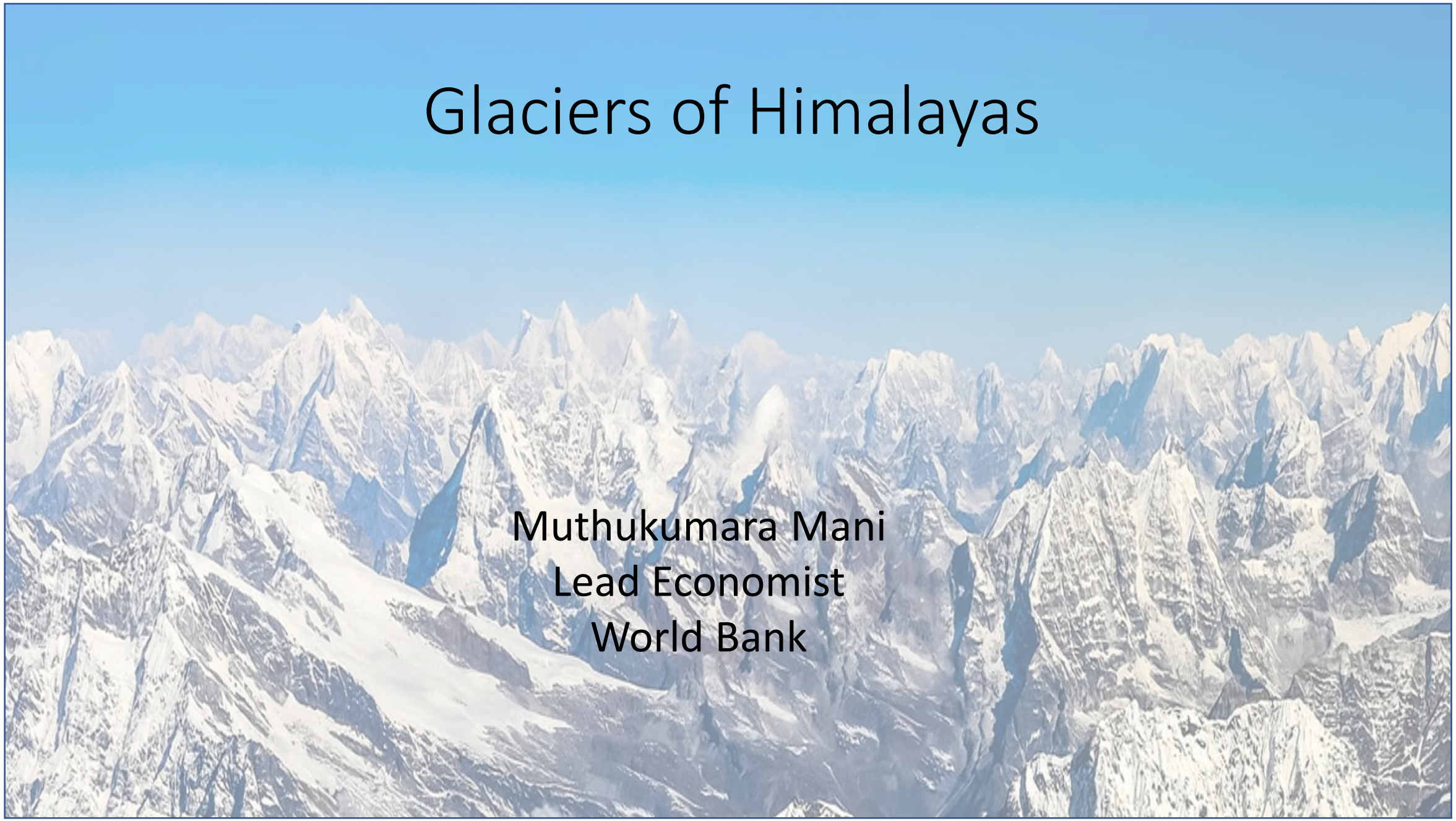
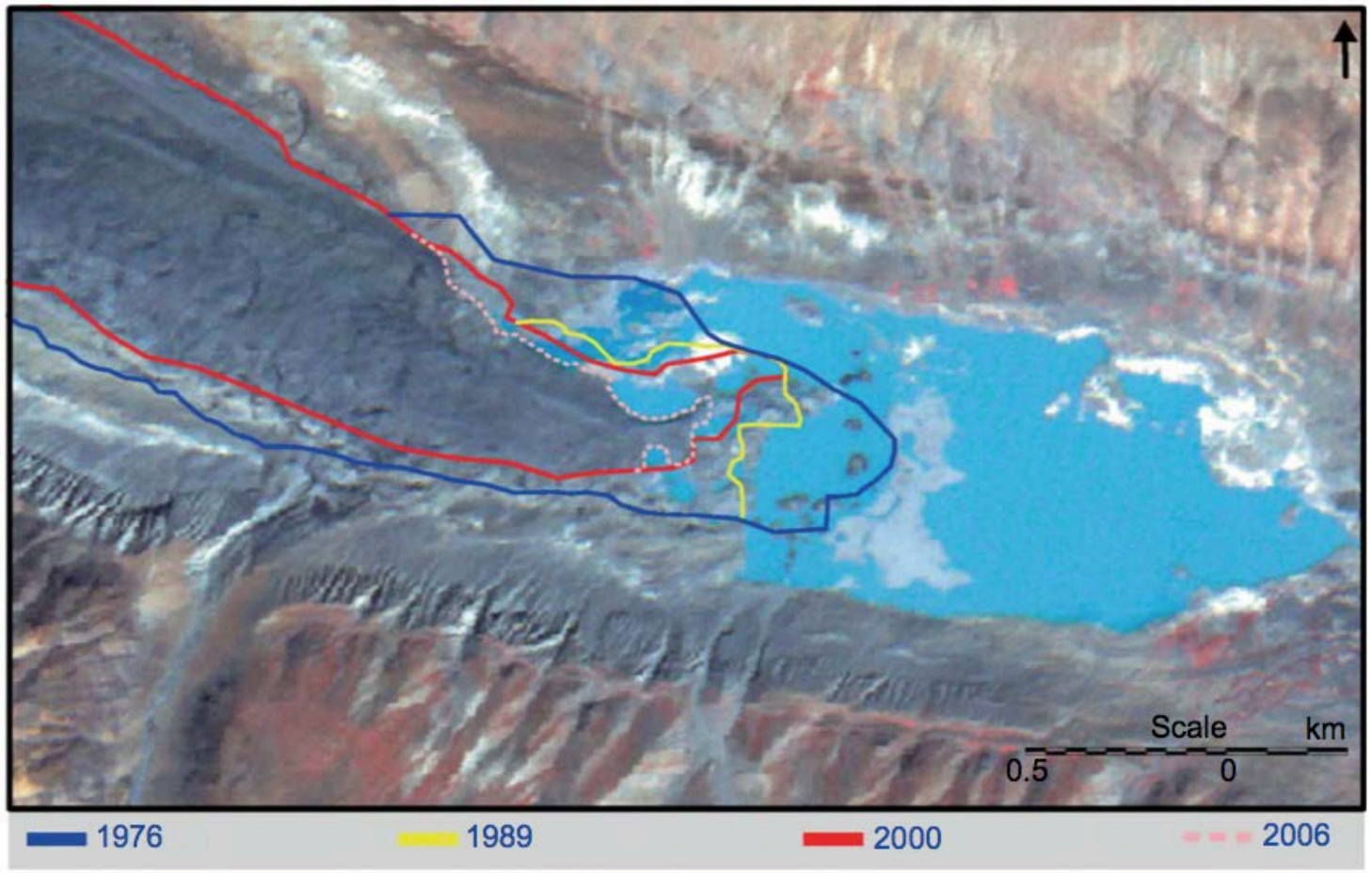
