Natural Hazards and Risks in a Changing World

Universität Potsdam

Identifying key predictors for the susceptibility of Himalayan glacier lakes to sudden outburst floods

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(Hovden 2012)

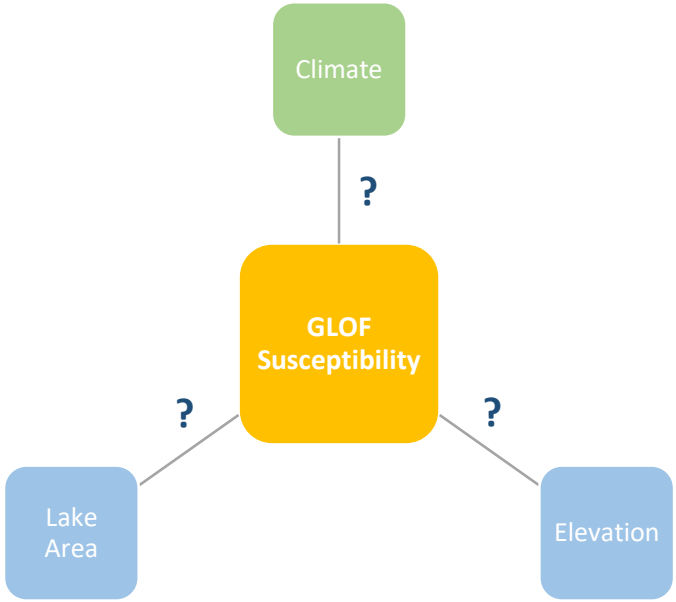
IPCC 2019 Change Prognosis:

- Decay of low-altitude glaciers and permafrost
- Increase in glacier lake area
- Hypothetical elevation dependent warming effects
- Increased frequency of rain-on-snow events at higher altitudes

➢ How are projected climate scenarios affecting future GLOF susceptibility in the Hindu-Kush Himalaya (HKH)?

Quantitative assessment of GLOF susceptibility across whole HKH using key morphologic and climatic predictors in a hierarchical statistical framework

Aftermath of the Kedarnath Disaster of June 2013:
HKH's most destructive and sole recorded example of a hydrometeorologically-triggered GLOF (https://www.indiatoday.in).

