

# Occurrence and characteristics of rock glaciers in the Poiqu basin – central Himalaya

## 1. Background

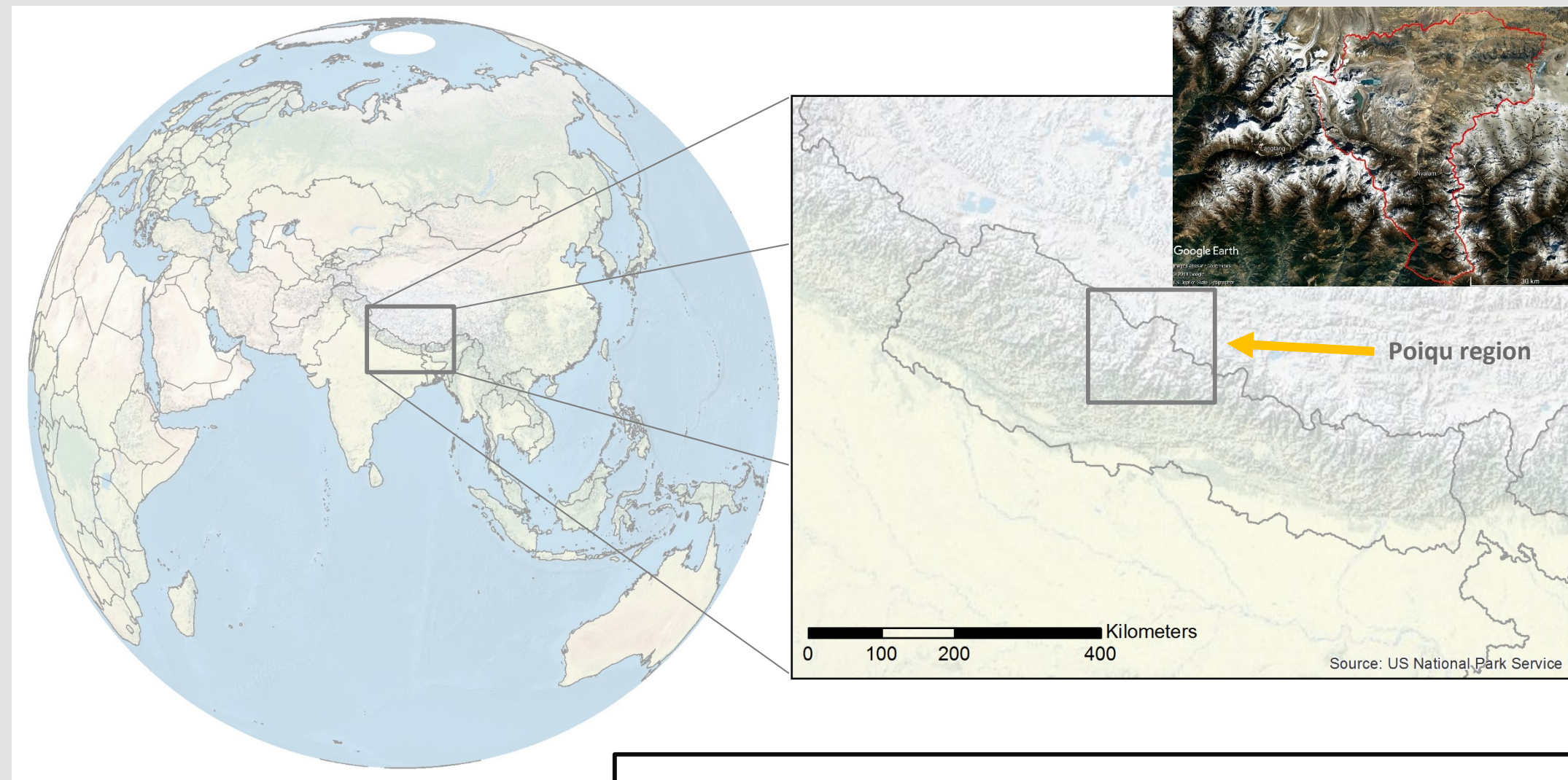
Rock glaciers (RG) in High Mountain Asia (HMA):

- RG are abundant, but information is rare
- meltwater from RG could be of interest for water supply
- RG could have serious hazard potentials when located above steep slopes or when damming lakes.