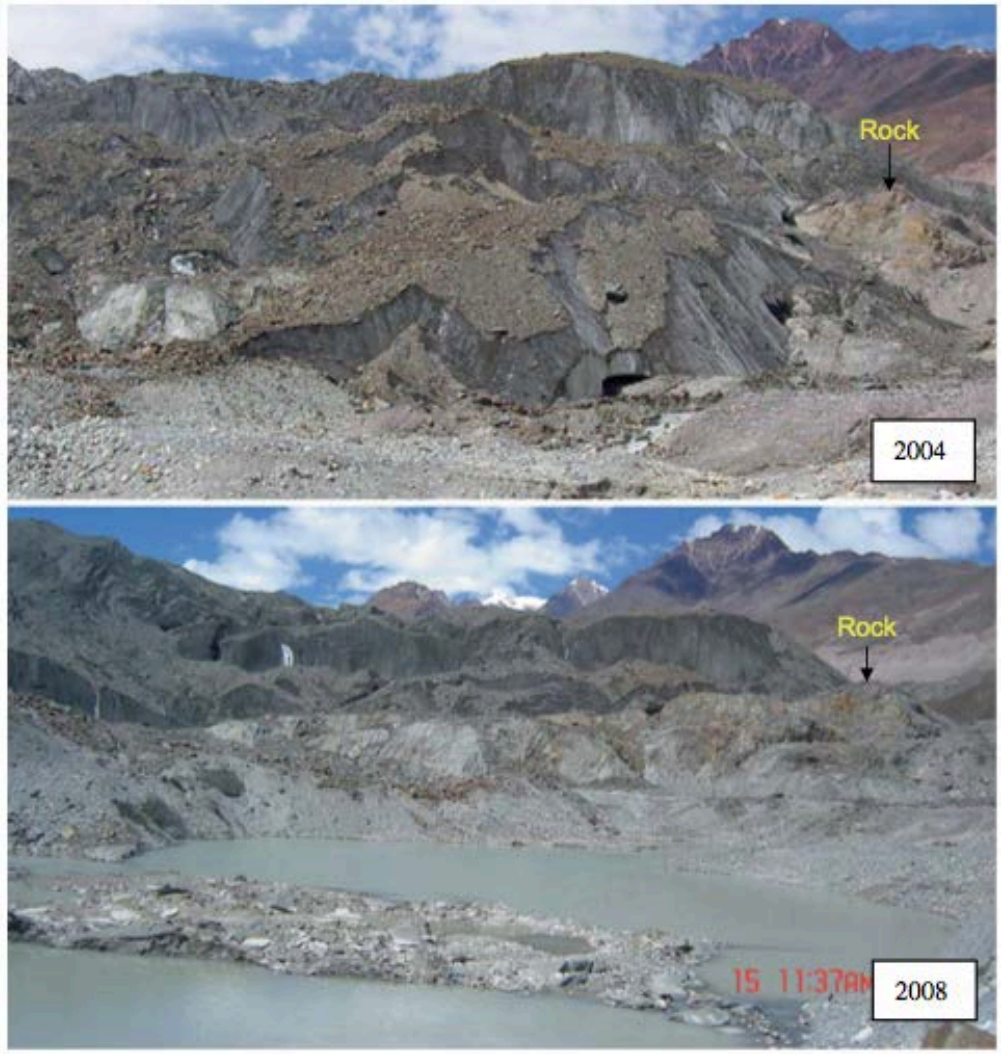
Glaciers of Himalayas



