

# Twenty First Century Climate Extremes Projection and Climate Vulnerability Risk Assessment in Homogeneous Climatic Zones using high Resolution Climate Data

Firdos KHAN

School of Natural Sciences, National University of Science and Technology, Islamabad  
*firdos.khan@sns.nust.edu.pkt, fkyousafzai@gmail.com*

Jürgen Pilz, Shaukat Ali, Sher Muhammad

May 5, 2020



# Overview

- 1 Introduction
- 2 Data and Target Location
- 3 Methodology
- 4 Climate Extremes Projections
  - Probability Density Functions
  - Spatio-temporal Trend Analysis
  - Climate Extremes, their Magnitude and Statistical Significance Analysis
- 5 Summary and Recommendations
- 6 Collaborative Research with National and International institutions
- 7 Q & A Session

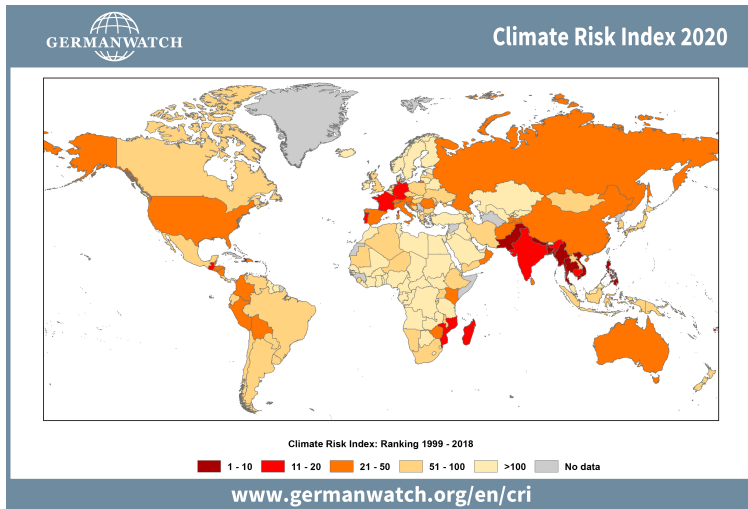


Figure 1: Climate risk index for 2020 where Pakistan is ranked at 5<sup>th</sup> position.

# Introduction: Motivation

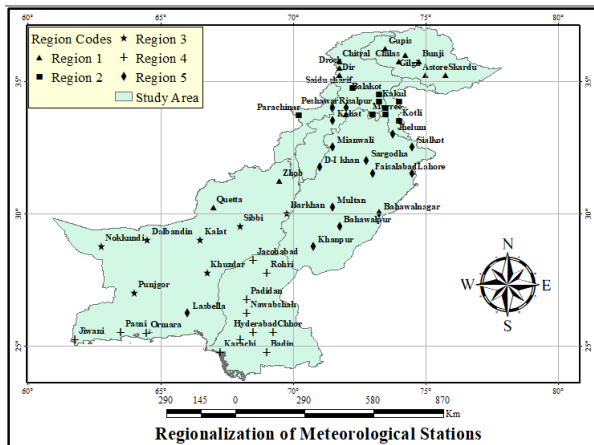


Figure 2: Five homogeneous climate regions (Ullah et al., 2020)<sup>1</sup>

<sup>1</sup> Ullah, H.; Akbar, M.; Khan, F. (2020) Construction of homogeneous climatic regions by combining cluster analysis and L-moment approach on the basis of Reconnaissance Drought Index for Pakistan. *Int. J. Climatol.* Vol. 40(1), Pp.324-341.

# Introduction: Objectives of this study

- Projection of climate extremes in the homogeneous climatic regions under the RCP4.5 and RCP8.5 for selected GCM(s)
- Spatio-temporal trend analysis of projected climate extremes
- Statistical significance analysis of projected climate extremes

## Two types of data have used

- Observed data for the duration of 1976-2005
- Fourteen GCMs outputs where each was divided into four independent chunks

Reference duration: 1976-2005

Future one (F1): 2011-2040

Future two (F2): 2041-2070

Future three (F3): 2071-2100

The target location of this study is Pakistan and divided into five homogeneous climate zone presented in Figure 2.

