Authors Response to peer-reviews for nhess-2024-6

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First we want to thank the two anonymous reviewers for taking their time to review our manuscript on compound droughts under climate change in Switzerland. Their feedback was very encouraging and helpful in terms of a more complete contextualization of the results and for (editorial) improvements and redactions.

The answers to the suggested improvements are colored in *Android Green*, new/altered parts are colored in *Azure*. Original line numbers and original reviewer comments/suggestions are colored in *Black*, while line numbers in *Deep carmine* [and in brackets] denote new line numbers to allow for change tracking Deleted parts are colored in *red* and are crossed-out (e.g., ~~This sentence was deleted.~~).

Review 1

Comment on nhess-2024-6 (Anonymous Referee #1)

Referee comment on "Compound droughts under climate change in Switzerland" (nhess-2024-6) by von Matt et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2024-6-RC1

Review of "Compound droughts under climate change in Switzerland" von Matt et al.

The topic of compound droughts is pressing and important, and the authors have contributed very nicely in identifying them and using scenarios to see how they might change in a warming climate, using transient climate and hydrological scenarios for Switzerland.

The paper is clearly structured and well written and provides a comprehensive and convincing introduction to the topic.

Thank you very much.

For some of the underlying assumptions and control model performance tests, the authors refer to previous studies (catchments and calibration validation performance). I think it is important to provide this information directly in the paper or in its appendix to understand the basis on which the scenarios were used and how reliable the models were. Looking at the referenced paper, it appears that the NSE was used to calibrate the models and the KGE and NSE were used to validate them. I would expect that particularly low flow periods would not be so well simulated, or at least not evaluated in the objective function. Perhaps this could also be mentioned in the discussion of uncertainty in the discussion.

As a minimum I would expect a table with the main characteristics of the catchments used, rather than just a map, including mean annual precipitation, mean annual discharge, altitude (range), glaciation percentage, size and some model performance in calibration and validation. The authors state at the end of their discussion that it is important to better understand the processes that lead to these compound droughts, and I believe that to understand these we also need to look at these catchment characteristics and therefore provide them in some form as well.

Thank you very much for this suggestion. We completely agree with you and have made the following adjustments:

1. A table (see Table 1) with catchment and climate characteristics is added to Appendix A of the manuscript and a separate table (see Table 2) with calibration/validation characteristics is added to the Appendix B of the manuscript. The table consists of all requested characteristics. A corresponding note on glaciation was added in the section *2 Data* as well. For consistency, we derived annual precipitation and annual runoff based on the observation-driven runoff simulations similar as was done for the validation of our compound drought characteristics (see Section *2 Data* and *Supplementary Material*) based on the longest overlapping period (1991–2014) within the reference period (1991–2020). Therefore, the mean annual precipitation is directly derived from catchment-level aggregated values originating from the observational MeteoSwiss RhiresD-dataset, while mean annual runoff is derived from the observation-driven PREVAH-simulations. A short description on presented metrics and climate characteristics are also provided as footnote to the corresponding tables. References to the table in the Appendix A and B were added on:

   Lines 126–128 [132–136]: "The restriction to lower lying small- to mid-size catchments and to the extended summer season ensures a focus on classical rainfall deficit droughts and limited influence of snow- and glacier-melt on streamflow discharge (Brunner et al., 2019b; Floriancic et al., 2020; Muelchi et al., 2021a, b). As such, all investigated catchments have a glaciation percentage of 0 %. A more detailed description of the investigated catchments including catchment and climate characteristics is presented in Table A1 in Appendix A."

2. Further, we included a more detailed description of the calibration and validation procedure, directly mentioning the key terms incorporated in the weighting scheme. The following sentences were added:

   Line 139 [149–163] : "~~PREVAH was calibrated such that also low flows are represented satisfactorily (inverted flow calibration; Muelchi et al. (2022))~~ The hydrological PREVAH-model was calibrated following the automated parameter estimation procedure PEST (Doherty, 2005) by using the objective function (Φ) which is defined as the squared sum of weighted residuals (see Muelchi et al., 2022):

   $$\Phi = \sum (w_i \times r_i)^2 \tag{1}$$

   where r_i denotes the residual of the i^{th} observation and w_i the weight associated with the i^{th} observation.