Muthukumara Mani
Lead Economist
World Bank

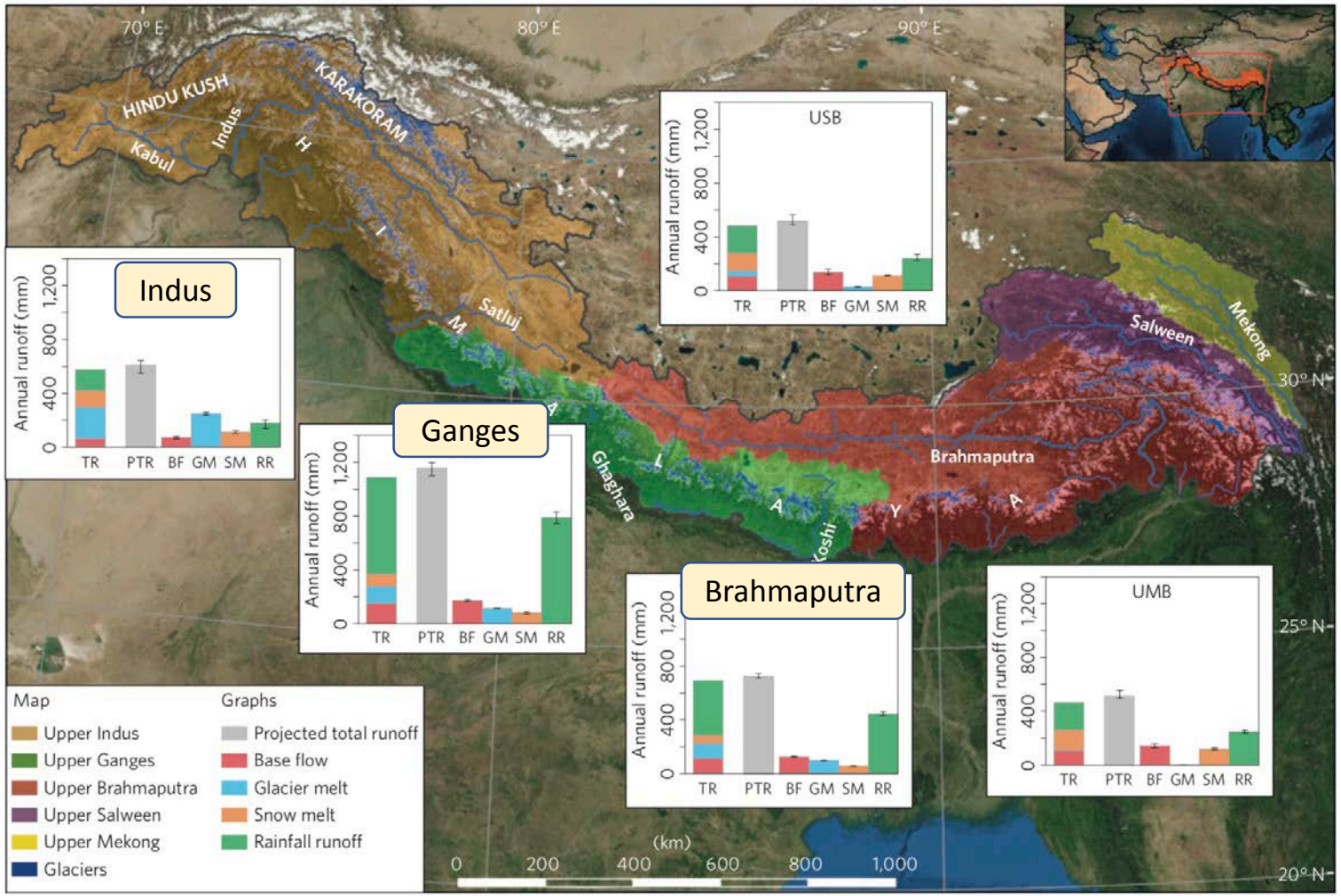
Many glaciers in Himalaya retreating rapidly





