



Glaciers\_cci

# Remote Sensing of Glaciers and Ice Caps

## Glacier hazards

Andreas Kääb

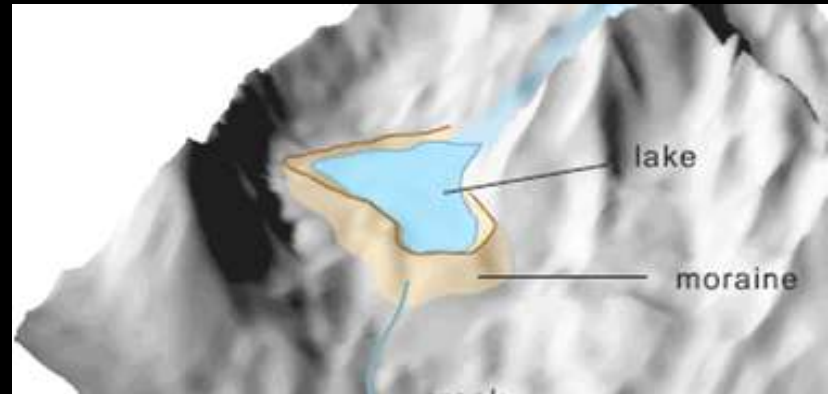
*Department of Geosciences, University of Oslo*

