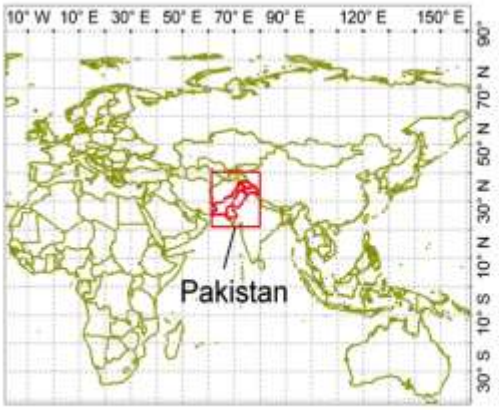
Karakoram Resources and Climate Change: Glacier, Water and Ecosystem

Snow and glacier spatial variations and the hydrological regime in Karakoram and western Himalaya (Northern Pakistan)

Dr. Adnan Ahmad Tahir
Department of Environmental Sciences
COMSATS Institute of Information Technology
Abbottabad (Pakistan)

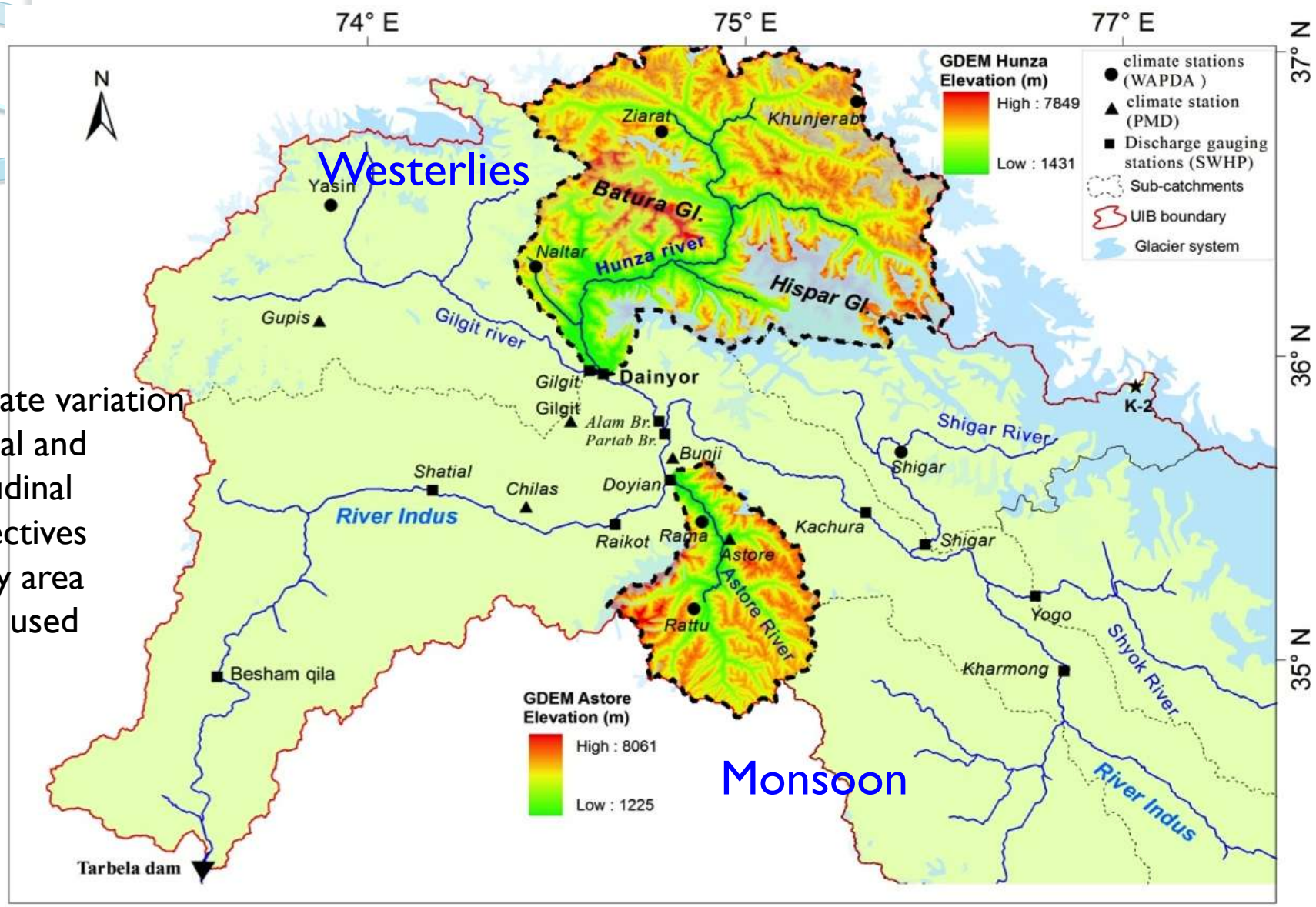
Background of this study

- Agric. Economy
- Precipitation contribution
- IBIS
- HKKH
- UIB & Tarbela (205,000 km^2)
- Altitude variation