Source: Kulkarni et al., 2011, IJRS

Snow and glaciers contribute significantly to water resources in South Asia

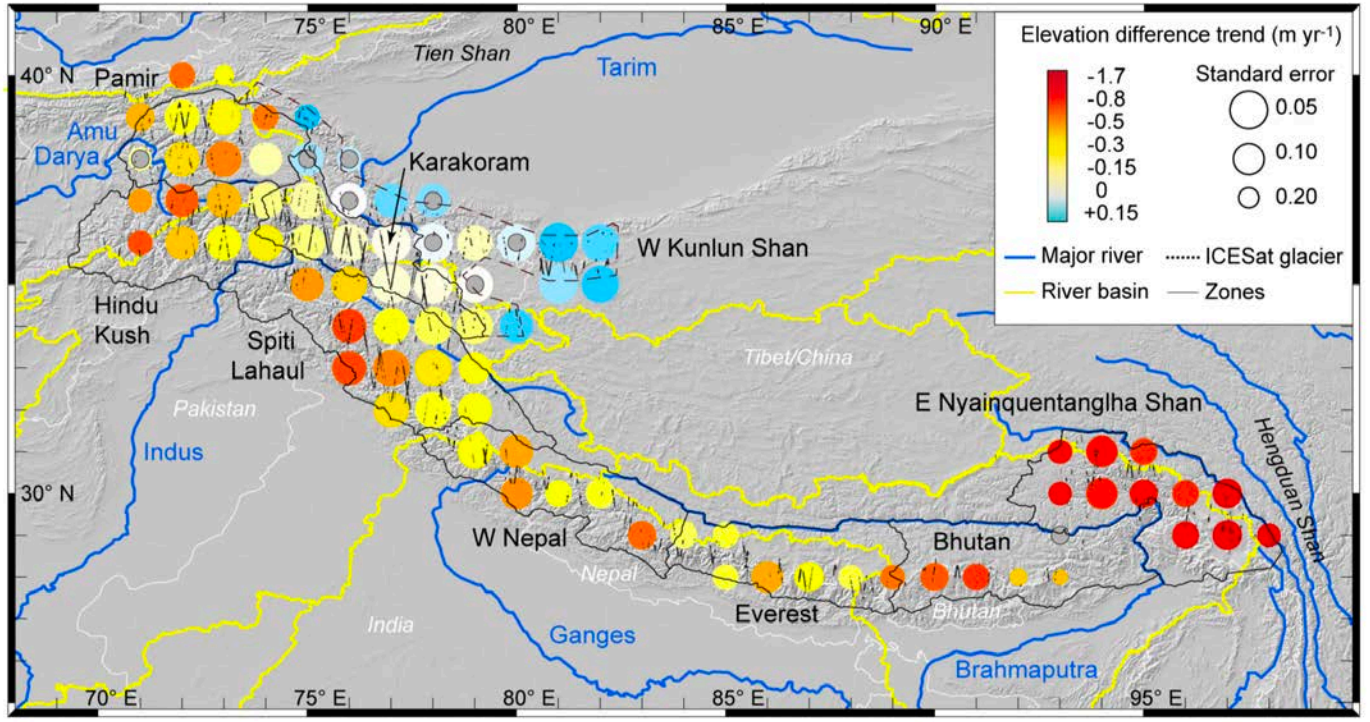


- Snow and glaciers most significant in Indus basin
- Their contributions are also sizable in upper Ganges and Brahmaputra basins

Lutz et al. (2014)

Knowledge of historic glacier changes is accumulating, but many uncertainties remain

- It is well known that glaciers in the Himalayas are changing
  - For example, large-scale estimates of change exist
- However, there is a lack of knowledge of local-scale changes
- This includes both on-the-ground and satellite-derived measurements
- This study is working with glacier experts to ensure latest local-scale estimates are publically available



Kääb et al., The Cryosphere, 2015

Study investigates combined impacts of climate change and black carbon

Black carbon from air pollution

Temperature increases from greenhouse gas emissions

Photos: Wikimedia Commons, livescience.com, National Geographic, Wikipedia, and PBS

Modeling Framework

- Climate modeling: Use existing climate model runs to understand global climate change signal and to contextualize within the range of uncertainty associated with climate change as well as other potential Monsoon effects
  - new climate model runs to investigate regional monsoon response to reduced aerosol emissions in South Asia

- Black carbon modeling: High-resolution atmospheric chemical transport model runs to investigate atmospheric transport of black carbon and other aerosols through the region – including deposition in mountain regions

- Glacier hydrological modeling: A physically representative snow and glacier hydrology model calibrated at high special resolution model that accounts for each energy balance component in terms of spatial geometry, precipitation, and surface air temperature

Study Objective

- Assess the sensitivity of precipitation, snow, glacier melt, and water in the context of global climate change, regionally produced aerosols / black carbon and other changes to the Himalayan Monsoon.
- Combine novel climate, chemistry and cryosphere-hydrology modelling to leverage existing work on glacier and snow melt.
- Formulate responses in terms of range of possible water resources scenarios, policy actions likely to impact results, and recommended follow-up studies to investigate impacts of water resources changes.

