Climate Change in the Hindu Kush Himalaya

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ICIMOD

HIMAP

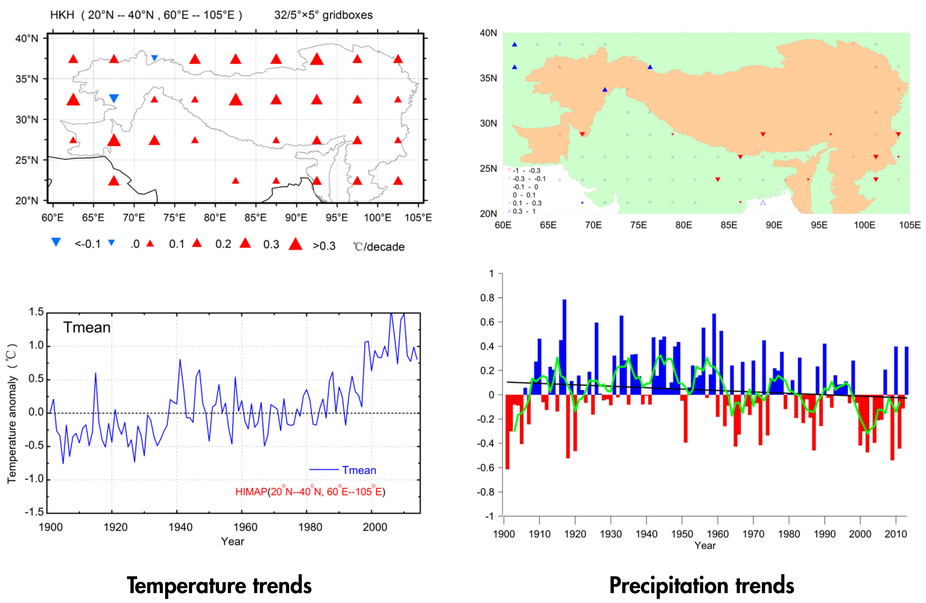
Introduction

- HKH plays an important role in global weather patterns. It serves as a heat source during summer and heat sink in winter. The HKH together with the elevated Tibetan Plateau exert significant influence on the Asian monsoon system.
- Himalayan region is sensitive to the climate change and variability. Most of the warming observed during the last few decades of the 20th century is attributed to the increase in anthropogenic greenhouse gas concentration.
- Intense monsoon rainfall leading to floods and landslides heavy winter precipitation in the HKH is brought about by synoptic weather disturbances moving from west to east and drought episodes are attributed to the increase in anthropogenic greenhouse gas concentration
- Robust estimates of the observed variability and long-term changes in climate over the HKH are inadequate owing to sparse and discontinuous observations.
- Reliable projections of climate over the HKH are crucial for assessment of the impacts of climate change and design and implement effective adaptation
- This chapter presents a broad overview of weather and climate elements pertaining to the HKH , focusing on past and present regional climate variations, and likely projections of future regional climate
- While this chapter takes stock of previous studies, the major part of the chapter is based on original analysis as studies in the HKH domain
- The study synthesizes major gap areas and future directions for diverse and multi-disciplinary solutions for climate change impact in the HKH.

