

**Increasing Drought Risks over the Past Four Centuries
amidst Projected Flood Intensification in the Kabul River
Basin (Afghanistan and Pakistan)—Evidence from Tree
Rings**

Nasrullah Khan¹, Hung T. T. Nguyen², Stefano Galelli^{2,3}, and Paolo Cherubini^{2,4,5}

¹Department of Botany, University of Malakand, Chakdara Dir Lower (P.O. Box 18800), Khyber Pakhtunkhwa Pakistan

²Tree Ring Laboratory, Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York, USA

³Pillar of Engineering Systems and Design, Singapore University of Technology and Design, Singapore

⁴WSL Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf Switzerland

⁵Faculty of Forestry, University of British Columbia, Vancouver BC, Canada

Contents of this file

Figures S1 to S6

Tables S1 to S5

Introduction

Figures S1 to S6 provide additional results complementing those presented in the main text. Tables S1 to S5 provides additional details about the chronologies and reconstruction skills.

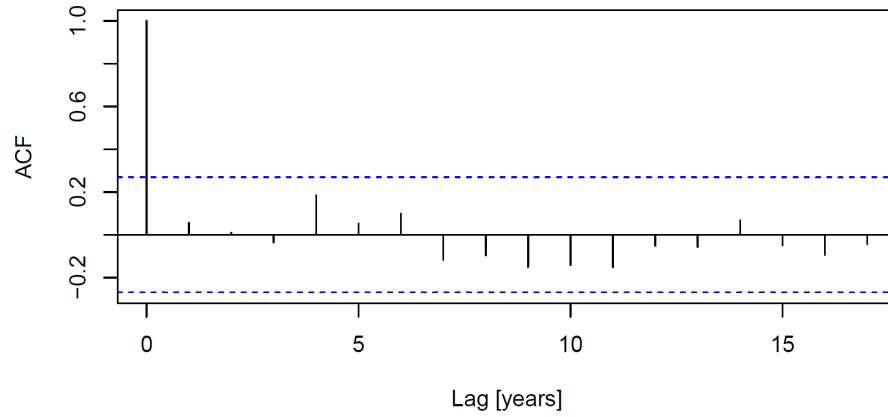


Figure S1. The autocorrelation function of the instrumental precipitation time series at Chitral.

