

Generation of Climate Change Scenarios based indices and its impacts on agriculture



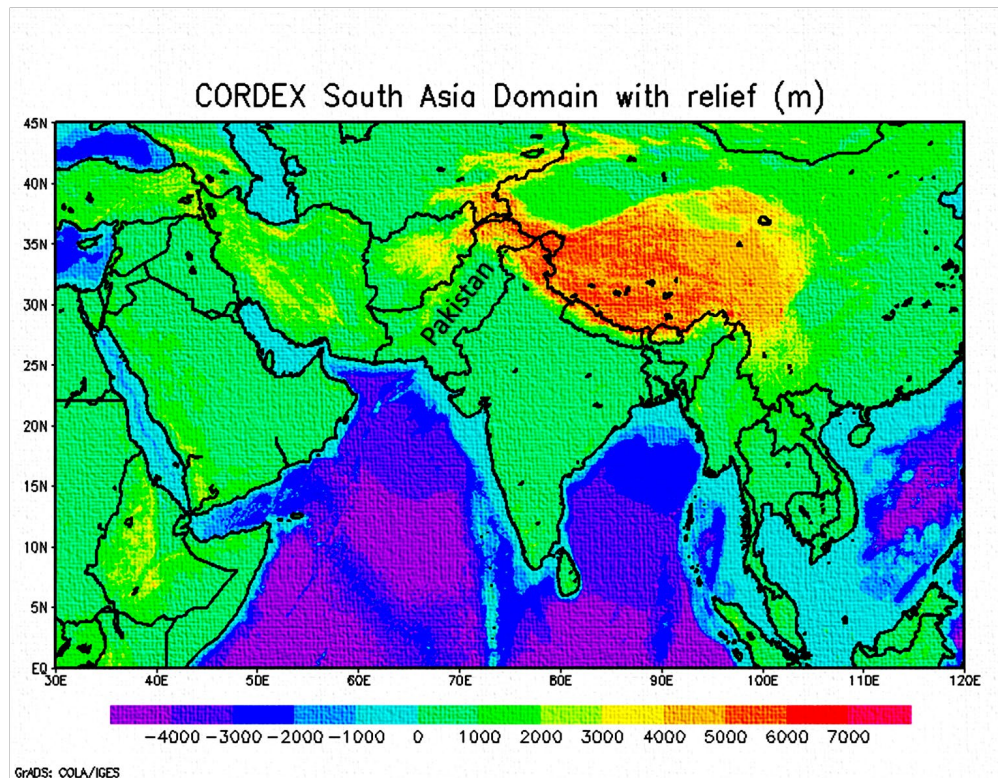
Dr. Shahzada Adnan, Burhan Ahmad, Usman Ali
Pakistan Meteorological Department

Statistical Bias Correction of Projections derived from CORDEX South Asia using Quantile Mapping over Pakistan Region

- Data used: SMHI-RCA4 CORDEX-SA dataset
- RCPs used: 4.5 and 8.5
- Method used: Quantile Mapping
- Statistics used for assessment: Probability Density Functions
- Ref: Burhan Ahmad; Ghulam Rasul (2018) International Journal of Global Warming (IJGW), Vol. 16, No. 4,
DOI: [10.1504/IJGW.2018.10017116](https://doi.org/10.1504/IJGW.2018.10017116)