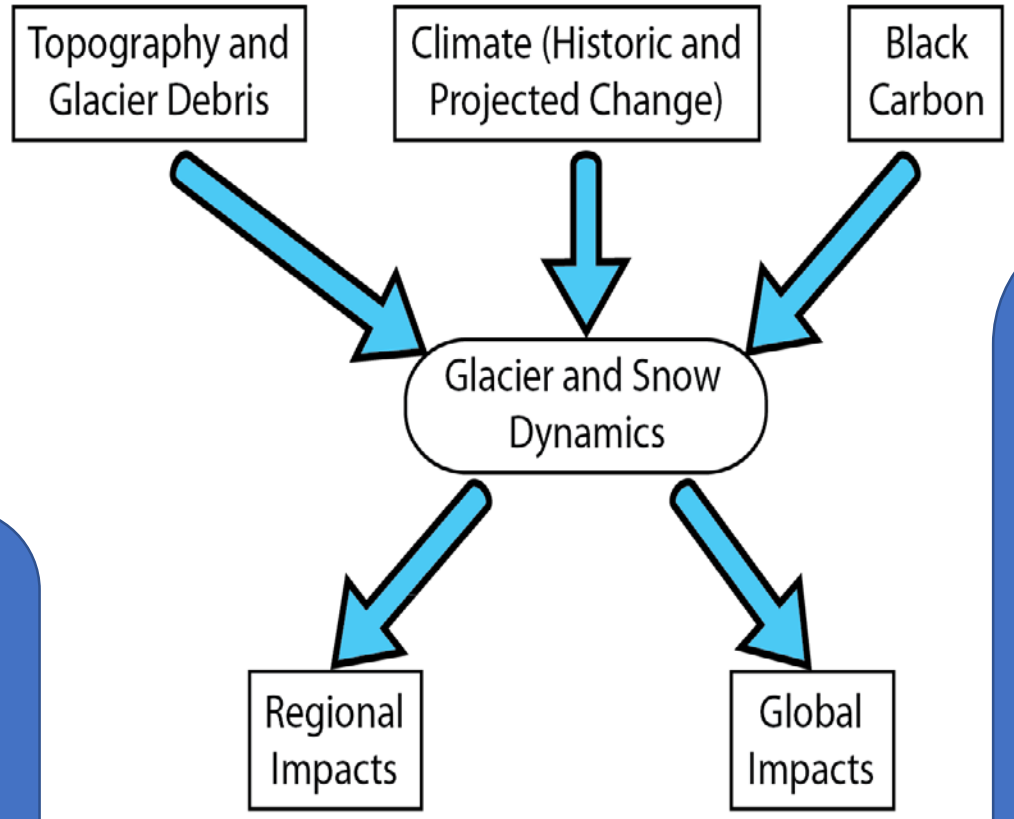
Study overview

Historic Climate

- Use ERA Interim historic climate model
- Downscaling methodology based on column moisture and slope

Future Climate

- Multiple GCMs
- Testing sensitivity to CO2 and aerosols
- Business-as-usual vs. low aerosol scenarios



Black Carbon

- Use WRF-Chem to assess black carbon and mineral dust in atmosphere
- Tag and track black carbon by source

Glacier and Snow Dynamics

- Conceptual Cryosphere Hydrology Framework (CCHF)
- Develop baseline and future projection streamflow scenarios
- Use climate and black carbon inputs