Poiqu study region (~1986 km<sup>2</sup>):

- transboundary mountain region between Nepal and China (watershed in China and the Bote Koshi/sun Koshi in Nepal)
- Mean elevation is 4898 m, minimum 1541 m and the maximum is 7993 m in the China territories
- Mean annual air temperature is relatively low (3.5°C at Nyalam weather station - 3750 m)
- South-westerly monsoon precipitation (South ~1100 mm, North ~700mm)

## Poiqu basin (~28°17'N, 85°58'E) – central Himalaya/Tibet



## Key findings

- High resolution imagery and DEM for RG determination necessary (< 3m res.)
- 370 RG overall (area: 21.2 km<sup>2</sup>)
- 147 RG can be classified as active
- RG mean altitude: ~5075 m a.s.l.
- DEM differencing challenging

## 2. Data

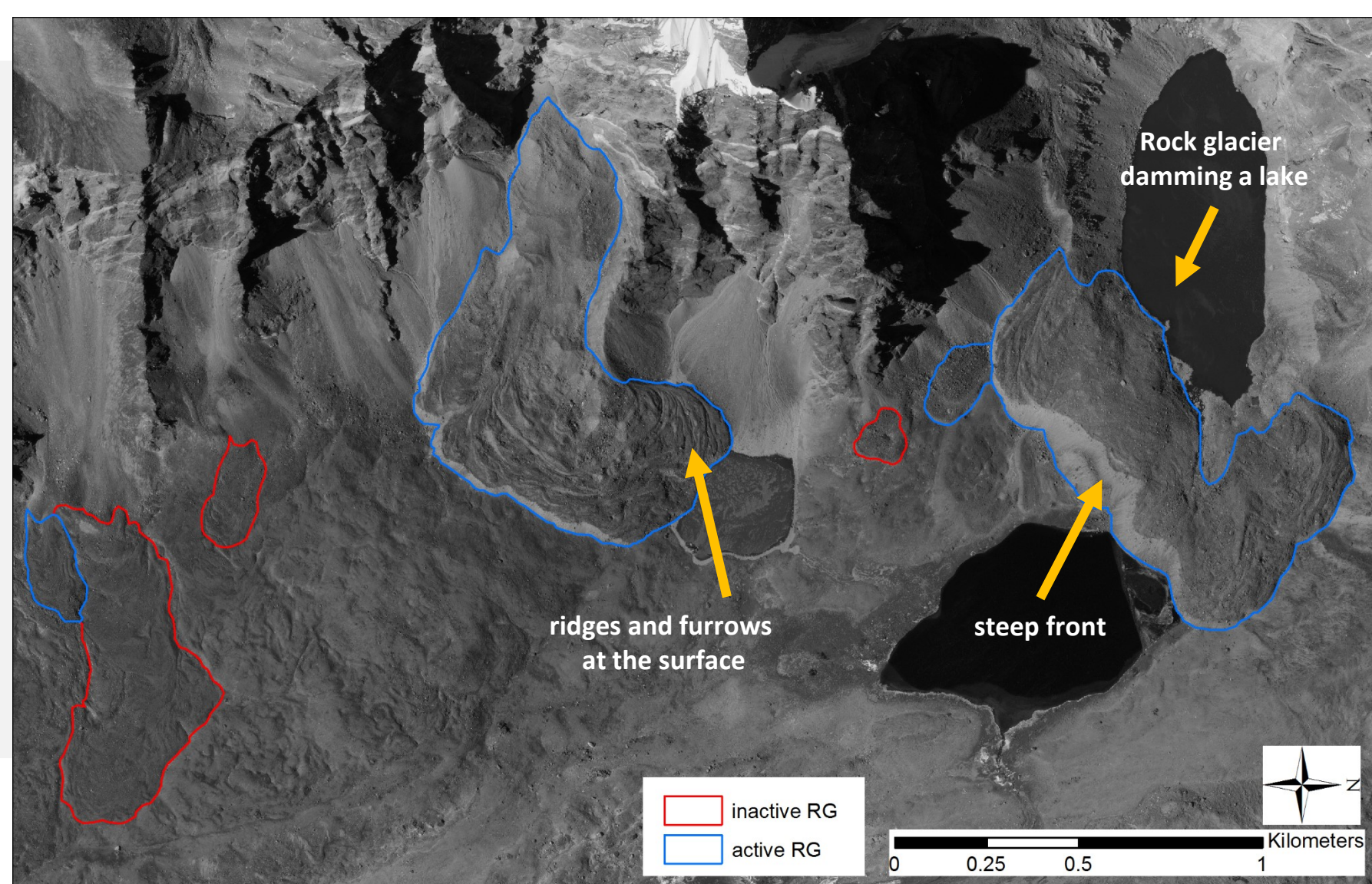
Dataset	Type	Resolution	Date
Pleiades	Optical	0.5	25.09.2018 – 04.11.2018
Pleiades DEM	Optical	1 m	25.09.2018 – 04.11.2018
SRTM DEM	Radar	30 m	11.02.2000
TanDEM X IDEM	Radar	90 m	12.12.2010 26.03.2012
ALOS-1 Palsar	Radar	10 m	16.07.2007,31.08.2007,16.10.2007, 16.01.2008,02.03.2008,02.06.2008, 18.07.2008