DOMAIN SETTINGS

CORDEX SOUTH ASIA DOMAIN

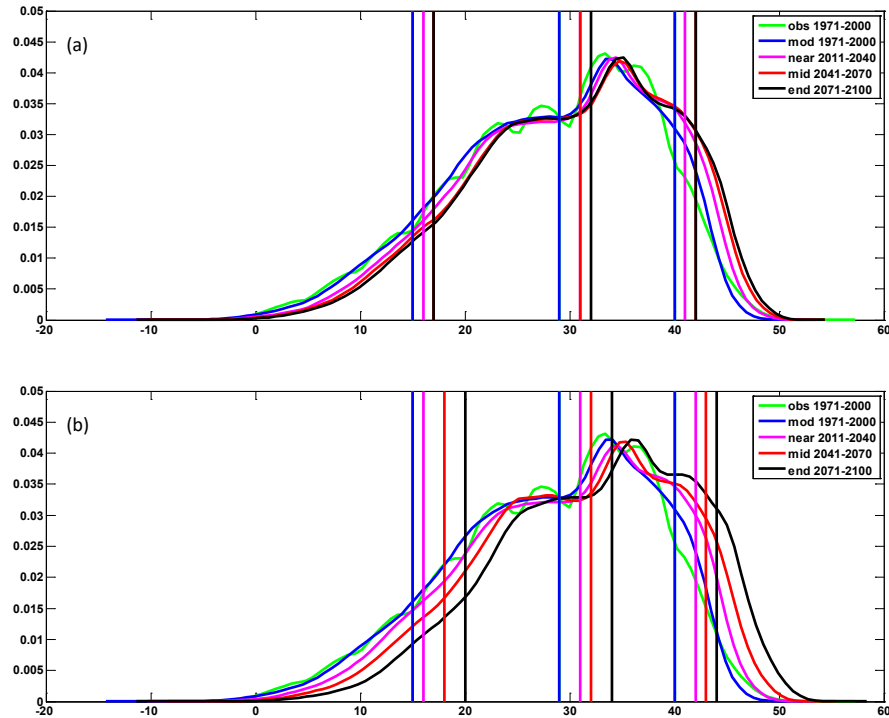


DOWNSCALING DOMAIN

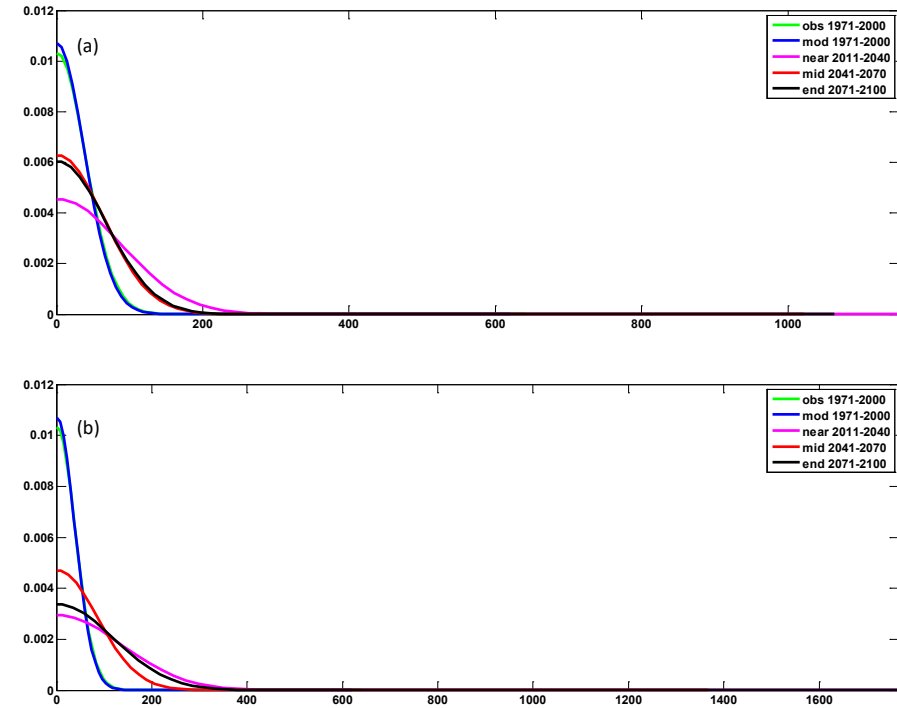


Baseline and Projected Probability Density Functions of SMHI RCA4 CORDEX Downscaled over Pakistan

Shifts in PDFs of projected TMAX (°C) under (a) RCP4.5 and (b) RCP8.5 emission scenarios. The three sets of vertical lines in each panel represent P10, P50, and P90 of each of the representative 30-year time slices.



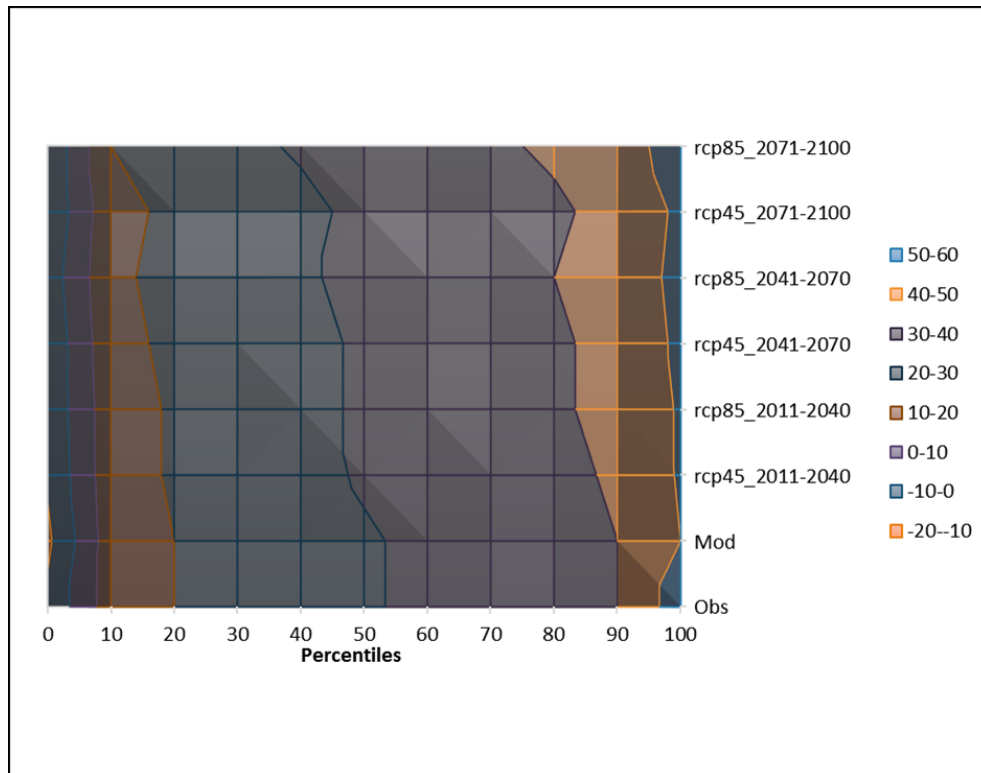
Shifts in PDFs of historical and projected PRECIPITATION (mm) under (a) RCP4.5 and (b) RCP8.5 emission scenarios.



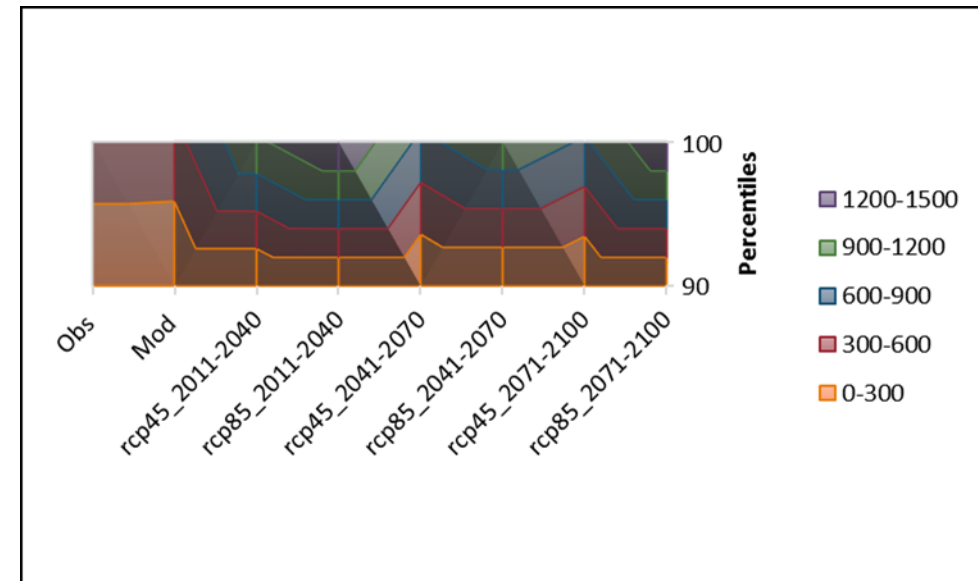
- More occurrences of hot extreme weather attributed to significant shifts in temperature extremes.
- Higher probability of more than 250 mm/day precipitation extremes in 2011-2040 projections.

Projected Shifts in Percentiles of SMHI RCA4 CORDEX Downscaled over Pakistan

Projected shifts in percentiles of TMAX (°C) under RCP4.5 and RCP8.5 with respect to observations. Surface is colour coded with a 10°C bin size which shows clear shifting and/or expansion of percentiles to higher degrees of bins.