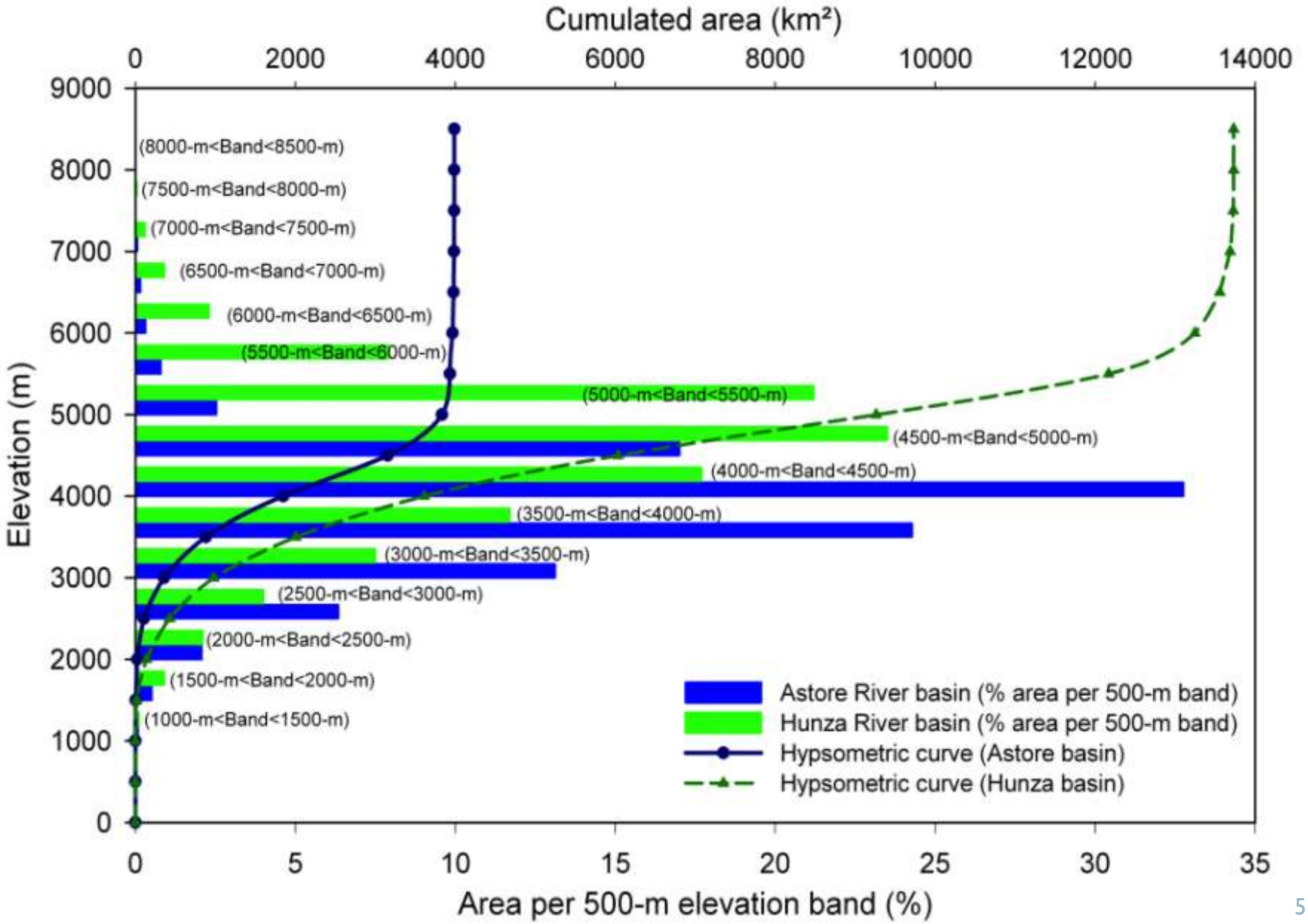


Climate and Study area

- Climate variation
- Spatial and altitudinal
- Objectives
- Study area
- Data used

