Socio-Hydrology of the Upper Indus Basin

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Meltwater-dependent irrigation systems

 Mostly subsistence-based

Crucial for rural livelihoods and food security
Nanga Parbat | Glacier Surface Changes between 1934 and 2000

Surface changes [m]
- < -30
- -30 - -20
- -20 - -10
- -10 - -5
- -5 - 5
- 5 - 10
- 10 - 20
- 20 - 30
- > 30

Data Source:
SRTM-DEM,
HighAsia8mMap,
Finsterwalder (1934)
Background:
Landsat 2019-09-24
Draft: S. Schmidt

Nüsser and Schmidt 2021
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Nanga Parbat: Rupal Valley

Large valley glaciers are no longer used for irrigation purposes
Former channels crossing lateral moraines are detectable

Nüsser and Schmidt 2017

Finsterwalder, 19 July 1934

Draft and Cartography: S. Schmidt & M. Nüsser
Data Source: Corona Image 1965-10-08 (USGS)
Quickbird Image 2003-07-19 (Digital Globe)
24 August 2006
Ladakh | Glacier Distribution

Cold arid region

Glaciers are located at altitudes above 5200 m

79 % are smaller than 0.75 km² and only 4 % are larger than 2 km²

Increase of minimum altitude to the east

Schmidt and Nüsser 2017
Ladakh | Seasonal water scarcity

Nüsser & Baghel 2015
Ladakh | Types of ice reservoirs

Nüsser et al. 2019
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Ladakh | Location of ice reservoirs

Nüsser et al. 2019
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Cryosphere-related hazards and risks
Village Gya: Land use pattern in 2013

Altitude: 4100 m a. s. l.

Highway from Manali to Leh

700 inhabitants

(Government of Jammu & Kashmir 2011)

Irrigated cultivation of barley

Source: Schmidt et al. 2020
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Destruction
2 houses and 1 link road washed away
3 houses and the hospital partly damaged
Fields of 14 families were affected

Photos: 30 September 2014

Schmidt et al. 2020
Gya Lake

Satellite data from the day of the GLOF

Lake is ice-covered over the whole year with few exceptions

Size increased from 0.03 km² in 1969 to 0.09 km² in 2014

Pléiades
6 August 2014
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Socio-hydrology is a useful framework to analyze the interactions between cryosphere dynamics and local irrigation networks (site-specific particularities) and to understand risks from cryosphere-related hazards.

Considering the local / regional scale: Even small glacier changes may have serious consequences; Even small GLOFS are potentially harmful for local populations.

Local settings and adaptation strategies vary across the region and they include technological solutions (new irrigation channels, ice reservoirs, water pipes).
Thank you for your attention.