Projected shifts in percentiles of PRECIPITATION (mm) under RCP4.5 and RCP8.5 with respect to observations. Surface is colour coded with a 300 mm bin size which shows clear expansion and inclusion of high magnitude extremes in projected timescales.



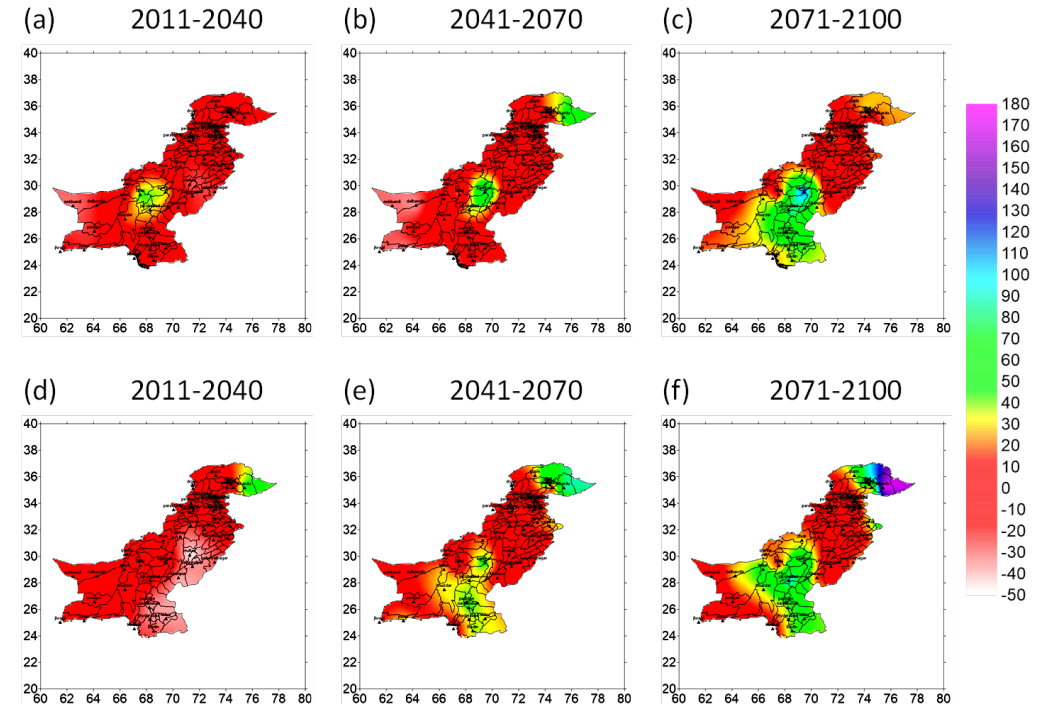
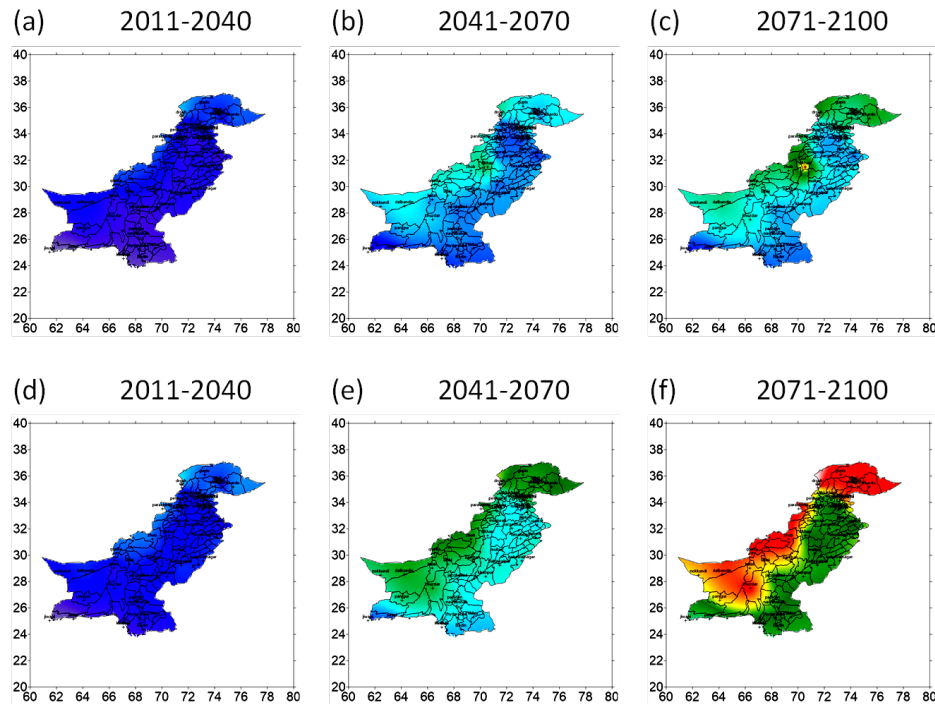
- With progression of projected timescales it is seen that the percentiles greater than 90 have expanded their 40-60°C TMAX bins to 70th percentile by the end of 21st century, which means that current temperate days would be shifted to extreme hot days in the projected periods.
- The Precipitation percentiles greater than 90 project high magnitude extremes with both the RCP4.5 and the RCP8.5 emission scenarios, which means that “heavy precipitation” extremes would be shifted to “very heavy” precipitation extremes in the projected periods.

Projected Changes in TMAX (°C) and PRECIP (mm)

Top Row (RCP4.5), Bottom Row (RCP8.5)