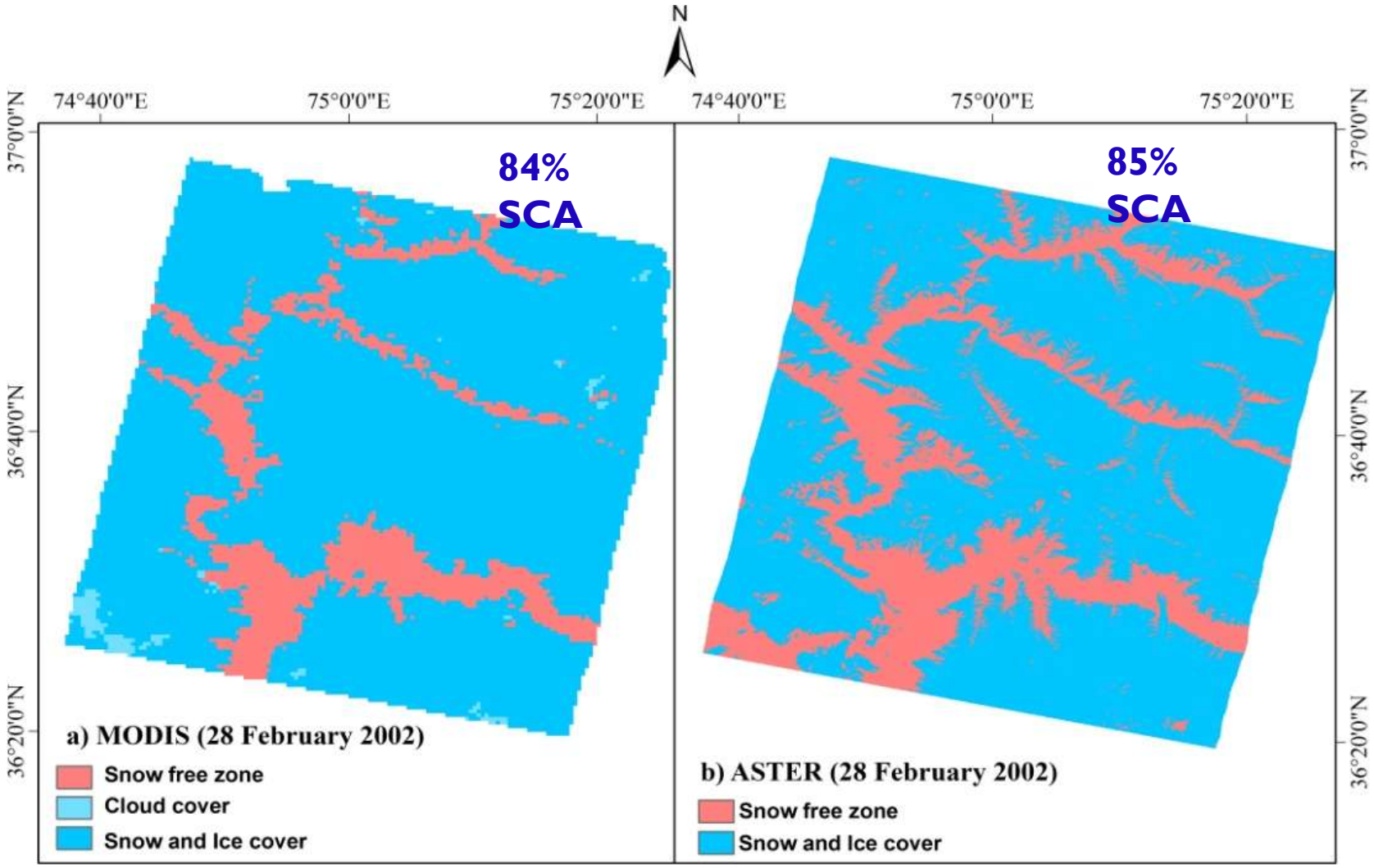


Hypsometric curves for Hunza and Astore



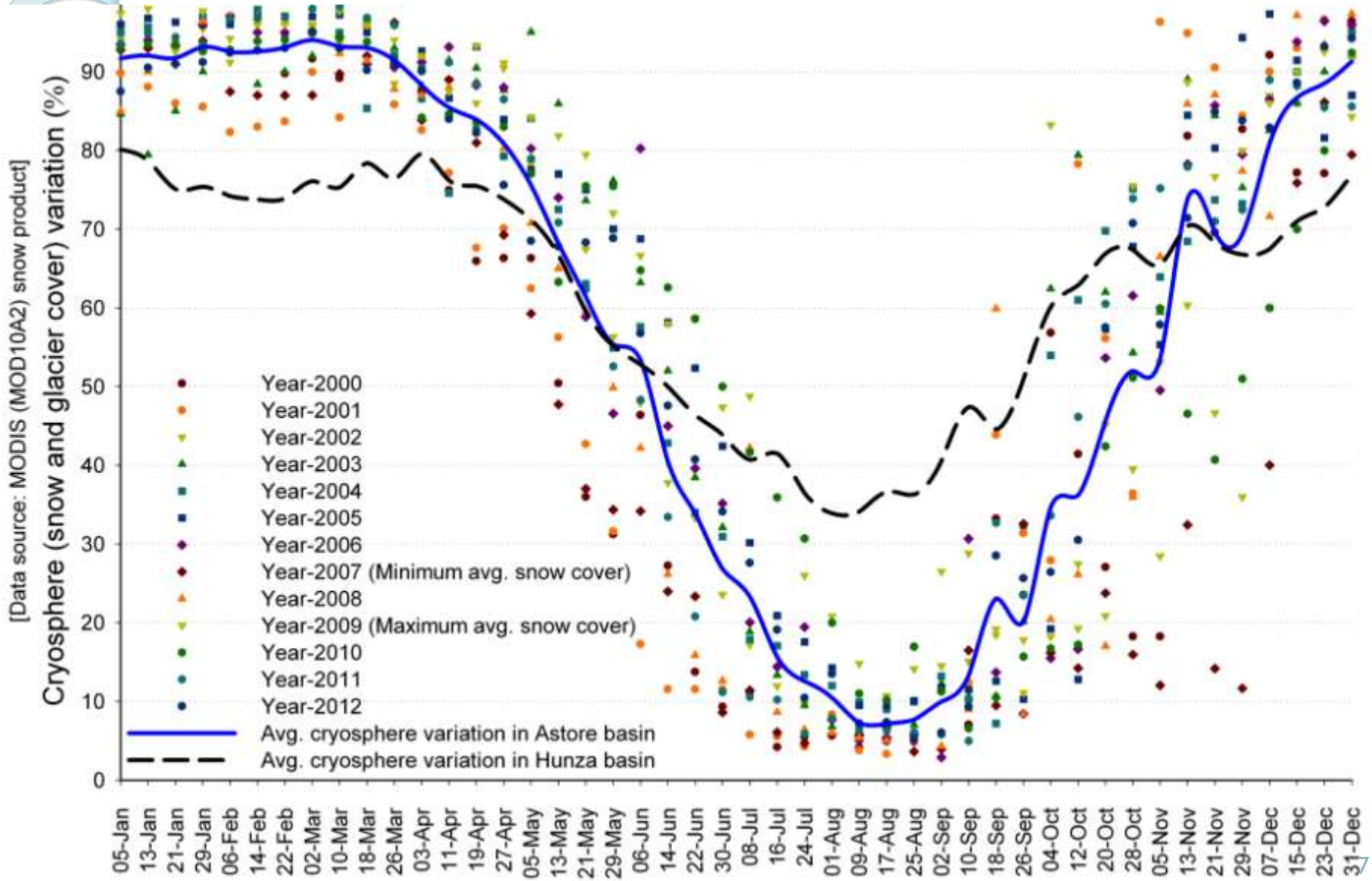
MODIS data validation with high resolution ASTER images

- Data base of MODIS
- Validation of MODIS



A comparison of ASTER and MODIS images.