   Four equally weighted observation groups were considered: 1) the observed runoff (Q), 2) the monthly mean runoff (Q_{month}), 3) the yearly volumes (Q_{year}) and 4) a transformed (inverted) runoff ($(max(Q) + min(Q)) - Q_i$) to add more weight to low flow conditions. Therefore, the objective function is conditioned towards a better representation of river flow regimes and low flow conditions (R. Muelchi, pers. com.; see also Muelchi et al., 2022). Performance was assessed by both the Nash-Sutcliffe (NSE, Nash and Sutcliffe, 1970) and Kling-Gupta (KGE, Gupta et al., 2009) Efficiency for calibration and validation periods separately. Calibration and validation metrics for all investigated catchments are presented in Table B1 in Appendix B. For more details see Muelchi et al. (2022)."

3. Lastly, we also complemented the discussion with a paragraph on model calibration/validation uncertainty and challenges of current hydrological models concerning the representation of low flows with emphasis on influences of fixed-storage assumptions of evapotranspiration and corresponding interactions with low flows / hydrological droughts realism in (present and) future climates.

   The following additions were made with regard to model calibration/validation:

   Lines 458–463 [480–490]: "Drought projections based on climate-hydrological model chains contain major sources of uncertainty, which should be considered when interpreting the results of this study. This includes choices of model ensembles, (hydrological) model-setup (including calibration and validation procedures), the representation of land-atmosphere interactions (e.g., plant-physiological processes), choice of drought index, multi-decadal variability, drought propagation, and catchment storage properties (Arias et al., 2021; Berg and Sheffield,

> 2018; Brunner et al., 2021; Lehner et al., 2017; Miralles et al., 2019; Orlowsky and Seneviratne, 2013; Scherrer et al., 2022; Vicente-Serrano et al., 2022).
>
> Current hydrological model calibration and validation mostly rely on calibration and validation metrics designed for specific applications (e.g. flood situations, Brunner et al., 2021). The Hydro-CH2018 hydrological scenarios use a multi-objective calibration scheme also accounting for the representation of low flow conditions (see Section 2; see also Muelchi et al., 2022). See Table B1 in Appendix B for validation metrics ($\mathrm{NSE}_{\mathrm{log}}$ and $\mathrm{KGE}_{\mathrm{log}}$) indicative of the representation of low flow conditions for all catchments."
>
> Lines 513–516 [540–544]: "Further, hydrological catchments have been calibrated independent of each other but can in some cases be part of a larger catchment (Muelchi et al., 2022). Future studies could thus also investigate the temporal evolution of spatially compounding droughts and their downstream propagation behaviour by hydrological simulations of coupled (sub-)watersheds and/or by accounting for spatial connectivity by incorporating a spatial calibaration/validation metric (Brunner et al., 2021)."
>
> The following additions related to the influence of the representation of evapotranspiration on low flow modelling were added:
>
> Lines 524–525 [552–559]: "Implementations of drought triggering processes vary among hydrological models and important storage variables are often parameterized (Melsen and Guse, 2019; Brunner et al., 2021). Assumptions on (fixed) (maximum) storage volumes in hydrological models are equivalent to an implicit limitation on deficit accumulation. Redesigned soil moisture storage implementations could therefore lead to more realistic hydrological model projections in future (Fowler et al., 2021). Improved realism in projections is of utmost importance with regard to recent studies highlighting the potential for shifts in catchment-specific rainfall-runoff relationships usually caused by (prolonged) multi-year droughts (Fowler et al., 2022; Brunner and Tallaksen, 2019; Saft et al.,2015). Consequentially, climate risk assessments based on hydrological model projections might underestimate the future hydro-climatic risk concerning reductions in water supply (Fowler et al., 2022)."

Other than that, I really enjoyed reading the paper and have very few and small technical comments:

Thank you very much for this kind/honoring comment!

L135 please add what the Hamon equations use as main variables to calculate PET (lon, lat, air temperature)

We added the following information:

Lines 137–139 [145–149]: "PET is calculated by the Hamon equations, which is a temperature-based estimation method which derives average PET based on the saturated water vapor density at the daily mean temperature adjusted for the number of daylight hours at the specific geographic location (lon, lat) (Hamon-PET; Hamon, 1961). The actual ET consists of evaporation terms from both interception and soil moisture storages (see Viviroli et al., 2009)."