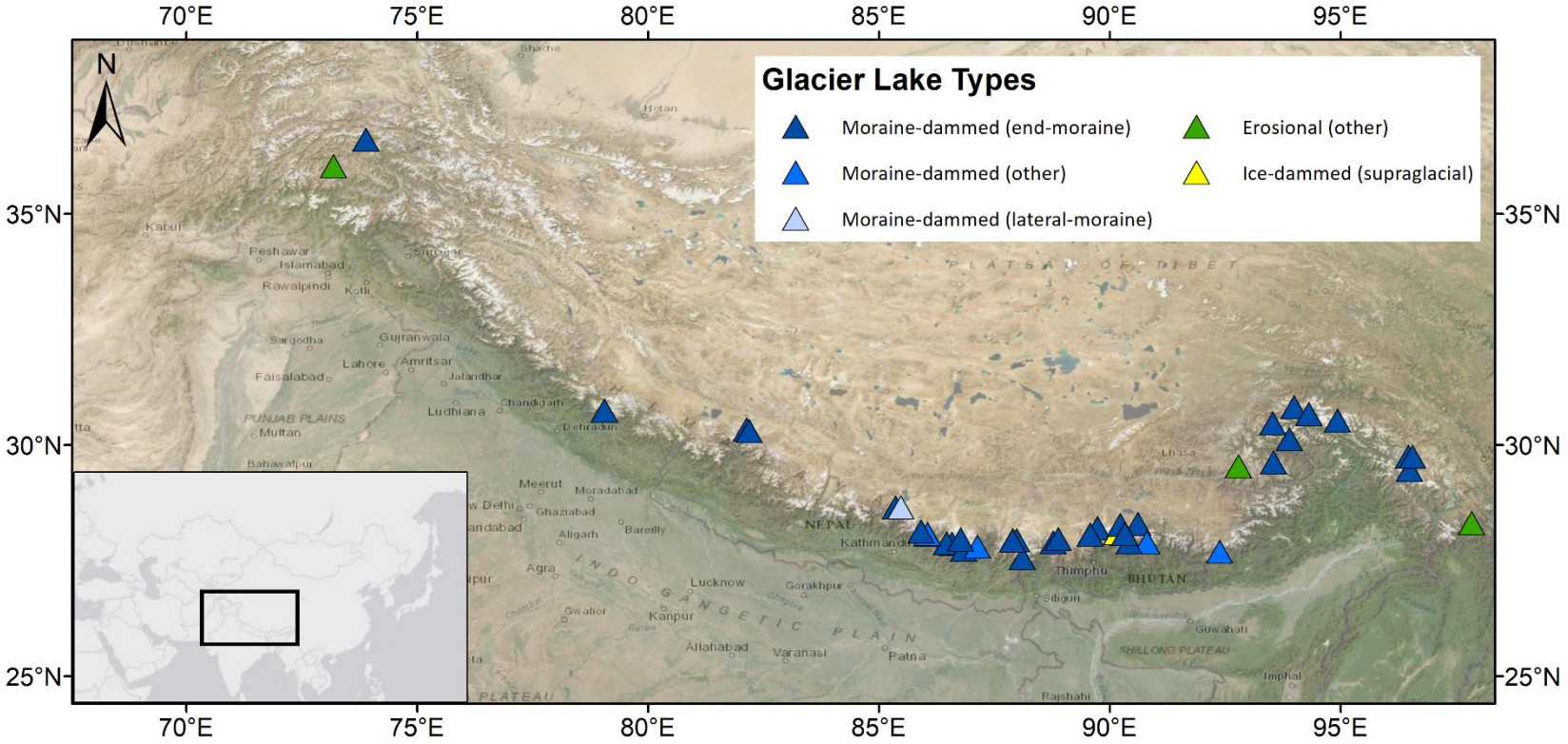


HKH Glacier Lake Inventories

- Glacier lake inventory: 7284 moraine-dammed lakes (Maharjan et al. 2018)
- Inventory of glacier lakes that have released GLOFs since 1980's: 38 locations (Veh et al. 2019)

Glacier Lake Parameters

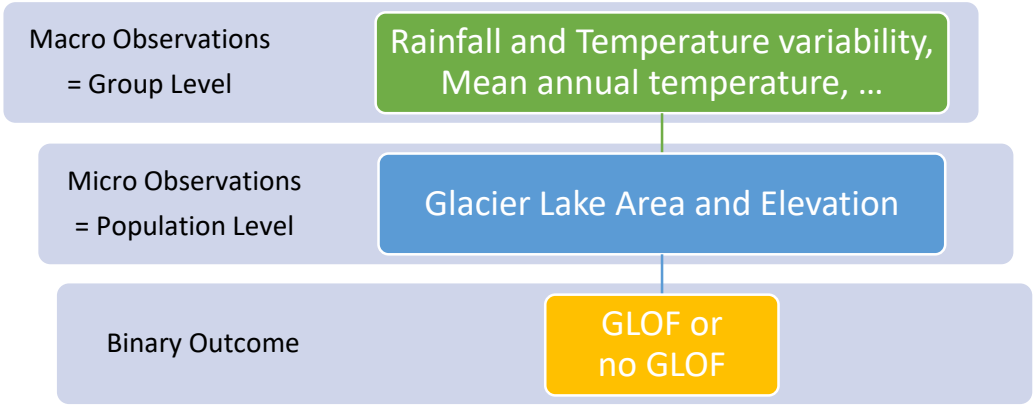
- CHELSA interpolated climate data (Karger et al. 2017)
- Topographic data derived from SRTM 30m DEM



Distribution and type of GLOF-generating glacial lakes along the Hindu-Kush Himalaya (1981 to 2017).

Bayesian Hierarchical Logistic Regression

- Assumption: GLOF susceptibility of HKH glacier lakes is structured
- Glacier lakes embedded within context (e.g. synoptic regime)
- Prior probabilities and random effects on population and group level

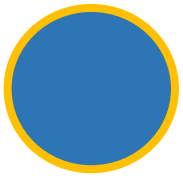


Model Comparison

- Iterative process of model building with different variants
- Predictive performance assessed and compared with leave-one-out cross-validation

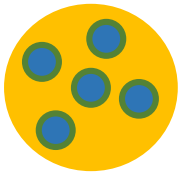
Predictors	Unit
Annual mean temperature	°C
Temperature seasonality	-
Mean temperature of wettest quarter	°C
Mean temperature of coldest quarter	°C
Annual precipitation	mm
Precipitation seasonality	-
Precipitation of warmest quarter	mm
Precipitation of coldest quarter	mm
Elevation	m asl
Lake area	m^2

