Dear editors and reviewers:

On behalf of my co-authors, thank you very much for your attention to our paper "Spatiotemporal responses of runoff to climate change on the southern Tibetan Plateau". My co-authors and I think that all the comments are valuable and very helpful for us to improve the manuscript. We have carefully revised the manuscript according to the reviewers' comments. The changes do not affect the results of the paper.

Please see below the item-to-item responses to the reviewers' comments and questions. A tracked version with the changes was also included.

We hope this manuscript will satisfy the requirement of the Hydrology and Earth System Sciences.

Best regards

He Sun

This resubmitted version of the paper has addressed my previous concerns effectively, demonstrating the authors' great efforts. The manuscript now provides a clear explanation of the novel motivation behind the work, and the research results are presented in an informative manner with well-crafted plots. The first comparisons of sub-basin runoff changes in the YZ river are particularly valuable, as they contribute to a better understanding of runoff changes at the downstream basin outlet, which will likely be of great interest to other researchers.

Reply:

Thanks for the comments. At the same time, we have carefully addressed the reviewer's comments point-by-point in the revision.

Before accepting this version, I have three minor suggestions:

1. Including additional statements on the calculation of runoff composition contributions in sub-basins would enhance reader understanding of differences among the sub-basins. For instance, providing formulas such as rainfall contribution = rainfall in the sub-basin / (rainfall + snowmelt + glacier melt) generated in the sub-basin area could clarify these calculations.

Reply:

"Based on the simulation of total runoff, and its three components (rainfall runoff, snowmelt, and glacier runoff), contribution of three components to total runoff in the basin can be calculated as:

$$Total\,runoff\ (TR) = Rainfall\,runoff\ (RR) + Snowmelt\,runoff\,(SR) + Glacier\,runoff\,(GR)$$

$$Rainfall\,runoff\ contribution = \frac{RR}{TR} \times 100\%$$

$$Snowmelt\,runoff\ contribution = \frac{SR}{TR} \times 100\%$$

$Snowmelt\ runoff\ contribution = \frac{SR}{TR} \times 100\%$”

We have added it in the revision.

2. It would be beneficial to include a table summarizing the model calibration and performance to provide a more straightforward description of the calibration procedure. This table could include details such as the calibration step, model parameters calibrated in each step, data used for evaluation, objective function, and performance metrics.

Reply:

We have added a Table to summarize the model calibration and validation in each step in the revision.

“Table 1. Values of the first (D1, m), the second soil depth (D2, m) and degree-day factor (DDF), and the Nash-Sutcliffe Efficiency (NSE) and Relative Bias (RB, %) of the simulated monthly streamflow with the Variable Infiltration Capacity (VIC)-Glacier model relative to the observation for the eight hydrological stations.

Step1. Calibration and validation of the glacier model					
Sub-basin	Hydrological station	DDF ($\mathrm{mm}{}^{\circ}\mathrm{C}^{-1}\,\mathrm{day}^{-1}$)	Calibration (glacier area observations)	Validation (glacier mass balance)	
			RB (%)	CC	RB (%)
LZ	LZ	10.97	-1.3	0.65-0.96	-15% to -45%
LZ-YC	YC	10.97	-3.7		
RKZ	RKZ	10.97	-6.2		
LS	LS	9.2	-2		
YC-NX	NX	6.8	-1.5		
NX-BXK	YG	6.5	1.7		
	BM	6.5			
	MT	6.5			

Step2. Calibration and validation of the VIC model							
Sub-basin	Hydrological station	D1(m)	D2(m)	Calibration (observed streamflow)		Validation (observed streamflow)	
				NSE	RB (%)	NSE	RB (%)
LZ	LZ	0.1	0.7	0.85	2.1	0.81	1.8
LZ-YC	YC	0.1	0.7	0.83	3	0.81	1.6
RKZ	RKZ	0.1	0.9	0.84	-4	0.71	-8
LS	LS	0.1	0.7	0.84	-2	0.82	-2
YC-NX	NX	0.1	1	0.86	-4	0.86	-5
NX-BXK	YG	0.1	1	0.82	-8	0.83	-5
	BM	0.1	1	0.83	-6	0.83	-5
	MT	0.1	1	0.71	6	0.73	5

3. Adding an additional discussion section to explore the underlying reasons for the different runoff change trends (both historical and future) in the sub-basins would enrich the results. In this section, quantitative comparisons of changes in total precipitation, temperature, snow fraction in precipitation, evapotranspiration, and glacier mass among the sub-basins could be included to provide more insight into the observed runoff change trends.