*kaeaeb@geo.uio.no, <http://folk.uio.no/kaeaeb>*

- Cases and processes



- New challenges



- Air- and spaceborne remote sensing



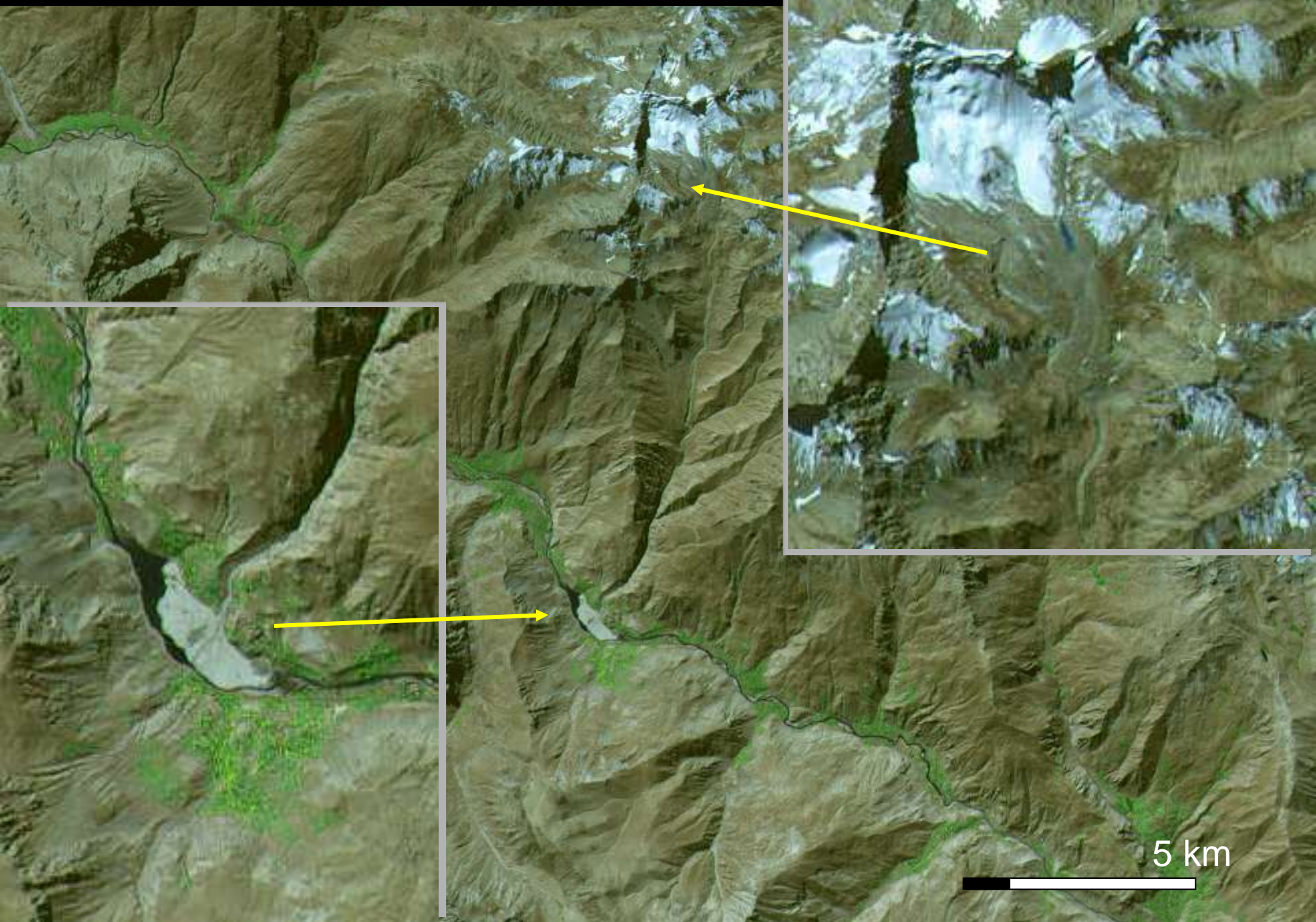
- Final remarks



# Shahdara (Tadjikistan/Pamirs): 7 Aug 2002, 1.2mio m<sup>3</sup>, 24†



# Shahdara (Tadjikistan/Pamirs)



Mauvasin / Giéto: 1818, 20 mio m<sup>3</sup>, 44†



# Perito Moreno



# Afghanistan



# Ice avalanches (Gutz glacier, Swiss Alps, 1996)





Caucasus/Kazbek, 20 September 2002



International Space Station

Up to 300 km/h fast



I. Galushkin

Karmadon, 18 km and 5 minutes later, 120 Mio m<sup>3</sup> , 130 †



I. Galushkin

Mudflow, another 15 km far



# Huascaran, 1970, 18000+



T. Hatakeyama



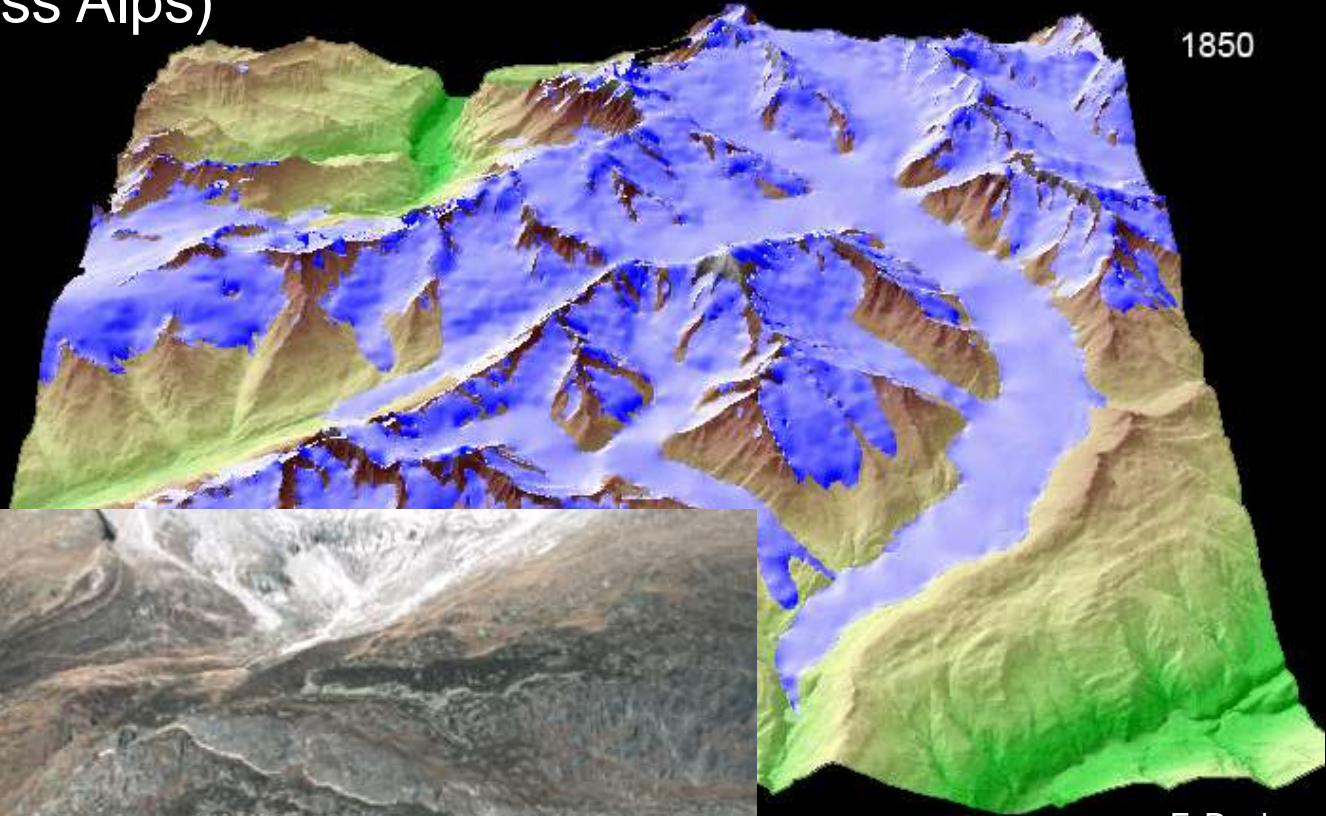
