

High Hopes and Broken Dreams

The interplay of climate change, natural hazards, and the mortality of high mountain expeditions in the Nepalese Himalayas

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Introduction

Catastrophic hazards leading to a high risk of death.

Weather conditions governing summit bid windows.

Ice and glacier movement, coverage, and depth.



Extremes

Seasons

Climate

Study Approach



Data:

- ERA5-Land
 - Climate Reanalysis
 - 1950-Today
 - 9x9km resolution
 - Relevant climate variables temperature snowfall
- Himalayan Database
 - 480 peaks
 - 11,400+ expeditions
 - 89,000+ members
 - 15,900+ literature records

Methods:

• Climate Data Retrieval and Handling with KrigR

- windspeed

• Bayesian Models with BRMS



The first years of production highlight the adding value of the dataset to ERA5 surface fields and meet the needs of the users for a more accurate surface dataset.

Product description

Period from 1950 to 5 days before the current date.

Spatial resolution ~9 km

The Himalayan Databa

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Death & Success at 8,000 masl

All Peaks > 8.000 masl Summit bid windows shrink over time. CHOY LHOT ANN1 DHA1 **EVER** 0.95 0.8 0.04 0.5 60 0.03 Summit Bid Time Window 0.02 0.01 40 0000 Mortality 0 20 40 60 20 40 60 0 LSHR MAKA MANA 0.04 Mortality rates 20 increase over time 0.03 0.02 Climate and 0.01 0 weather may 0.00 1960 1980 2000 2020 explain this! 20 40 60 20 40 0 20 40 60 0 0 60 Years Year



General Conditions

Trends in annual mean (μ) and standard deviation (σ):

- 1. Air temperatures are warming
- 2. Snow depth decreases
- 3. Windspeeds at summits increase
- Destabilization of glaciers and seracs
- Larger build-up of more fragile cornices





General Conditions

Seasonal mean and standard deviation:



Intensity of:

- 1. Snowfall increases pre-monsoon, but decreases post-monsoon
- 2. Windspeed increases in both seasons, but becomes more variable pre-monsoon

Snowstorm likelihood increases in pre-monsoon season.

Short-term Weather Stability

Autocorrelative coefficient of daily conditions per season for several lag lengths:





Stability of:

- 1. Snowfall decreases more pre-monsoon
- 2. Windspeed decreases more pre-monsoon

The pre-monsoon season has become less favourable for mountaineering expeditions than the post-monsoon season.

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Number & Length of Extreme Events

Count of (consecutive) days exceeding 5% and 95% range of seasonal values

1. More extreme temperatures and longer heatwaves post-monsoon

Post-Monsoon mountaineering at increased risk of heatwaves, avalanches, and serac collapses

- 2. More extreme high snowfall amounts premonsoon
- 3. More extreme high windspeeds premonsoon

Pre-Monsoon mountaineering at increased risk from (snow) storms



Catastrophic Events in Mountaineering





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Implications & Further Work

Himalayan mountaineering schedules respond strongly to changes in seasonal weather conditions.

Pre- and post-monsoon mountaineering seasons pose divergent hazards to expeditions.

Himalayan summits are not subject to homogenous weather and climate trends.

Untangling what leads to success and death in Himalayan mountaineering requires further investigation. Local infrastructure, legislation, and expedition practices ought to accommodate.

Expedition planning ought to plan and prepare for hazards depending on season.

Traffic and rescue preparedness ought to be re-evaluated for each summit.

Further work is required utilizing more precise and complete data sources.

Contact us with Questions or Suggestions!

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