Reply:

We have analyzed the underlying reasons for the different runoff change trends in the upper Nuxia (NX) hydrological station and downstream of the NX hydrological station (NX-BXK sub-basin). In addition, we added three tables about projected changes (%) in mean annual and seasonal total runoff and its three components (rainfall, snowmelt and glacier), precipitation and temperature in 2021–2050 and 2071–2100, respectively, relative to 1971–2000 under the two SSPs in the YZ basin and its two sub-basins.

“Increased total runoff are projected to be primarily influenced by increased rainfall runoff, with minor contributions from increased snowmelt and glacier runoff under both SSPs scenario through the 21st century. However, in comparison to the 1971–2000 mean, a reduction of approximately -6% to -14% is projected in the first half of the 21st century (2021–2050) in the YZ and its NX and NX-BXK sub-basins under the SSP2-4.5 and SSP5-8.5 scenario (Figure 8). This reduction is attributed to decreased rainfall (-9% to -19%) and snowmelt (-5% to -6%), which may result in the decline of freshwater supply. Conversely, there is a broadly consistent increase (6%–32%) in total runoff in the second half of the 21st century (2071–2100), mainly driven by increased rainfall (4%–52%) and glacier runoff (9%–78%), suggesting that the YZ basin will not face a water supply crisis in the end of 21st century.

The increased total runoff in the NX basin is primarily attributed to increased rainfall runoff and spring snowmelt, indicating an earlier spring snow melt and delayed fall freeze-up. Similarly, the increased total runoff in the NX-BXK basin is mostly a result of increased rainfall and glacier runoff, coupled with decreased snowmelt, primarily due to reduced snowfall with ongoing warming in each month. Future changes in seasonal runoff across the entire YZ basin closely align with those in the NX-BXK sub-basin due to its significant contribution to the overall runoff of the YZ basin.”

Table 2. Projected changes (%) in mean annual and seasonal total runoff and its three components (rainfall, snowmelt and glacier) in 2021–2050 and 2071–2100, respectively, relative to 1971–2000 under the two SSPs in the YZ basin and its two sub-basins. The uncertainties are indicated with one standard deviation.

