Climate-Informed-Seasonal Mixing Approach to Estimate Flood Quantiles

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Research Gap

- Traditional flood frequency analysis (FFA) – independent and identically distributed (*iid*) assumption
- Warming climate conditions challenge this *iid* assumption
- Commonly used climate-informed studies neglect the influence of different climate variables on different seasons

Key Contribution

Integrating climate-informed (non-stationary) approach with seasonal mixing to incorporate climate influence on flood quantiles and addressing the inter-seasonal differences

Synthetic case study

- Two cases - flood quantiles are changed for only the dominant season
- Climate-Informed-Seasonal Mixing FFA (CI-SM-FFA) vs 1) traditional, 2) trend-informed, and 3) dominant-season-based climate-informed approach

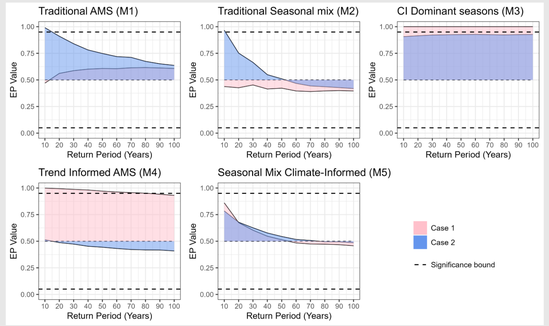


Figure 1. Exceedance Probability (EP) values of the synthetic datasets for different models across various return periods. Note: EP value closer to 0.5 indicates the model quantile estimate is closer to the baseline estimate.

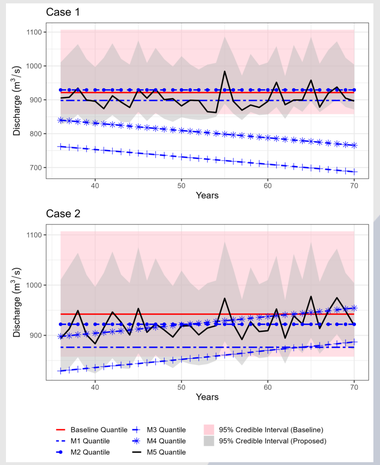
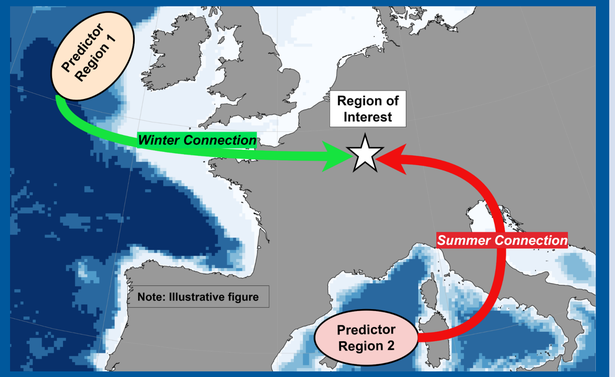


Figure 2. Flood quantiles (30-year return period) of all selected models along with the baseline quantile estimate. Note: Baseline model - Traditional model fitted only with the flood samples from the validation period.

Methodology (CI-SM-FFA)

1. Selection of seasonal climate predictor based on the best model fit quantified by Widely Applicable Information Criterion
2. Non-stationary GEV location parameter is conditioned on climate predictor. The parameter is modelled by Bayesian MCMC sampling.
3. Multiplicative mixing model to derive the annual flood quantile
4. Performance of the proposed CI-SM-FFA is assessed by estimating the quantiles for the projected validation period and comparing against the baseline model fitted only with the validation flood samples

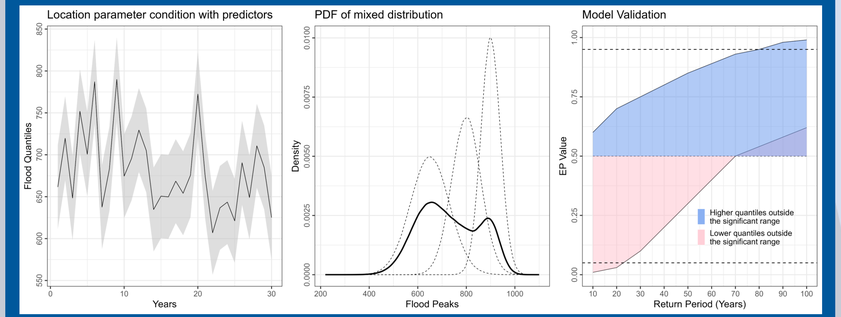
1. Identification of Seasonal Climate Predictor



2. Statistical link (Climate predictors → Flood Quantiles)

3. Seasonal Mixing to estimate flood quantile

4. Validation of the projected quantile estimates



European case study

- Applied CI-SM-FFA approach to 638 gauges in Europe
- 5 North Atlantic-based and 4 Mediterranean-based climate indices selected to identify the best predictor
- **Evaluation procedure – Fitted the model only for the calibration period and evaluated the performance for the validation period**

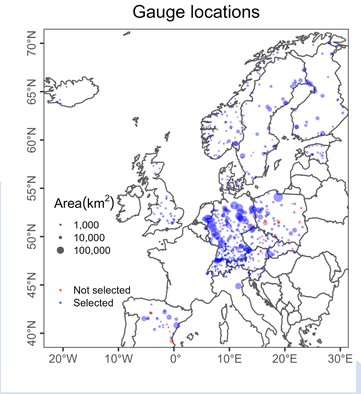


Figure 3. Locations of stream gauges selected based on the data length criteria.

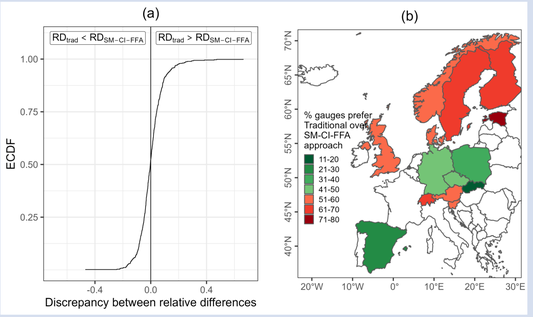


Figure 4. Comparison of the relative difference values (RD) for the traditional and the CI-SM-FFA quantile estimates in comparison with the baseline estimate. Note: Discrepancy is the difference between the RD values. A positive discrepancy value indicates the gauge favors the CI-SM-FFA approach.

Key Inferences

1. **For synthetic case - consistent high performance is noticed for CI-SM-FFA approach, whereas the varied skill is observed for the other competing models (Fig. 1)**
2. **Applicability of CI-SM-FFA approach to the European gauges shows that the proposed approach is preferable for 50% of the gauges (Fig. 4a)**
3. **For gauges in the central Europe region and Spain CI-SM-FFA approach is preferred (Fig. 4b) – Mediterranean-based indices and NAO have been selected as potential predictor in these regions at different seasons**

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