Pathframe	Interferogram	Time span (days)	Perpendicular baseline (m)
509/550	20070716-20070831	46	293
509/550	20080116-20080302	46	487
509/550	20071016-20080602	230	969
509/550	20070716-20080718	368	-832

## 3. Method

### 3.1 MAPPING

- Manual mapping based on optical Pleiades imagery with 0.5m resolution
- Rock glaciers were identified based on their characteristic shape and their surface structure.

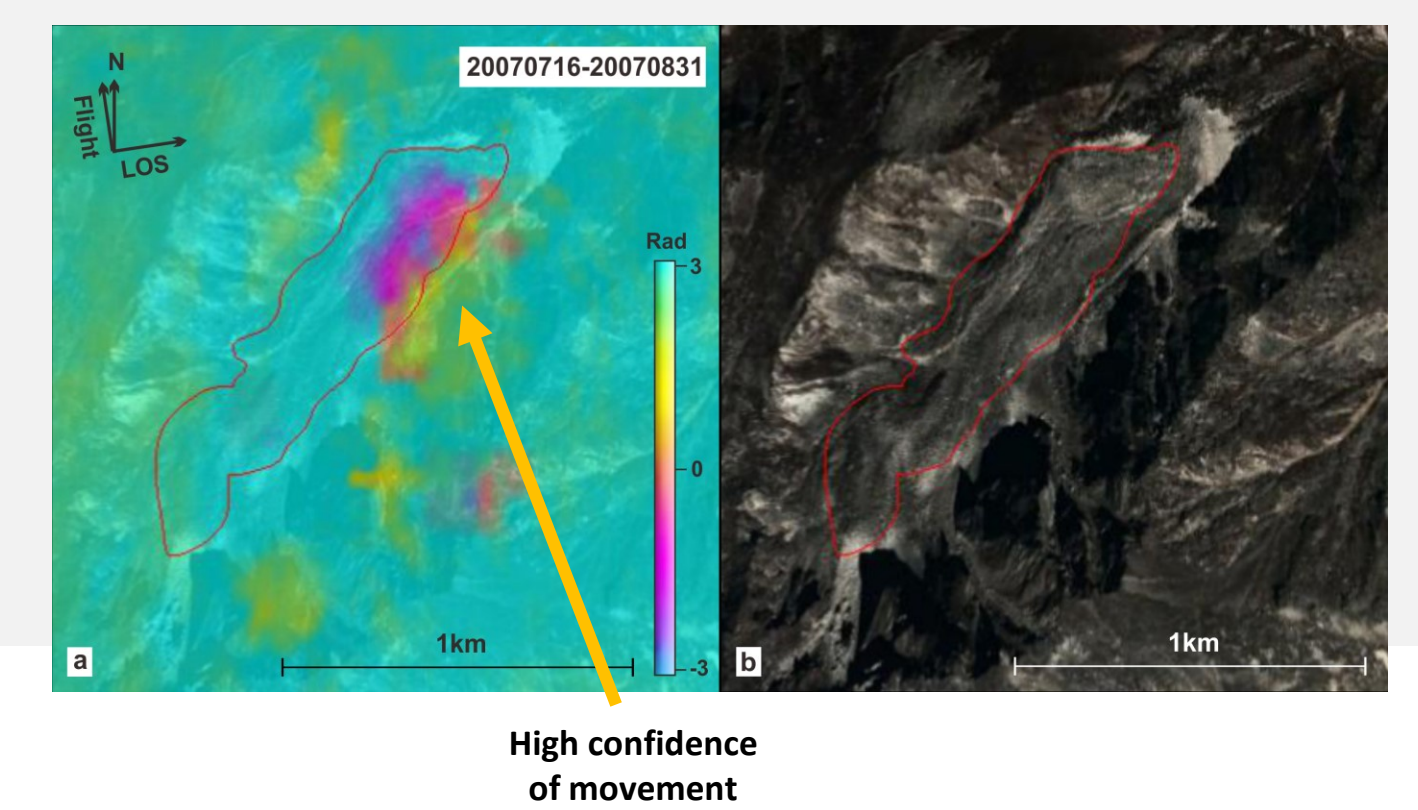


### 3.2 DEM CREATION

- A Pleiades DEM, derived from the Pleiades tri-stereo bundle images using Rational Polynomial Function (RPC) model in PCI, was created and used it for a) creating a hillshade to support rock glacier identification and b) to derive their topographical parameters.
- Planimetric adjustment, on average 10 well-distributed GCPs (collected from S2) for each tri-stereo pair.
- sensor model improved by using 100 tie points
- epipolar pairs calculated from forward, nadir and backward looking views
- Semi Global Matching with filter to generate 1m DEMs
- DEMs mosaicked with same spatial resolution.