Basin	Period	Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
NX	2021-2050 (SSP2-4.5)	Total	-15±3	-15±3	-10±4	-7±6	-9±7	-5±7	3±7	-3±3	-11±4	-11±5	-12±3	-14±3	-6±4
		Rainfall	-15±3	-16±3	-16±3	-14±3	-1±4	29±14	1±12	-7±9	-10±4	-12±5	-9±5	-13±4	-9±5
		Snowmelt	6±7	-6±6	-14±7	-30±5	-34±5	-14±5	33±12	19±5	-17±3	-28±3	-20±5	-11±6	-5±4
		Glacier	0±0	0±0	0±0	0±0	54±18	5±7	-4±4	-5±4	2±8	39±12	0±0	0±0	5±5
	2071-2150 (SSP2-4.5)	Total	-6±4	-6±4	0±5	8±7	5±11	1±6	14±7	9±7	2±7	5±6	-2±5	-4±4	6±6
		Rainfall	-6±4	-8±3	-8±3	-7±4	13±7	87±22	25±14	18±9	13±8	12±9	12±7	-3±4	11±7
		Snowmelt	38±17	27±11	25±11	-10±7	-30±8	-19±6	20±11	8±7	-20±3	-26±4	-9±10	13±14	-8±5
		Glacier	0±0	0±0	0±0	0±0	47±29	6±8	-1±7	1±8	9±13	57±25	0±0	0±0	9±8
	2021-2050 (SSP5-8.5)	Total	-15±3	-14±3	-10±3	-6±5	-7±7	-5±6	3±7	-2±5	-10±5	-10±5	-11±4	-13±3	-5±5
		Rainfall	-35±2	-41±2	-30±2	-36±3	24±11	320±49	157±26	8±8	-27±5	-48±3	-40±3	-29±3	-9±6
		Snowmelt	9±11	-3±8	-8±6	-28±6	-31±6	-14±6	30±10	17±4	-18±2	-30±4	-20±7	-10±8	-6±4
		Glacier	0±0	0±0	0±0	0±0	55±13	7±6	-1±4	-1±6	7±9	52±12	0±0	0±0	9±6
	2071-2150 (SSP5-8.5)	Total	11±10	12±9	25±11	50±17	50±18	34±13	54±28	47±24	35±17	42±19	27±16	16±12	40±18
		Rainfall	-18±7	-26±6	-12±8	-7±10	165±40	689±122	377±108	89±36	24±19	-14±12	-20±9	-9±9	52±24
		Snowmelt	131±32	91±21	77±21	14±15	-18±11	-22±8	19±13	14±13	-23±7	-27±8	24±16	67±21	-4±7
		Glacier	0±0	0±0	0±0	0±0	187±72	72±23	45±21	48±24	78±31	0±0	0±0	0±0	78±27
NX-BXK	2021-2050 (SSP2-4.5)	Total	-17±3	-18±3	-20±5	-10±9	-15±7	-18±6	-10±6	-11±4	-16±4	-15±7	-15±4	-17±3	-14±4
		Rainfall	-16±3	-15±4	-16±5	-5±12	-16±11	-21±9	-19±7	-19±5	-23±5	-20±7	-17±4	-17±2	-19±5
		Snowmelt	-38±6	-43±4	-36±5	-27±6	-26±5	-20±4	14±8	33±7	48±7	-9±9	-27±8	-31±7	-6±4
		Glacier	0±0	0±0	0±0	0±0	77±14	-1±6	-10±5	-16±3	-14±4	4±8	0±0	0±0	-7±4
	2071-2150 (SSP2-4.5)	Total	-10±4	-9±6	-9±6	9±13	6±12	-5±8	3±11	-2±8	-4±9	1±12	-8±5	-10±4	-1±7
		Rainfall	-9±3	-8±5	-3±6	13±16	15±18	1±12	1±12	-5±10	-7±9	-5±12	-10±5	-10±4	-2±8
		Snowmelt	-24±11	-26±9	-27±7	-8±10	-15±8	-16±9	15±8	34±7	62±24	23±19	-24±9	-19±7	1±5
		Glacier	0±0	0±0	0±0	0±0	95±32	5±10	-5±10	-13±8	-12±7	21±14	0±0	0±0	-1±8
	2021-2050 (SSP5-8.5)	Total	-17±3	-18±4	-20±3	-12±5	-16±5	-18±5	-10±4	-10±3	-13±4	-13±9	-13±5	-16±3	-13±3
		Rainfall	-16±3	-15±4	-15±4	-6±6	-17±5	-23±9	-20±6	-19±5	-21±5	-18±9	-17±4	-17±3	-19±5
		Snowmelt	-38±4	-42±7	-37±4	-31±6	-26±4	-19±4	15±5	33±6	52±6	-6±12	-25±9	-32±8	-5±2