L139 what does "satisfactorily" mean in terms of performance, please specify

Thank you for pointing out this imprecise statement which is related to your previous suggestion of providing more detailed information on model calibration and validation statistics. We now circumvent the use of "satisfactorily" by directly referring to the Table B1 in Appendix B (see Table 2) containing calibration and validation metrics representative for low flow situations ($\mathrm{NSE}_{\log}$ and $\mathrm{KGE}_{\log}$).

Line 139 [149–163] → see 2. in previous corrections
Lines 458–463 [480–490] → see 3. in previous corrections

L441 Section ???

The section referencing was updated/corrected (see also *Additional adjustments*).

Review 2

Comment on nhess-2024-6 (Anonymous Referee #2)

Referee comment on "Compound droughts under climate change in Switzerland" (nhess-2024-6) by von Matt et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2024-6-RC2

Revision of the manuscript number "nhess-2024-6" entitled "Compound droughts under climate change in Switzerland".

This manuscript contributes to analyzing compound droughts in different catchments in Switzerland under two circumstances: modelling present and forecasting future climates. The paper is well-structured and written overall and can be published in its present form.

Thank you very much!

I have a few technical comments:

1. L28. Change redaction.

   We adjusted the redaction (newline was removed) and slightly rephrased the corresponding sentence.

   Lines 28–29 [28–29]: "There is no single definition of droughts that covers all aspects of the drought phenomenon (Wilwhite and Glantz, 1985; Lloyd- Hughes, 2014; Van Loon, 2015; Brunner et al., 2021; Ault, 2020)."

2. L54. What do you mean by "strongly non-linear"? Be more specific with the degree or type of the function, or just mention it as "non-linear".

   Thank you for pointing out this imprecise statement. We now adjusted the sentence to be more generalizing:

   Lines 52–55 [52–55]: "The exact sequence of the drought signal trans- lation through the hydro-terrestrial system may differ depending on drought typology, drought generating processes, and on human interactions (e.g., water abstractions) and is often non-linear in nature (Brunner et al., 2023; Haile et al., 2020; Savelli et al., 2022; Tijdeman et al., 2018; Van Loon, 2015; Van Loon and Van Lanen, 2012)."

3. L55. Avoid using qualifiers such as "strongly", instead, be more specific with the type of relationship between the variables.

   Thank you for this suggestion. In this specific sentence we excluded the qualifier "strongly". The sentence is now as follows:

   Lines 55–59 [55–59]: "While meteorological droughts are tied to climate variability (precipitation), soil moisture and hydrological drought characteristics are spatio-temporally more variable due to the importance of local factors such as water storage and release or catchment characteristics (e.g., Apurv et al., 2017; Apurv and Cai, 2020; Denissen et al., 2020; Haslinger et al., 2014; Peña-Angulo et al., 2022; Staudinger et al., 2017, 2014; Sutanto and Van Lanen, 2022; Tijdeman et al., 2018; Van Lanen et al., 2013)."

4. L103-L106. Improve redaction.

   Similar to the first suggestion, the extensive spacing was removed.

5. L119-L120. It could be better if you slightly describe what you show in every single section, not only writing the section title.

   Thank you for your suggestion. We complemented the most important sections with additional information on section contents. The paragraph is now as follows:

   Lines 119-120 [119–126]: "The remainder of this paper is structured as follows: In section *2 Data* the catchments and (model) simulations are introduced. In section *3 Methods* drought indices are presented, the compound events are defined and the climate change assessment approach is described. Section *4 Multivariate compound droughts* presents the results for compound droughts on catchment-level (aggregated on Greater regions) while section *5 Spatial extent of multivariate compound droughts (Spatially compounding droughts)* presents results related to the spatial extent of compound droughts (across multiple catchments). In section *6 Discussion* the results from previous sections are wrapped up with a discussion on plausibility and uncertainties inherent to the present analysis and section *7 Conclusions* then concludes with the most important findings and future prospects in terms of mitigation and adaptation actions."