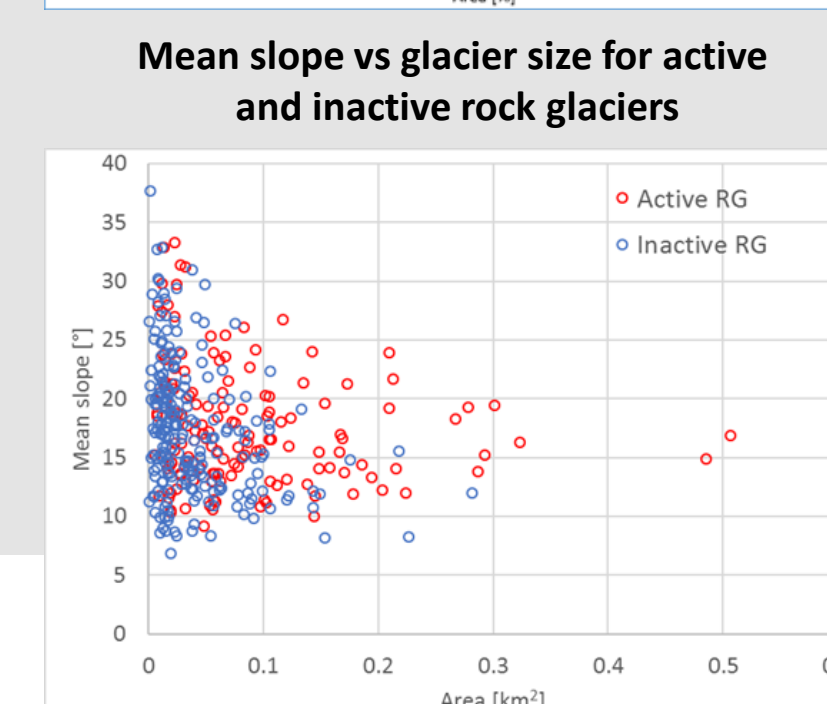
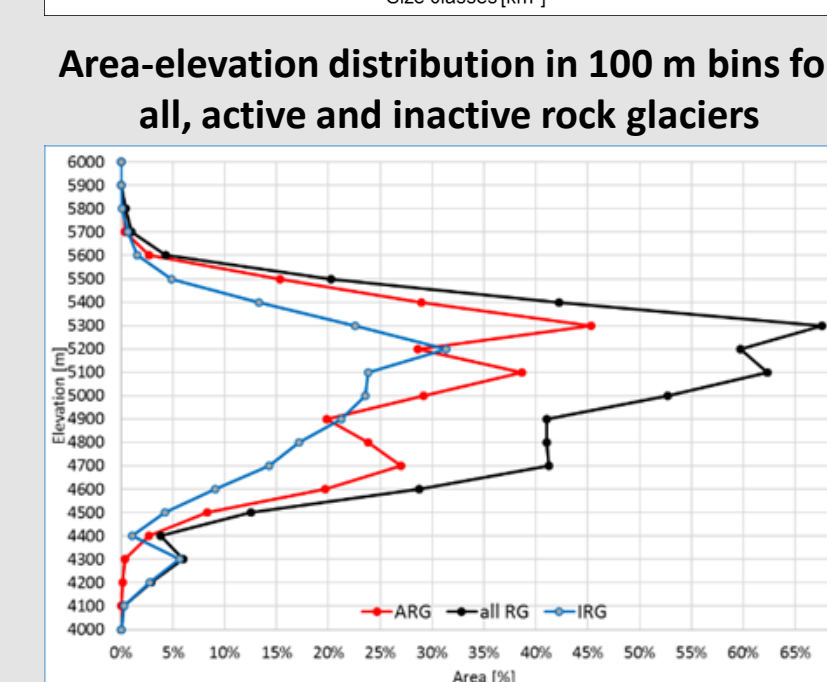
