Baseline data as source of uncertainty in large-scale hydrology - a case study

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Motivation

Global hydrological models (GHMs) provide key information for international stakeholders and policymakers. Valuable decision support is hampered by uncertainty in model runs. In particular, uncertainty in baseline data, used for

(1) bias-correction of climate scenarios,

(2) parameter adjustment, and

(3) assessment of future changes

has rarely been addressed. [1] [3]

Does uncertainty in baseline data effect outcomes in projecting the future?

References

[1] Gao, J.; Sheshukov, A. Y.; Yen, H.; Douglas-Mankin, K. R.; White, M., J.; Arnold, J. G. (2019): Uncertainty of hydrologic processes caused by bias-corrected CMIP5 climate change projections with alternative historical data sources. In: Journal of Hydrology, 568, 551-561 https://doi.org/10.1016/j.jhydrol.2018.10.041

[2] Müller Schmied, H.; Eisner, S.; Franz, D.; Wattenbach, M.; Portmann, F. T.; Flörke, M.; Döll, P. (2014): Sensitivity of simulated global-scale freshwater fluxes and storages to input data, hydrological model structure, human water use and calibration. In: Hydrology and Earth System Sciences, 18, 3511-3538. https://doi.org/10.5194/hess-18-3511-2014

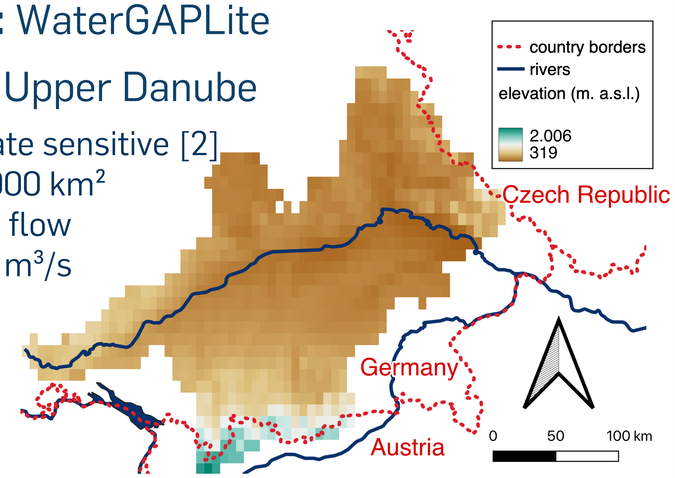
[3] Remesan, R.; Holman, I. P. (2015): Effect of baseline meteorological data selection on hydrological modelling of climate change scenarios. In: Journal of Hydrology, 528, 631-642. http://dx.doi.org/10.1016/j.jhydrol.2015.06.026

Material & Methods

Model: WaterGAPLite

Basin: Upper Danube

- Climate sensitive [2]
- ~48.000 km²
- Mean flow ~640 m³/s



Meteorological Forcing:

EWEMBI2b	0.5° x 0.5°
E-OBS v23.1e	0.1° x 0.1°
DWD	station data

Additive/multiplicative approach (ΔT=+5°C; ΔP_{winter}=+15%; ΔP_{summer}=-25%) for scenario-like data.

Methods

A. Individual model calibration (1995-2005)

B. Comparison between simulated scenario-like discharge and calibration-independent discharge (2006-2016)

Results

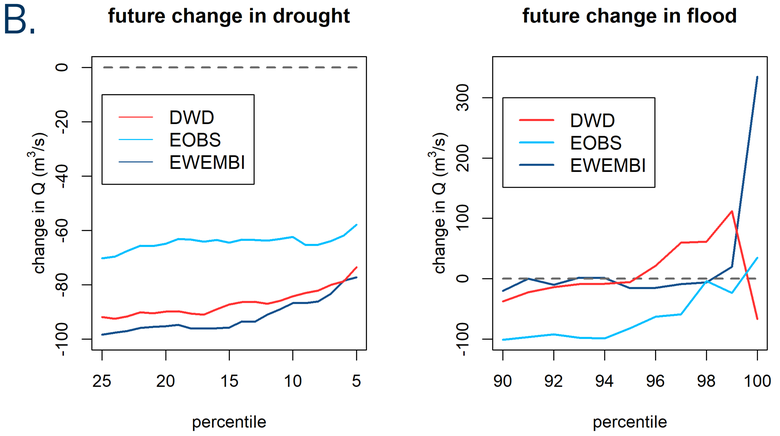
best

A.

DWD	EOBS	EWEMBI	Criteria
0.49 | 0.58	0.54 | 0.59	0.22 | 0.39	NSE
0.57 | 0.52	0.59 | 0.54	0.47 | 0.38	logNSE
0.58 | 0.7	0.69 | 0.77	0.47 | 0.63	KGE
1.00 | 0.94	1.00 | 0.95	1.00 | 0.93	a $\left(\frac{\mu_{sim}}{\mu_{obs}}\right)$
1.40 | 1.27	1.27 | 1.16	1.50 | 1.30	b $\left(\frac{\sigma_{sim}}{\sigma_{obs}}\right)$
0.87 | 0.87	0.85 | 0.84	0.82 | 0.81	$r_{Pearson}$

cal↑ ↑val

B.



Conclusion & Outlook

Future estimates for drought are less uncertain than future estimates for flood.

How does baseline uncertainty propagate using multi-variate calibration?