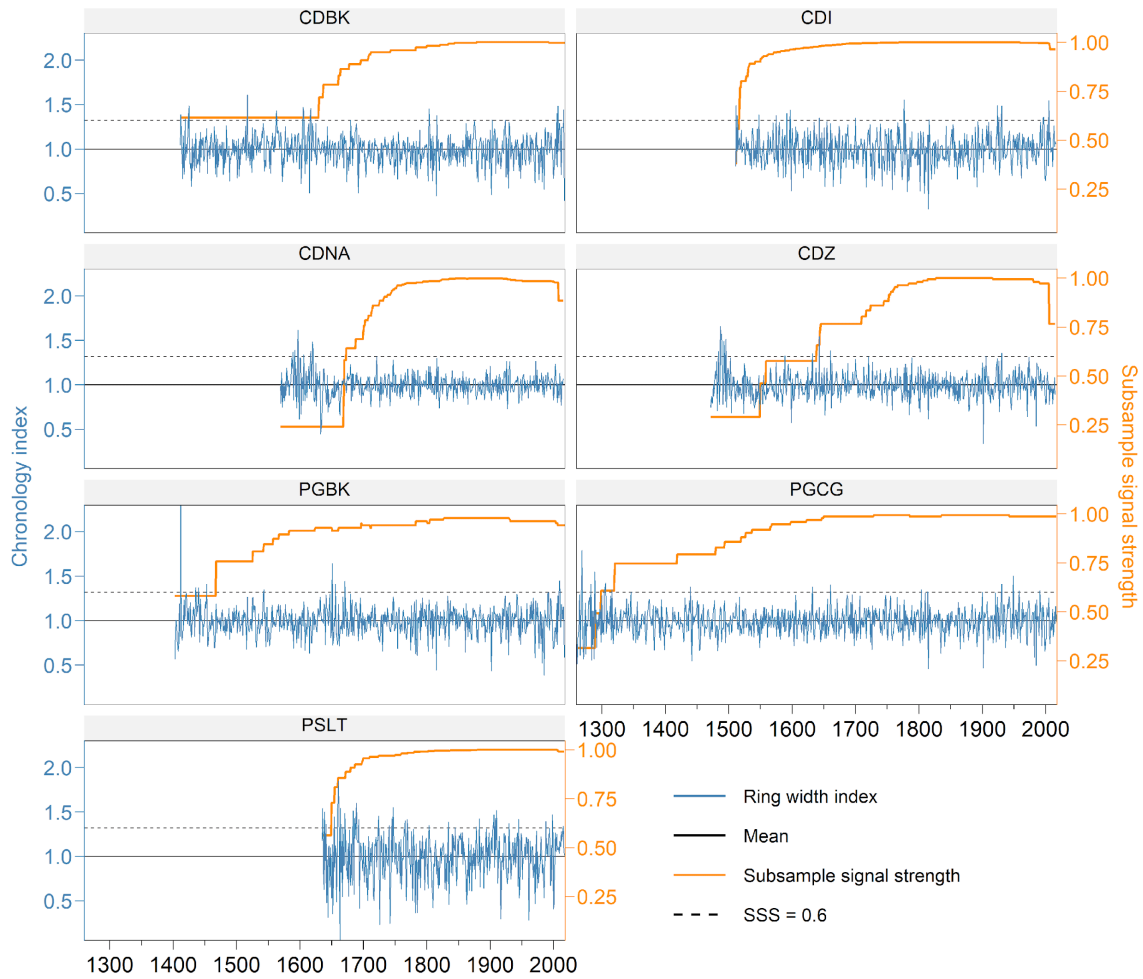


Figure S2. Time series of the seven chronologies used in this study and their subsample signal strength (SSS).

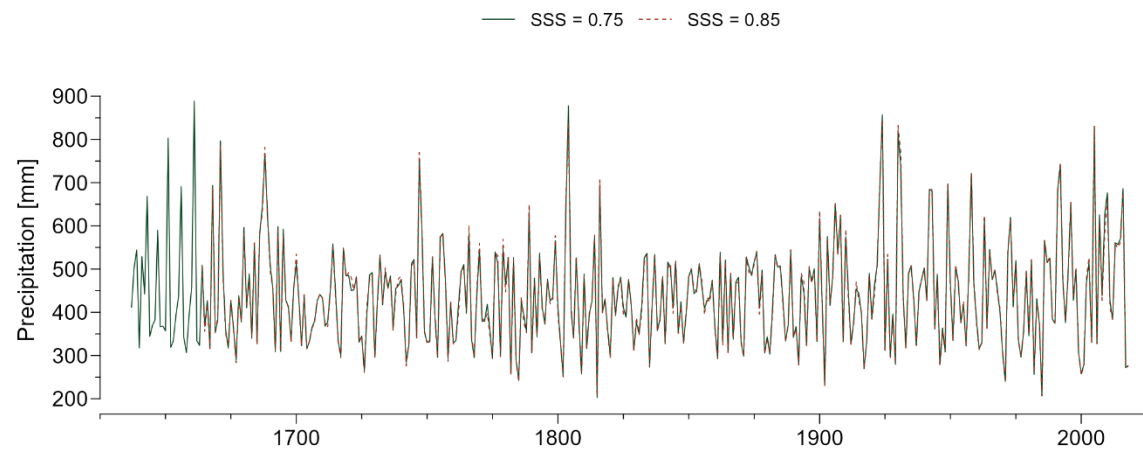


Figure S3. Comparison of reconstructions using SSS cutoff values of 0.75, and 0.85.