6. L123. Fix units. 1702 km2 and 1500 m.a.s.l.

   The units were fixed from km2 to km^2 and m asl to m.a.s.l. Other instances have been checked too (see *Additional adjustments*).

7. Figure 7, the label on the ordinate might be better if it says "probability".

   We adjusted the label according to your suggestion from 'Density' to 'Probability'. Further, the color-scale of the figure was adjusted following suggestions from the editor (see *Additional adjustments*).

Additional adjustments

Suggestions from previous editor and consistency adjustments

In this section, additional corrections which were suggested by the (previous) editor are listed. Note: The assigned editor for this manuscript has changed since.
Further, several minor adjustments mainly considering grammatical inconsistencies or adjustments to *NHESS* house standards were made (see also *Tracked Changes* (Latexdiff)).

The changes are as follows:

1. Line 354 [377]: Incorrect subsubsectioning. Seasonality was changed from a subsubsection (~~4.3.1 Seasonality~~) to a regular subsection (4.4 Seasonality).

2. Zenodo Repository was updated by incorporating tables on catchment-climate characteristics and model calibration/validation statistics.
   → see `https://doi.org/10.5281/zenodo.10908410`

3. Figure 7: Caption of Fig. 7 included a description on uncertainty bounds which were not shown in the figure to enhance readability/clearness. The sentence was therefore deleted.

   The adjustments are as follows:
   "Seasonality of compound drought days. Shown is the median value aggregated over all catchments per Greater regions and day of year (DOY) (lines).~~Shading indicates the IQR-range of all model chains.~~ Probability density distributions are shown for both the mitigation (RCP2.6) and the non-mitigation (RCP8.5) scenario for the periods reference, 2035, 2060, 2085 (colored). Dashed lines indicate the extended summer season from (begin of) May (DOY 122) to (the end of) October (DOY 305)."

4. Several inconsistencies were adjusted and *NHESS* standards adopted, including (among others):

   1) en–dashes, 2) change of "Southern Switzerland" to "southern Switzerland".

   → See also *Tracked Changes* (Latexdiff).

5. Color-scales were adjusted towards colorblind-friendliness following the suggestion of the (previous) editor.

   The following Figures have been adjusted in the manuscript:

   Figure 1, Figure 7, Figure 8 and Figure 9

   In the *Supplementary material*:

   Figure S1, Figure S2 and Figure S3

Table 1: Catchment and climate[a] characteristics for all investigated catchments.