		Glacier	0±0	0±0	0±0	0±0	81±15	2±7	-7±4	-13±4	-11±5	10±7	0±0	0±0	-4±4
	2071-2150 (SSP5-8.5)	Total	2±6	6±7	21±12	51±23	45±19	21±16	24±19	24±16	22±17	34±20	11±11	3±7	25±14
		Rainfall	0±6	4±6	23±13	55±31	62±27	39±25	21±25	10±18	1±15	10±15	-1±7	-2±6	18±14
		Snowmelt	4±17	-6±8	-6±13	16±15	-2±14	-17±10	12±7	73±16	171±45	95±47	4±17	10±15	17±7
		Glacier	0±0	0±0	0±0	0±0	291±85	74±28	42±24	27±19	33±20	0±0	0±0	0±0	57±25
YZ	2021-2050 (SSP2-4.5)	Total	-16±3	-16±3	-17±3	-9±8	-14±7	-13±6	-5±6	-6±3	-13±4	-13±6	-13±4	-15±3	-10±4
		Rainfall	-16±3	-15±3	-15±3	-5±9	-9±11	-12±9	-15±7	-13±4	-18±4	-15±6	-15±3	-16±3	-14±5
		Snowmelt	-20±6	-33±4	-30±5	-28±5	-30±5	-20±4	21±8	28±6	-2±3	-26±4	-24±4	-22±5	-5±3
		Glacier	0±0	0±0	0±0	0±0	70±16	4±6	-7±4	-12±3	-9±5	13±9	0±0	0±0	-2±4
	2071-2150 (SSP2-4.5)	Total	-7±4	-8±4	-6±5	8±10	6±12	-3±7	7±8	5±7	0±8	2±9	-4±5	-7±4	2±6
		Rainfall	-8±3	-8±4	-5±4	11±12	26±18	11±12	7±9	6±9	2±9	3±9	-6±4	-8±3	4±7
		Snowmelt	3±12	-12±9	-15±7	-7±9	-21±7	-19±7	15±8	21±6	-2±6	-20±4	-15±9	-5±10	-4±4
		Glacier	0±0	0±0	0±0	0±0	74±30	8±9	-3±8	-8±8	-5±9	31±17	0±0	0±0	3±8
	2021-2050 (SSP5-8.5)	Total	-16±2	-16±2	-16±2	-10±4	-14±5	-13±5	-5±5	-5±3	-11±5	-11±6	-12±4	-14±3	-9±4
		Rainfall	-16±3	-16±3	-15±3	-6±5	-10±6	-14±9	-15±6	-12±5	-16±5	-14±7	-14±4	-16±3	-14±5
		Snowmelt	-19±5	-32±6	-29±3	-30±5	-28±4	-20±4	20±7	27±5	-2±3	-27±4	-24±6	-22±6	-6±3
		Glacier	0±0	0±0	0±0	0±0	72±14	6±6	-4±4	-9±4	-5±6	21±9	0±0	0±0	2±5
	2071-2150 (SSP5-8.5)	Total	7±8	9±8	21±9	50±19	47±18	27±14	35±21	38±21	30±17	37±18	21±14	11±9	32±15
		Rainfall	3±7	5±7	16±9	49±23	79±28	58±25	42±29	38±24	28±18	30±17	11±11	5±8	33±18
		Snowmelt	56±20	21±11	14±14	18±14	-8±12	-20±9	12±5	40±14	14±11	-13±11	12±14	36±17	5±6
		Glacier	0±0	0±0	0±0	0±0	250±81	80±26	44±22	34±21	46±23	0±0	0±0	0±0	65±26

Table 3. Projected changes (%) in mean annual and seasonal precipitation in 2021–2050 and 2071–2100, respectively, relative to 1971–2000 under the two SSPs in the YZ basin and its two sub-basins. The uncertainties are indicated with one standard deviation.

Basin	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
NX	2021-2050 (SSP2-4.5)	-1.5±5.7	0.1±7.3	-4.1±4.7	6.9±7.8	18.4±10	10.5±8.5	11.4±3.8	1.2±4.0	3.7±5.4	6.6±5.43	-10.8±9	-11.8±13	6.50±3.3
	2071-2100 (SSP2-4.5)	-0.1±9	1.8±7.6	-2.9±5.9	14.2±14	25.4±10	15.4±8.5	18.1±4.9	9.0±4.80	11.9±5.2	14.8±8.9	-12.6±9	-12.3±13	12.8±3.8
	2021-2050 (SSP5-8.5)	-0.5±7.6	1.2±4.7	1.02±7.1	10.9±9.4	20.2±9	8.7±10.1	10.1±4.8	2.7±4.6	2.8±5.2	3.2±8.3	-13.6±8	-14.5±9	6.42±3.7
	2071-2100 (SSP5-8.5)	3.69±10	6.41±7.7	5.95±8.8	29.9±18	49.2±13	34.9±14	36.5±18	24±11.3	22.3±7.9	40.8±14	3.5±12.4	-9.5±10	29.4±9.6
NX-BXK	2021-2050 (SSP2-4.5)	-1.1±11	-3.4±5.1	-3.6±8.4	2.5±11.8	9.7±9.9	-0.2±5.8	1.94±7.8	-3.4±4.5	-9.5±6.1	-7.2±9.7	-15.4±12	-11±9.9	-1.9±3.8
	2071-2100 (SSP2-4.5)	2.8±11.6	-1.1±8.4	1.04±9.2	12.2±14	22.9±14	4.74±6.6	11.5±11	-0.1±8.6	-2.7±9.9	-1.6±13	-14.2±11	-10±11	4.55±5.1
	2021-2050 (SSP5-8.5)	-3.1±7.8	-4.4±7.3	-1.6±5.2	-0.1±6.9	9.91±5.9	-2.7±6.9	0.68±6.7	-3.3±6.1	-7.5±5.8	-7.9±13	-15.5±9	-16±9.3	-2.6±3.3
	2071-2100 (SSP5-8.5)	9±13	4.13±6.3	15.3±16	32.8±21	41.4±18	17.5±14	22.2±20	8.8±16.8	-1.6±10	11.9±15	-1.8±13	-7.8±18	15.6±8.7
YZ	2021-2050 (SSP2-4.5)	-1.3±8.7	-2.2±5.7	-3.8±6.5	4.19±9.9	14±9.8	6±7	8.2±4.9	-0.1±3.7	-1.8±4.7	-1.1±7	-13±10	-11.3±10	2.76±3.3

