EGU2010-7248: A proposal to reduce streamflow predictive uncertainty in ungauged basins

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1. Introduction

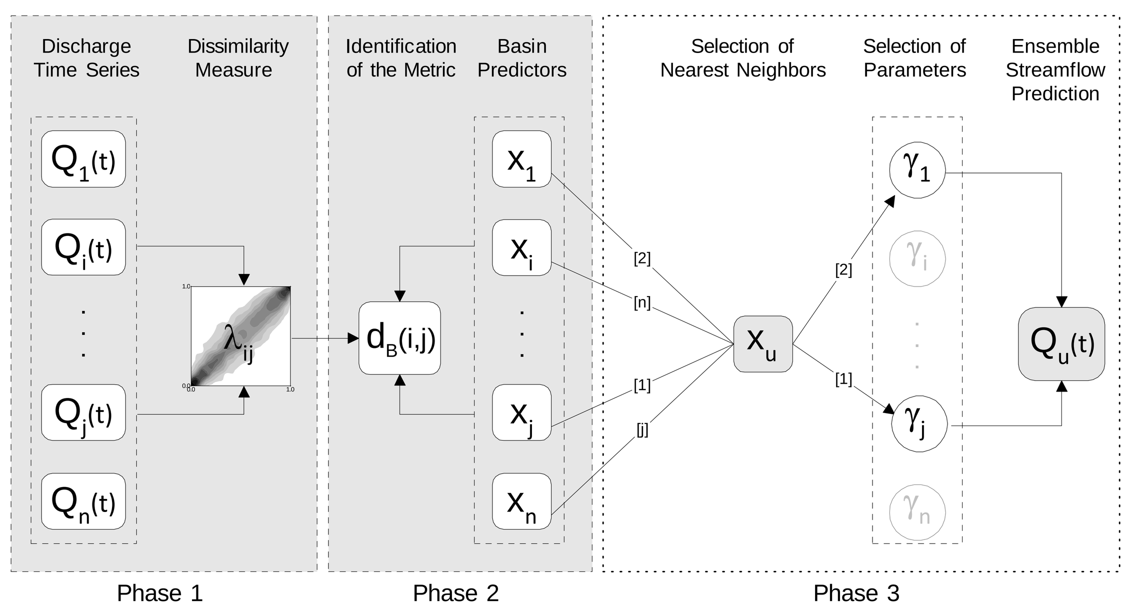
One of the main goals of the PUB Science Plan is to reduce uncertainty in hydrological predictions. Prediction in ungauged basins is, however, a complex task mainly because the hydrologic processes occurring within a basin take place over a wide range of spatio-temporal scales for which no agreed upon general hydrological theory is still available.

Due to these reasons, we hypothesize that three phases are required to guaranty the transferability of information from donor basins to an ungauged locations:

Phase 1: Selection of a dissimilarity measure λ based on discharge time series of donor basins.

Phase 2: Adaptation of a metric d_B in the space of catchment properties $\mathbf{x}$. Constrain the selection of the metric with various runoff characteristics.

Phase 3: Implementation of a multiscale parameter regionalization (MPR) technique that is able to relate model parameters with basin characteristics. Subsequently, prediction of streamflow by transferring model parameters γ from gauged basins.



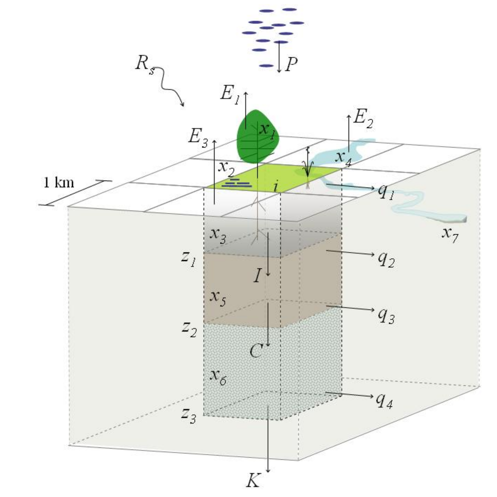
Estimation procedure for daily streamflow $Q(t)$ in a ungauged basin u