# Methods: Theoretical framework

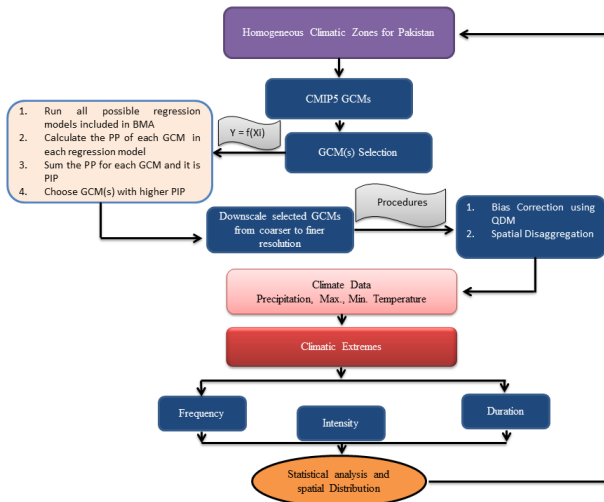


Figure 3: Schematic representation of methodology.

# Results: PDF of climate extremes

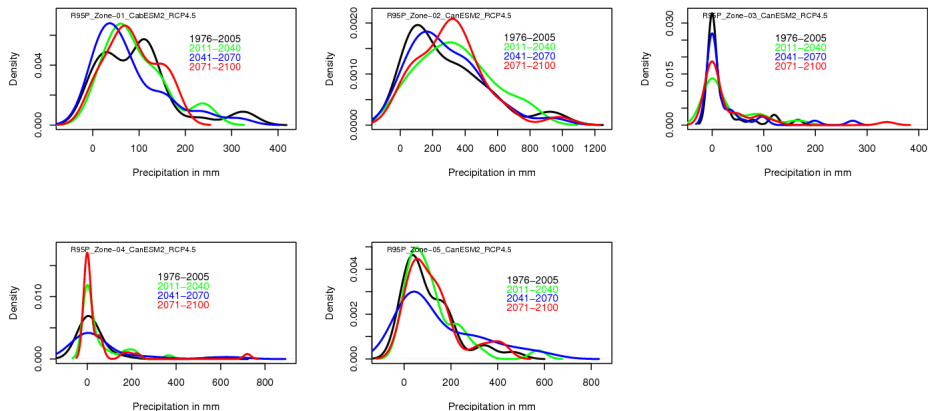


Figure 4: R95P for CanESM2 under the RCP4.5.



# Results: PDF of climate extremes

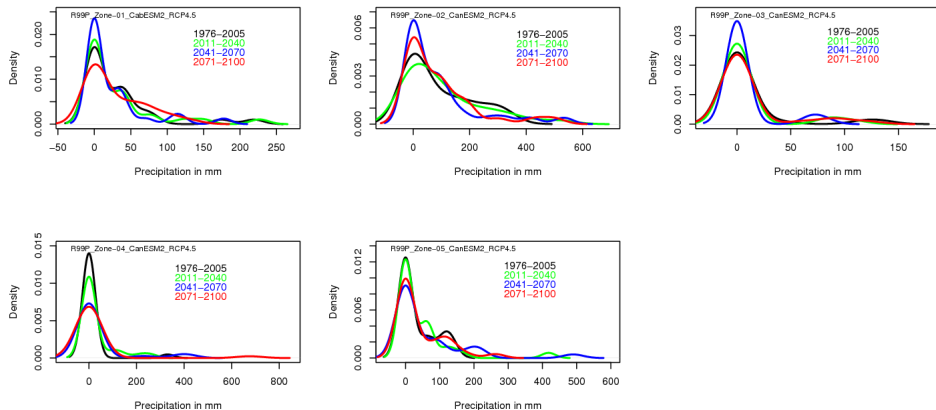


Figure 5: R99P for CanESM2 under the RCP4.5.

# Results: PDF of climate extremes

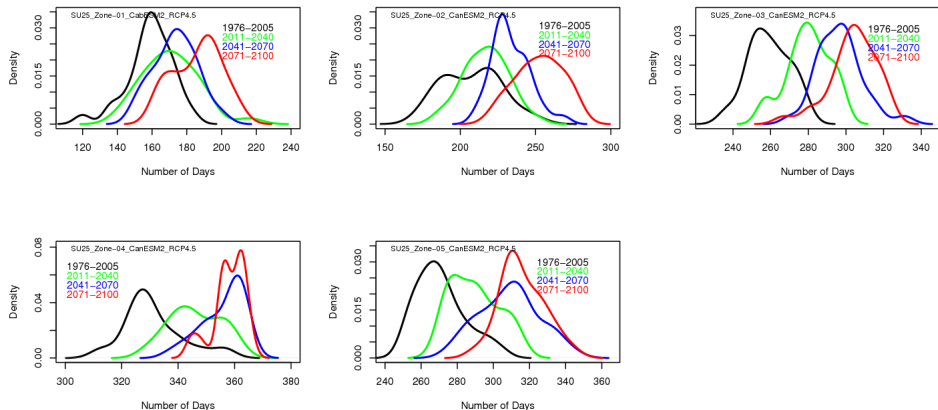


Figure 6: SU25 for CanESM2 under the RCP4.5.