	2071-2100 (SSP2-4.5)	1.7±10.3	-0.1±7.6	-0.2±7.4	13±14	24.1±11	11±6.23	15.9±6	6.3±5.68	5.7±6.37	5.5±10.8	-13.5±10	-10±11	9.2±4.28
	2021-2050 (SSP5-8.5)	-2.1±7.2	-2.5±5.5	-0.8±5.6	4±7	15±6.3	4±8.2	6.9±4.84	1±4.5	-1.5±4.8	-3±10.2	-14±7.7	-15±8.4	2.4±3.2
	2071-2100 (SSP5-8.5)	7±11.9	4.9±5.9	12.4±13	31.7±19	45.3±14	27.7±13	31.6±18	20.2±11	12.2±8.1	24.6±14	0.3±12.9	-8±14.8	23.3±8.7

Table 4. Projected changes (℃) in mean annual and seasonal temperature in 2021–2050 and 2071–2100, respectively, relative to 1971–2000 under the two SSPs in the YZ basin and its two sub-basins. The uncertainties are indicated with one standard deviation.

Basin	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
NX	2021-2050 (SSP2-4.5)	1.43±0.35	1.04±0.535	1.139±0.527	1.428±0.607	1.231±0.524	1.023±0.348	0.835±0.209	0.939±0.26	1.027±0.383	0.838±0.184	1.372±0.507	1.657±0.597	1.163±0.279
	2071-2100 (SSP2-4.5)	3.192±0.935	2.952±0.651	2.93±0.51	3.226±0.678	2.95±0.795	2.541±0.42	2.412±0.468	2.459±0.46	2.58±0.606	2.55±0.508	3.508±1.097	3.787±0.9	2.924±0.472
	2021-2050 (SSP5-8.5)	1.599±0.29	1.34±0.543	1.341±0.335	1.42±0.378	1.178±0.422	1.111±0.336	1.061±0.258	1.147±0.288	1.207±0.395	1.256±0.196	1.821±0.728	1.953±0.443	1.369±0.222
	2071-2100 (SSP5-8.5)	6.227±0.778	5.826±0.634	5.72±0.805	5.982±1.252	5.435±1.095	4.735±0.838	4.535±1.064	4.721±1.158	5.05±1.05	5.558±1.224	6.679±1.684	6.916±1.489	5.615±0.853
NX-BXK	2021-2050 (SSP2-4.5)	0.88±0.454	0.56±0.475	0.274±0.396	0.537±0.349	0.427±0.207	0.32±0.326	0.465±0.326	0.543±0.311	0.671±0.323	0.327±0.303	0.708±0.334	1.204±0.534	0.576±0.246
	2071-2100 (SSP2-4.5)	2.55±0.974	2.291±0.655	1.88±0.588	2.245±0.557	2.083±0.458	1.895±0.66	2.036±0.763	2.027±0.58	2.162±0.553	1.923±0.601	2.64±0.749	3.152±0.979	2.24±0.51
	2021-2050 (SSP5-8.5)	1.108±0.168	0.791±0.45	0.446±0.268	0.505±0.295	0.515±0.294	0.508±0.404	0.721±0.293	0.783±0.317	0.839±0.32	0.712±0.22	1.181±0.4	1.54±0.296	0.804±0.164
	2071-2100 (SSP5-8.5)	5.406±0.841	4.852±0.654	4.365±0.785	4.656±1.02	4.269±0.82	3.823±1.033	4.008±1.191	4.246±1.349	4.551±1.048	4.719±1.299	5.692±1.329	6.303±1.409	4.741±0.902

