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# Climate change and its impacts on HKH region

#### The Hindu Kush Himalaya

Global asset for food, energy, water, carbon, and cultural and biological diversity

Monsoon dominated climate

Tues

U00SUON BUILTS

Majority of areas receiving > 50% during monsoon

Western parts westerly dominated

# Monsoon dominated climate



Shrestha, 2008

#### Flow regime

Hydrographs location dependent Monsoon domination in flow regime



Shrestha et al., 2013

# It's all about GHG emission, but

Changing emission scenarios Total vs per capita emission Mountains vs plains Emission vs impacts



WB and other sources



#### Climate change in HKH



Region	<b>Data</b> source	Period	Trend (°C/decade)			
			Tmax	Tmin	DTR	Tmean
НКН	СМА	1901-2014	0.077*	0.176 *	-0.101*	0.104*
		1951-2014	0.156*	0.278 *	-0.123*	0.195*
Globe	GHCN	1901-2014				0.084*
(Lands + Oceans)		1951-2014				0.129*

HKH warming comparable to the global average

Krishnan et al., 2019 (HKH Assessment) based on CMA GLASAT dataset (Xu et al., 2014)

#### Temperature extremes



Krishnan et al., 2019 (HKH Assessment) based on CMA GLASAT dataset (Xu et al., 2014) Warm extremes increasing

#### Precipitation



Krishnan et al., 2019 (HKH Assessment) based on CMA GLASAT dataset (Xu et al., 2014)

#### Future Climate Change Climate projection - 25 CMIP5 GCMs



Change from 2006 to 2100 relative to 1976–2005 RCP4.5 - blue RCP8.5 - red 25-model ensemble mean is shown by solid line

Krishnan et al., 2019 (HKH Assessment)

The projected temperature change in RCP4.5. is  $2.5 \pm 1.5$  in HKH by the end of the 21st century relative to the 1976– 2005 [5.5 ±1.5 in RCP8.5]

Projected changes in mean annual precipitation (%) over HKH region with						
respect to 1976–2005 period						
	Scopario	Spatial range of annual precipitation change (%)				
	Scenario	CMIP5	CORDEX	NEX		
Near Future	RCP4.5	2–8	5–15	5–20		
	RCP8.5	4–15	10–20	5–25		
Far Future	RCP4.5	5–15	10–20	15–25		
	RCP8.5	10–20	15–30	20–40		

Krishnan et al., 2019 (Assessment of Climate Change over the Indian Region)

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#### HKH in 1.5 Degree world

RCP	Model	Global	HKH	НКН1	HKH2	НКН3
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



For HKH domain a 1.5 °C global temperature increase would mean a temperature increase of  $1.8 \pm 0.4$  °C Warming is even more pronounced

for mountain regions

For the Karakoram, Central Himalayas, and Southeast Himalayas this would imply regional temperature increases of

2.2 ± 0.4 °C 2.0 ± 0.5 °C 2.0 ± 0.5 °C

Krishnan et al., 2019 (HKH Assessment)

#### Take away messages

Even if global warming is kept to 1.5 °C, warming in the HKH region will likely be at least 0.3 °C higher, and in the northwest Himalaya and Karakoram at least 0.7 °C higher

For the past five to six decades, the HKH have shown a rising trend in temperatures including extreme warm events; a falling trend of extreme cold events; and a rising trend in extreme values and frequencies of temperature-based indices

Extremes in precipitation also likely have increased in the past. Precipitation is projected to increase in the future, but with varying quantum depending on models.

The HKH is experiencing increasing variability in western disturbances and a higher probability of snowfall in the Karakoram and western Himalaya

Consensus among models for the HKH region is weak—a result of the region's complex topography and the coarse resolution of global climate models.



### Impact of climate change on different sectors

### Climate change impact on different sectors

Climate change and extreme impacts

Cryosphere to water resources

Impact on human system to ecosystems

Impact on different sectors (water, agriculture, food secturity, livelihood, energy, infrastructure, ecosystem)



### **Changes in glaciers**





#### Impact on glaciers

25% decrease in glacier area in Nepal from 1980 to 2010

Figure 4.1: Glacier number, area, and estimated ice reserves in Nepal in ~1980, 1990, 2000, and 2010



Glacier area decreased from

- ~1980: 5168 km<sup>2</sup>
- 2010: 3902 km<sup>2</sup>

Bhutan: 23% loss of glacier area

One third of the Himalayan ice will be gone by 2100 (kraaijenbrink2017, HKH Assessment, 2019)

What could be the impact on downstream water availability?

### Increase in flood events in the future



Understanding the impact of climate change on hydrological extreme (Floods and droughts) is important

50 year return period of flood events are likely to increase

• Koshi: at least 100%

Floods and flash floods might be more frequent in future compared to present period

#### Disaster risk increasing with more extreme events





Big unknown: understanding hydrological extreme and seasonal shifts?

### **Extreme events and infrastructure**

CHINA

**MtEverest** 

ursel

Huge potential for hydropower in Koshi 214 MW from 7 hydropower (37% of total Nepal)

50 large hydropower projects have identified (JICA 1985)

NEPAI

Potential risk from GLOF and climate

#### Legend

- Koshi river basin
- Koshi barrage
- Canal
- Existing hydropower
- Proposed hydropower
- Potentially Dangerous Glacial Lakes

#### Elevation

- High : 8806
- Low : -17



#### Data Source: Koshi Basin Information System, ICIMO

# Drought

The years 1991, 1992, 2005, 2006 and 2009 are found to be rainfall deficient years (Dahal et al. 2015)

More than 90 % of stations recorded drought during the winter season of year 2006 and 2009 (Dhahal et al. 2015)

330 million people were affected by drought in India in 2016 due to severe water shortages and farmers suffer crop losses

Impact of climate change on different forms of drought and livelihood

#### The Himalavan Times > Nepal > Drought forces Bajura men to leave villages for livelihood Drought forces Bajura men to leave villages for livelihood

Published: November 17, 2016 4:16 pm On: Nepal



PRAKASH SINGH



File – Locals of northern Bajura district heading to India for jobs after drought destroyed their crops, in the district.



## Impact on gender and society

Time spent collecting

water and fuel per day <sup>1</sup>

WOMEN

HOURS



# Summary

Climate change is impacting different aspect of societies

The impact of gradual climate change and climatic extremes will be more common in the coming day

Poor and vulnerable communities will be hard hit

Better understanding of climate change will help to design adaptation strategies



# Thank you