G. Plafker



# Elbrus (Caucasus)



# Aletsch Glacier (Swiss Alps)



F. Paul

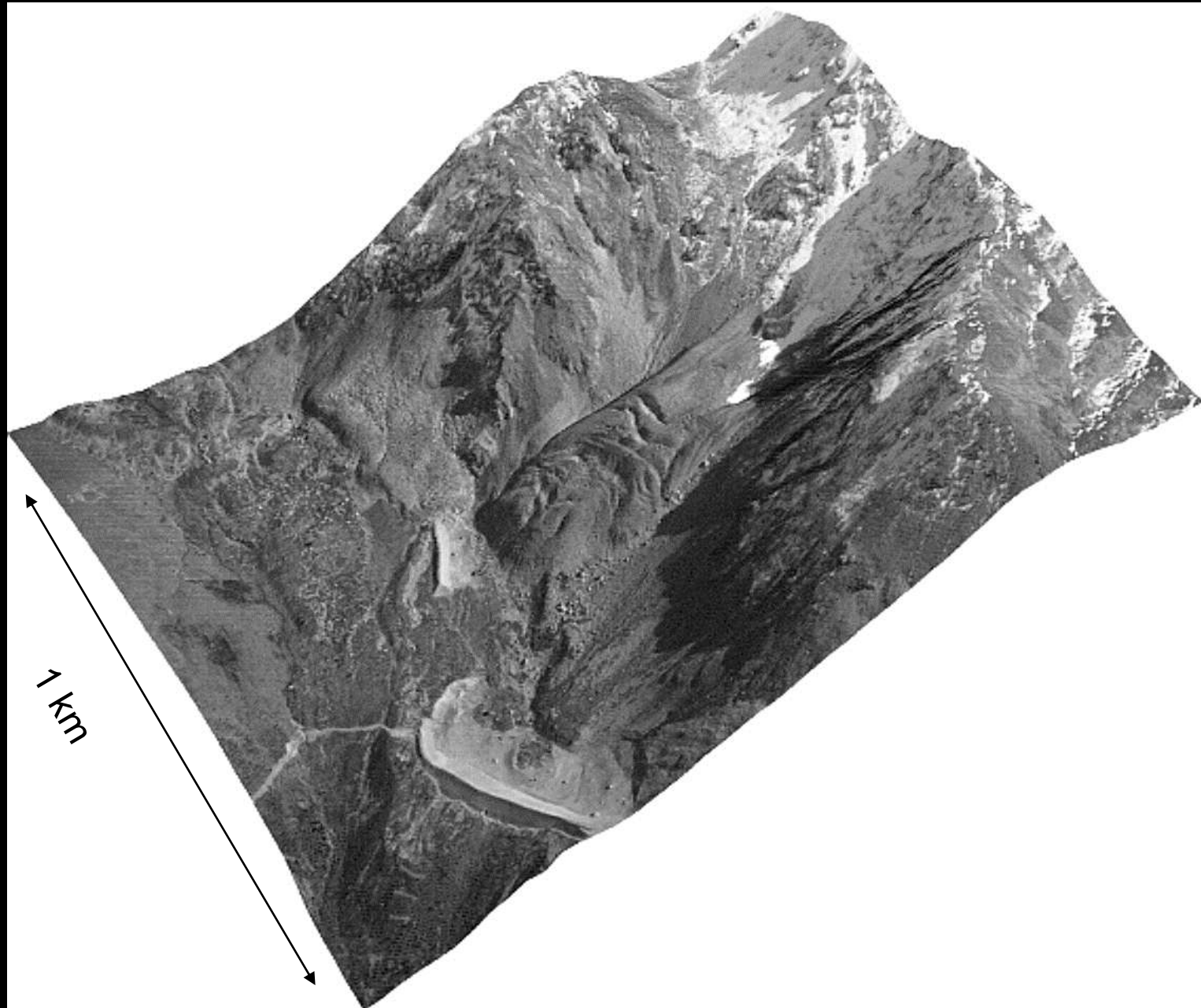
# Debris flows from permafrost







# Instability of perennially frozen debris



# Permafrost - ice - geology interactions



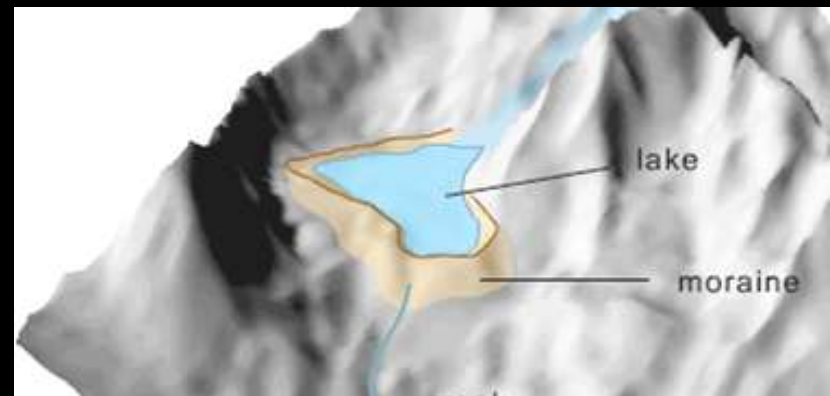
0 to -5°C

-5 to -10°C

- Cases and processes



- New challenges



- Air- and spaceborne remote sensing



- Final remarks



- Climate change induces shifts of cryospheric hazard zones beyond historical limits
  - Human activities extend towards endangered zones  
> increasing vulnerability
  - Chain reactions
- 
- >>> Historical data alone not any more sufficient for hazard assessment
  - >>> Remote sensing + spatial modelling needed