Hydrologic model links changes in climate, glaciers, and water resources

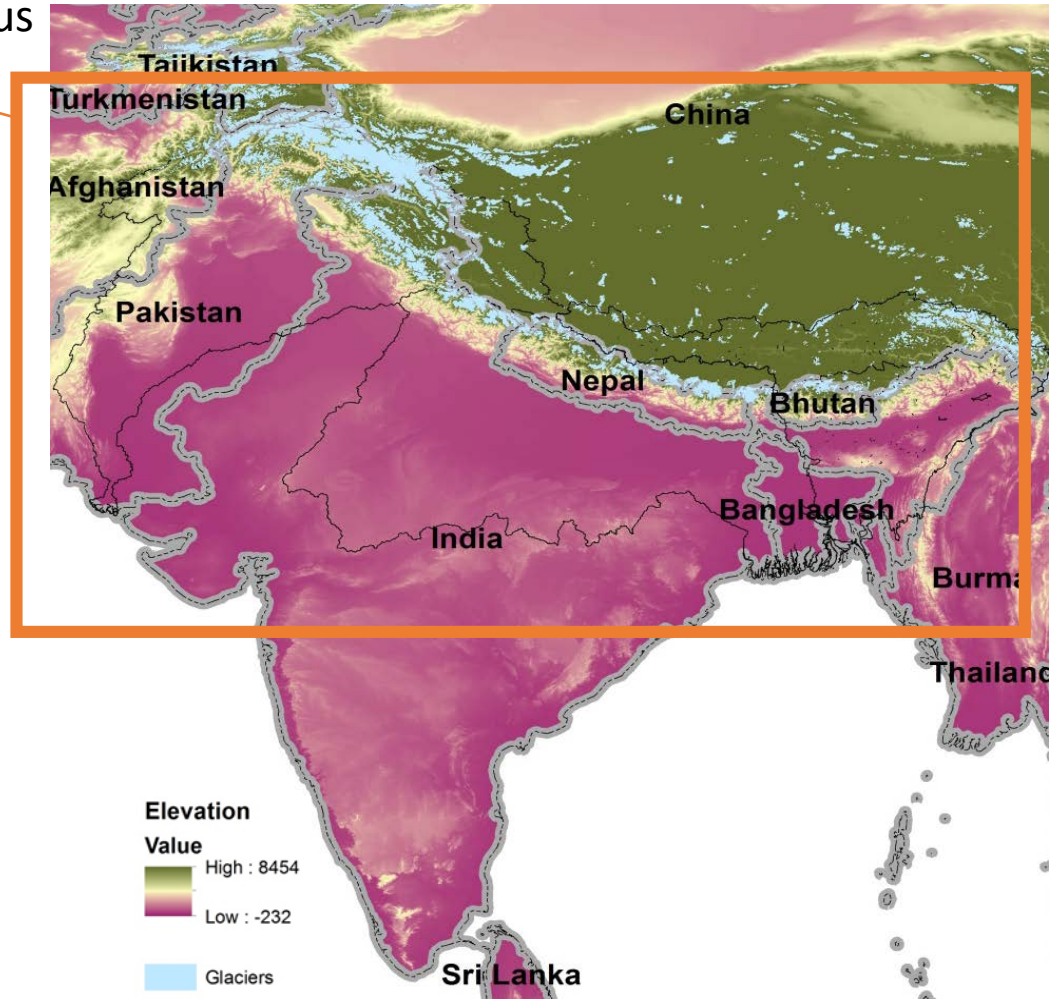
Historic conditions

Global climate change

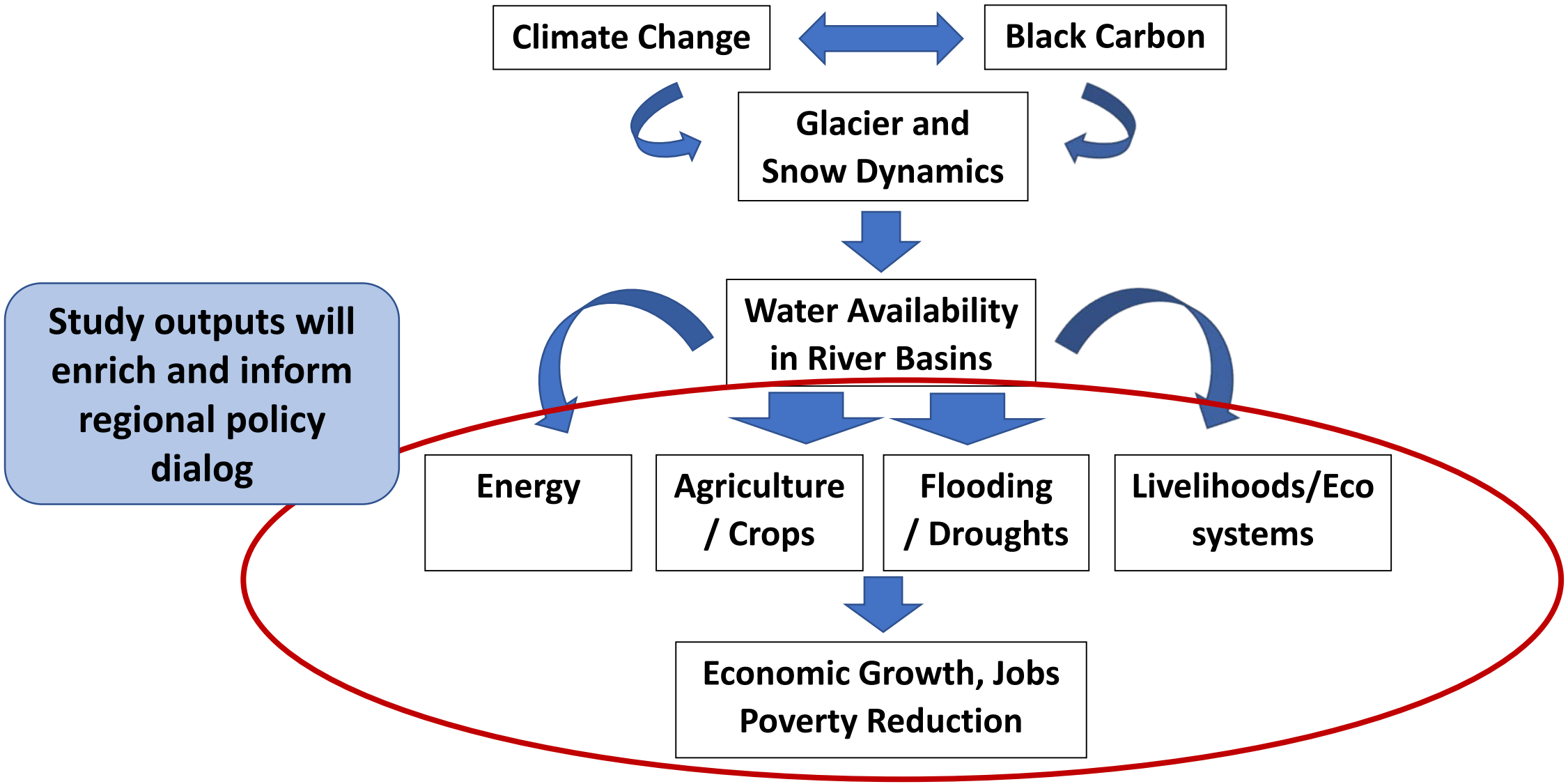
Black carbon

Changes in glaciers and water resources

Study area: Ganges, Brahmaputra, and Indus



Implications for policy and investments



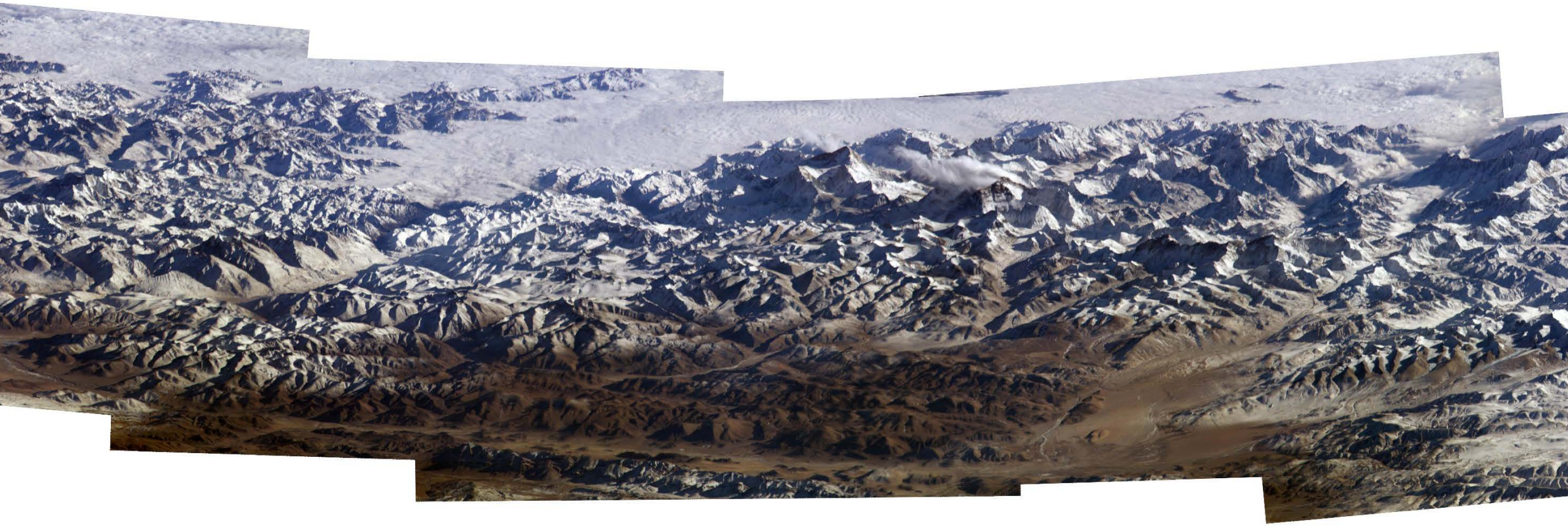
Value addition

- First of it's kind study investigating the sensitivity of snow, glaciers, and water resources in South Asia to regionally produced aerosols/black carbon in the context of global greenhouse gas emissions and other monsoon influences
  - Identify sources of black carbon by sector and country
  - Implement "business as usual" vs. low aerosol scenarios in the context of global scenarios (RCPs 4.5 and 8.5)
- Use of state-of-the art and robust glacier hydrology modeling approach
  - Conceptual cryosphere hydrology framework to test uncertainty of multiple model assumptions
- Utilize the results to formulate regional policy perspectives

Next steps

- HKH Regional Conference on “Cryosphere, Glacier Melting and Mountain Economy” - Trans-boundary Solutions for Resilient HKKH Mountains, 17-18 September 2018, Kathmandu
- Glacier and Mountain Economy Knowledge-Policy Platform
- Kathmandu Draft Declaration on Cryosphere, Glacier Melting, and the Mountain Economy
  - the need for urgent, collaborative and effective actions at all levels to monitor and take relevant steps to help Hindu Kush Himalaya countries effectively address climate change, atmospheric pollution, and mountain poverty
  - consolidate and share available knowledge and good practices to solve local, national and regional problems arising from glacier melting, the vulnerability of mountain communities, and the threats to the sustained supply of mountain ecosystem services.

Thank you



(Wikicommons)