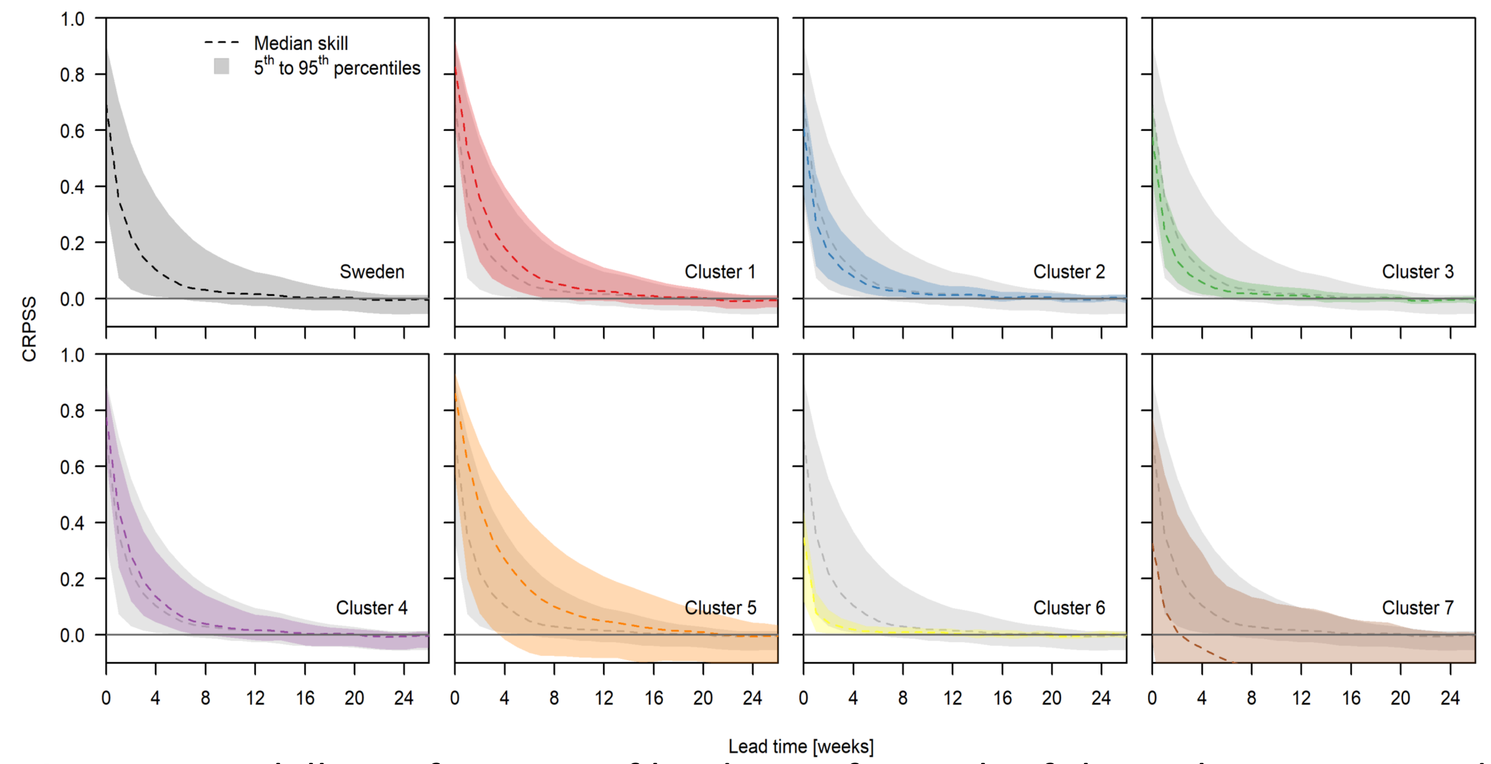


Fig. 6. Forecast skill as a function of lead time for each of the 7 clusters in Sweden.

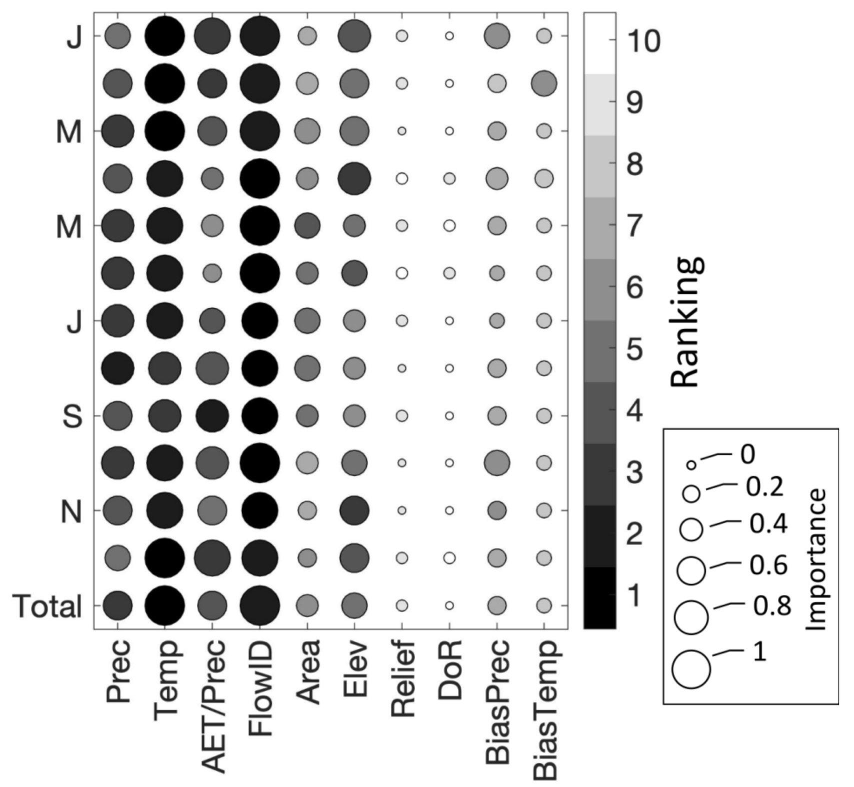


Fig. 7. Importance ranking of descriptors that influence the forecast quality for all months.

Conclusions

- Due to the large sampling, we can detect spatial and temporal patterns of forecast quality.
- Forecasts can be regionalized, based on a priori knowledge of the local hydro-climatic conditions.
- Streamflow can generally be well predicted in river systems with slow hydrological responses.