Global Model



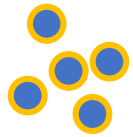
- One logistic regression of all data

Hierarchical Model



- One logistic regression of grouped data

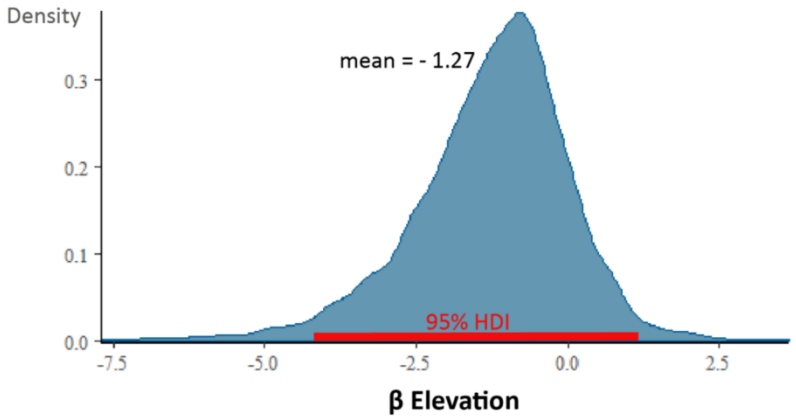
Many Models



- One logistic regression of data per group

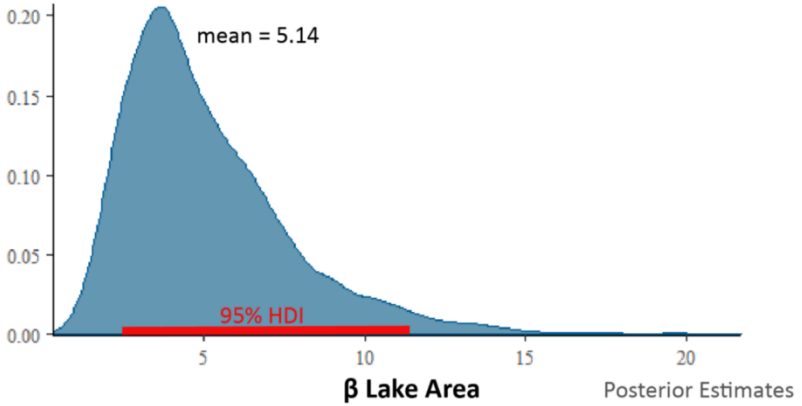
Predictors

- Elevation and lake area
- Larger and lower-lying glacier lakes were more credibly prone to sudden outburst
- Lake area has greater influence than elevation



Seasonal Groups

- Seasonal patterns are credible controls on GLOF susceptibility
- Increase in summer precipitation considerably raises GLOF history probability



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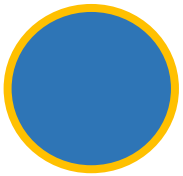

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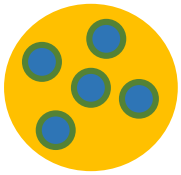

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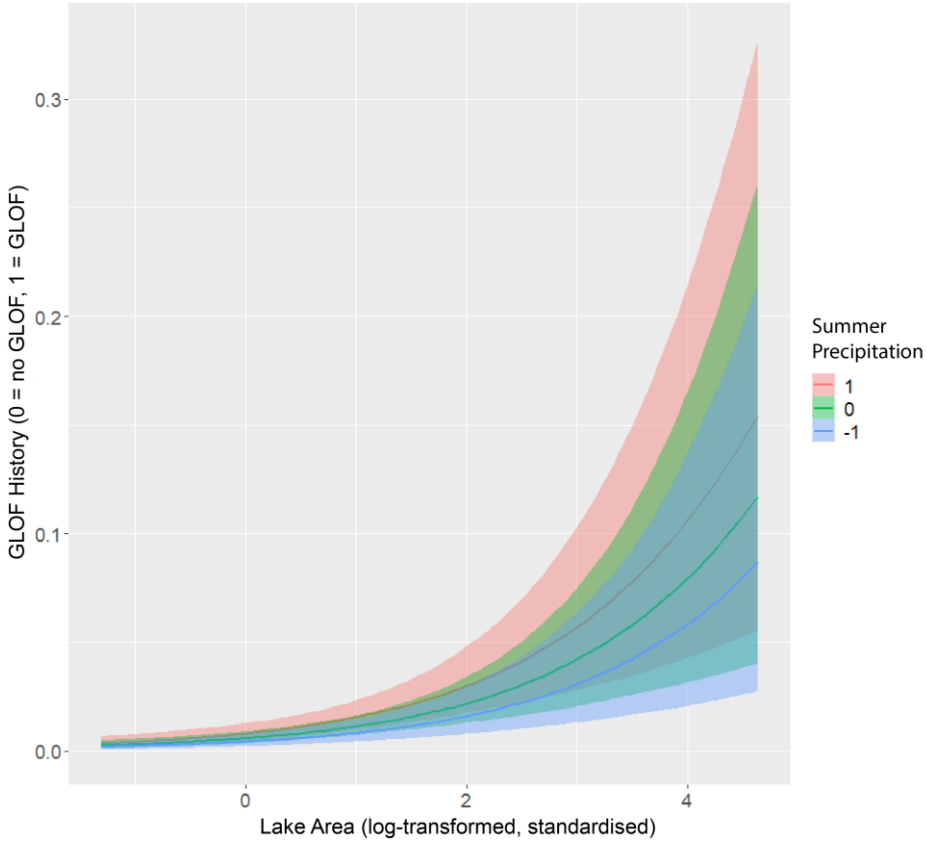

Sources of External Figures:

- Slide 1: Hovden, A. 2012: Glacial Lake Outburst Flood in Halji, Limi VDC 30 June 2011. https://www.asianart.com/articles/halji2/index.html
- Slide 2: India Today 2013: Kedarnath survivors tell horrific tales about disaster. https://www.indiatoday.in/mail-today/story/kedarnath-survivors-tell-horrific-tales-about-disaster-167313-2013-06-19