- Cases and processes



- New challenges



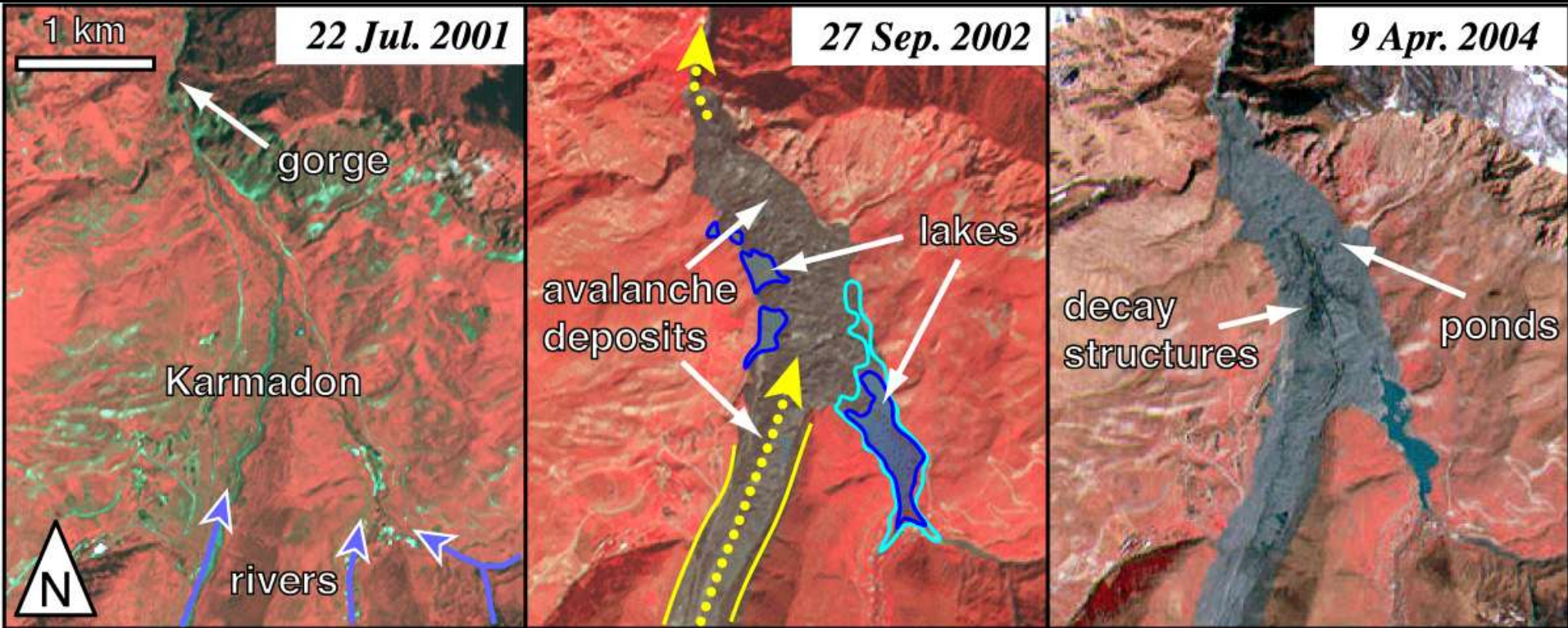
- Air- and spaceborne remote sensing



- Final remarks