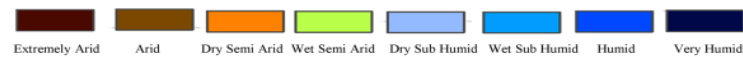
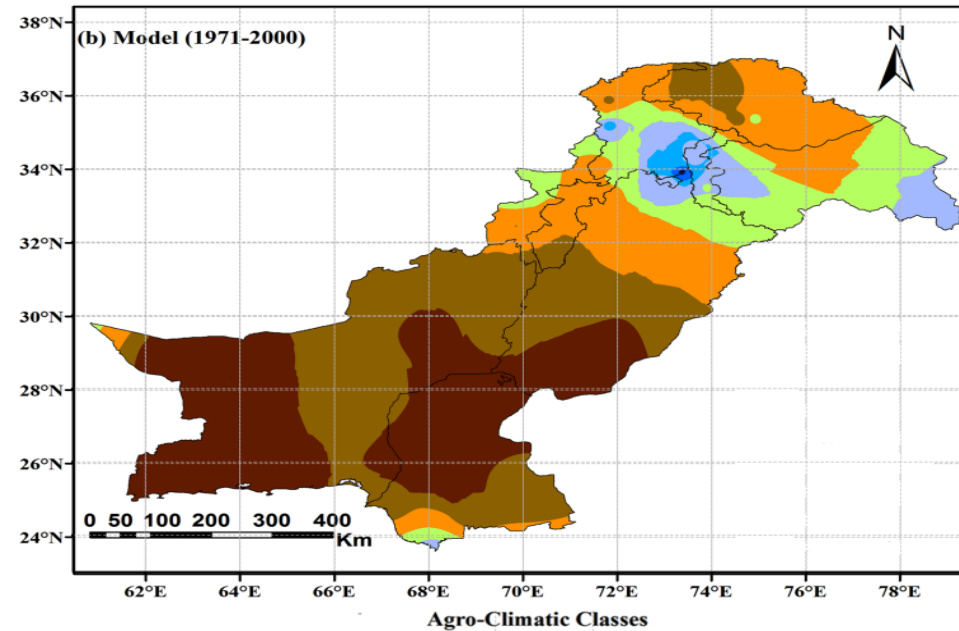
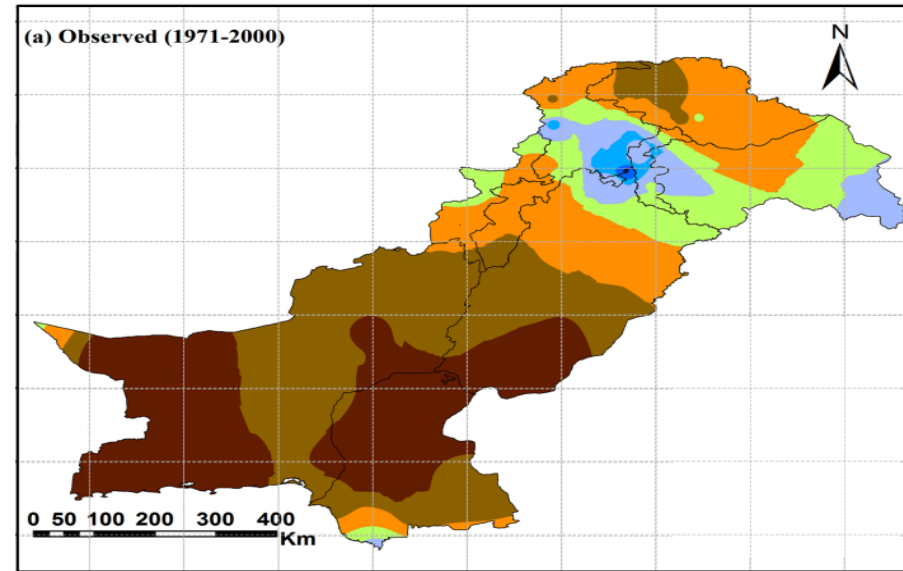
TMAX (°C). PROJECTED TEMPERATURE IS SEEN TO AFFECT ITS HIGHEST TOWARDS NORTH-WESTERN REGIONS (SPECIALLY CHITRAL BASIN, HINDUKUSH) WITH UP TO 6.5°C INCREASE BY THE END OF CENTURY UNDER THE RCP8.5 EMISSION SCENARIO

PRECIPITATION(mm). INITIALLY DRY BUT PROGRESSIVELY WET CONDITIONS ARE PROJECTED AT THE CONJUNCTION OF SINDH, PUNJAB, KPK AND BALUCHISTAN PROVINCES WITH UP TO 100% INCREASE. MOREOVER, NORTH-EASTERN SIDES OF THE DOMIAN INCLUDING HIMALAYAS PROJECT UP TO 180% INCREASE BY THE END OF CENTURY.



Shifting of agro-climatic zones and enhancement in Crop water demands using CORDEX for 21st century over Pakistan

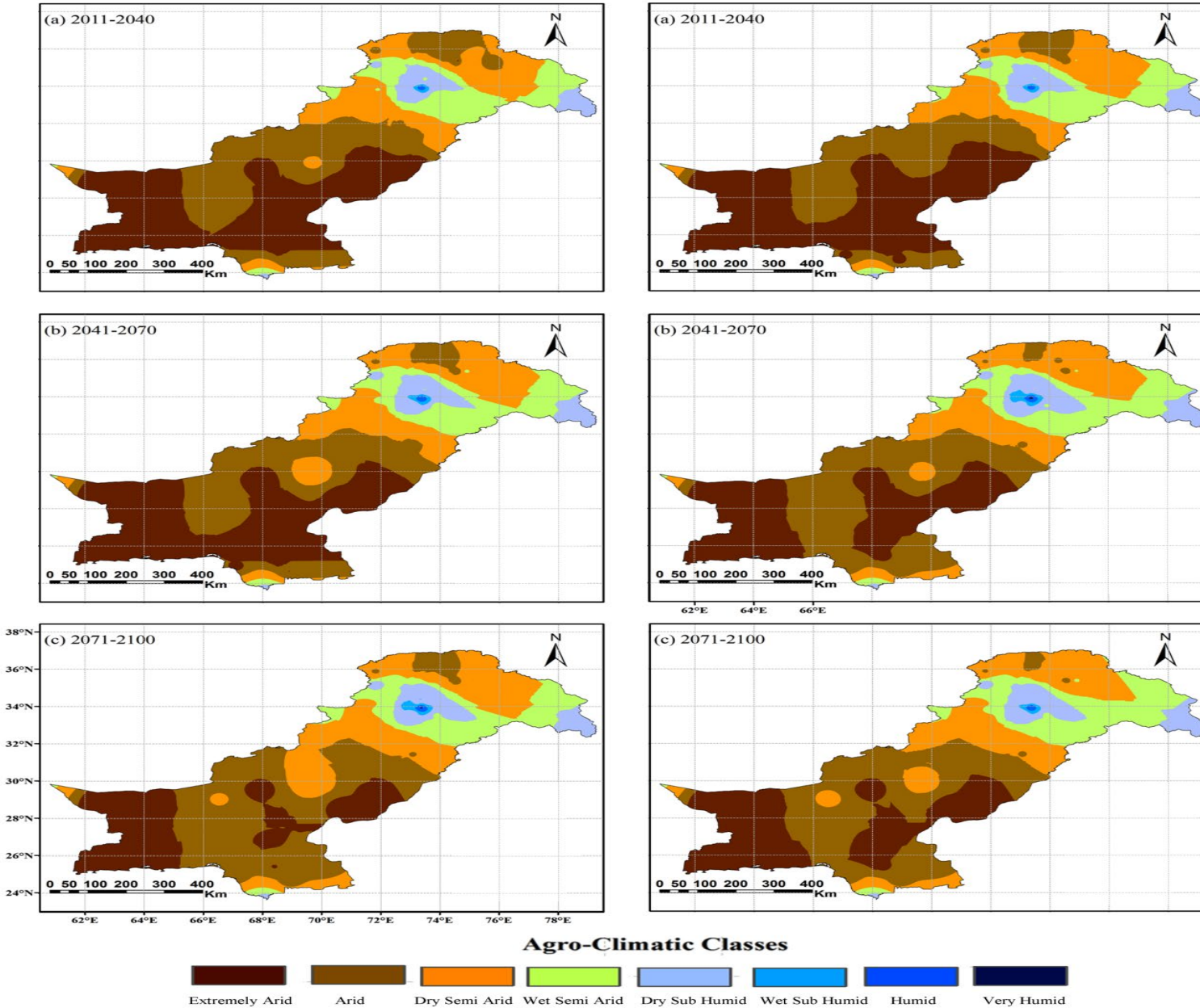
Comparison of agro-climatic zones by using observed and bias-corrected model baseline data for the time period (1971-2000) over Pakistan.