Catchment	Greater region	Water name	Place	Area [km^2]	Mean height (min - max) [m.a.s.l.]	Glaciation [%]	Lon / Lat [WGS 84, degrees]	Mean annual precipitation [mm]	Mean annual runoff [mm]
2604	Pre-Alps	Biber	Biberbrugg	31.9	1008 (602 - 1515)	0	8.72 / 47.15	1218	490
2303	Pre-Alps	Thur	Jonschwil-Muehlau	492.9	1027 (535 - 2431)	0	9.08 / 47.41	2145	1634
2468	Pre-Alps	Sitter	St. Gallen-Bruggen	261.1	1045 (445 - 2431)	0	9.33 / 47.41	1198	480
2176	Pre-Alps	Sihl	Zuerich-Sihlhoelzli	342.6	1047 (402 - 2223)	0	8.53 / 47.37	1806	1157
2603	Pre-Alps	Ilfis	Langnau	187.4	1047 (681 - 2045)	0	7.8 / 46.94	1293	466
2634	Pre-Alps	Kleine Emme	Emmen	478.3	1058 (425 - 2290)	0	8.28 / 47.07	1325	676
2070	Pre-Alps	Emme	Emmenmatt	443.0	1072 (562 - 2161)	0	7.75 / 46.95	1591	862
2179	Pre-Alps	Sense	Thoerishaus	351.2	1076 (524 - 2182)	0	7.35 / 46.89	1831	629
2486	Pre-Alps	Veveyse	Vevey-Copet	64.5	1108 (372 - 1959)	0	6.85 / 46.47	1276	623
2609	Pre-Alps	Alp	Einsiedeln	46.7	1161 (660 - 1783)	0	8.74 / 47.15	1676	911
2487	Pre-Alps	Kleine Emme	Werthenstein-Chappelboden	311.5	1171 (525 - 2290)	0	8.07 / 47.03	1528	952
2112	Pre-Alps	Sitter	Appenzell	74.4	1254 (445 - 2431)	0	9.41 / 47.33	1254	562
2409	Pre-Alps	Emme	Eggiwil-Heidbuehl	124.4	1283 (562 - 2161)	0	7.8 / 46.87	1217	574
2300	Pre-Alps	Minster	Euthal-Rueti	59.1	1352 (642 - 2223)	0	8.81 / 47.08	1560	832
2343	Pre-Alps	Langeten	Huttwil-Haeberenbad	59.9	765 (566 - 1123)	0	7.83 / 47.12	1904	1024
2477	Pre-Alps	Lorze	Zug-Letzi	100.2	822 (411 - 1556)	0	8.5 / 47.18	1716	1213
2305	Pre-Alps	Glatt	Herisau-Zellersmuehle	16.7	836 (624 - 1145)	0	9.26 / 47.4	1777	1313
2308	Pre-Alps	Goldach	Goldach-Bleiche	50.4	840 (391 - 1245)	0	9.47 / 47.49	1358	1035
2155	Pre-Alps	Emme	Wiler Limpbachmuendung	924.1	871 (430 - 2161)	0	7.55 / 47.16	1346	715
2412	Pre-Alps	Sionge	Vuippens-Chateau	43.4	872 (674 - 1457)	0	7.08 / 46.66	1685	1095
2181	Pre-Alps	Thur	Halden	1085.0	914 (445 - 2431)	0	9.21 / 47.51	1451	778
2374	Pre-Alps	Necker	Mogelsberg	88.1	962 (604 - 1513)	0	9.12 / 47.36	1552	822
2312	Swiss Plateau	Aach	Salmsach-Hungerbuehl	47.4	476 (391 - 609)	0	9.36 / 47.55	1419	910
2386	Swiss Plateau	Murg	Frauenfeld	213.3	596 (381 - 1113)	0	8.89 / 47.57	1728	1144
2126	Swiss Plateau	Murg	Waengi	80.1	654 (456 - 1113)	0	8.95 / 47.5	1411	524
