Supplementary Materials

Hydroclimatology of the Chitral River in the Indus Basin under Changing Climate

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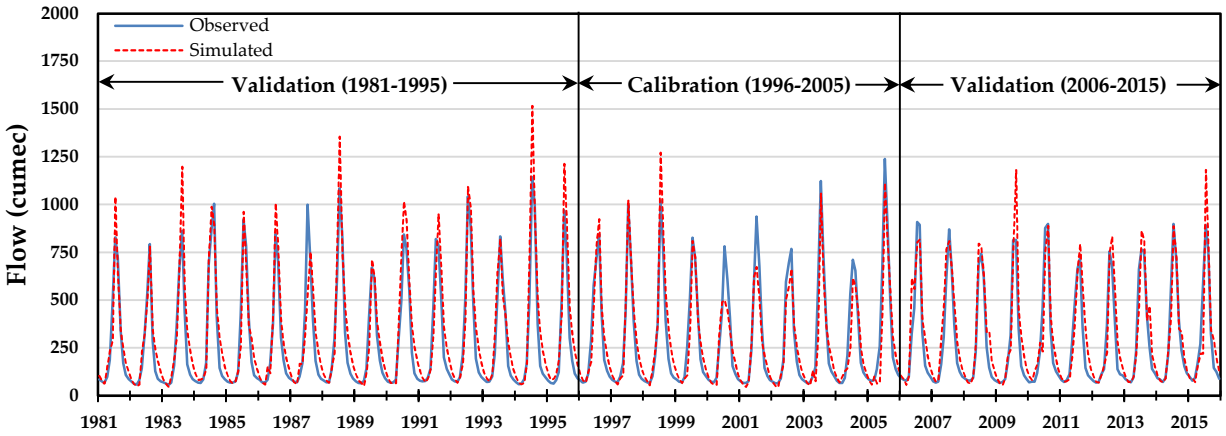

Figure S1. Simulated and Observed Flow during Calibration and Validation Periods on Monthly Basis, Chitral River Basin.

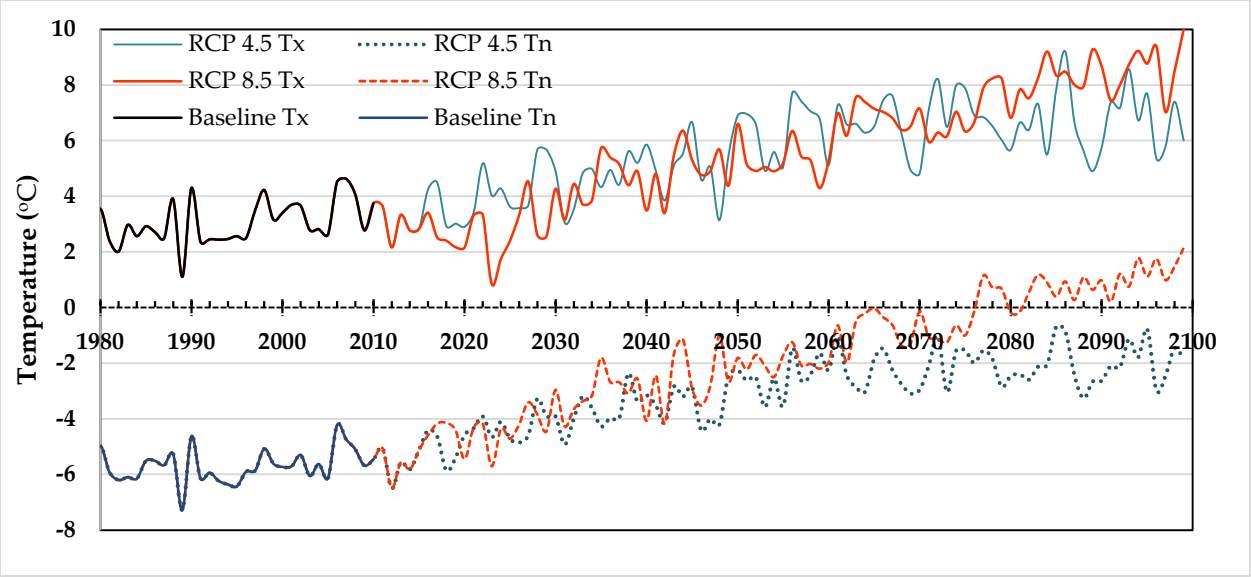

Figure S2. Mean Annual Maximum and Minimum Temperatures (T_x, T_n) for Baseline, RCP4.5 and RCP8.5, Chitral River Basin.