2. Dissimilarity measures[1]

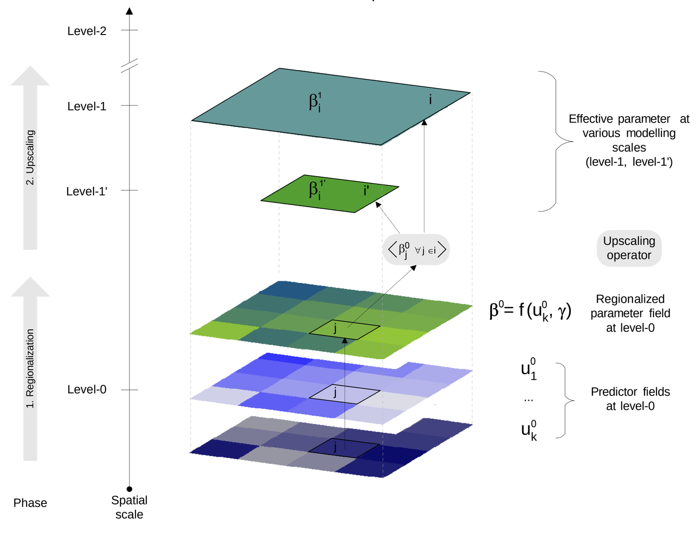
Dissim. Measure	Estimator
1	$\lambda^1_{ij} = (\rho - L_{ij}) + \frac{\lvert U_{ij} - L_{ij}\rvert}{U_{ij}+L_{ij}}$
2	$\lambda^2_{ij} = (1 - \mathrm{r}_{ij}) + \xi \lvert A_{ij}\rvert$
3	$\lambda^3_{ij} = M_{ij} + \xi \lvert A_{ij}\rvert$

- $i,\ j$ — pair of donor basins
- $U_{ij},\ L_{ij}$ — upper and lower-corner cumulated probabilities of the empirical density copula (EDC) of runoff time series
- ρ — given probability (say 20%)
- r — Spearman's rank correlation of the EDC
- ξ — scaling factor
- A_{ij} — degree of asymmetry of the EDC
- M_{ij} — Kolmogorov-Smirnov statistic of the the distribution function of the discharge difference $\Delta q(t) = q(t) - q(t-1)$

3. mHM Model and Parametrization



State variable at cell i, time t



Regionalization and upscaling

State equations: cell i, time t:

$$\dot{\mathbf{x}}_i(t) = \mathbf{f}(\mathbf{x}_i, \mathbf{u}_i, \boldsymbol{\beta}_i) + \boldsymbol{\eta}_i(t) \quad \forall i \in \Omega$$

Output: runoff:

$$\mathbf{q}_l(t) = \mathbf{g}(\mathbf{x}, \mathbf{u}, \boldsymbol{\beta}) + \boldsymbol{\epsilon}_l(t)$$

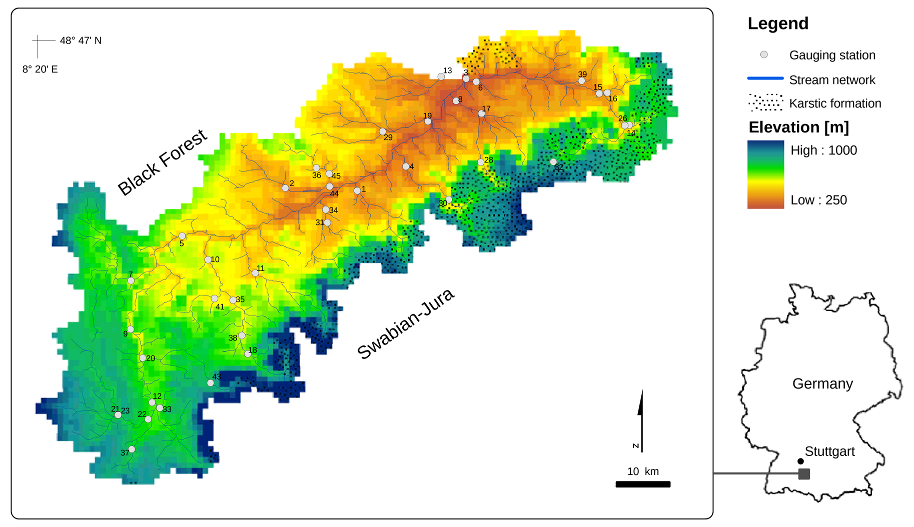
Regionalization[2]:

$$\beta^0_{lj}(t) = f_l\Big(\boldsymbol{u}^0_j(t), \boldsymbol{\gamma}\Big)$$

Upscaling[2]:

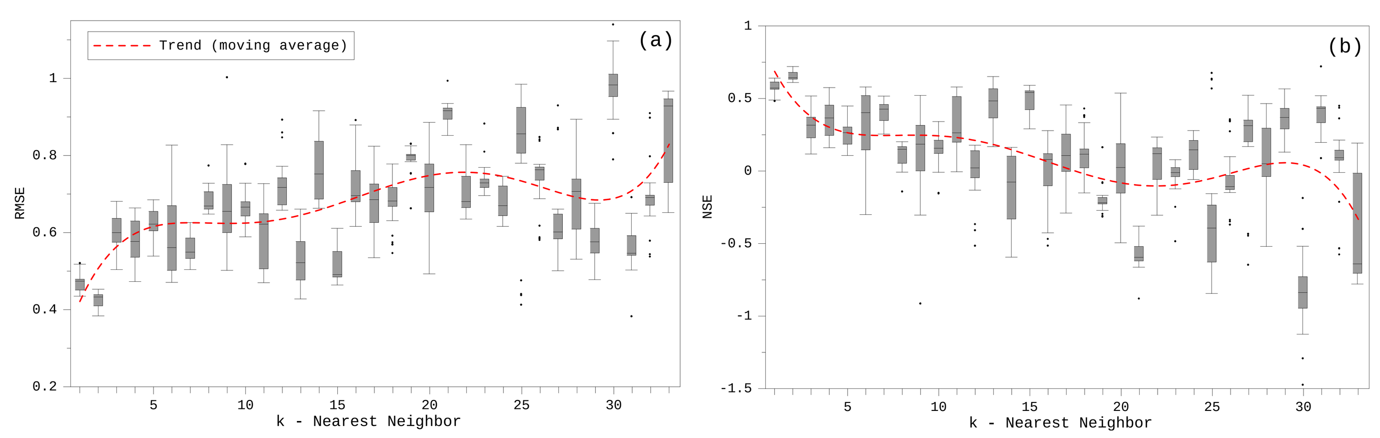
$$\beta^1_{li}(t) = \mathrm{O}_l\Big\langle \beta^0_{lj}(t) \quad \forall j \in i \Big\rangle$$