Comparison of agro-climatic zones based on RCP4.5 and RCP 8.5 for the time period (2011-2040), (2041-2070) and (2071-2100) over Pakistan.

RCP 4.5

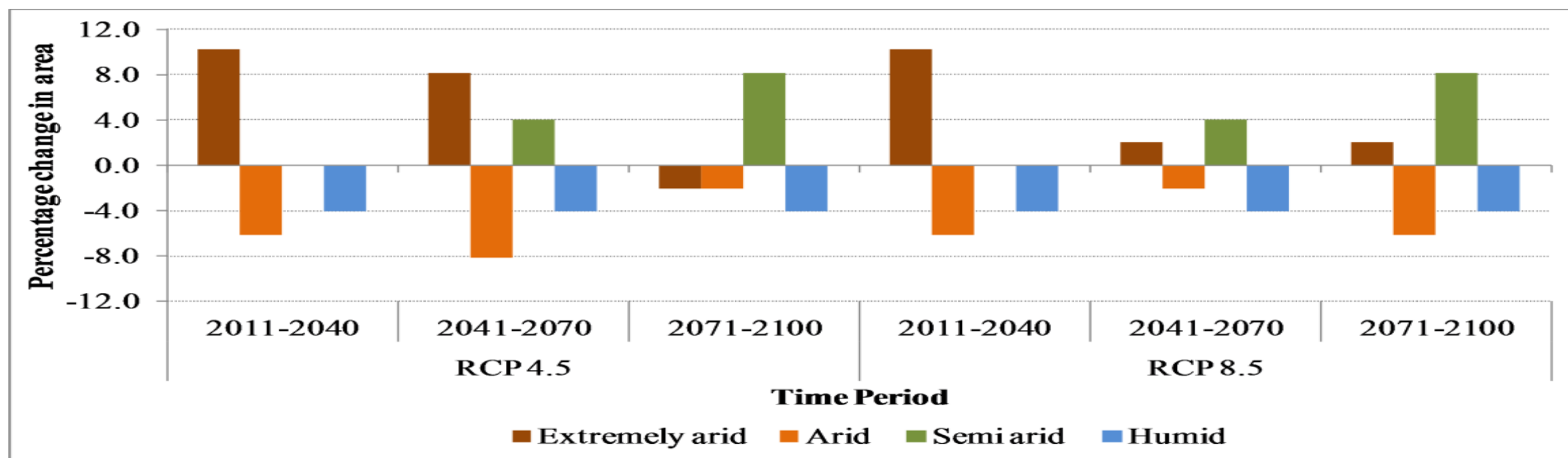
RCP 8.5



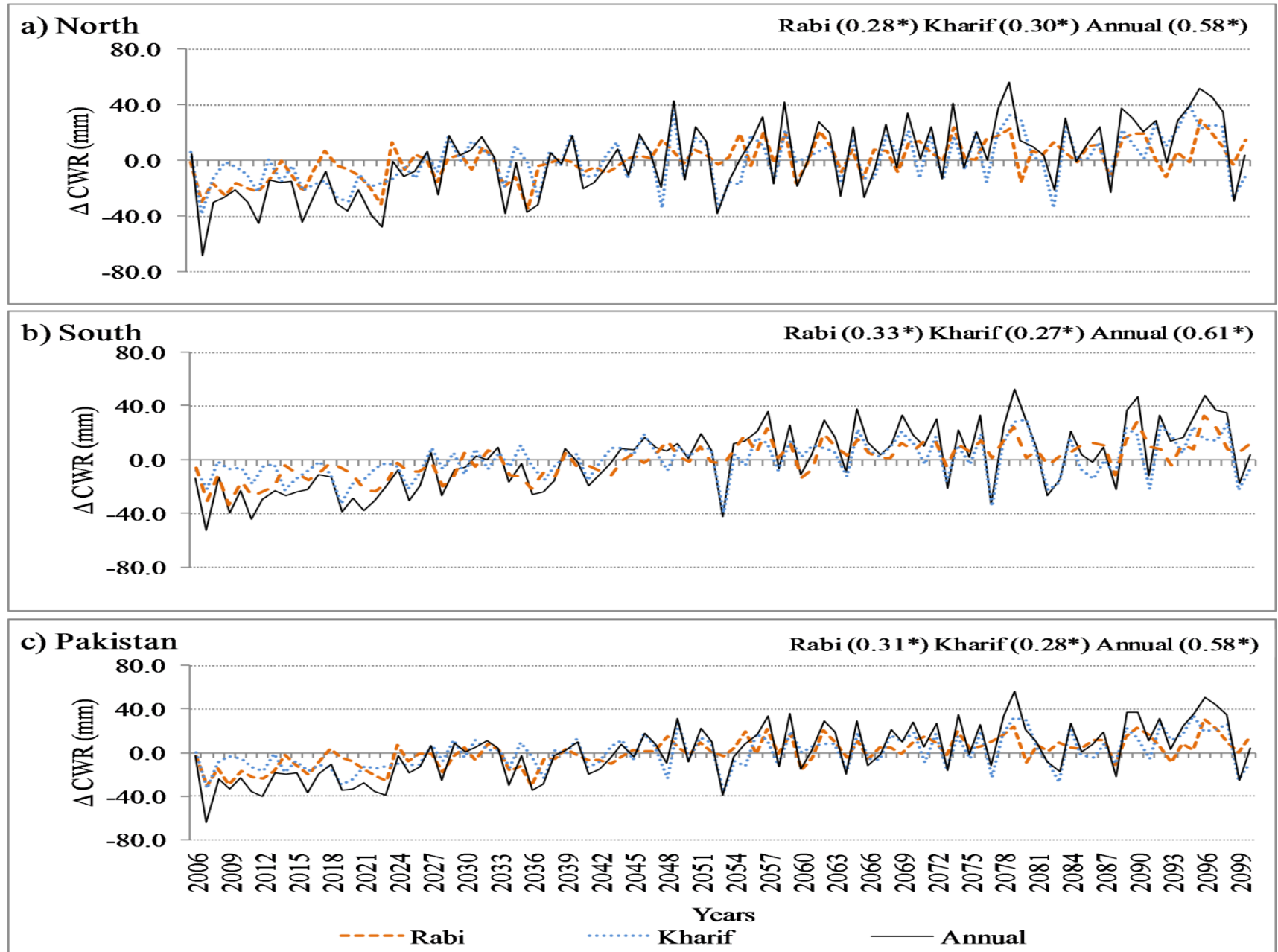
Variation and shifts in Agro-climatic zones of Pakistan under RCP 4.5 and RCP 8.5 Scenarios.