YZ	2021-2050 (SSP2-4.5)	1.319±0.358	0.942±0.511	0.963±0.488	1.246±0.541	1.069±0.441	0.88±0.332	0.761±0.214	0.858±0.258	0.954±0.37	0.735±0.191	1.236±0.437	1.564±0.576	1.044±0.259
	2071-2100 (SSP2-4.5)	3.064±0.933	2.818±0.641	2.716±0.519	3.026±0.636	2.774±0.688	2.409±0.433	2.335±0.506	2.37±0.477	2.495±0.594	2.424±0.512	3.331±0.991	3.658±0.896	2.785±0.465
	2021-2050 (SSP5-8.5)	1.501±0.234	1.229±0.512	1.159±0.311	1.233±0.348	1.043±0.367	0.989±0.344	0.992±0.249	1.072±0.278	1.132±0.378	1.146±0.192	1.69±0.642	1.869±0.396	1.254±0.198
	2071-2100 (SSP5-8.5)	6.061±0.768	5.628±0.619	5.444±0.793	5.712±1.188	5.198±0.955	4.55±0.864	4.428±1.088	4.624±1.195	4.948±1.048	5.388±1.228	6.477±1.537	6.79±1.427	5.437±0.846

This manuscript investigates the spatiotemporal responses of runoff to climate change across six sub-basins of the Yarlung Zangbo (YZ) river basin, with a particular focus on differences between the upstream Nuxia and the downstream Nuxia-Pasighat basin. The manuscript is well-written and is of interest to Hydrology and Earth System Sciences. However, some improvements are necessary before publication.

Reply:

Thanks for the comments. At the same time, we have carefully addressed the reviewer's comments point-by-point in the revision.

1. The authors focus on six sub-basins of the YZ basin. Therefore, they should explain the changes in runoff and their possible causes. Additionally, it would be beneficial to elucidate why there is a negative trend in the RKZ sub-basin.

Reply:

"Simulated annual total runoff demonstrates increasing trends of 8.1–18.8 mm/10yr for 1971–2020 across six sub-basins within the NX basin, except for the RKZ sub-basin with an insignificant change (-1.1 mm/10yr), resulting in a significantly increasing trend of 9.4 mm/10yr ($p<0.05$) over the entire NX basin. Strong correlations between annual variation of total runoff, precipitation, and rainfall runoff exist in these sub-basins (CC of 0.90–0.99, $p<0.05$), while total runoff shows weak relationships with temperature and glacier runoff.

Streamflow mutates in 1997 at the RKZ sub-basin of the YZ basin. Increased precipitation and evaporation caused an insignificant runoff change during 1971–1997. However, due to significant decrease of precipitation and increase of evaporation, runoff decreased during 1998–2020, resulting in the insignificant decrease for 1971–

2020.”

These have been clearly indicated in the result and discussion section of revision.

2. The authors provide a table showing the parameters and performance of the VIC-Glacier model during the calibration and validation periods. It is recommended that they provide more details about the observed data used for each step.

Reply:

We have added a Table to summarize the model calibration and validation in each step in the revision.

“Table 1. Values of the first (D1, m), the second soil depth (D2, m) and degree-day factor (DDF), and the Nash-Sutcliffe Efficiency (NSE) and Relative Bias (RB, %) of the simulated monthly streamflow with the Variable Infiltration Capacity (VIC)-Glacier model relative to the observation for the eight hydrological stations.