2132	Swiss Plateau	Toess	Neftenbach	343.3	659 (380 - 1298)	0	8.65 / 47.52	1328	708
2471	Swiss Plateau	Murg	Murgenthal-Walliswil	183.4	659 (410 - 1123)	0	7.83 / 47.25	1992	1168
2450	Swiss Plateau	Wigger	Zofingen	366.2	662 (419 - 1393)	0	7.94 / 47.28	1186	552
2500	Swiss Plateau	Worble	Ittigen	67.1	678 (494 - 954)	0	7.48 / 46.97	1589	434
2369	Swiss Plateau	Mentue	Yvonand La Mauguettaz	105.3	683 (436 - 946)	0	6.72 / 46.78	1307	639
2432	Swiss Plateau	Venoge	Ecublens-Les Bois	227.6	694 (372 - 1662)	0	6.55 / 46.54	1287	826
2034	Swiss Plateau	Broye	Payerne-Caserne d'aviation	415.9	724 (368 - 1574)	0	6.94 / 46.84	1214	591
2497	Swiss Plateau	Luthern	Nebikon	104.7	754 (474 - 1393)	0	7.97 / 47.19	1738	1140
2044	Swiss Plateau	Thur	Andelfingen	1701.6	773 (354 - 2431)	0	8.68 / 47.6	1409	876
2159	Swiss Plateau	Guerbe	Belp-Muehlimatt	116.1	849 (508 - 2128)	0	7.5 / 46.89	1398	647
2493	Jura	Promenthouse	Gland	119.8	1035 (372 - 1667)	0	6.27 / 46.41	1511	974
2307	Jura	Suze	Sonceboz	127.2	1044 (634 - 1595)	0	7.17 / 47.2	1514	1047
2480	Jura	Areuse	Boudry	377.7	1084 (427 - 1573)	0	6.84 / 46.95	1312	594
2202	Jura	Ergolz	Liestal	261.2	591 (296 - 1181)	0	7.73 / 47.49	1598	1092
2434	Jura	Duennern	Olten-Hammermuehle	233.8	714 (390 - 1383)	0	7.89 / 47.35	1190	610
2106	Jura	Birs	Muenchenstein	887.3	733 (256 - 1424)	0	7.62 / 47.52	1974	1904
2479	Jura	Sorne	Delemont	213.9	785 (408 - 1326)	0	7.35 / 47.37	1593	949
2610	Jura	Scheulte	Vicques	72.7	797 (419 - 1292)	0	7.43 / 47.35	1843	1093
2478	Jura	Birse	Soyhieres-Bois du Treuil	569.5	811 (380 - 1424)	0	7.4 / 47.39	1224	573
2122	Jura	Birse	Moutier-La Charrue	185.8	927 (493 - 1424)	0	7.38 / 47.28	1872	1441
2210	Jura	Doubs	Ocourt	1275.4	960 (407 - 1448)	0	7.07 / 47.35	1119	455
2370	Jura	Doubs	Le Noirmont-La Goule	1046.7	985 (503 - 1448)	0	6.93 / 47.23	1103	469
2270	Jura	Doubs	Combe des Sarrasins	998.5	985 (553 - 1448)	0	6.88 / 47.2	1507	809
2167	Southern Switzerland	Tresa	Ponte Tresa-Rocchetta	609.1	805 (198 - 2207)	0	8.85 / 45.97	1259	744
2629	Southern Switzerland	Vedeggio	Agno	99.9	921 (198 - 2198)	0	8.91 / 46	1988	1498
2461	Southern Switzerland	Magliasina	Magliaso-Ponte	34.4	927 (269 - 1904)	0	8.88 / 45.98	1257	467
2321	Southern Switzerland	Cassarate	Pregassona	75.8	991 (272 - 2198)	0	8.96 / 46.02	1030	494