# Results: PDF of climate extremes

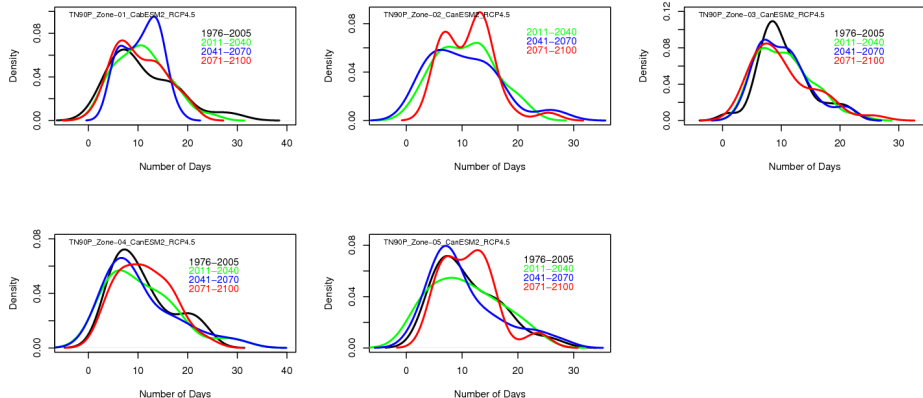


Figure 7: TN90P for CanESM2 under the RCP4.5.

# Results: PDF of climate extremes

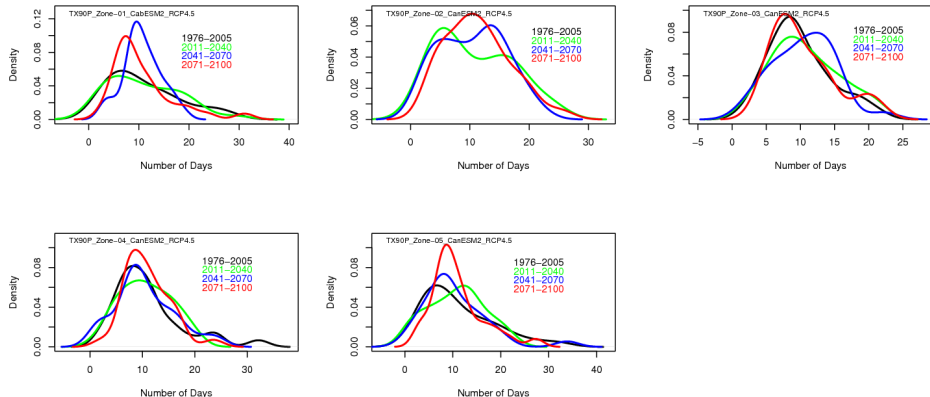


Figure 8: TX90P for CanESM2 under the RCP4.5.

# Results: Spatio-temporal trends analysis

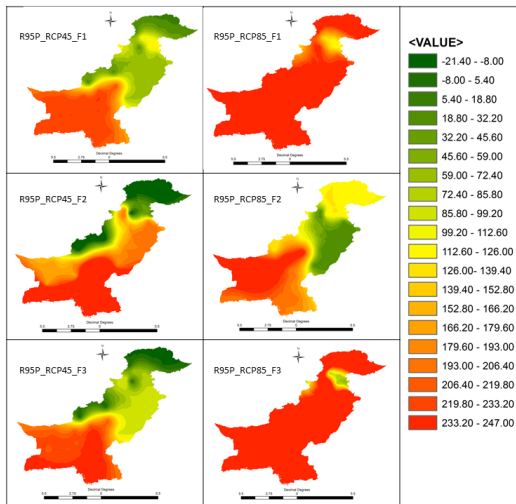


Figure 9: R95P percent Changes for CanESM2 under the RCP4.5 and RCP8.5.