Scenarios	Time period	Agro-climatic zones			
		Extremely arid	Arid	Semi arid	Humid
RCP 4.5	2011-2040	↑	↓	no change	↓
	2041-2070	↑	↓	↑	↓
	2071-2100	↓	↓	↑	↓
RCP 8.5	2011-2040	↑	↓	no change	↓
	2041-2070	↑	↓	↑	↓
	2071-2100	↑	↓	↑	↓

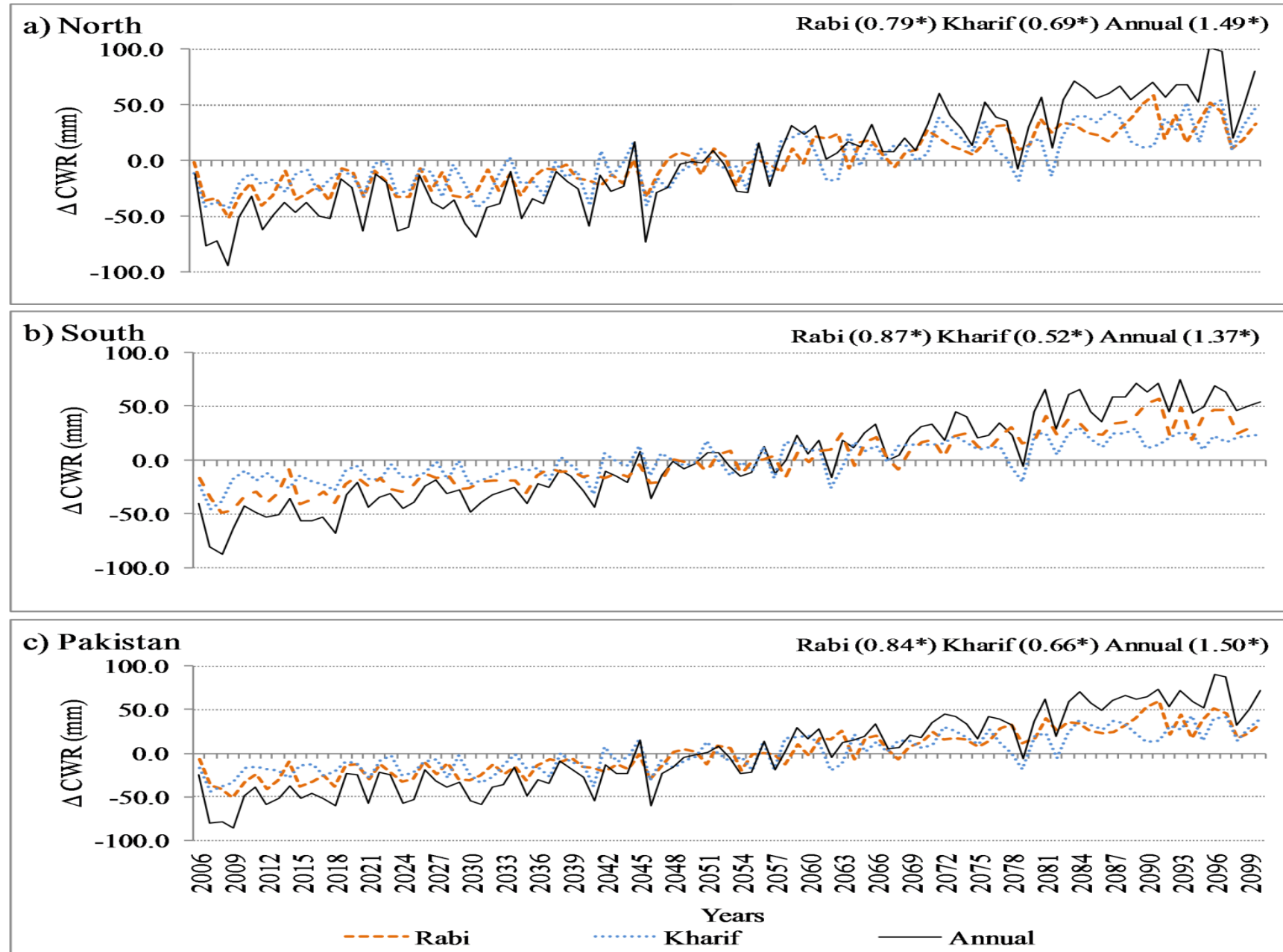
↑ : Increase ; ↓ : Decrease



Trends of crop water requirement (mm) over Pakistan during (2011-2100) under RCP4.5. (*) represents the slope is statistically significant at 95% confidence level.



Trends of crop water requirement (mm) over Pakistan during (2011-2100) under RCP8.5. (*) represents the slope is statistically significant at 95% confidence level.