Snow and glacier cover variation –
MODIS MOD10A2 images



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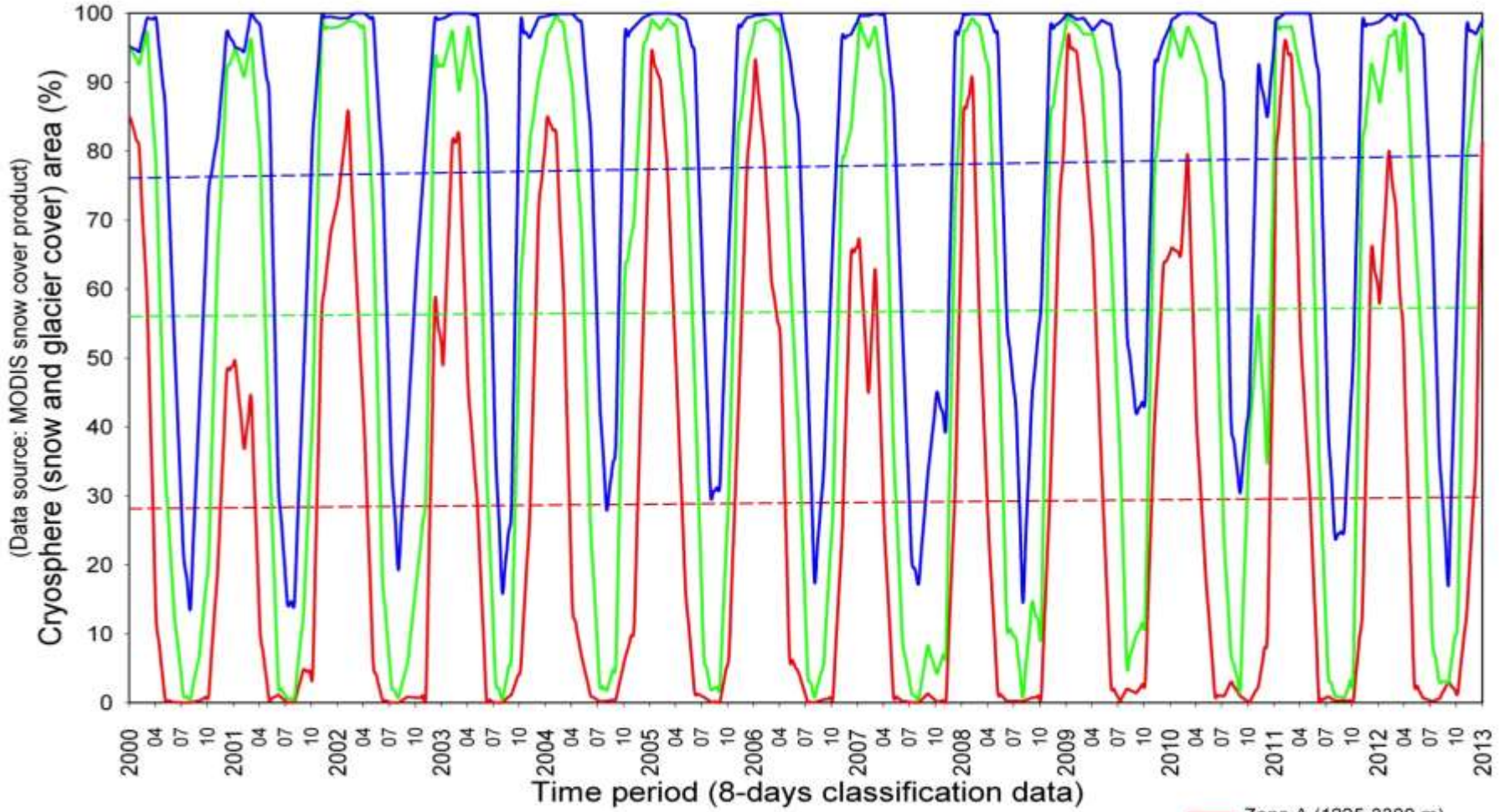
www.hydrol-earth-syst-sci.net/15/2275/2011/
doi:10.5194/hess-15-2275-2011

Hydrology and Earth System Sciences

- Snow and glacier extent
- Increasing trends at higher elevation (accumulation zone)
- No P measurements of the accumulation zone

Snow cover dynamics and hydrological regime of the Hunza River basin, Karakoram Range, Northern Pakistan