# Karmadon

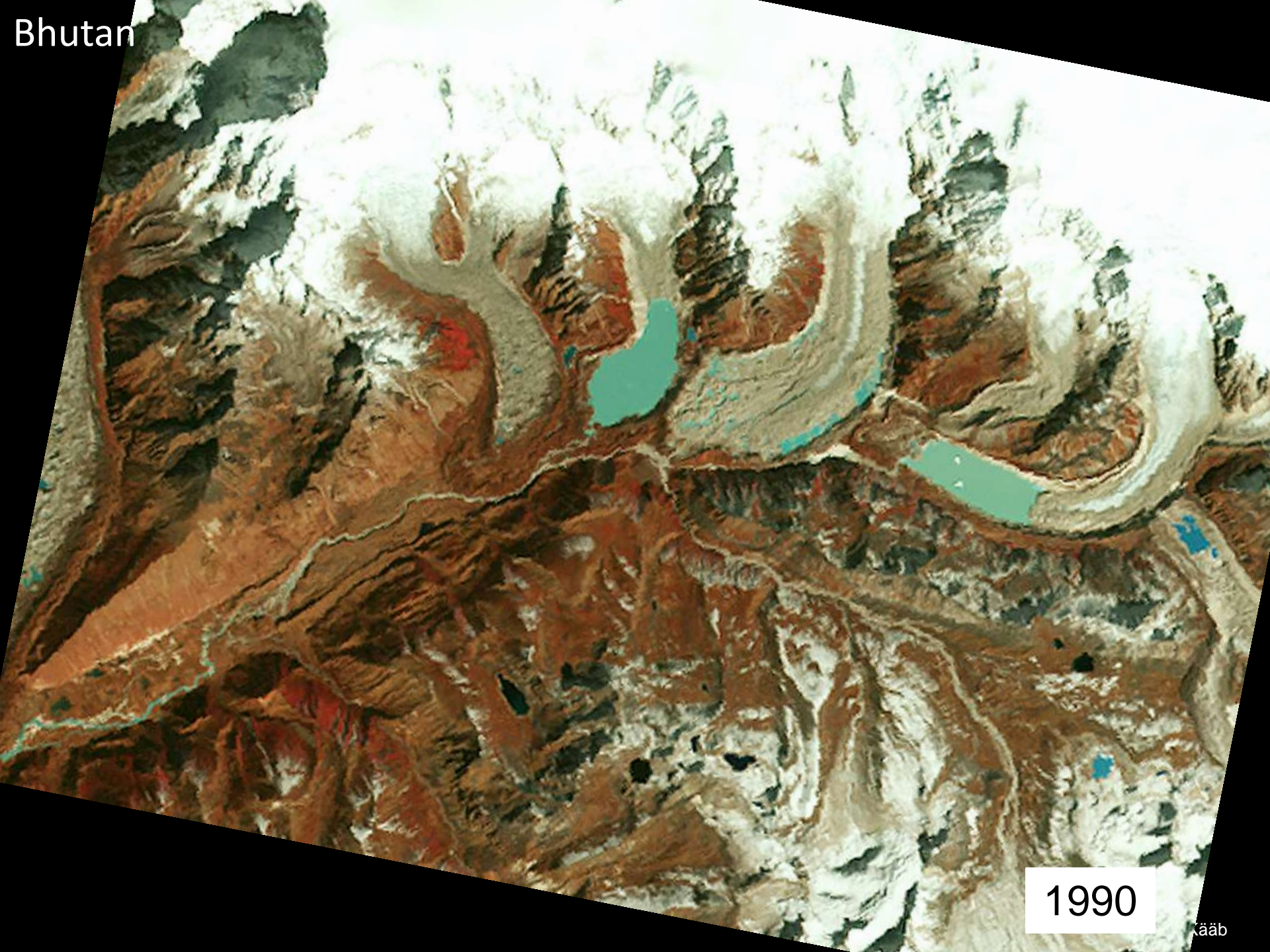


Lugge Tsho (Bhutan): 7 Oct 1994, 28mio m<sup>3</sup>, >20†