# Results: Spatio-temporal trends analysis

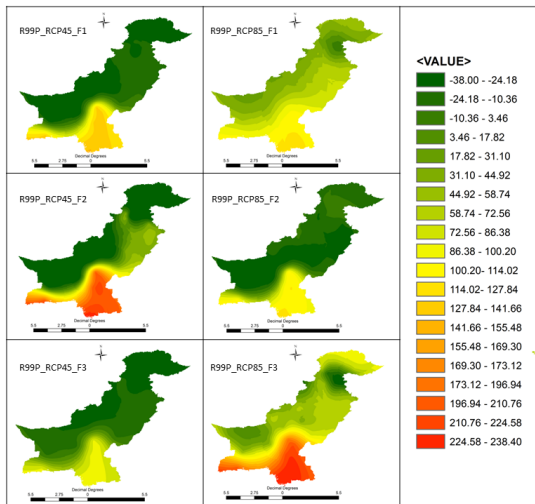


Figure 10: R99P percent Changes for CanESM2 under the RCP4.5 and RCP8.5.

# Results: Spatio-temporal trends analysis

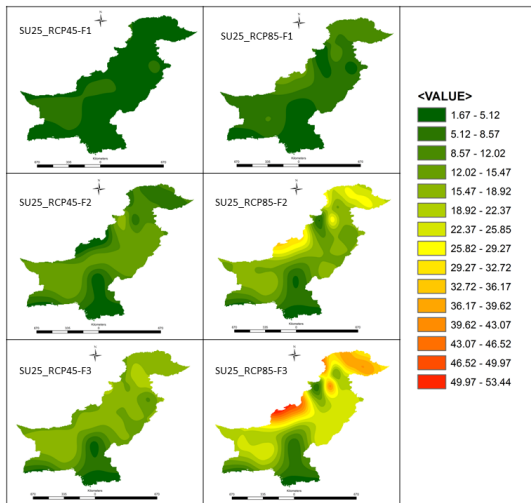


Figure 11: SU25 percent Changes for CanESM2 under the RCP4.5 and RCP8.5.

# Results: Spatio-temporal trends analysis

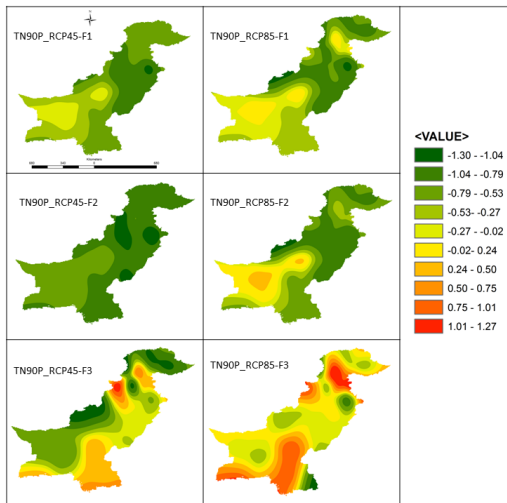


Figure 12: TN90P percent Changes for CanESM2 under the RCP4.5 and RCP8.5.



# Results: Spatio-temporal trends analysis

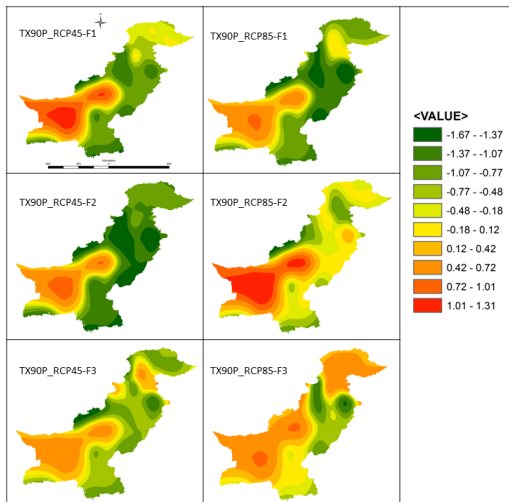
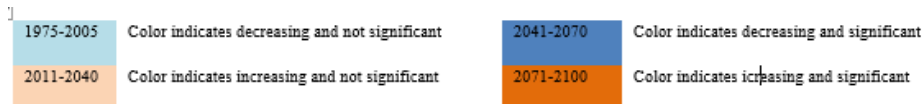


Figure 13: TX90P percent Changes for CanESM2 under the RCP4.5 and RCP8.5.

# Results: Climate Extremes and their Statistical Significance



1975-2005	Color indicates decreasing and not significant	2041-2070	Color indicates decreasing and significant
2011-2040	Color indicates increasing and not significant	2071-2100	Color indicates increasing and significant

**Figure 14:** Definitions of four squares and colors of climate extremes presented in Figures 15-18. The four square represent different time duration and color shows status of each climate extreme. Light color show decrease/increase while deep color shows significant decrease/increase in climate extremes. Where green color shows no changes in climate extremes. Statistical significance of extremes events were tested at 5 perecent level of significance.