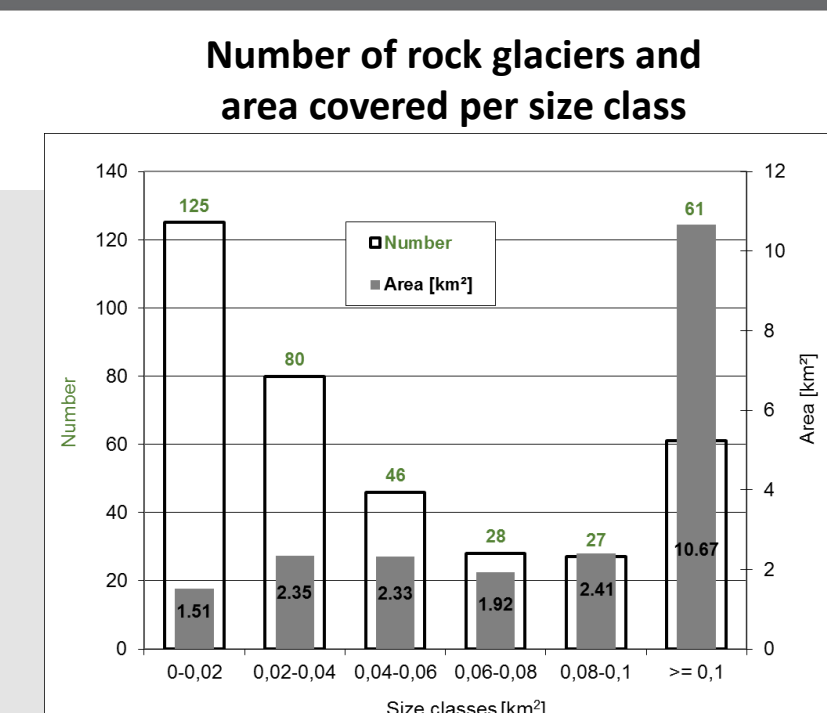
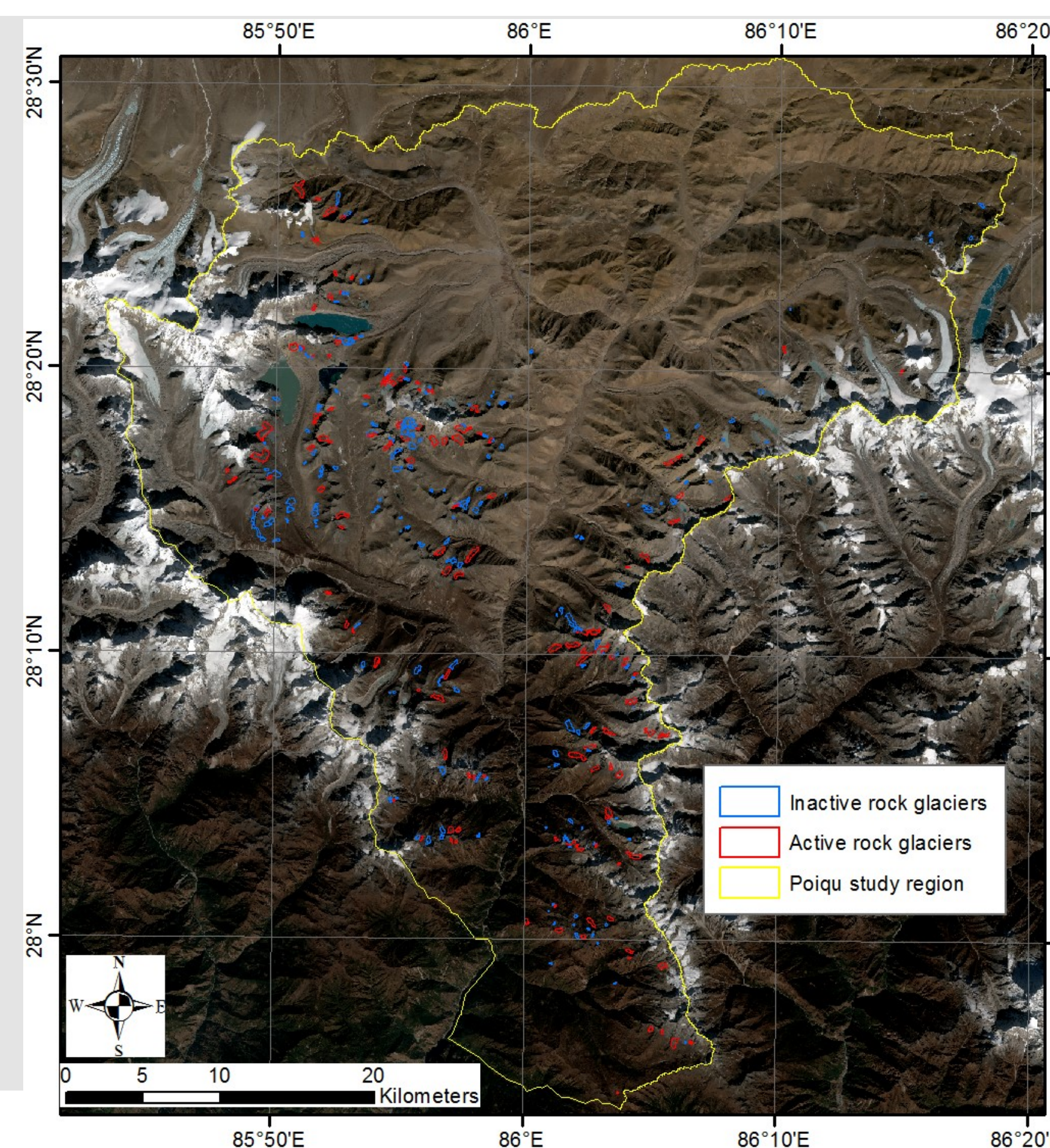
### 3.3 InSAR

