**BACKGROUND**

**What**

Kyagar Glacier experienced a dramatic glacier surge in 2014 which caused 40 meters thickening at the glacier terminus and the formation of an ice dam. The ice dam blocks the main river and impounds a large lake prone to rapid outburst floods.

**Where**

Kyagar Glacier is located in the Chinese Karakoram Mountains, at an elevation of 4800-7000 m a.s.l. It is extremely remote and access is restricted for political reasons.

**REMOTE MONITORING OF IMPELLING OUTBURST FLOOIDS AT KYAGAR GLACIER, CHINESE KARAKORAM**

**OVERVIEW**

We present an overview of the glacier surge and hazardous ice-dammed lake outbursts at Kyagar Glacier. Since the surge ended in 2015, outburst floods occurred several times. In 2017 the lake was its largest since 2002, and according to our records the 11th largest since 1950. Remote sensing is the only way of monitoring the glacier surge, the development of the lake and lake drainage mechanisms. We create time series of digital elevation models to assess the height of the ice dam and potential future lake volume.

**RECENT GLACIER LAKE OUTBURST FLOODS**

Glacier lake outbursts occurred each summer since the surge in 2014. In 2015 and 2016 outbursts were rapid and caused steady rises in the river level (m). In 2017 the ice-dammed lake drained completely and rapidly through subglacial channels.

**DATA AND METHODS**

**Satellite systems and application**

- **TOPDEM**: ~2 m Surface elevation and velocity
- **Swatiell 4**: 10 m Surface velocities
- **Swatiell A**: Optical, 10 m Surface observations
- **LakeSat**: Optical, 15 m Surface velocities

**Glacier surface velocities / input pass offset tracking**

- **RDOPS**: ~10 cm pixels for radar images
- **Phase correlation for SAR images**
- **Intensity correlation for SAR images**

**Digital elevation models: single pass SAR interferometry**

- **TanDEM-X**: 6 m pixels for SAR images
- **SAR interferometry phase difference between the images is comparable to height**

**GLACIER SURFACE ELEVATION CHANGES**

In 2017, drainage was unexpected, occurring entirely in 3 days. It is evident that the lake level dropped more rapidly than anticipated, indicating the need for better monitoring.

**OUTLOOK**

Since the glacier surge, we have recorded five glacier lake outbursts with volumes from 25-80 million m³, draining through both subglacial drainage and dam overtopping. The largest observed lake occurred in 2017 but the flood impacts were minimised because of slower and incomplete drainage and low baseflow of Yarkant River.

Factors which need to be understood to anticipate future hazard:

- **How will the ice dam height evolve in time?** For this, timely DEMs are crucial.
- **Velocity tracking continues to be useful to assess mass transport to the terminus, when we don’t have DEMs.**
- **How will the ice dam height evolve in time?** For this, timely DEMs are crucial.
- **What will we see a large rapid outburst again or slower, incomplete drainage and low baseflow of Yarkant River?**

**PREVIOUS WORKS**

- Round et al., 2016, Gorge dynamics and lake outburst of Kyagar Glacier, Karakoram, The Cryosphere, 11
- Hussmann et al., 2016, Hazard assessment of glacier lake outburst floods from Kyagar Glacier, Karakoram Mountains, China, Ann. Glaciology, 15

**Monitoring Impending outburst floods**

We use the volume of water along the river to identify the GLOF hazard and anticipating large outburst flood volumes.

**Factors we use a digital elevation model of the lake basin and the most recent available satellite images.**

For future volumes we need to:

- **Phase correlation for optical images**
- **Intensity correlation for SAR images**
- **Differential interferometry using double pass**
- **Single pass interferometry for DEM calculation**
- **Bathymetric curves calculated, 21 meters, including rapid penetration**