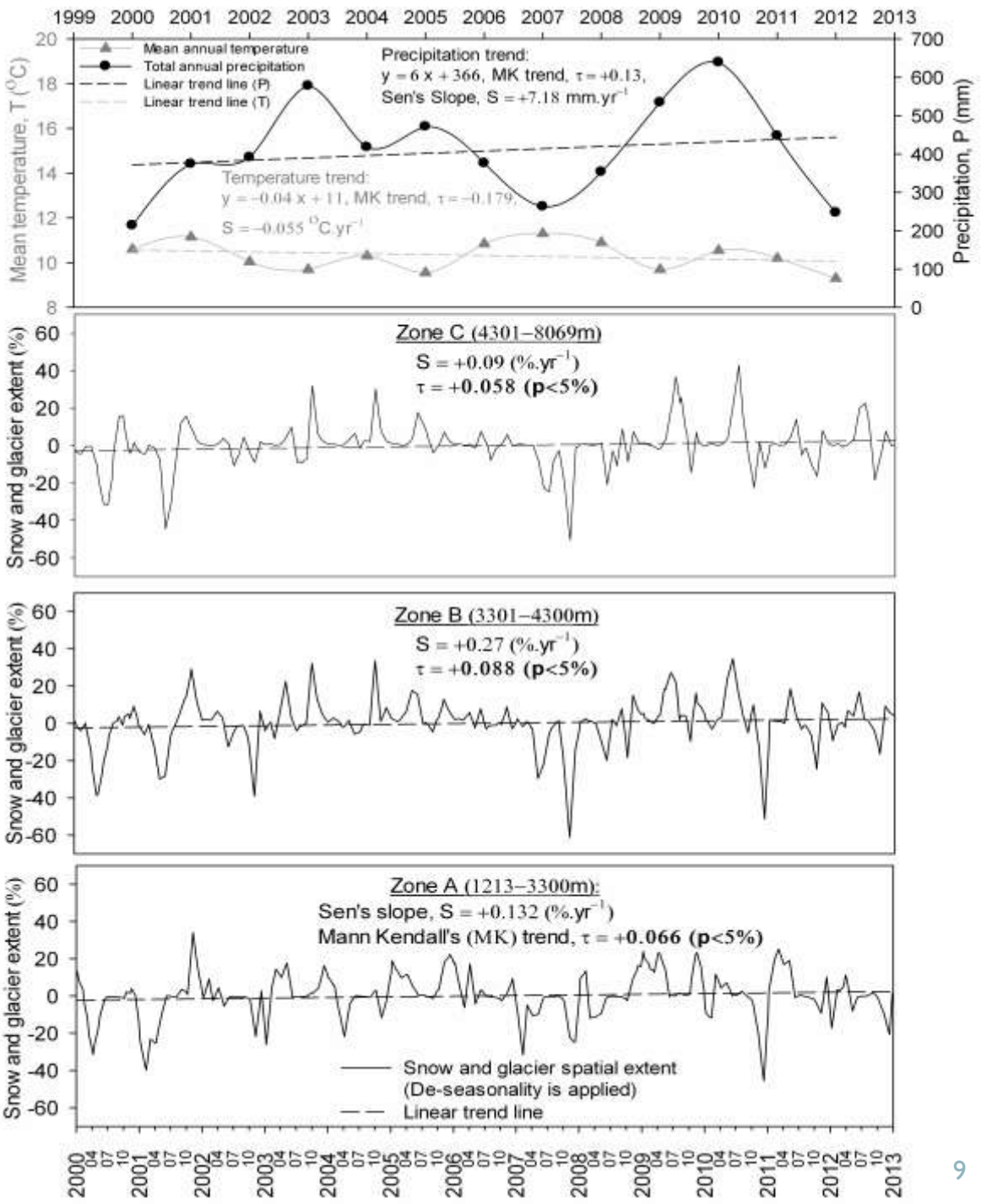


Mann Kendall's trend analysis (τ values in brakets indicate seasonal/periodic trend):
Zone A: Sen's slope = 10×10^{-5} (%/day), Kendall's tau coefficient, $\tau = 0.032$ (0.026)
Zone B: Slope = 0.1×10^{-5} (%/day), Kendall's tau coefficient, $\tau = 0.001$ (–0.011)
Zone C: Slope = 11×10^{-5} (%/day), Kendall's tau coefficient, $\tau = 0.035$ (0.027)

Snow and glacier spatial extension trend (After removing the seasonal cycles from time series)

Increasing trend in all zones over the data period

Climate trend over the same period



Seasonal climate trends in Astore basin

Linear trends in Precipitation:

Summer total precipitation (JJAS):

$y = (0.27\ x) + 86.4$

Seasonal Mann-Kendall's trend coefficient, $\tau = +0.08$

Sen's slope, $S = +0.28\ (mm.yr^{-1})$

Winter total precipitation (DJF):

$y = (0.25\ x) + 110$

Seasonal Mann-Kendall's trend coefficient, $\tau = +0.052$

Sen's slope, $S = +0.313\ (mm.yr^{-1})$

Linear Trends in Temperatures:

Summer mean temperature (JJA):