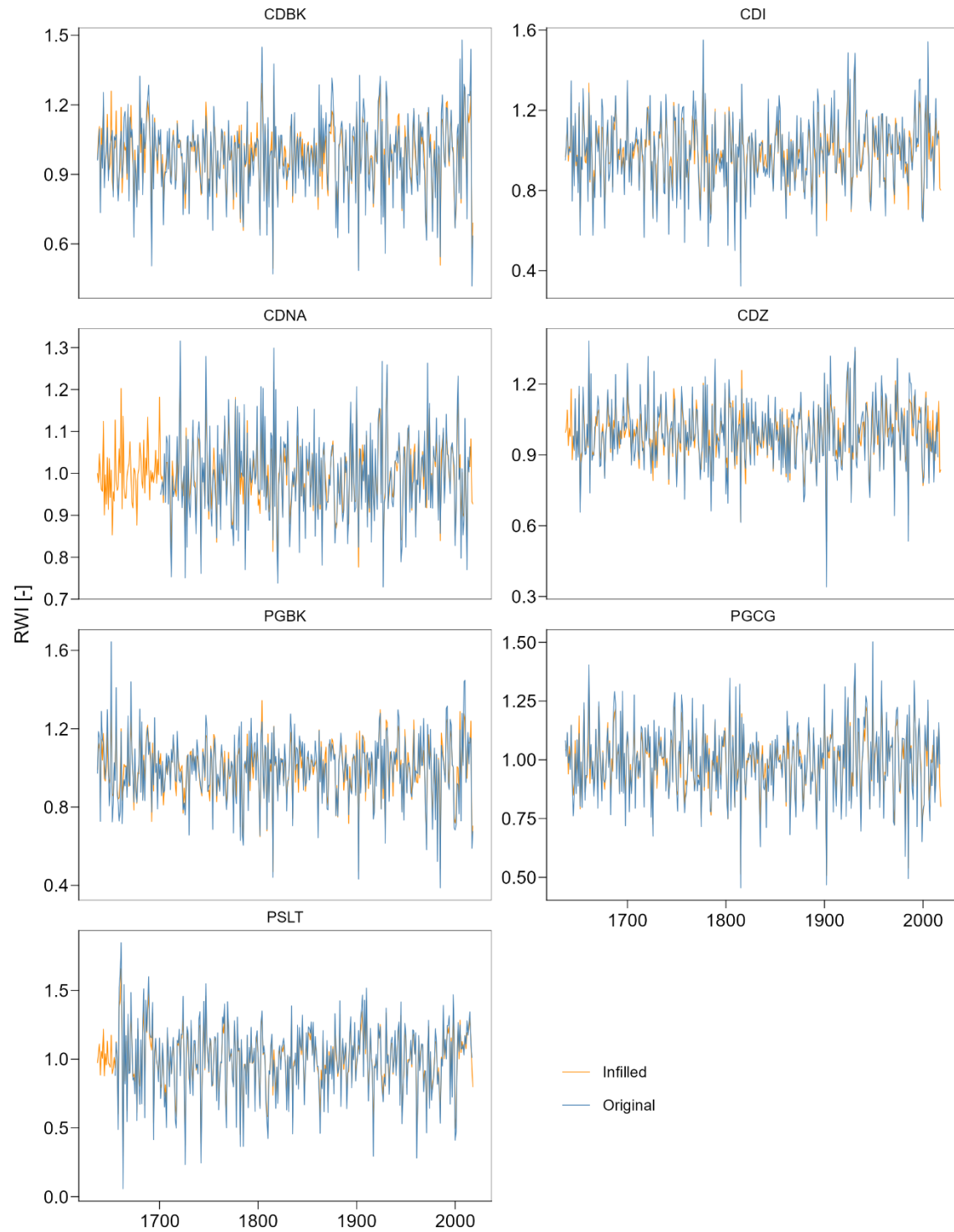


Figure S4. Comparison of infilled and original tree ring time series.