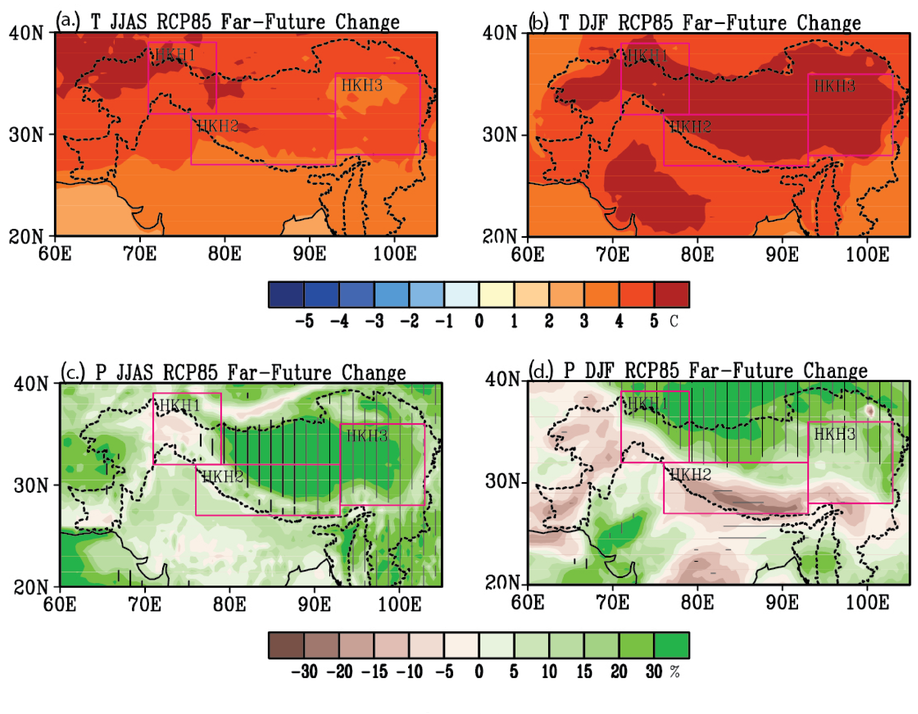
Policy Messages

- **For robust climate change analysis and adaptation planning, long-term hydrometeorological monitoring in the HKH should be improved.** High-altitude areas of the HKH lack long-term observational data, and the available data suffer from large inconsistencies and from high inhomogeneity. Systematic bias is also present—through the urbanization effect on temperature observations, and through the wind effect on precipitation observations.
- **For accurate cryospheric projections, more reliable projections of elevation-dependent warming are crucial.** Although the evidence for elevation-dependent warming in the HKH is strong, the precise mechanisms underlying this phenomenon are not well understood at present.
- **Policies and planning should focus on improved management and mitigation measures to address hydrometeorological extremes.**

Images



Temperature trends **Precipitation trends**



Temperature and Precipitation Projection

What does 1.5 °C rise in global average temperature mean for HKH region?

Analysis of an ensemble of five General Circulation Model runs projecting a global temperature increase of 1.5°C by the end of the 21st century, reveals a 1.5 °C global temperature increase would mean a temperature increase of 1.8 ± 0.4 °C averaged over the region

Looking at the mountain ranges solely, this enhanced warming is even more pronounced. For the Karakoram, Central Himalayas, and Southeast Himalayas, a 1.5 °C global temperature increase would imply regional temperature increases of 2.2 ± 0.4 °C, 2.0 ± 0.5 °C, and 2.0 ± 0.5 °C respectively.

Comaprision of results of models projecting 1.5 degree increase in near-surface air temperature (°C) globally and for the HKH and the three sub-domains. The temperature change os for the end-of-century from the per-industrial period (2071-2100 vs 1851-1880)

RCP	Model	Global	HKH	HKH1	HKH2	HKH3
RCP2.6	GISS-E2-R_r1i1p3	1.48	1.82	1.87	1.73	2.35
RCP2.6	MIROC5_r1i1p1	1.48	1.95	2.54	2.46	2.28
RCP2.6	NorESM1-ME_r1i1p1	1.44	1.68	2.05	1.85	1.63
RCP2.6	HadGEM2-AO_r1i1p1	1.57	1.47	2.04	1.49	1.50
RCP2.6	MPI-ESM-MR_r1i1p1	1.58	2.16	2.58	2.42	2.11
MEAN		1.51	1.82	2.22	1.99	1.97
RANGE		0.14	0.69	0.71	0.97	0.85
SD		0.06	0.26	0.32	0.43	0.39

Past and future of HKH Climate

Changes in Extremes

- Most parts of the HKH underwent significant long-term changes in frequencies of extreme temperature events over the last decades.
- Extreme cold events significantly decreased in most parts of East HKH especially in Southwest China and TP, while the extreme warm events increased over the whole HKH.
- Annual intense precipitation days (frequency) and annual intense precipitation intensity had increasing trends.
- The elevation-dependent warming (EDW) phenomenon in the HKH in particular in the TP and its surrounding regions was reported by many research groups

Future Change

- The projected temperature changes with RCP4.5 and RCP8.5 scenarios suggests that during summer (winter) relatively higher (lower) warming will occur over the hilly regions of northwest Himalaya and Karakoram (HKH1) than in the central Himalaya (HKH2) and southeast Himalaya and Tibetan Plateau (HKH3).
- There is a divergence among models in projecting future changes in precipitation.
- Future projections of annual mean precipitation change, based on CMIP5 multi-model ensemble mean indicated an increase in the precipitation over the HKH for both (RCP4.5 and RCP8.5) scenarios