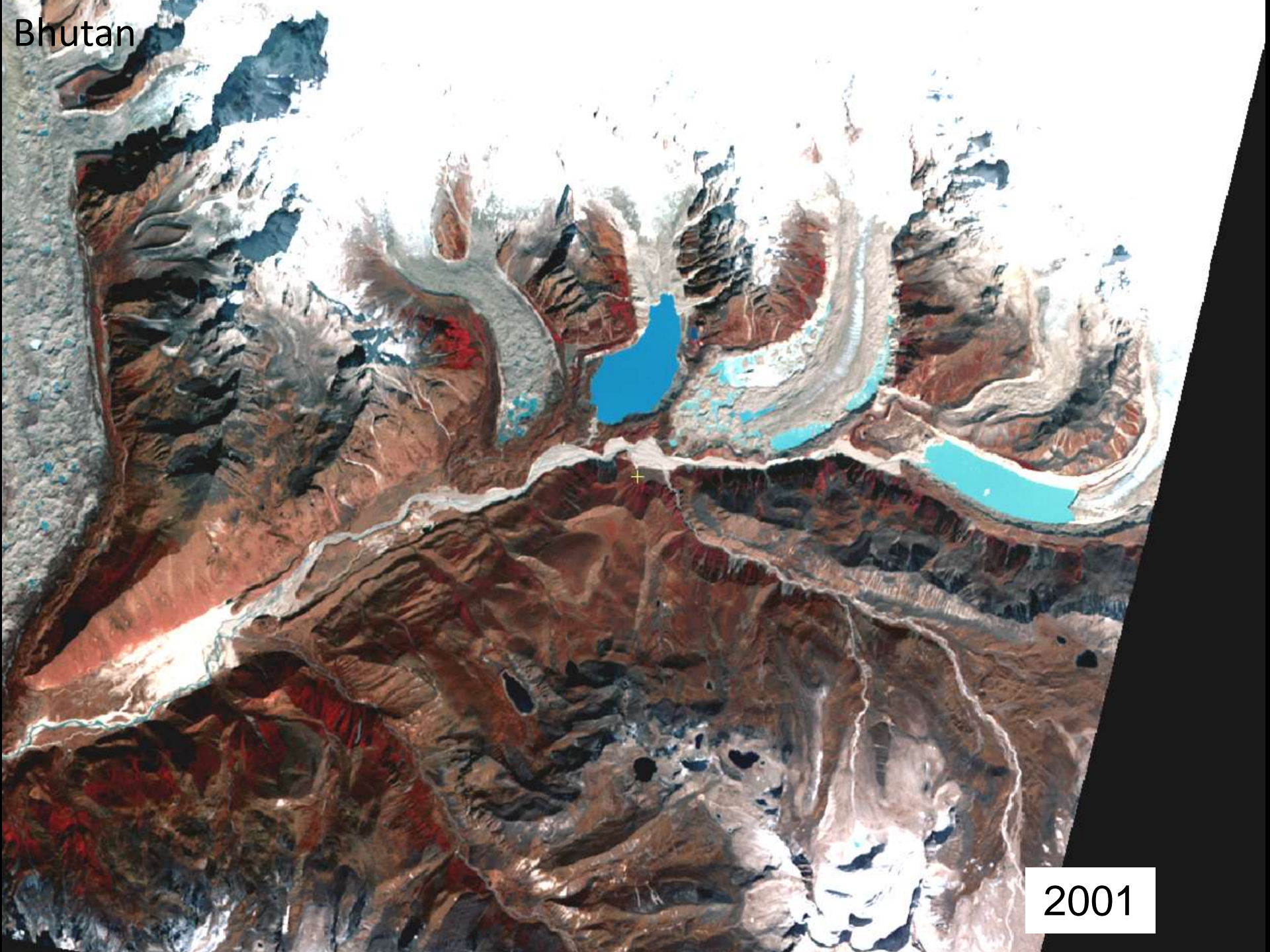
Bhutan



1990

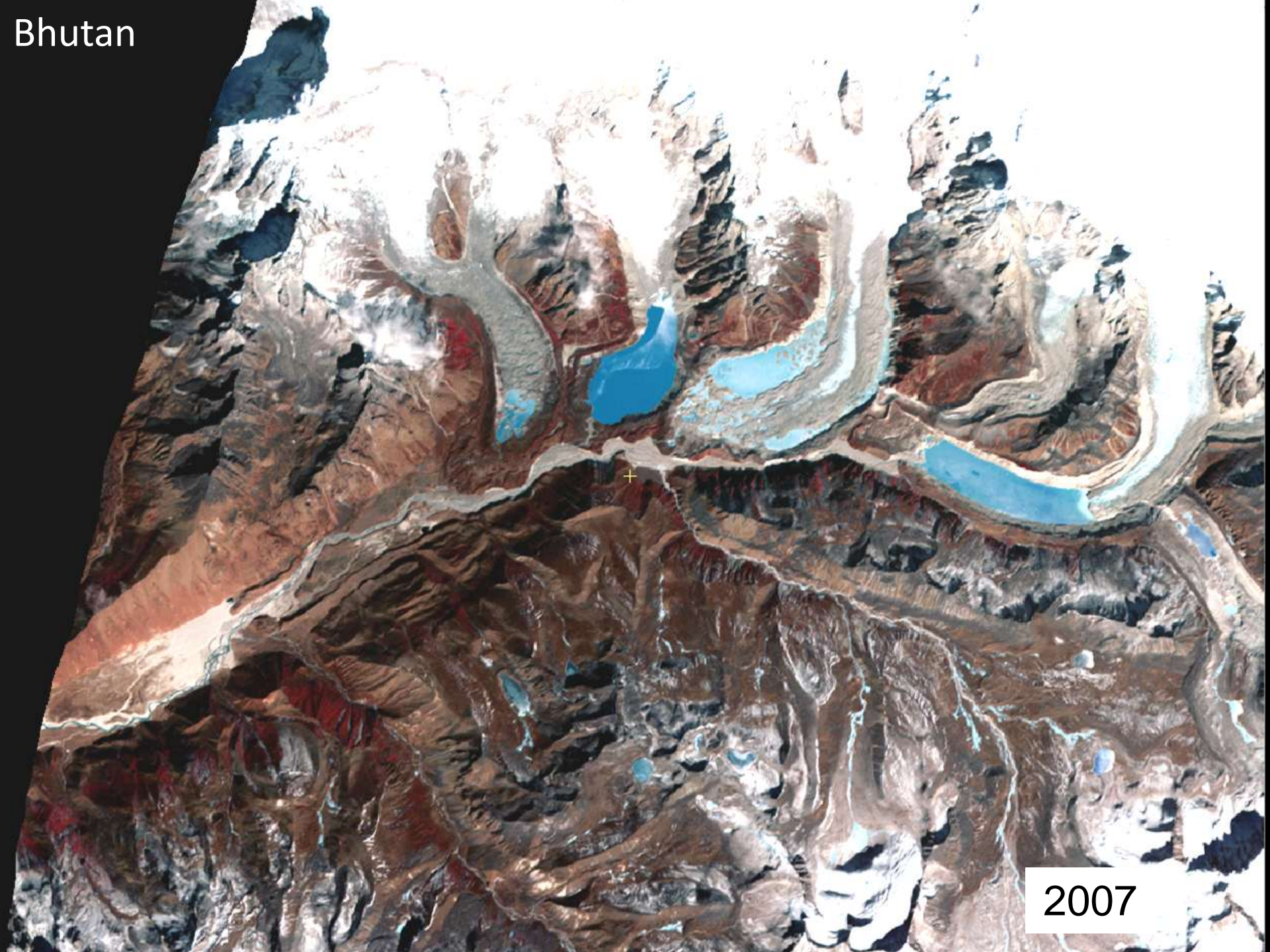
kaab

Bhutan

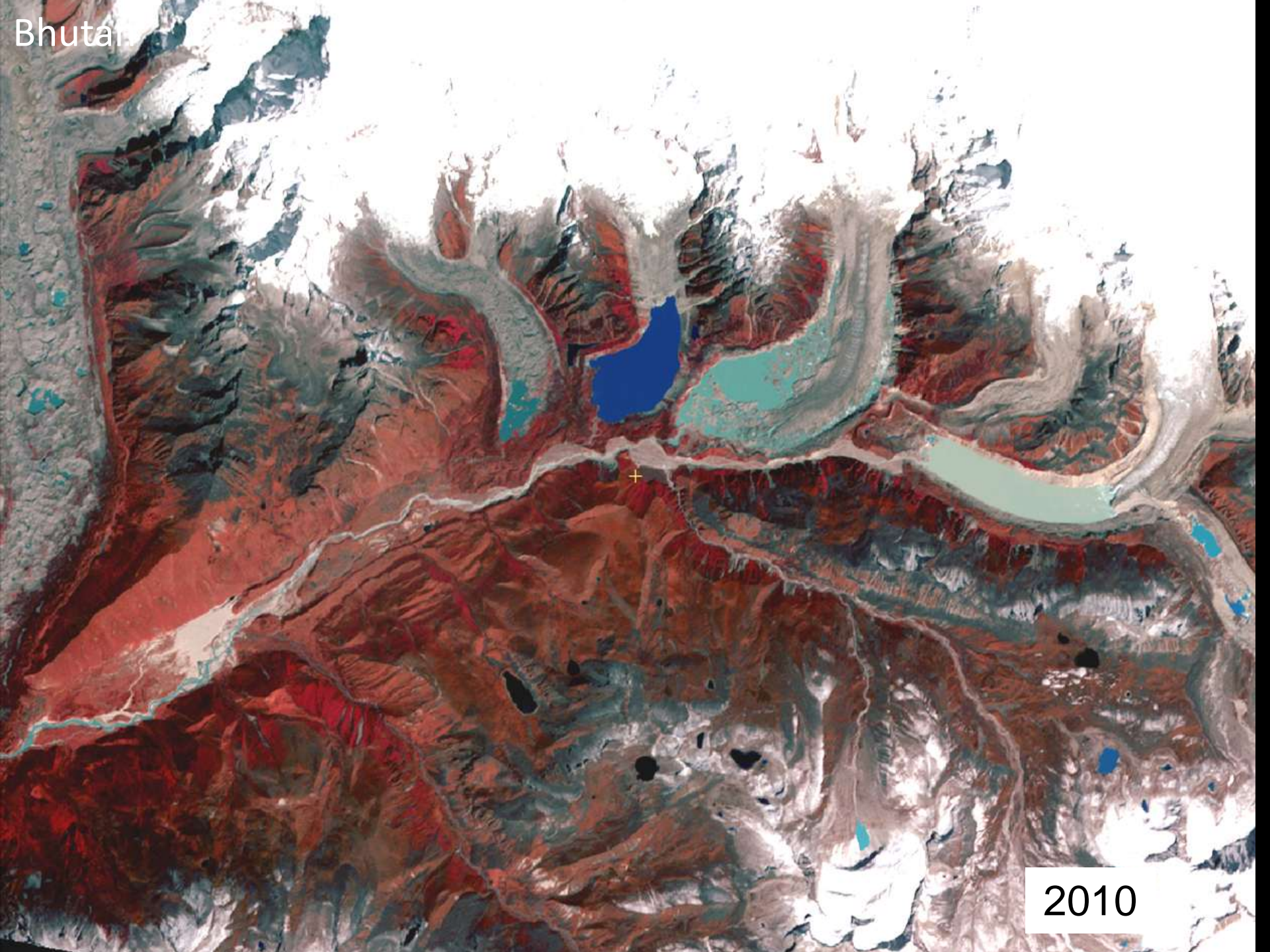


2001