Step1. Calibration and validation of the glacier model					
Sub-basin	Hydrological station	DDF (mm°C^{-1} day^{-1})	Calibration (glacier area observations)	Validation (glacier mass balance)	
			RB (%)	CC	RB (%)
LZ	LZ	10.97	-1.3	0.65-0.96	-15% to -45%
LZ-YC	YC	10.97	-3.7		
RKZ	RKZ	10.97	-6.2		
LS	LS	9.2	-2		
YC-NX	NX	6.8	-1.5		
NX-BXK	YG	6.5	1.7		
	BM	6.5			
	MT	6.5			
Step2. Calibration and validation of the VIC model					

Sub-basin	Hydrological station	D1(m)	D2(m)	Calibration (observed streamflow)		Validation (observed streamflow)	
				NSE	RB (%)	NSE	RB (%)
LZ	LZ	0.1	0.7	0.85	2.1	0.81	1.8
LZ-YC	YC	0.1	0.7	0.83	3	0.81	1.6
RKZ	RKZ	0.1	0.9	0.84	-4	0.71	-8
LS	LS	0.1	0.7	0.84	-2	0.82	-2
YC-NX	NX	0.1	1	0.86	-4	0.86	-5
NX-BXK	YG	0.1	1	0.82	-8	0.83	-5
	BM	0.1	1	0.83	-6	0.83	-5
	MT	0.1	1	0.71	6	0.73	5

3. The authors could expand the discussion on hydrologic modeling, considering the glacier melt component, in other high mountainous basins. They should also explore the possible reasons for variations in glacier contribution within the same basin.

Reply:

Thanks for the comments.

“Forcing inputs, parameters, and representation of physical processes are major sources of uncertainty in glacier simulations. Precipitation is the most important atmospheric input for land surface hydrology models, and an overestimate/underestimate of precipitation may be compensated by an underestimate/overestimate of glacier melt in the model simulation. For example, Zhang et al. (2013) simulated glacier runoff by the VIC-Glacier model with the APHRODITE precipitation estimates in the upper Indus (UI) river basin of the TP during 1961–2009, and suggeted that contribution of glacier runoff to total runoff was about 48.2. However, Meng et al. (2023) simulated glacier runoff by the VIC-Glacier model with the corrected MERRA-2 precipitation estimates in the UI basin, suggested that glacier runoff contributed of 24% to total runoff. The difference between Zhang et al. (2013) and Mengand (2023) mostly resulted from the higher amount of corrected MERRA-2 than APHRODITE precipitation estimates in the UI basin, because the underestimation of precipitation-induced runoff would be compensated by glacier runoff.

Sun and Su (2020) suggested that mean annual glacier runoff contributed about 45% to total runoff in the NX-BXK sub-basin for 1980–2000, using a hydrological model without calibration and validation due to a lack of hydrometeorological observations in the sub-basin. In this study, we utilized newly acquired rain gauge data, and streamflow, glacier mass balance, and glacier and snow cover observations in the NX-BXK sub-basin, glacier runoff was simulated using the well-validated VIC-Glacier model, forced by a comprehensively reconstructed long-term precipitation dataset in this study. The updated contribution of glacier runoff to total runoff during 1971–2020 in the NX-BXK sub-basin was determined to be 19%."

These have been clearly indicated in the discussion section of revision.

The study uses the VIC-Glacier hydrological model to examine historical and future runoff changes across six sub-basins, highlighting significant differences in rainfall, snowmelt, and glacier runoff contributions. The findings provide critical insights for water resource management and adaptation strategies in this important region. The manuscript is well-organized and provides a comprehensive analysis of research question. I believe the manuscript is suitable for publication on HESS after some minor revisions.

Reply:

Thanks for the comments. At the same time, we have carefully addressed the reviewer's comments point-by-point in the revision.

1. The manuscript will benefit from a more detailed introduction to the forcing data and the accuracy of the datasets from the authors' previous studies. Especially, how snowfall is estimated and whether the undercatch is corrected.

Reply:

Thanks for the comments. We have added more details about forcing data in the revised version.

"The daily precipitation data with a spatial resolution of 10×10 km for 1961–2020 was reconsructed by correcting gridded estimates from the ERA5 precipitation of the European Centre for Medium-Range Weather Forecasts (ECMWF) based on 580 rain gauges in the monsoon-dominated TP region (290 rain gauges in the YZ basin, Figure 1) and the Random Forest-based (RF) machine learning algorithm (Sun et al., 2022). Inputs of the RF algorithm selected in this study include: 1) geographical features (e.g., longitude, latitude, elevation, slope gradient and aspect), which influence precipitation distribution, and 2) climatic features derived from the ERA5 (e.g., convective available potential energy, lifting condensation level, and total column water vapor), which represent the potential for the generation and development of precipitation. The corrected precipitation data set was evaluated at a point scale by comparing it with gauge observations, and has been inversely evaluated by the hydrological model, which demonstrates its suitability for hydrological simulation (Sun et al., 2022)."