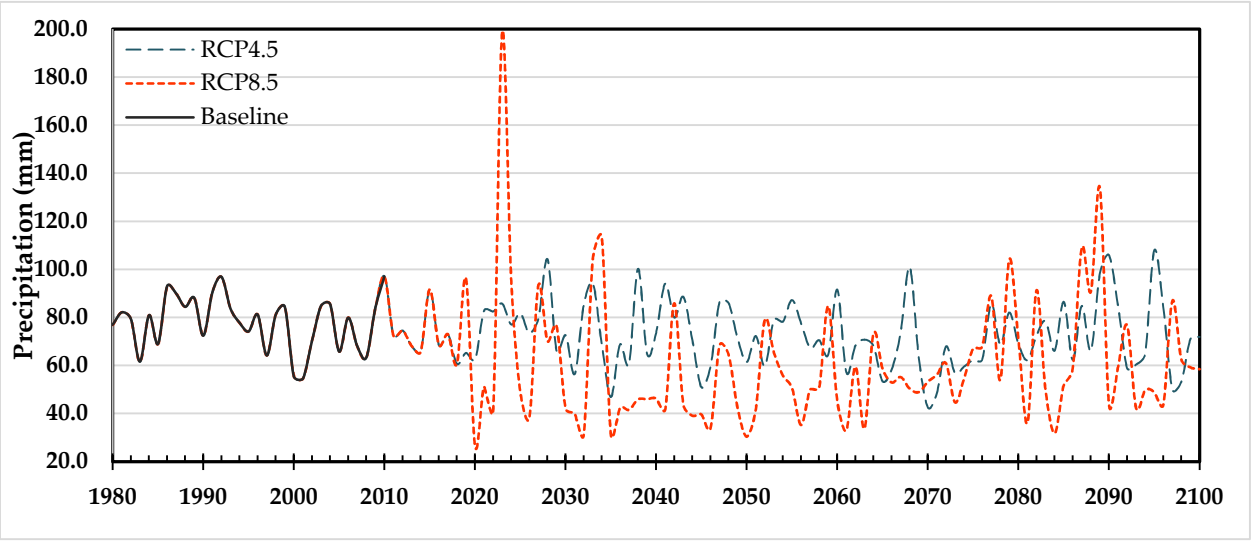

Figure S3. Mean Annual Precipitation for Baseline, RCP4.5 and RCP8.5, Chitral River Basin.