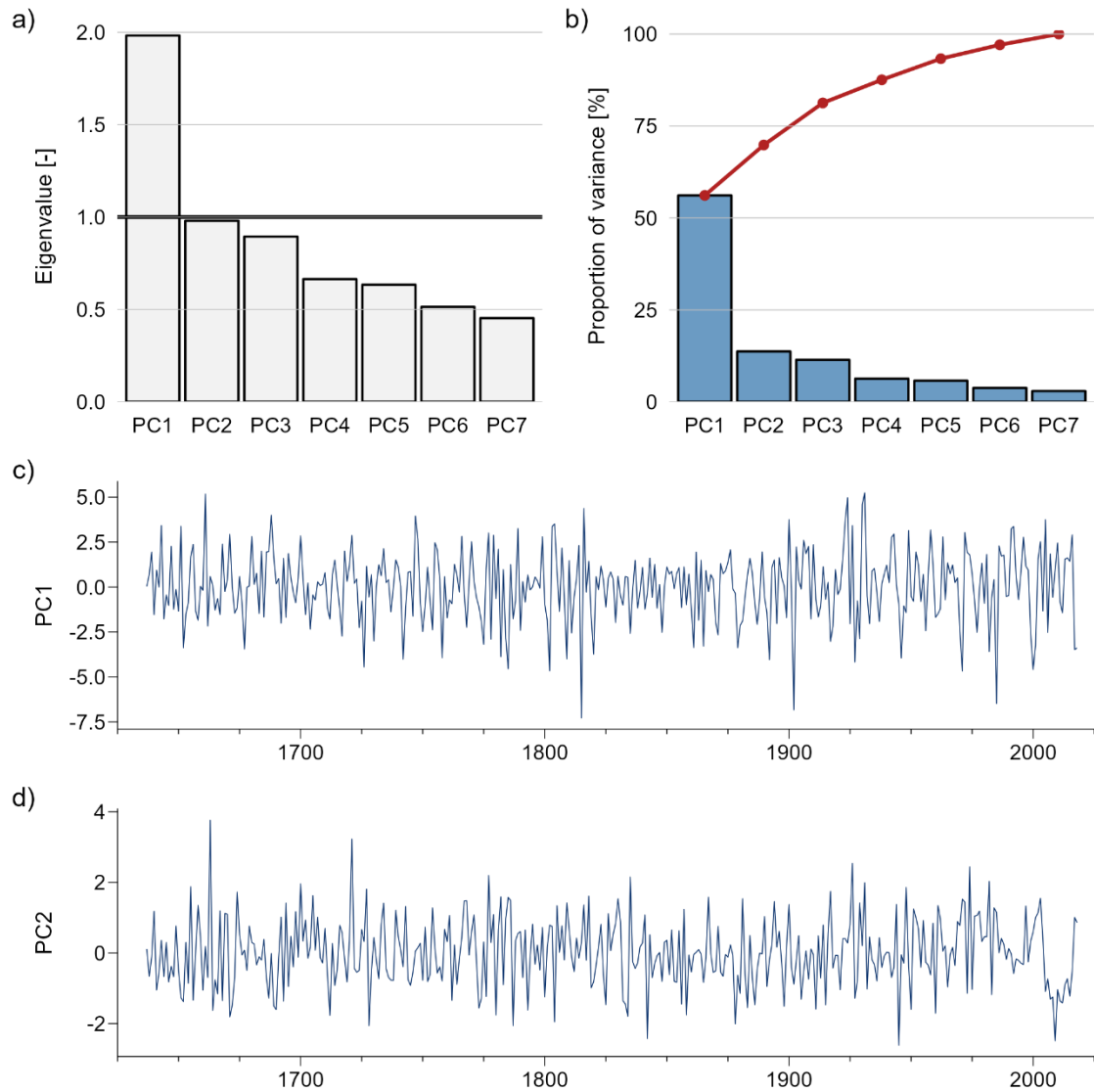


Figure S5. Principal component analysis results. a) Eigenvalue of each principal component (PC). b) Proportion of total variance explained by each PC (blue bars) and cumulative proportion of variance (red line). c) Time series of PC1. d) Time series of PC2.