Future Projection Seasonal Crop Water Requirement for 21st Century

Rabi Season (Oct-Apr)

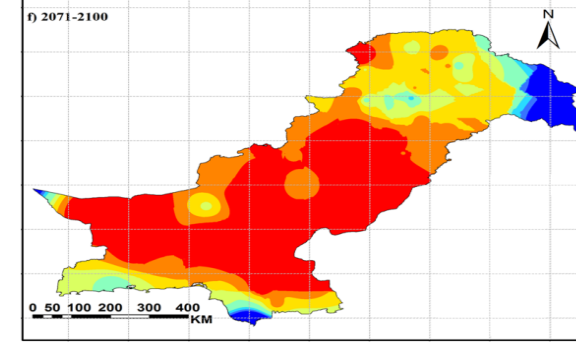
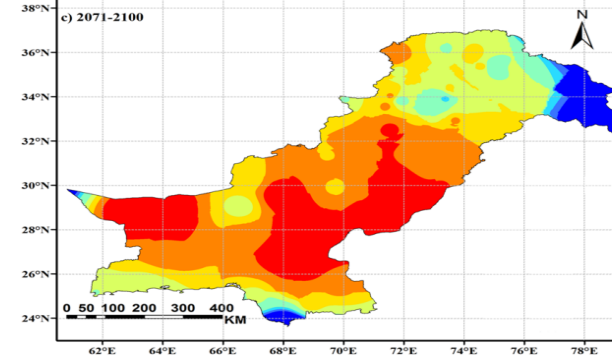
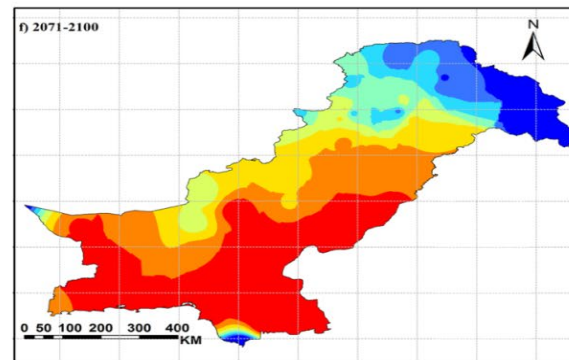
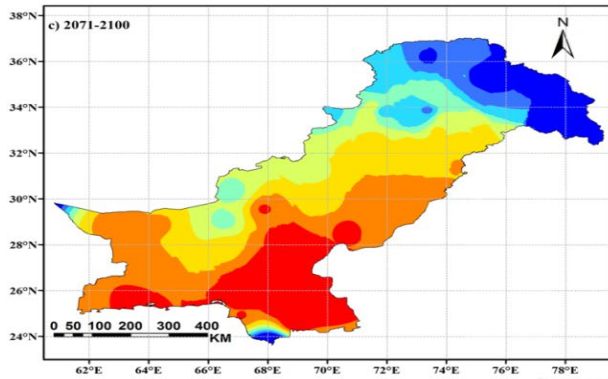
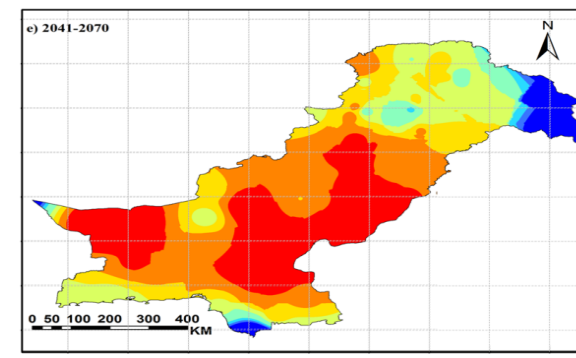
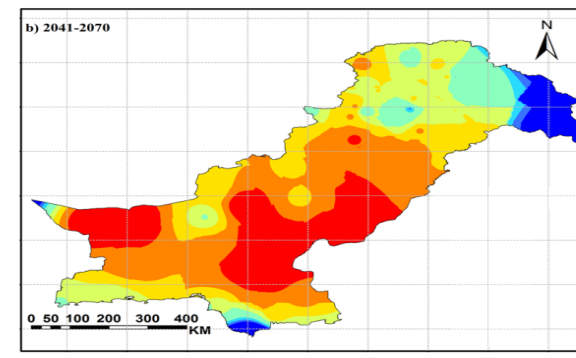
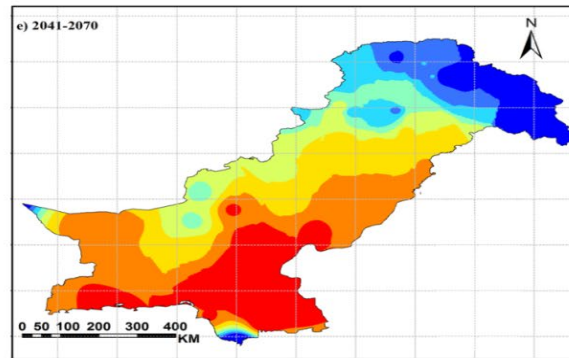
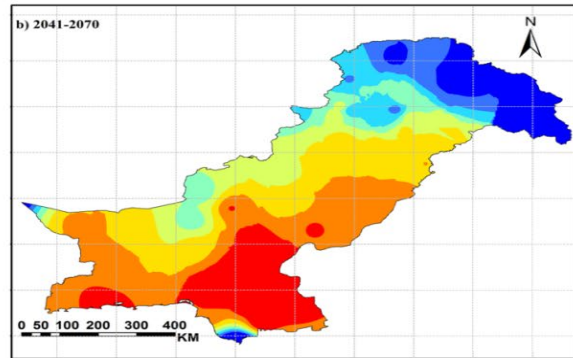
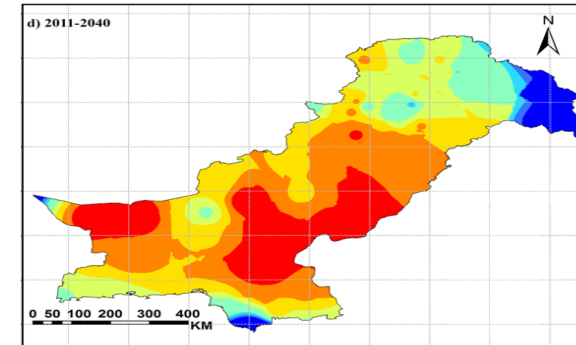
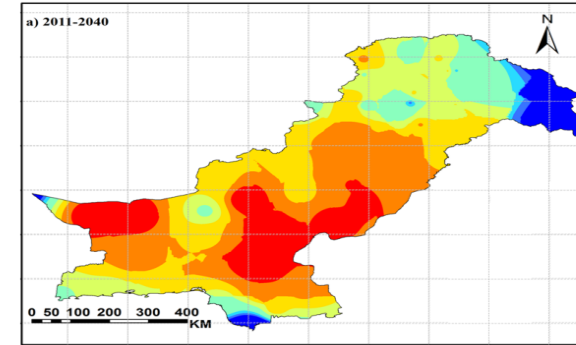
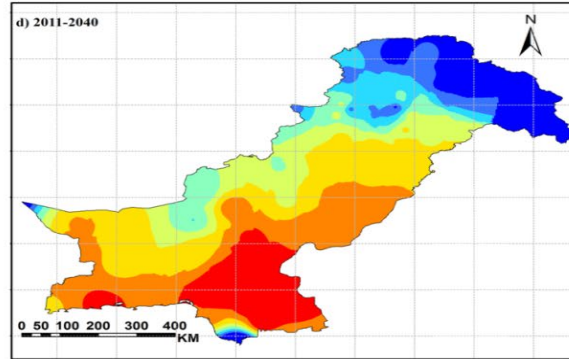
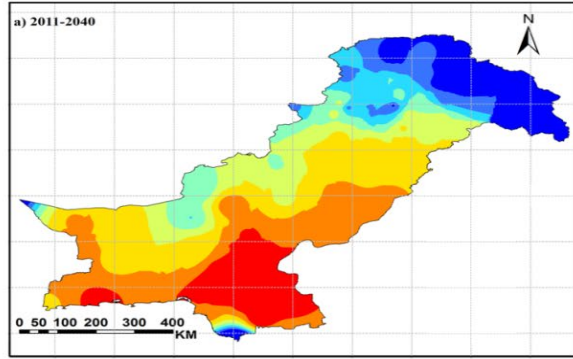
Kharif Season (May-Sep)