# Results: Climate Extremes and their Statistical Significance

Zone/Variable		Precipitations' Extremes for RCP4.5																
	Model/ Indices	DTR	FD0	GSL	ID0	SU2 5	T M A X m e a n	T M L N e m e a n	TN10 P	TN9 0P	TNN	TN X	TR2 0	TX10 P	TX9 0P	TX N	TXX	
Z1	CMCC-CMS																	
	EC-EARTH																	
Z2	CMCC-CMS																	
	FGOALS-s2																	
Z3	EC-EARTH																	
	GFDL-ESM-2M																	
Z4	MPI-ESM-LR																	
	MIROC-ESM-CHEM																	
Z5	canESM2																	
	CCSM4																	

Figure 15: Temperature extremes and their statistical significance under the RCP4.5

# Results: Climate Extremes and their Statistical Significance

Zone/Variable		Precipitations' Extremes for RCP4.5											
	Model/ Indices	RX1day	Rx5day	SDII	R10	R20	CDD	CWD	R95p	R99p	PRCPTOT		
Z1	CMCC-CMS												
	EC-EARTH												
Z2	canESM2												
	FGOALS-g2												
Z3	EC-EARTH												
	GFDL-ESM-2M												
Z4	MPI-ESM-LR												
	MIROC-ESM-CHEM												
Z5	canESM2												
	CCSM4												

Figure 16: Precipitation extremes and their statistical significance under the RCP4.5

# Results: Climate Extremes and their Statistical Significance

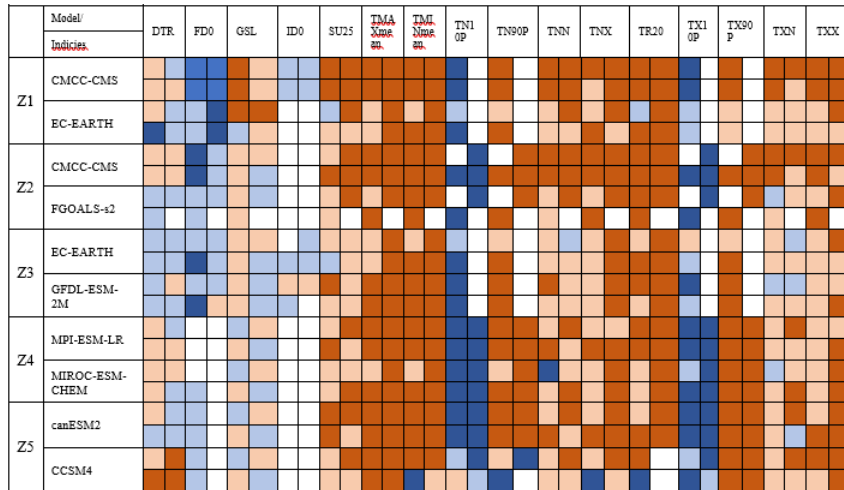


Figure 17: Temperature extremes and their statistical significance under the RCP8.5

# Results: Climate Extremes and their Statistical Significance

Zone/Model		Precipitations' Extremes for RCP8.5											
	Model/ Indices	RX1day	Rx5day	SDII	R10	R20	CDD	CWD	R95p	R99p	PRCPTOT		
Z1	CMCC-CMS												
	EC-EARTH												
Z2	canESM2												
	CMCC-CMS												
Z3	EC-EARTH												
	GFDL-ESM-2M												
Z4	MPI-ESM-LR												
	MIROC-ESM-CHEM												
Z5	canESM2												
	CCSM4												

Figure 18: Precipitation extremes and their statistical significance under the RCP8.5

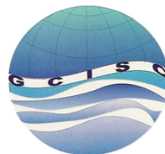
# Summary & Recommendations

- TN10P and TX10P have decreasing trends while TN90P and TX90P have increasing trends in future across Pakistan under RCP4.5 and RCP8.5 scenarios.
- The number of summer days (SU25) and frost days (FD0) are increasing and decreasing, respectively, in the country under both scenarios.
- TMAXmean and TMINmean are increasing in all climate regions for both climate change scenarios.
- R95P, R99P have mixed trend, however, it is increasing during future while PRCPTOT has mixed trend in different climate zones.
- Further analysis required to investigate the impacts of projected climate extremes on agriculture production in zone-5, water availability in zone-1, drought situation in zone-3 and zone-4, climate extremes and Monsoon phenomena in zone-2.

# Collaborative Research with National and International institutions



Asian Development Bank





# Questions and Answers

Thank you!