Additional information on their activity of the rock glaciers was provided by the InSAR technique using ALOS-1 data.

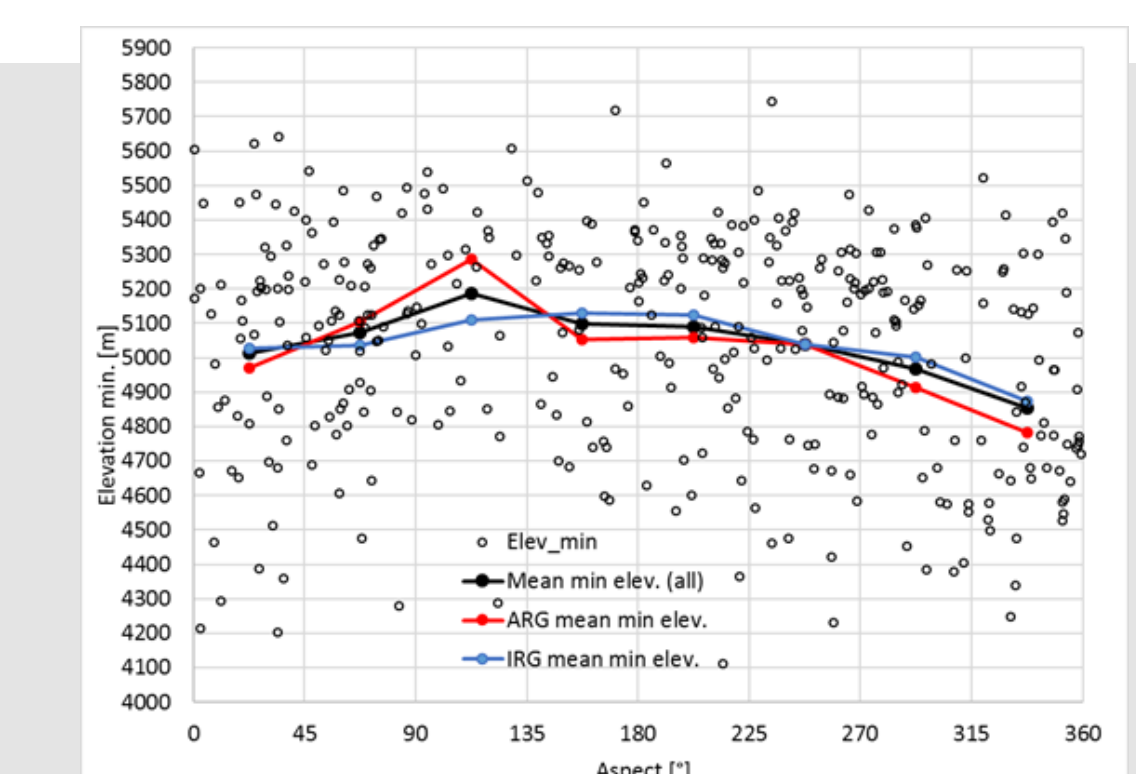


## 4. Results

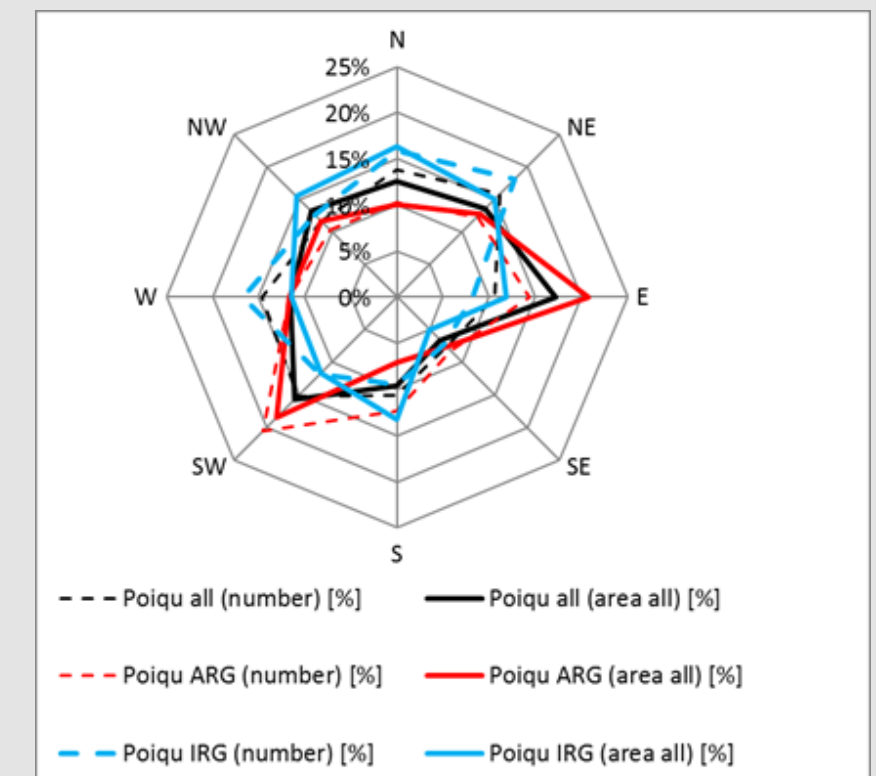
- Rock glacier inventory for the Poiqu basin (28°17'N, 85°58'E) – central Himalaya/Tibet
- 370 rock glaciers covering an area of about 21.2 km<sup>2</sup>.
- Rock glaciers are located between 3715 m and 5850 m with a mean altitude of ~5075 m a.s.l.
- mean slope of all rock glaciers is close to 17.4° (min. 6.8°, max. 37.6°)
- rock glaciers face towards the Northeast (19%) and West (18.5%)
- 147 rock glaciers can be classified as active
- rock glaciers damming lakes and above roads located were found which could threaten the infrastructure in case of instability