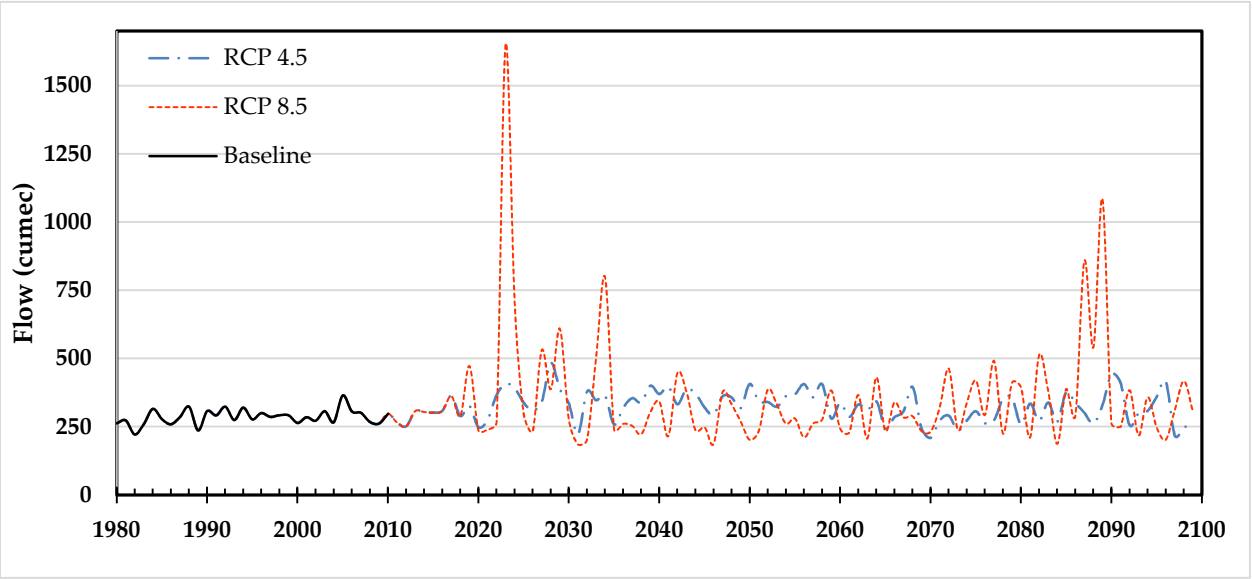

Figure S4. Mean Annual Flow for Baseline, RCP4.5 and RCP8.5, Chitral River Basin.

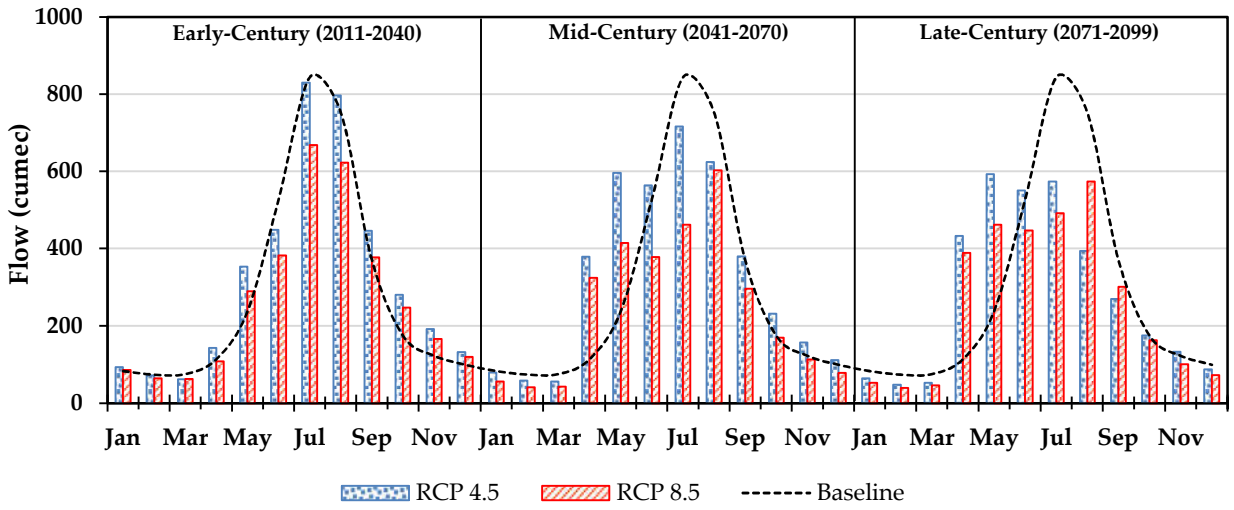

Figure S5. Comparison of the Baseline Monthly Flows with the Projected Flows for RCP4.5 and RCP8.5 during Early, Mid and Late Century, Chitral River Basin.

Table S1. Summary of GCMs and recent studies conducted for evaluation of over region.

No.	Model	Abbreviation	Reference
1	MIROC5_r1i1p1	Model for Interdisciplinary Research on Climate version-5	[24]
2	MIROC5_r2i1p1	Model for Interdisciplinary Research on Climate version-5	[24]
3	CMCC-CMS_r1i1p1	Centro Euro-Mediterraneo sui Cambiamenti Climatici	[26]
4	MPI-ESM-LR_r1i1p1	Max Planck Institute Earth System Model	[24]
5	MPI-ESM-LR_r3i1p1	Max Planck Institute Earth System Model	[24]

Table S2. Biases (Pbias) between different statistical indices estimated for daily observed precipitation and GCM-simulations on annual and seasonal basis, during 1981-2010 over Chitral Basin. Pbias is the difference between observed and GCMs-simulations for each statistical index. In column 10, total of each identity (5 identities are dark blue, Medium blue, Light blue, underlined italic and bold). In column 11, the show rank of the GCM by considering score from column 10.