Bhutan

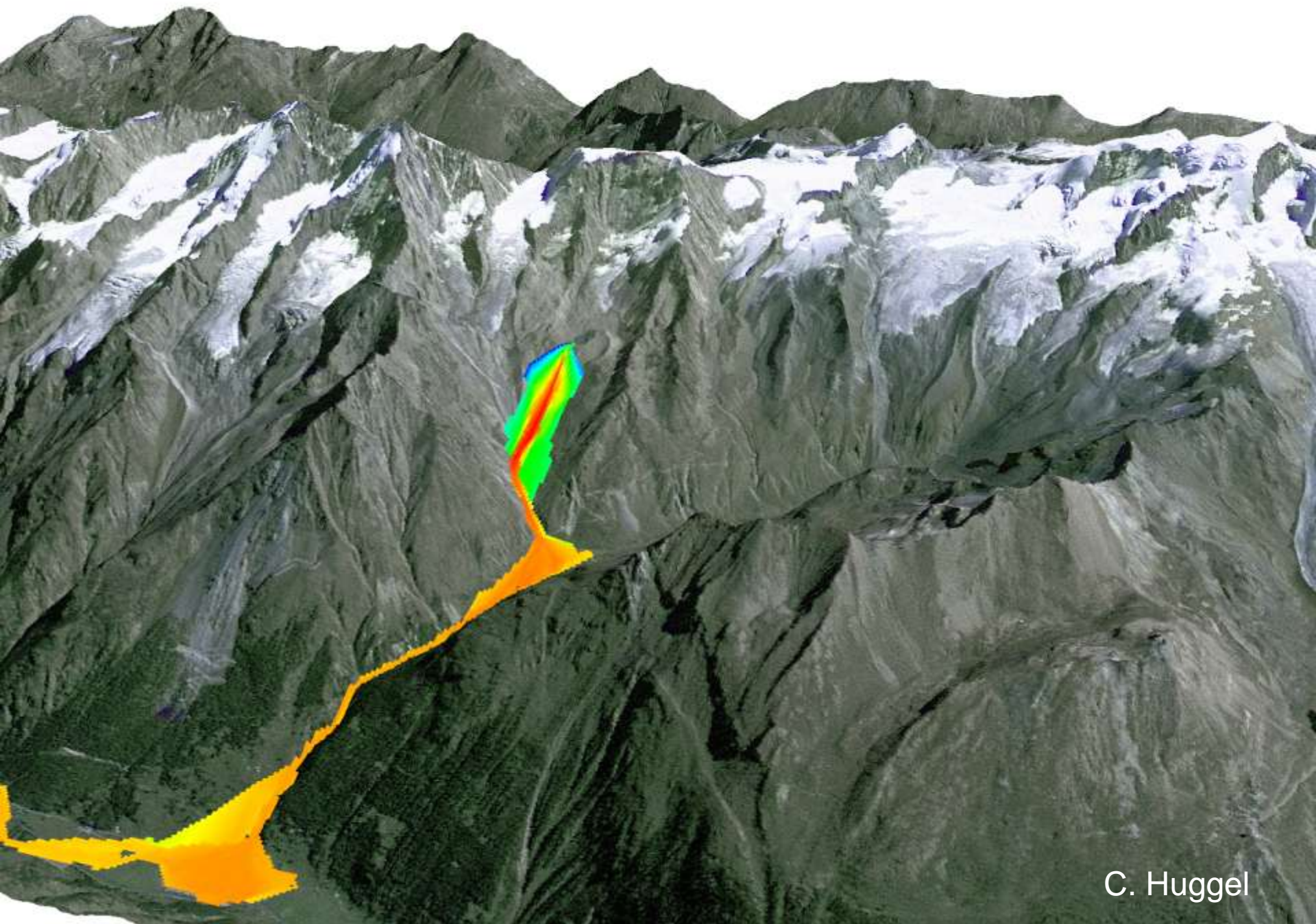


2007

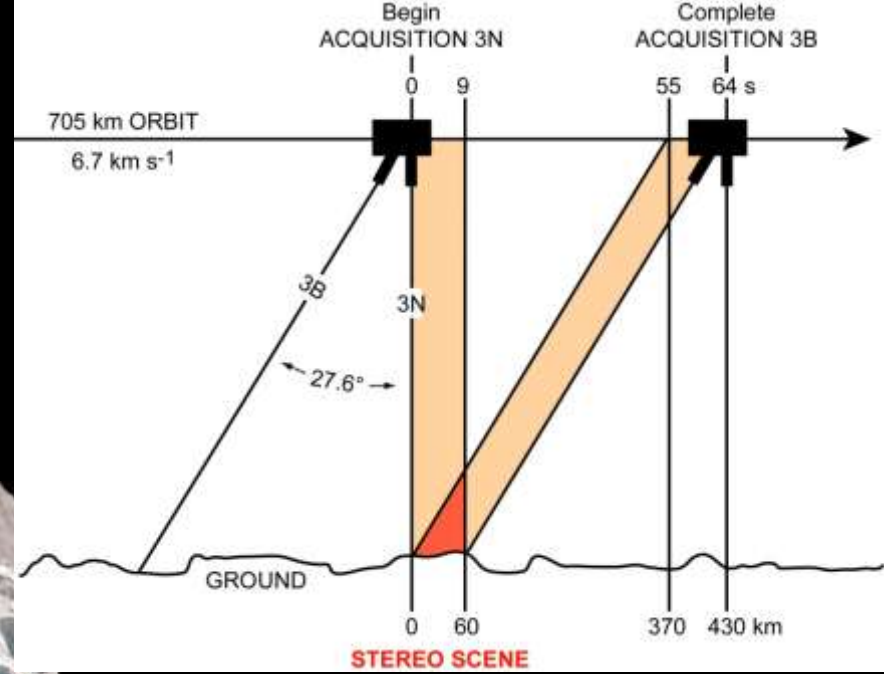
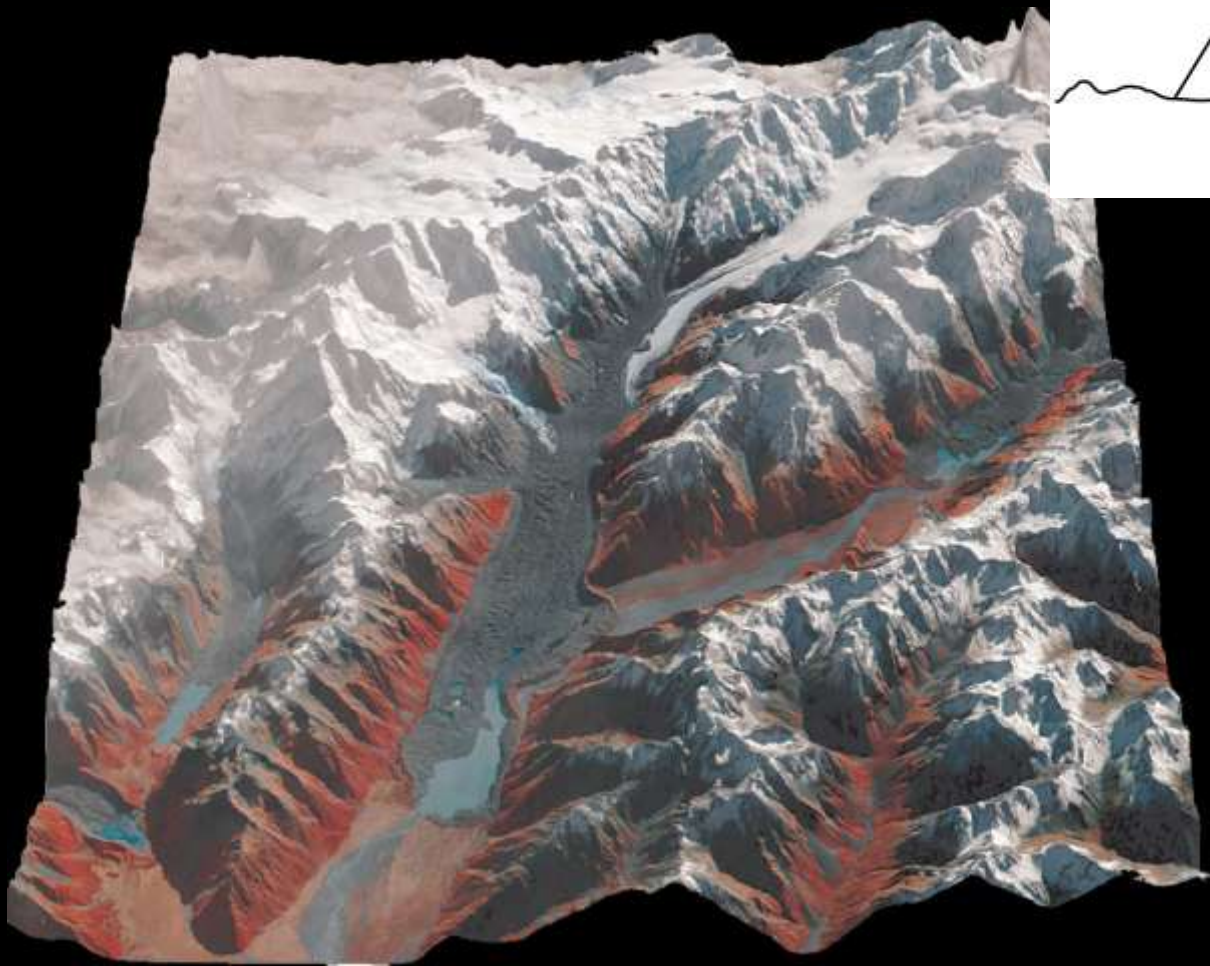