### Minimum elevation vs. rock glacier aspect and sector averages for all, active and inactive rock glaciers



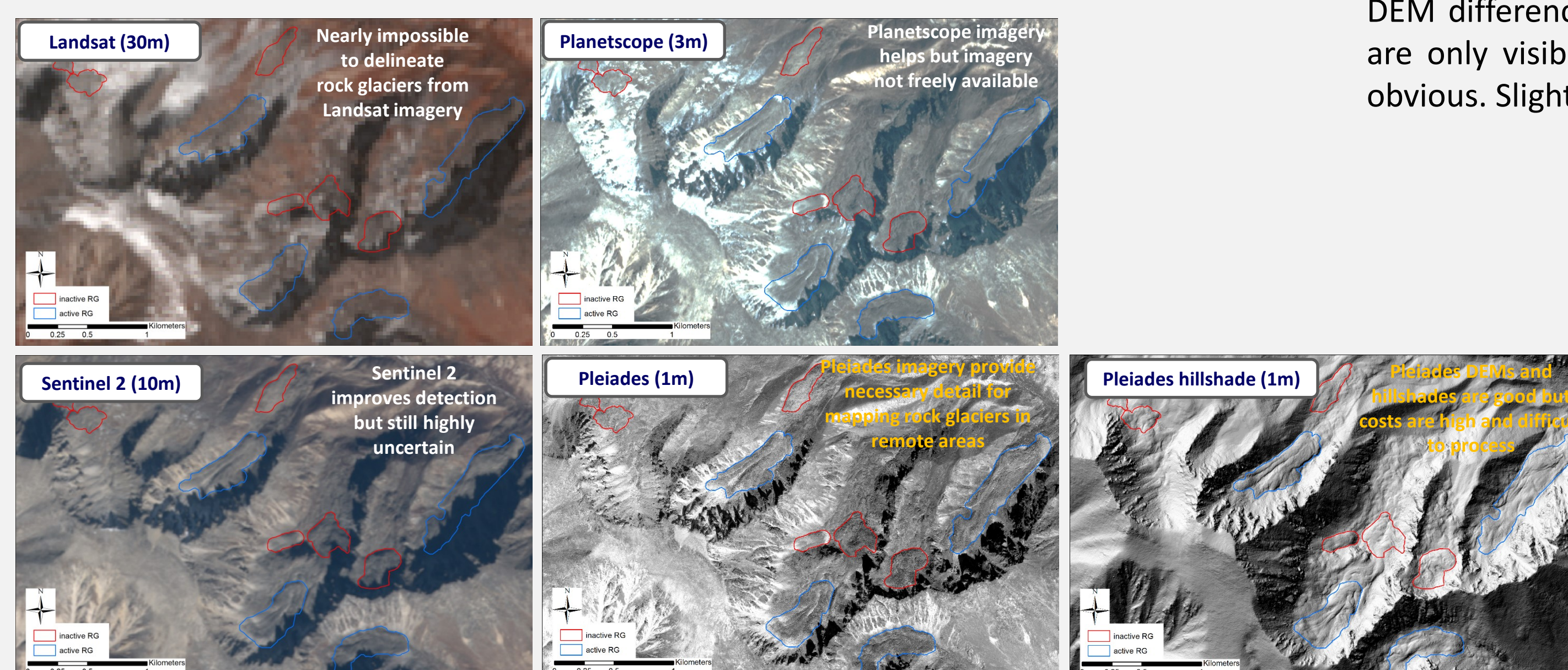
### Area distribution versus aspect per sector for all, active and inactive rock glaciers



## 5. Discussion

### 5.1 MAPPING

Preliminary results of rock glacier mapping of the same region, which were based on Sentinel 2 images with 10 m resolution and the 8 m High Mountain Asia DEM revealed slightly less rock glaciers (362) in numbers and but indicated a much larger rock glacier area (>40 km<sup>2</sup>). We conclude that high resolution data is of utmost importance when creating a rock glacier inventory.



### 5.2 DEM DIFFERENCING

DEM differencing is challenging on rock glaciers. Distinct elevation differences are only visible on glaciers. Elevation differences on rock glaciers are not so obvious. Slight mass gain on rock glaciers is visible.

