Long Term Climate Impacts on Hydro Power in Bhutan

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ICIMOD: A regional intergovernmental mountain knowledge, learning and enabling centre

Regional Programmes
1. Adaptation and Resilience
2. Transboundary Landscape
3. River Basins and Cryosphere
4. Atmosphere
5. Mountain Environment Regional Information System
6. Mountain Knowledge and Action Networks

The Hindu Kush Himalaya
Global asset for food, energy, water, carbon, and cultural and biological diversity

OUTLINE

Part 1: Climate change
Key messages from HIMAP 1st Assessment Report

Part 2: Climate impacts on Hydropower in Bhutan

Even 1.5 Degrees is Too Hot for the HKH

HKH will warm more compared to global mean and warm more rapidly at higher elevations

- 2.1 ± 0.1°C in a 1.5 degree world
- 5.5 ± 1.5°C by 2100 relative to 1976-2005 at current emission pathways

For areas above 2,000m, if 1.5°C by 2100 then:
- Karakoram (2.2 ± 0.4°C)
- Central Himalayas (2.0 ± 0.5°C)
- Southeast Himalayas (2.0 ± 0.5°C)

Source: HIMAP climate change chapter and Kraaijenbrink et al. 2017, Nature
Climate Change Impacts on Water Resources

- Loss of storage in the form of ice
- Changing precipitation and flow patterns – more floods and droughts; high uncertainty
- Greater impact for those living closer to glaciers
- Predicted annual flow volume – no significant change
Not running out of water, but...

- Climate change is expected to drive **consistent increases in total runoff** of the Indus, Ganges and Brahmaputra

- **Indus**: increased glacier melt, then declines after mid-century

- **Ganges/Brahmaputra**: increased runoff due mainly to precipitation

- Climate change is likely to affect groundwater, especially springs in the mid-hills of the HKH, but limited evidence.
Disaster risk is increasing

- Floods, droughts, landslides, glacial lake outburst floods
- One-third of disasters are floods, many crossing national borders

➢ More than 1 billion people at risk of exposure to increasing frequency and intensity of natural hazards
Flood magnitude may double

Mean relative change in 50 year return period of floods

Average river flow will increase by 2100 in upper river basins:
- 50% in upper Indus
- 30%–40% in upper Ganges
- 25%–50% in upper Brahmaputra

Intensities of ‘once in 50 years’ flood events will increase:
- 40%–110% in upstream areas
- 115%–150% in downstream areas

Wijngaard et al. 2017, PLOS One
Part 2: Climate impacts on Hydropower in Bhutan

- Economically feasible hydropower potential 24,000 MW
- Installed capacity about 1,500 MW
- Envisages about 74 dams across river basins
Changes in Climate, hydrology and impacts on different sectors

- Climate variability (spatial and seasonal)
- Changes in Cryosphere (snow and ice reserve)
- Cryosphere dynamics and hydrological regimes
- Climate change impacts on Glacial lakes
## Threats/Variabilities

- Prediction of an increase in summer flows in the rivers in the short run, decrease in the long-run

- Under a warmer and more variable climate, the onset of monsoons will be more erratic which will cause disruptions in natural cycles

- Bhutan is already experiencing increase in frequency of intense monsoon rains causing flash floods and landslides

## Impacts on Hydropower

- Disruption of average flows affect optimum hydropower generation

- Uncertainty in the magnitude of flow increase affect hydropower generation

- Damage to infrastructure, transmission pipelines and power distribution
- Increased Sediments affect the optimal performance
Climate Change and State of Cryosphere

- Bhutan has lost over 20% of its glaciers since 1980. Growing in size - increasing the risk of GLOF
- Total ice volume measurements vary considerably
- No strong trends have been observed in snow cover
- Little is known about the distribution of permafrost
Key Messages

1. The atmospheric concentration of greenhouse gases and short-lived climate pollutants has increased, snow and ice have diminished and the trend is likely to continue.

2. Hydropower generation will get more and more uncertain in future due to climate impacts:
   - Changes in Hydrological regime
   - The magnitudes of extreme events
   - Hazards associated with shrinking glaciers, glacial lake outburst floods
Access to Electricity & Clean Cooking in 2014 (% of population)

- Over 80% of rural population in HKH countries rely on traditional solid fuel for cooking & heating

Performance on Regulatory Indicators of Sustainable Energy (RISE)

- Persistence of manifold barriers on 3 pillar of SE4ALL

Source: IEA & World Bank, 2017
Long-Term Development Goal

- Improved access to appropriate, modern, affordable, and reliable energy services in the HKH region, as well as enhanced safeguarding of essential mountain ecosystem services

Key Outcome

- Innovative mountain specific sustainable energy solutions in the context of climate change mitigation and adaptation

Core Components

1. **Knowledge**, data management and awareness raising
2. **Policy** development and implementation
3. **Capacity** development
4. Promotion of investment, entrepreneurship and innovation

**Up-Coming Event (Department of Renewable Energy + ICIMOD + ADB)**

SUSTAINABLE ACCESS TO CLEAN ENERGY FOR HINDU KUSH HIMALAYA
Thimphu, Bhutan, 25-26 February 2019
Thank you