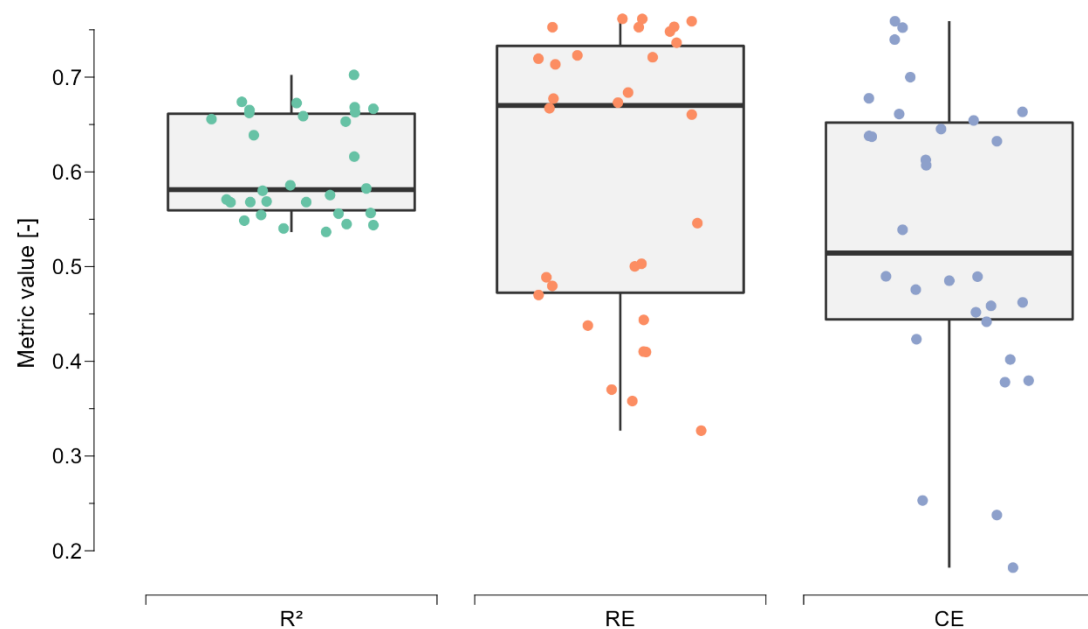


Figure S6. Distributions of performance metrics across 30 cross-validation runs. The jitter dots show the scores of each metric in each run, and the box plots show the spread of the scores.

Table S1. Geographical details of tree ring sites.

Locations	Species	Chronology	Latitude (N°)	Longitude (E°)	Elevation (m)
Islambiky	Cedrus deodara	CDI	35.40984	71.94037	2834
Bumburet Kalash	Cedrus deodara	CDBK	35.68119	71.62434	2815
Ziarat	Cedrus deodara	CDZ	35.36239	71.79461	2937
Nuristan Afghanistan	Cedrus deodara	CDNA	35.382	71.32481	2480
Chitral Gol	Pinus gerardiana	PGCG	35.90379	71.74668	2931
Bumburet Kalash	Pinus gerardiana	PGBK	35.68119	71.62434	2815
Lowari Top	Picea smithiana	PSLT	35.33342	71.80591	2860

Table S2. Comparison of different detrending methods. Data adaptive methods (Friedman and cubic spline) performed better than negative exponential curve fitting.

Chronology	\bar{r}		
	Friedman	Cubic spline	Negative exponential
CDBK	0.398	0.276	0.251
CDI	0.371	0.290	0.279
CDNA	0.220	0.154	0.144
CDZ	0.254	0.185	0.178
PGBK	0.361	0.291	0.268
PGCG	0.276	0.200	0.177
PSLT	0.541	0.514	0.475

Table S3. Comparison of skill scores of reconstructions using the residual versus the ARSTAN chronologies.

Chronology	R²	RE	CE
<i>Residual</i>	0.605	0.600	0.531
<i>ARSTAN</i>	0.428	0.364	0.245

Table S4. Final chronology statistics.

Chronology	Cores/trees	\bar{r}	Mean interseries correlation
CDBK	19/10	0.398	0.554
CDI	62/31	0.371	0.635
CDNA	38/19	0.220	0.495
CDZ	21/15	0.254	0.499
PGBK	19/12	0.361	0.593
PGCG	19/11	0.276	0.535
PSLT	23/23	0.541	0.686

Table S5. Comparison of skill scores of reconstructions using different SSS cutoff values.

SSS cutoff	Starting year	R²	RE	CE
0.75	1637	0.605	0.600	0.531
0.85	1664	0.598	0.589	0.516