Models	Statistic/Seasons	Mean (mm/day)	SD (mm/Day)	Percentile (95%)	5-day Max rainfall (mm)	% Wet days	Max dry spells length	Max wet Spell Length	Total Number of Identities	Ranking
MIROC5_r1i1p1	Annual	-0.12	-0.15	-0.39	5.1	*0.08*	-11	-2	11	**1**
	Winter	0.34	-0.24	-0.43	-11.2	0.15	**-20**	*-10*	8	
	Pre-Monsson	0.05	-0.31	-0.68	3.1	0.06	**-11**	-4	3	
	Monsoon	0.02	*0.45*	0.65	10.3	0.15	**-14**	*-7*	*3*	
MIROC5_r2i1p1	Annual	-0.16	-0.68	-0.15	7.5	-0.06	-12	-3	6	**2**
	Winter	0.4	-0.1	0.47	*-14.8*	0.07	-7	-4	10	
	Pre-Monsson	0.22	-0.19	0.28	*-16.91*	0.03	-5	-5	5	
	Monsoon	-0.47	-0.11	**3.06**	15.82	**0.2**	*-6*	-3	*3*	
CMCC-CMS	Annual	0.21	*-0.82*	**-3.35**	**35.6**	-0.07	-17	2	4	**4**
	Winter	*0.79*	**-1.12**	*-1.15*	**-17.3**	*0.5*	-5	-5	0	
	Pre-Monsson	0.24	*-0.35*	**-2.35**	-9.5	-0.01	-9	-3	10	
	Monsoon	*-0.61*	0.33	*-2.22*	*19.4*	*0.18*	-5	-3	*9*	
MPI-ESM-LR_r1i1p1	Annual	**-0.34**	**-0.83**	*-1.76*	-10.85	-0.03	*-20*	3	5	**3**
	Winter	0.58	-0.53	**1.18**	-11.32	0.12	*-13*	-1	5	
	Pre-Monsson	*0.29*	0.15	-0.84	**-26.39**	*0.08*	*-10*	-5	8	
	Monsoon	-0.4	-0.17	1.08	7.46	0.16	-4	1	*6*	
MPI-ESM-LR_r3i1p1	Annual	*-0.22*	-0.67	-0.93	*-14.3*	**-0.1**	**-28**	3	3	**5**
	Winter	**0.96**	*-1.02*	-0.94	-10.3	**0.9**	-6	-4	6	
	Pre-Monsson	**0.54**	**-0.36**	*-1.98*	-6.4	**-0.12**	-7	*-6*	3	
	Monsoon	**-0.66**	0.48	-1.05	**25.4**	0.14	-3	-2	*4*	

Note: Negative (-) values show overestimation and positive (+) values shows underestimation. Each identifier has rank according to biasness (e.g. dark Blue, Medium Blue, light blue, underlines italic and bold Italic ranked 1, 2, 3, 4 and 5, respectively, with respected to observed data).

Table S3. Ranking and evaluation of GCM-simulated basin-wide T_x (T_n), (a) before bias corrections and, (b) after bias corrections, using linear scaling (LS), during 1981-2010, over Chitral River basin

Observed data Obs_ μ (°C) = 2.2 (-6.3); Obs_SD (°C) = 8.43 (7.6)					
	Temperature (°C)				
Models	E_μ (°C)	E_SD (°C)	RMSE (°C)	R	Ranking
MIROC5_r1i1p1	10.5(0.5)	1.9 (2.1)	4.2(5.51)	0.84(0.81)	1
MIROC5_r2i1p1	10.2(-0.1)	2.59 (2.28)	8.13 (5.1)	0.77 (0.79)	3
CMCC-CMS_r1i1p1	10.75(-15.08)	2.51 (3.7)	7.31 (6.84)	0.73 (0.74)	4
MPI-ESM-LR_r1i1p1	8.23(0.89)	2.2 (2.12)	5.8 (6.1)	0.81 (0.79)	2
MPI-ESM-LR_r3i1p1	18.3(-0.78)	5.8 (4.15)	7.8 (9.34)	0.71(0.68)	5

Obs_ μ (°C) = Observed mean; Obs_SD (°C) = Observed standard deviation; E_μ (°C) =error between mean observed and GCMs-simulated; E_SD (°C) =errors between standard deviation: RMSE= Root mean square error, R= Correlation coefficient. Note: Negative (-) shows overestimations and positive (+) values shows underestimations. Note: Dark blue, Medium blue, light blue, underlines italic and bold ranked 1, 2, 3 ,4, and 5, respectively, with respected to observed data.