$y = (-4.9*10^{-3}\ x) + 20$

Seasonal Mann-Kendall's trend coefficient, $\tau = -0.075$

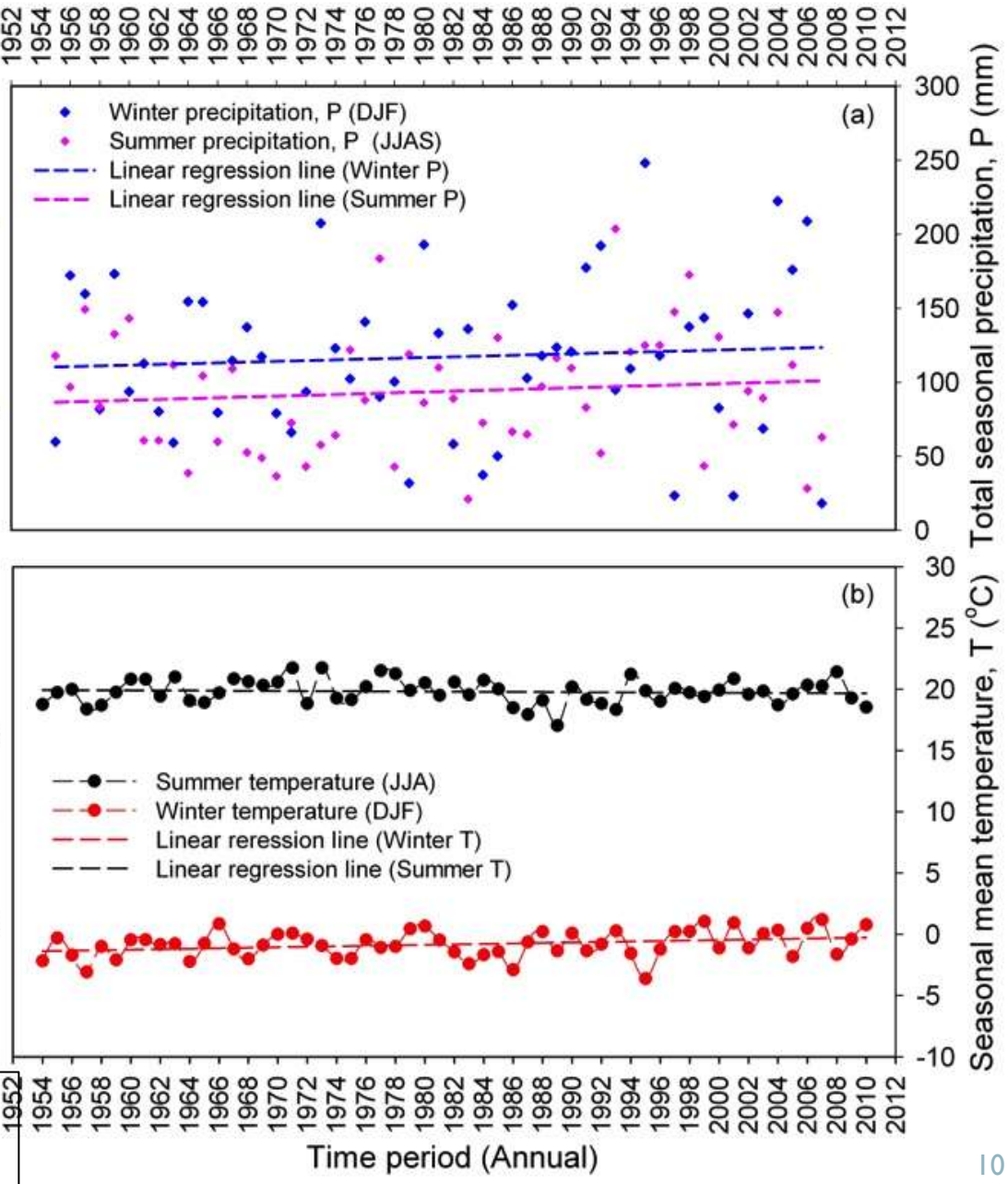
Sen's slope, $S = -0.008\ (^{o}C.yr^{-1})$

Winter mean temperature (DJF):

$y = (0.02\ x) - 1.4$

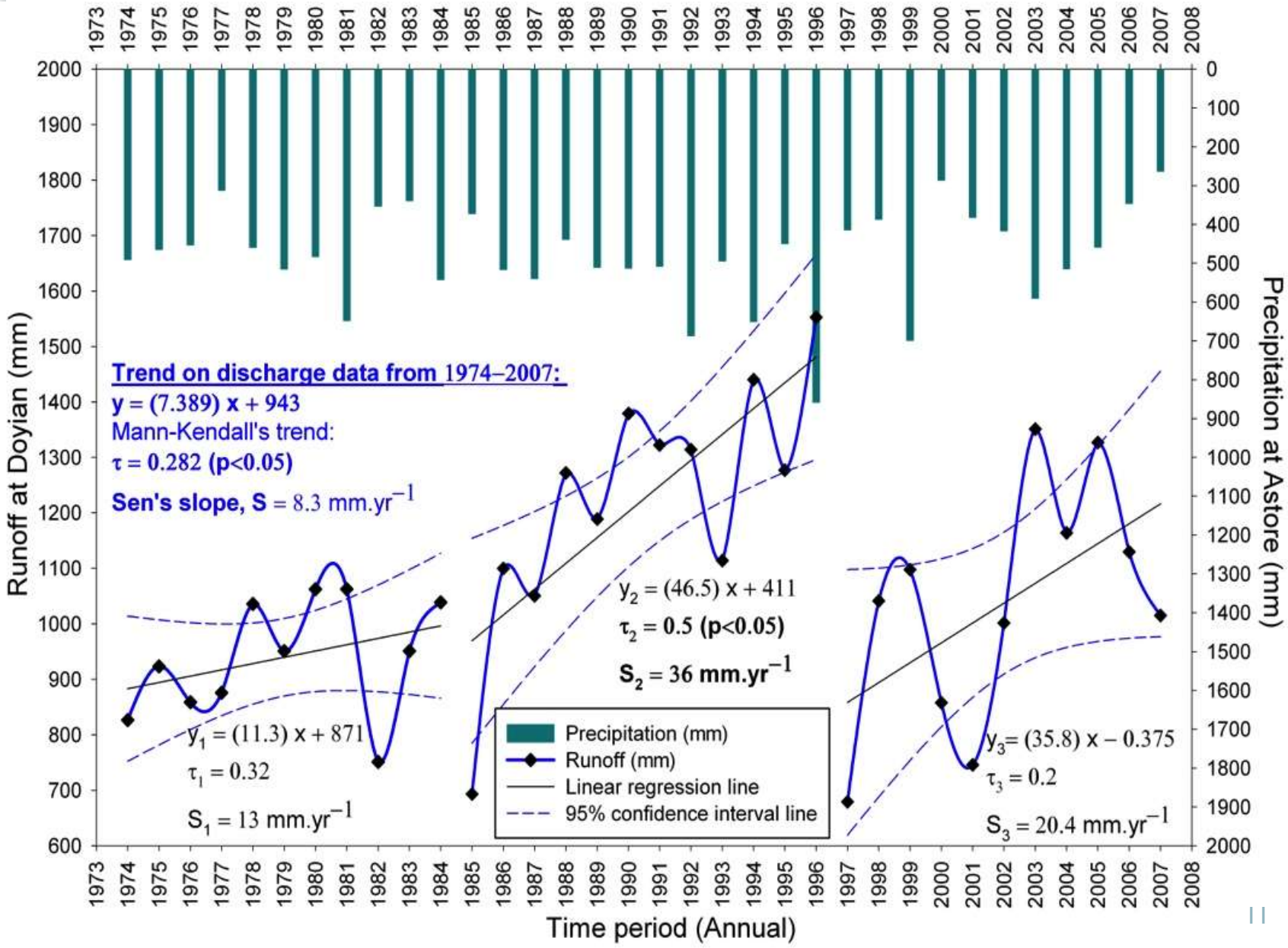
Seasonal Mann-Kendall's trend coefficient, $\tau = 0.056$