4. Study Area



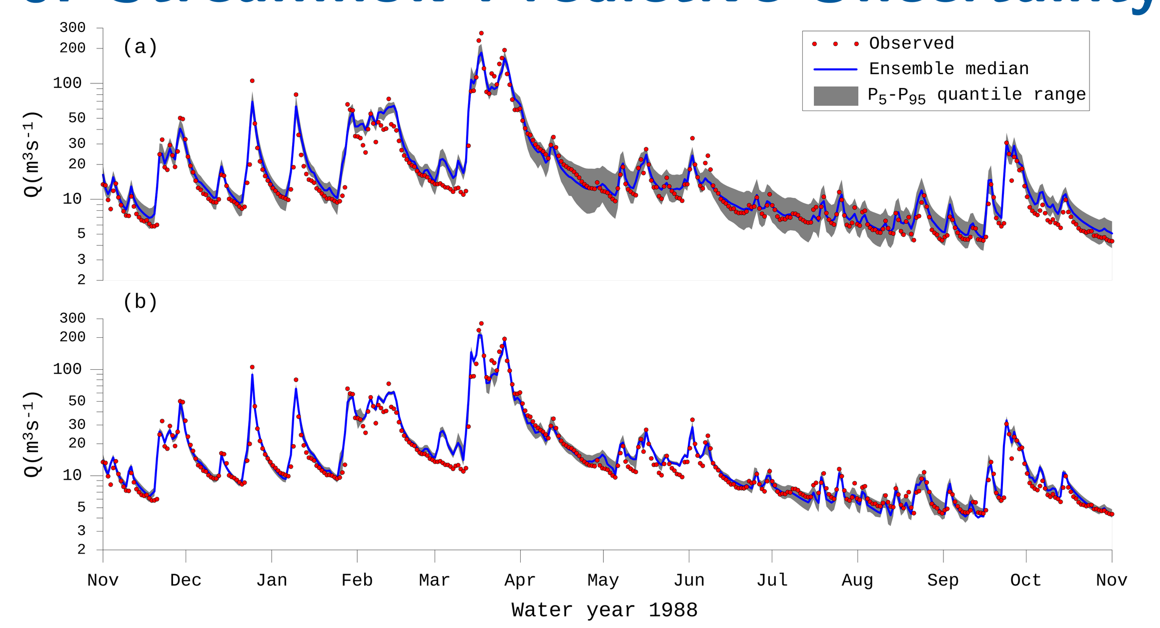
Location of the upper Neckar river basin and 38 gauging stations employed in this study.

5. Variability obtained with the best norm based on λ^3



Boxplot showing the variation of the RMSE [left] and the NSE [right] obtained for each consecutive nearest neighbor of basin Nr. 7

6. Streamflow Predictive Uncertainty



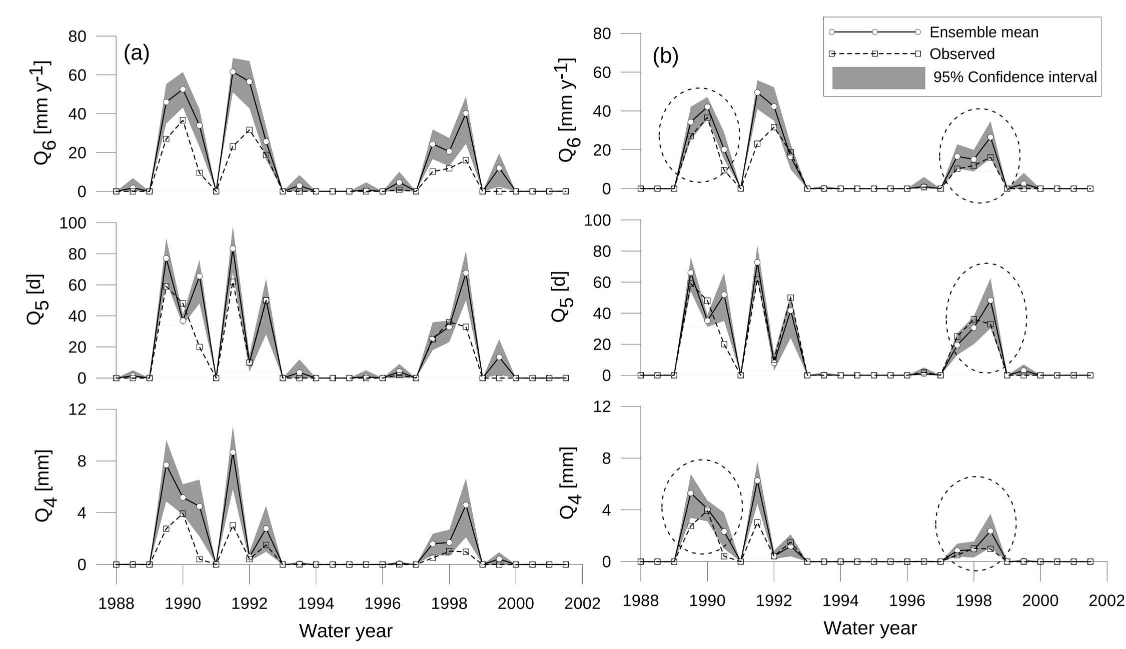
Metric d_B selected with out constrains based on runoff characteristics