RCP 4.5

RCP 8.5

RCP 4.5

RCP 8.5



Crop Water Requirement (mm)



Crop Water Requirement (mm)



Trends of monthly, seasonal and annual CWR in Pakistan during (2011-2100) under RCP 4.5.

Months/Season	North			South			Pakistan		
	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100
Jan	-0.01	-0.01	-0.07	0.03	0.05	-0.03	0.02	0.00	-0.05
Feb	0.07	0.11	-0.08	0.05	0.11	-0.02	0.08	0.14	-0.06
Mar	-0.11	0.01	0.08	-0.11	0.08	0.07	-0.10	0.06	0.11
Apr	0.08	-0.04	-0.01	0.09	0.02	0.08	0.07	-0.03	0.04
May	0.05	-0.03	-0.07	0.07	-0.02	-0.05	0.05	-0.02	-0.06
Jun	0.09	-0.02	0.10	0.00	-0.04	0.02	0.05	-0.03	0.07
Jul	0.18	0.07	0.09	0.11	0.01	0.15	0.17	0.05	0.09
Aug	0.24	0.12	0.16	0.17	0.14	0.10	0.24	0.14	0.09
Sep	0.15	0.12	0.06	0.20	0.22	0.09	0.18	0.15	0.07
Oct	0.17	0.12	0.02	0.16	0.17	0.07	0.17	0.14	0.03
Nov	0.09	-0.04	0.03	0.06	-0.02	0.02	0.08	-0.02	0.03
Dec	0.02	0.01	0.00	0.04	0.01	0.00	0.03	0.01	0.00
Rabi	0.41	0.26	0.04	0.43	0.37	0.06	0.42	0.32	0.08
Kharif	0.87	0.30	0.38	0.58	0.30	0.31	0.68	0.35	0.37
Annual	1.17	0.59	0.60	1.05	0.76	0.48	1.05	0.66	0.45

Bold value represents statistically significant at 95% confidence level.


Trends of monthly, seasonal and annual CWR in Pakistan during (2011-2100) under RCP 8.5.

Months/ Season	North			South			Pakistan		
	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100	2011-2040	2041-2070	2071-2100
Jan	0.11	0.16	0.06	0.07	0.25	0.07	0.09	0.20	0.06
Feb	0.07	0.04	0.05	0.13	0.01	0.14	0.08	0.03	0.10
Mar	0.23	0.34	0.03	0.27	0.30	0.09	0.25	0.32	0.07
Apr	0.01	0.22	0.09	0.04	0.15	0.21	0.02	0.17	0.15
May	0.00	-0.09	0.01	0.05	-0.01	0.05	0.01	-0.04	0.02
Jun	0.06	-0.02	0.13	0.18	0.10	0.10	0.10	0.02	0.14
Jul	0.07	0.35	0.31	0.05	0.19	0.03	0.06	0.28	0.19
Aug	-0.04	0.56	0.35	0.12	0.23	0.11	0.05	0.45	0.27
Sep	-0.07	0.24	0.10	0.07	0.04	0.08	0.00	0.15	0.08
Oct	-0.01	0.09	0.20	0.09	0.02	0.19	0.05	0.07	0.18
Nov	0.00	0.09	0.10	0.01	0.11	0.14	0.00	0.10	0.12
Dec	0.05	0.07	0.03	0.05	0.10	0.03	0.05	0.09	0.02
Rabi	0.41	1.03	0.63	0.71	0.97	0.94	0.58	1.01	0.75
Kharif	0.09	0.97	0.79	0.45	0.59	0.25	0.25	0.75	0.64
Annual	0.51	1.74	1.47	1.09	1.50	1.22	0.72	1.76	1.41

Bold value represents statistically significant at 95% confidence level.

Impacts based Recommendations

- For Gilgit-Baltistan/Azad Jammu Kashmir regions, winters are becoming shorter and may continue to follow the trend that may enhance snow/glaciers melting and cause flash/riverine floods/GLOF events more frequently. Establishment of Early Warning Systems are proposed for this region.
- For Khyber Pakhtunkhwa as mean maximum temperatures are increasing so forestation/plantation is recommended
- For Balochistan, evaporative demands are increasing. Hence, additional irrigation infrastructure, restoration of Kareez system and water resources along with climate smart agriculture are proposed.
- For Punjab, Increasing trend in the mean minimum temperature indices may cause implications for food and agriculture sectors in the Punjab province. Sowing of climate resilient varieties of seeds are proposed.
- For Sindh, Heat waves have claimed lives besides bringing extreme distress among the masses so urban planning is needed.



Thank you!
Question?

Save Water – Save Earth.