[a] Mean annual precipitation and mean annual runoff were derived based on the CTRL-simulations driven by observations for the largest overlapping period (1991–2014) within the reference period (1991–2020). For precipitation this corresponds to the direct derivation from the RhiresD dataset (MeteoSwiss, 2021a; Frei and Schär, 1998) aggregated on catchment-level while mean annual runoff is derived based on PREVAH model simulations (see Section 2; also see Muelchi et al., 2022).

Table 2: Calibration and validation metrics for all investigated catchments[a].

Catchment	**Greater region**	**Water name**	**Place**	**NSE**$_{\mathbf{log}}$ (calibration)	**NSE**$_{\mathbf{log}}$ (validation)	**KGE**$_{\mathbf{log}}$ (calibration)	**KGE**$_{\mathbf{log}}$ (validation)
2604	Pre-Alps	Biber	Biberbrugg	0.81	0.82	0.85	0.89
2303	Pre-Alps	Thur	Jonschwil-Muehlau	0.84	0.83	0.89	0.93
2468	Pre-Alps	Sitter	St. Gallen-Bruggen	0.83	0.83	0.89	0.89
2176	Pre-Alps	Sihl	Zuerich-Sihlhoelzli	0.72	0.72	0.84	0.87
2603	Pre-Alps	Ilfis	Langnau	0.80	0.79	0.87	0.88
2634	Pre-Alps	Kleine Emme	Emmen	0.84	0.83	0.88	0.92
2070	Pre-Alps	Emme	Emmenmatt	0.79	0.80	0.87	0.89
2179	Pre-Alps	Sense	Thoerishaus	0.79	0.82	0.87	0.90
2486	Pre-Alps	Veveyse	Vevey-Copet	0.71	0.68	0.88	0.88
2609	Pre-Alps	Alp	Einsiedeln	0.59	0.57	0.87	0.87
2487	Pre-Alps	Kleine Emme	Werthenstein-Chappelboden	0.82	0.83	0.87	0.90
2112	Pre-Alps	Sitter	Appenzell	0.80	0.82	0.85	0.91
2409	Pre-Alps	Emme	Eggiwil-Heidbuehl	0.76	0.76	0.82	0.87
2300	Pre-Alps	Minster	Euthal-Rueti	0.69	0.70	0.83	0.87
2343	Pre-Alps	Langeten	Huttwil-Haeberenbad	0.77	0.78	0.82	0.89
2477	Pre-Alps	Lorze	Zug-Letzi	0.76	0.79	0.88	0.89
2305	Pre-Alps	Glatt	Herisau-Zellersmuehle	0.71	0.63	0.84	0.90
2308	Pre-Alps	Goldach	Goldach-Bleiche	0.75	0.74	0.81	0.86
2155	Pre-Alps	Emme	Wiler Limpbachmuendung	0.80	0.82	0.88	0.91
2412	Pre-Alps	Sionge	Vuippens-Chateau	0.79	0.80	0.84	0.86
2181	Pre-Alps	Thur	Halden	0.86	0.88	0.90	0.94
2374	Pre-Alps	Necker	Mogelsberg	0.77	0.74	0.87	0.88
2312	Swiss Plateau	Aach	Salmsach-Hungerbuehl	0.68	0.58	0.88	0.91
2386	Swiss Plateau	Murg	Frauenfeld	0.85	0.81	0.91	0.94
2126	Swiss Plateau	Murg	Waengi	0.85	0.86	0.91	0.90
2132	Swiss Plateau	Toess	Neftenbach	0.82	0.73	0.92	0.94
2471	Swiss Plateau	Murg	Murgenthal-Walliswil	0.79	0.74	0.86	0.88
2450	Swiss Plateau	Wigger	Zofingen	0.80	0.82	0.87	0.93
2500	Swiss Plateau	Worble	Ittigen	0.72	0.72	0.81	0.85
2369	Swiss Plateau	Mentue	Yvonand La Mauguettaz	0.79	0.80	0.88	0.87
2432	Swiss Plateau	Venoge	Ecublens-Les Bois	0.88	0.88	0.91	0.93
2034	Swiss Plateau	Broye	Payerne-Caserne d'aviation	0.38	0.32	0.89	0.88
2497	Swiss Plateau	Luthern	Nebikon	0.51	0.44	0.85	0.88
2044	Swiss Plateau	Thur	Andelfingen	0.87	0.89	0.91	0.94
2159	Swiss Plateau	Guerbe	Belp-Muehlimatt	0.80	0.84	0.89	0.87
2493	Jura	Promenthouse	Gland	0.78	0.71	0.93	0.90
2307	Jura	Suze	Sonceboz	0.84	0.84	0.90	0.91
2480	Jura	Areuse	Boudry	0.75	0.75	0.90	0.91
2202	Jura	Ergolz	Liestal	0.84	0.82	0.92	0.92
2434	Jura	Duennern	Olten-Hammermuehle	0.85	0.85	0.89	0.91
2106	Jura	Birs	Muenchenstein	0.80	0.80	0.91	0.94
2479	Jura	Sorne	Delemont	0.79	0.82	0.91	0.92
2610	Jura	Scheulte	Vicques	0.79	0.80	0.80	0.82
2478	Jura	Birse	Soyhieres-Bois du Treuil	0.74	0.74	0.91	0.92
2122	Jura	Birse	Moutier-La Charrue	0.79	0.83	0.87	0.84
2210	Jura	Doubs	Ocourt	0.79	0.76	0.90	0.87
2370	Jura	Doubs	Le Noirmont-La Goule	0.74	0.70	0.88	0.86
2270	Jura	Doubs	Combe des Sarrasins	0.72	0.65	0.88	0.87
2167	Southern Switzerland	Tresa	Ponte Tresa-Rocchetta	0.68	0.52	0.87	0.88
2629	Southern Switzerland	Vedeggio	Agno	0.73	0.46	0.91	0.89
2461	Southern Switzerland	Magliasina	Magliaso-Ponte	0.53	0.29	0.87	0.87
2321	Southern Switzerland	Cassarate	Pregassona	0.67	0.48	0.89	0.87

[a] The metrics NSE$_{\text{log}}$ and KGE$_{\text{log}}$ are indicative of the representation of low flow conditions in the Hydro-CH2018 hydrological model simulations (see Muelchi et al., 2022). Both metrics range from [$-\infty$ to 1], with 1 equal to a perfect performance and values > 0 equaling to a better predictive performance than the mean of observations. The calibration and validation periods cover period 1985–2014 for most catchments. Even years were used for calibration and uneven years for validation. For more information see Muelchi et al. (2022).