Metric d_B selected with constrains based on runoff characteristics

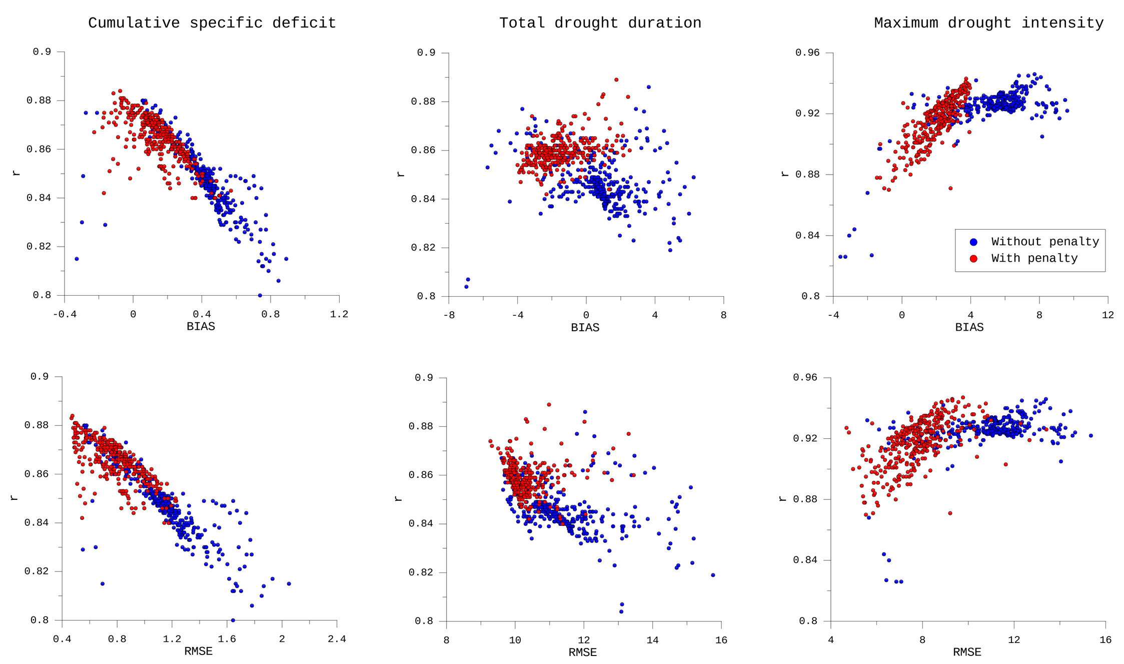
Predictions obtained for basin Nr. 5

7. Low-flow Characteristics and Model Efficiency

Metric d_B not constrained — Metric d_B constrained



Predictions obtained for basin Nr. 5. Q_4= cumulative specific deficit, Q_5= total drought duration, and Q_6= maximum drought intensity.



Efficiency measures for each low-flow characteristic

8. Conclusions

This procedure lead to a reduction up to 20% of the streamflow predictive uncertainty if compared with the unconstrained selection.

References

[1] L. Samaniego, A. Bárdossy, and R. Kumar, "Streamflow prediction in ungauged catchments using copula-based dissimilarity measures," *Water Resour. Res.*, vol. 46, 2010.

[2] L. Samaniego, R. Kumar, and S. Attinger, "Multiscale parameter regionalization of a grid-based hydrologic model at the mesoscale," *Water Resources Research*, 2010, in Press.

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