Sen's slope, $S = +0.022\ (^{o}C.yr^{-1})$

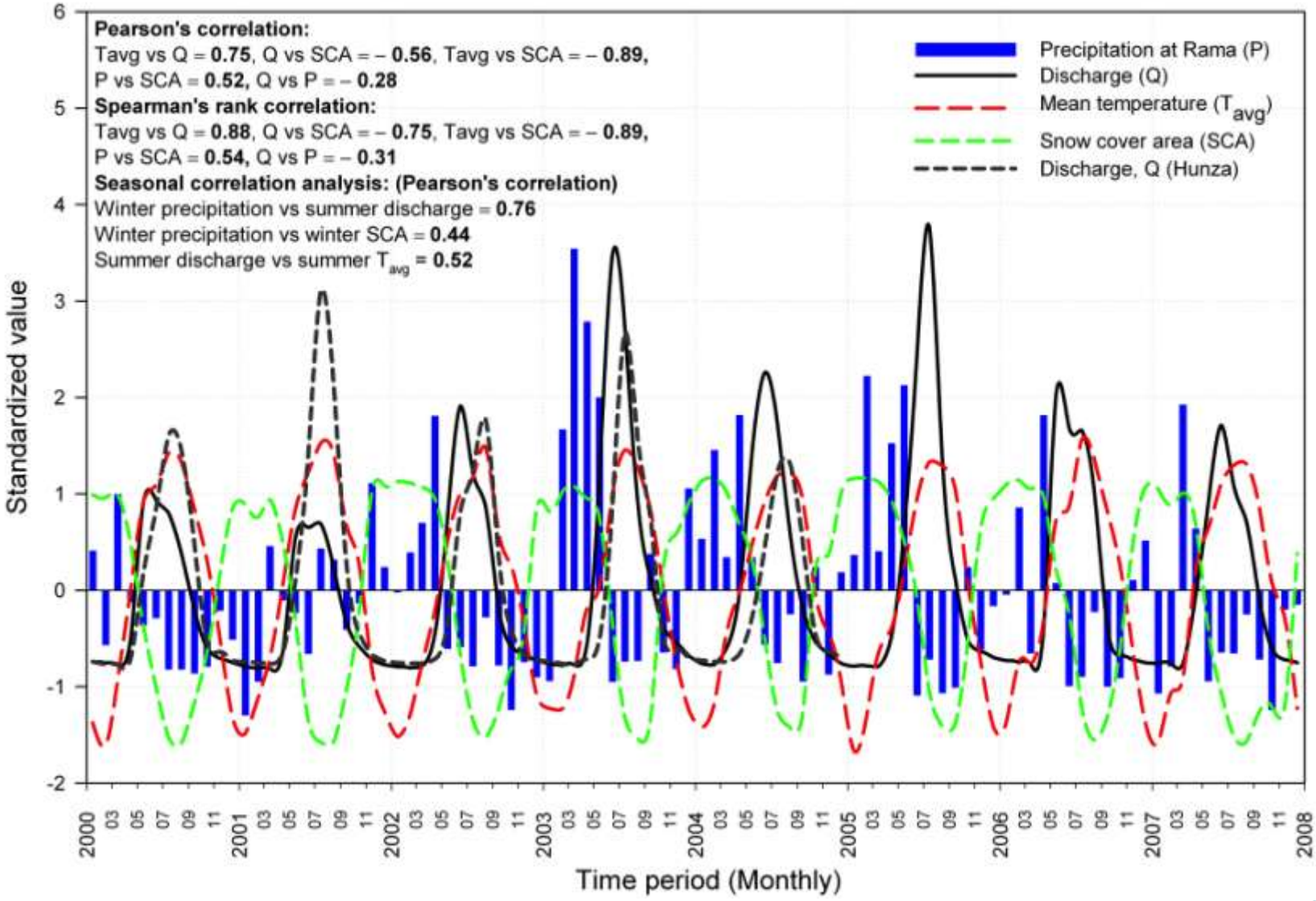


Though not significant but signal to the increasing snow and glacier cover

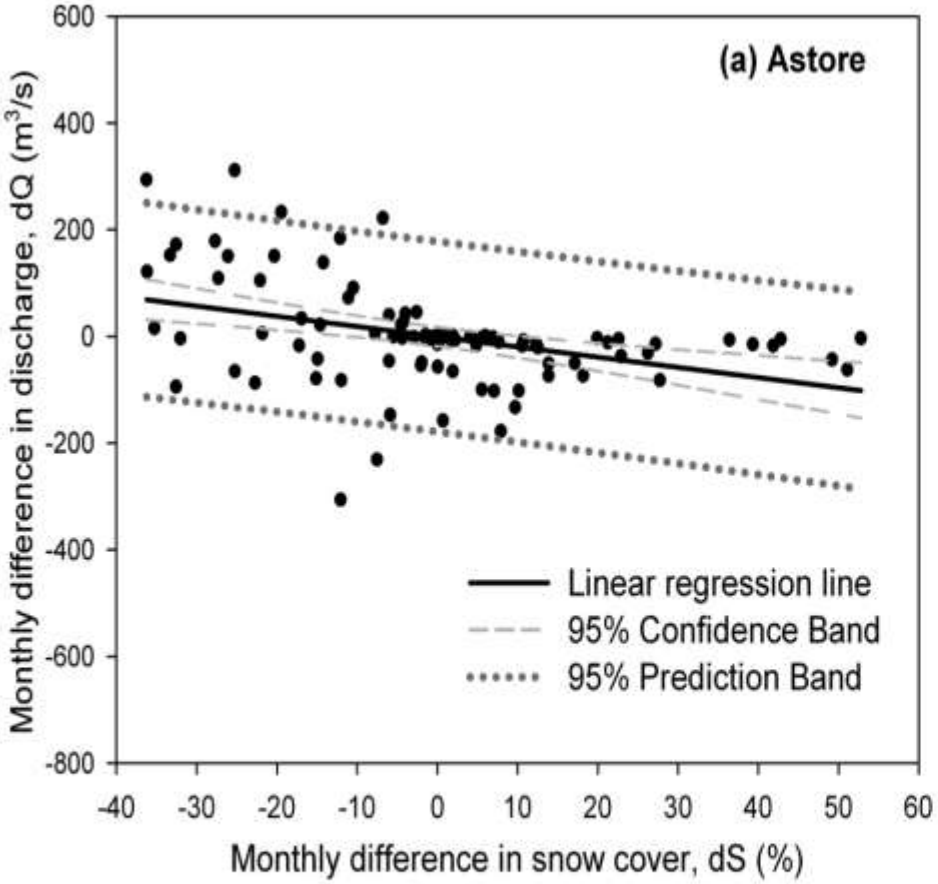
Stream flow trend in Astore river



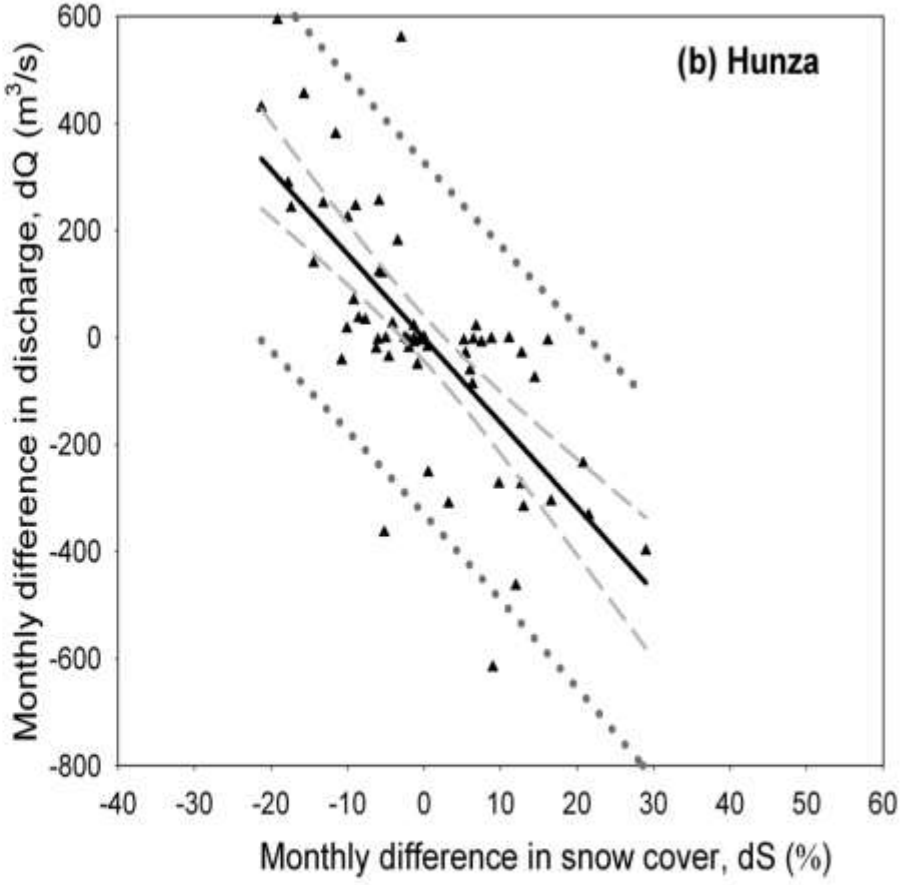
Hydrological regime in Astore basin



Hydrological regime – dQ vs dS



Astore:
Pearson correlation coefficient = r = – **0.39** (P<0.05)
Spearman rank correlation coefficient = r = – **0.48** (P<0.05)
Kendall's correlation coefficient = r = – **0.36** (P<0.05)



Hunza:
Pearson correlation coefficient = r = – **0.73** (P<0.05)
Spearman rank correlation coefficient = r = – **0.75** (P<0.05)
Kendall's correlation coefficient = r = – **0.56** (P<0.05)

Suggestions

- Monitoring other sub-catchments
- Installation of more climate stations at high-altitudes
- Ground observations of snow and glaciers
- Study of climate in different altitudinal bands
- Snowmelt-Runoff modeling under climate variability scenarios

Thanks for your Attention!

Any questions please?