The daily precipitation records from 150 meteorological stations inside China for 1961–2016 were collected from the China Meteorological Administration (CMA, http://data.cma. cn/), and extra monthly observations from 118 meteorological stations outside China are collected from the Global Historical Climatology Network (GHCN, https://www.ncdc.noaa. gov/ghcn-monthly) for 2005–2013. In addition, monthly precipitation data for 2014–2016 from 312 rain gauges in the southeastern TP were collected from the governmental hydrometeorological agencies. These obtained gauge estimates have undergone quality control procedures to preprocess (validated, corrected, or removed) erroneous data (e.g., daily precipitation values less than 0 mm, and undercatch), and only monthly records that are derived from at least 3 years of consecutive observation are used in this study. We have made this point clear in the Sun et al. (2022).

Reference:

Sun, H., Yao, T., Su, F., He, Z., Tang, G., Li, N., et al., 2022. Corrected ERA5 precipitation by machine learning significantly improved flow simulations for the Third Pole basins. J. Hydrometeorol. 23. https://doi.org/10.1175/JHM-D-22-0015.1.

2. I suggest adding more discussions about the generalizability of the methods, results, and conclusions in this study.

Reply:

We have added more discussions about methods, results, and conclusions in the revision.

3. Please discuss the potential impact of land cover and land use change on the conclusions in this study.

Reply:

Thanks for the comments.

"Liu et al. (2023) studied the effect of vegetation growth induced by climate change to runoff variation during 1981–2010 in the YZ basin with the Variable Infiltration Capacity (VIC) model, suggesting that implanting grassland effectively reduces flash flood runoff in the short term and balances groundwater runoff in the long term. Broad-leaved and coniferous forests, with their longer growth cycles, also play a key role in adjusting soil moisture. Ji et al. (2023) explored the effect of vegetation growth on runoff changes in the YZ basin by computing the functional equation for the Normalized Difference Vegetation Index (NDVI) and Budyko parameter, suggesting that the NDVI and discharge both presented an increasing trend, and the contributions of NDVI on streamflow change in the 1998–2015 were about 43.04%."

References:

Liu, X., Lu, H., Yang, K., Xu, Z., Wang, J. 2023. Responses of runoff processes to vegetation dynamics during 1981–2010 in the Yarlung Zangbo River basin. Journal of Hydrology: Regional Studies, 50, 101553.

Ji, G., Yue, S., Zhang, J., Huang, J., Guo, Y., Chen, W. 2023. Assessing the impact of vegetation variation, climate and human factors on the streamflow variation of yarlung

zangbo river with the corrected budyko equation. Forests, 14(7), 1312.

4. Section 5.2 provides very general implications. I wonder whether this part is necessary since the water management recommendations are just loosely and conceptually linked to the findings in this study.

Reply:

Thanks for the comments. We have deleted Section 5.2 in the revision.

5. Please add more details in the "Data availability" section.

Reply:

"Daily precipitation, maximum and minimum temperature, and wind speed estimates with a spatial resolution of 10×10 km during 1971–2100 were adopted from Sun et al. (2022), and were downloaded from the National Tibetan Plateau/Third Pole Environment Data Center (TPDC, https://doi.org/10.11888/Atmos.tpdc.272885). Daily transient climate estimates, at a spatial resolution of 10×10 km for 1971–2100 under 20 scenarios (10 GCMs × 2 SSPs) used in this study were from Sun et al. (2024). Observed streamflow was from the Ministry of Water Resources, China. Two shapefiles of glacier inventory were downloaded from the "Environment & Ecological Science Data Center for west China" (http://westdc.westgis.ac.cn/glacier) and Randolph Glacier Inventory (RGI) 6.0 (https://www.glims.org/RGI/rgi60_dl.html). Observed annual glacier mass balance data from Gurenhekou and Parlung No.94 glacier sites since 2005 were downloaded from the TPDC. The snow cover fraction (SCF) estimates during 2006–2018 were form the Moderate Resolution Imaging Spectroradiometer (MODIS) 10CM (https://nsidc.org/ data)." We have added it in the revision.