Bhutan

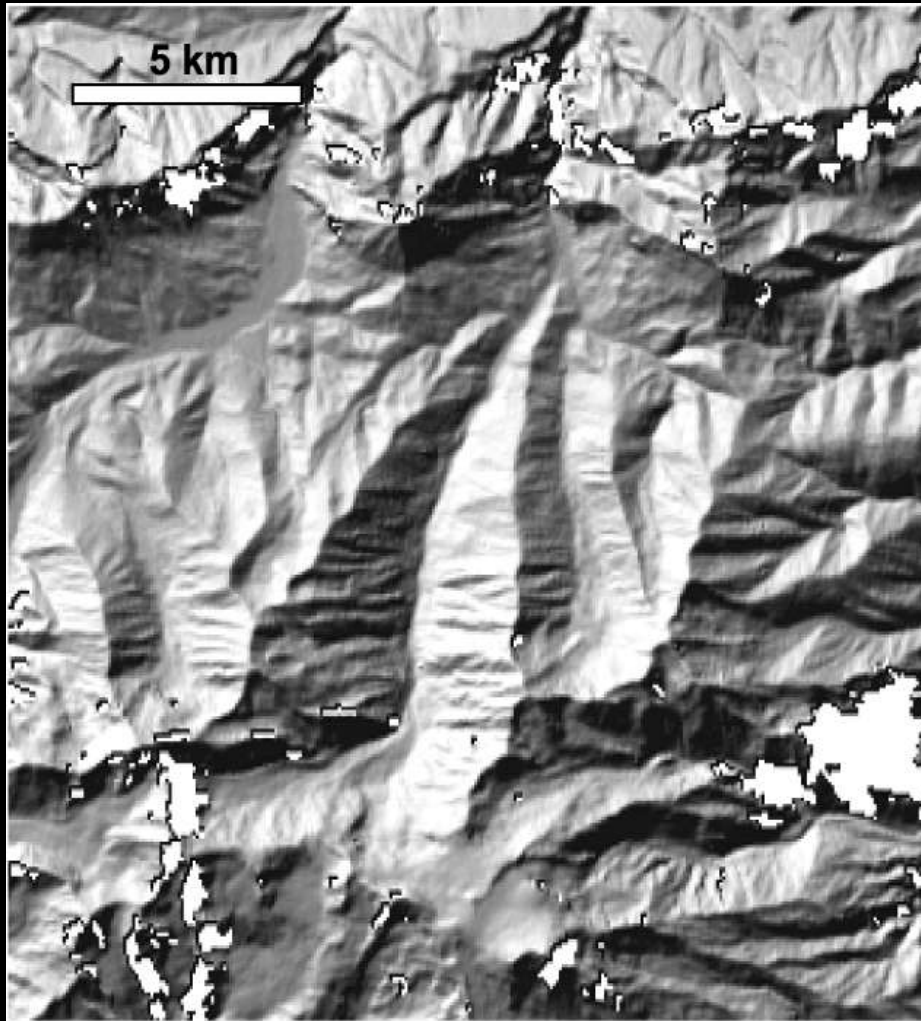
2010



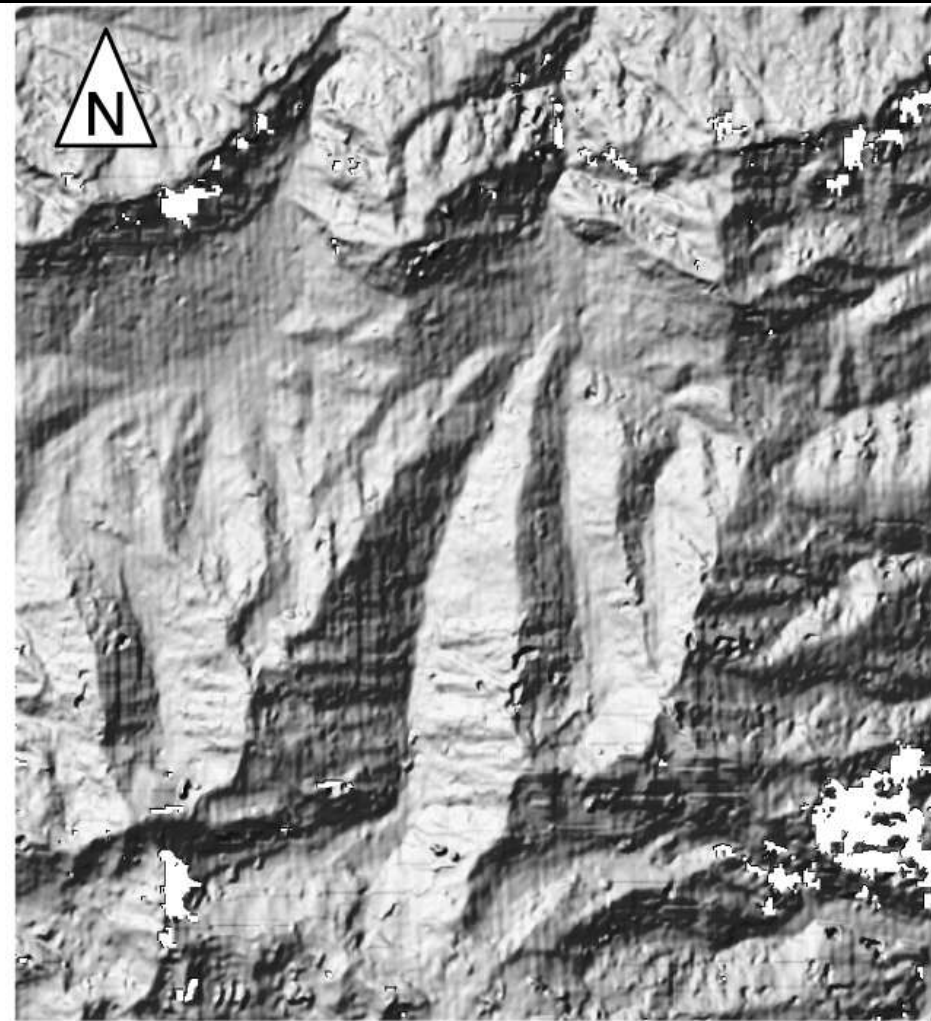
# Elevation models



# Elevation differences

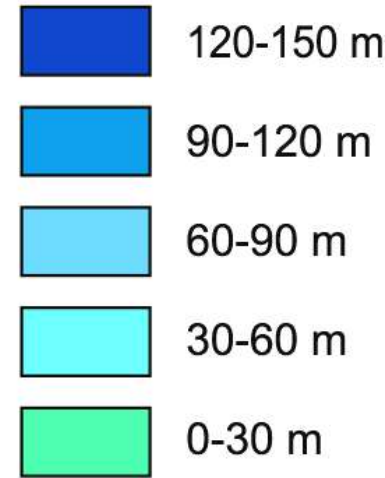
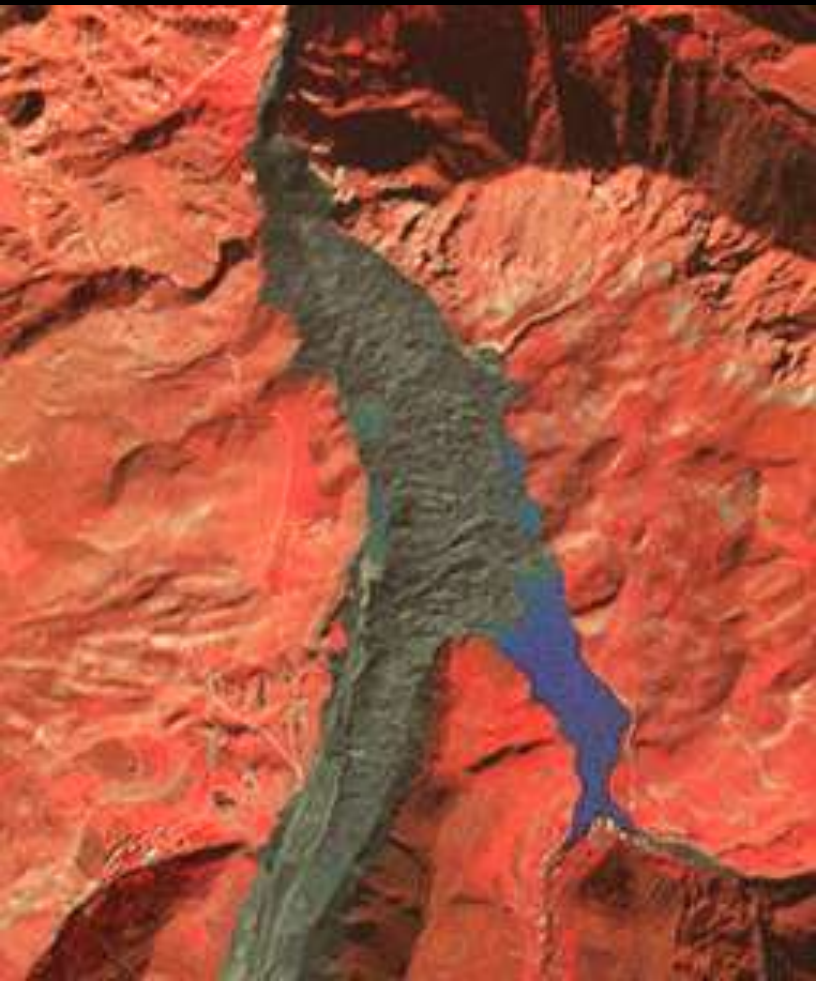


SRTM3



ASTER

# Elevation differences



ASTER 2002 - SRTM 2000

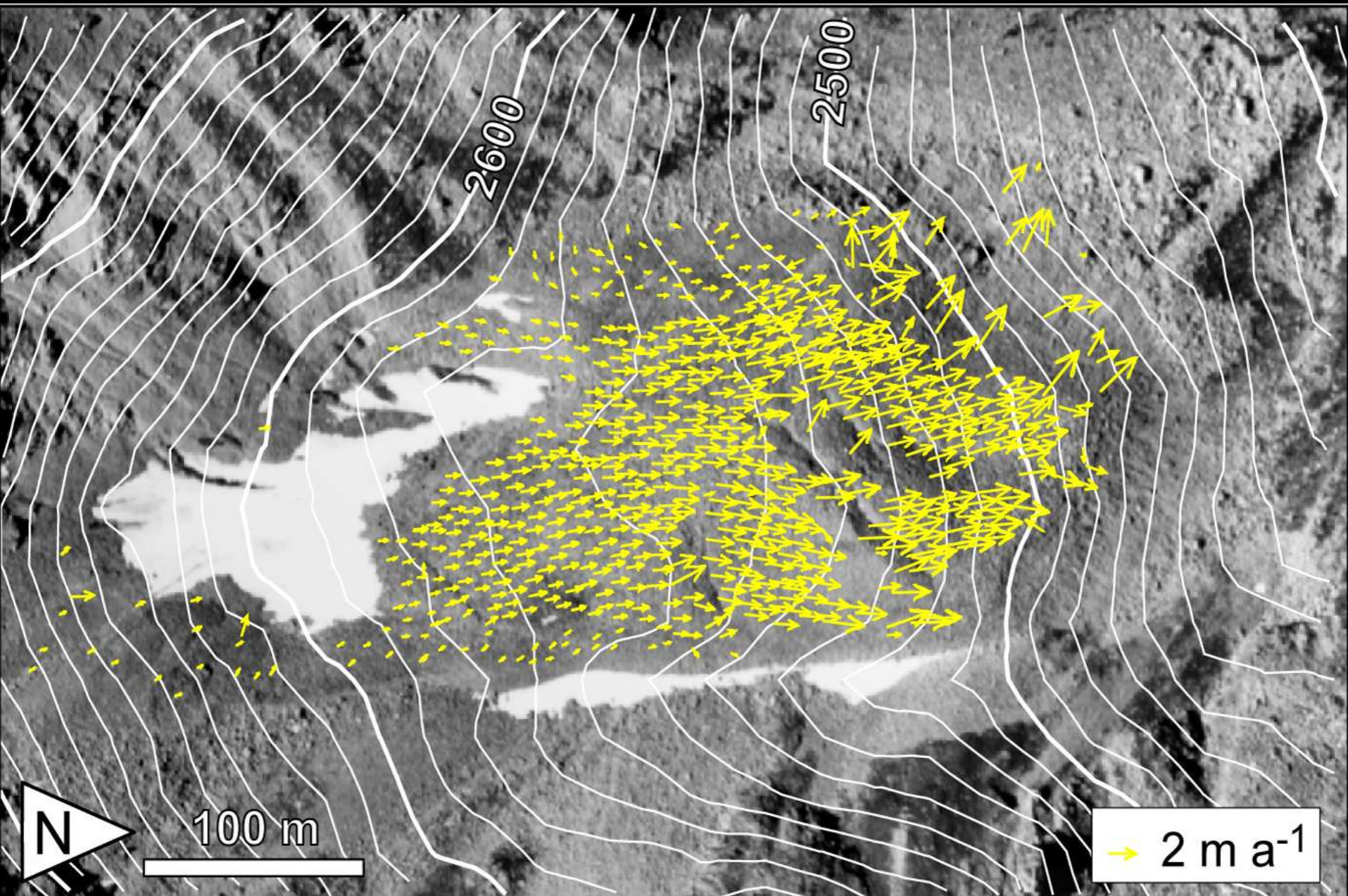


# Turtmann valley: instability of creeping permafrost



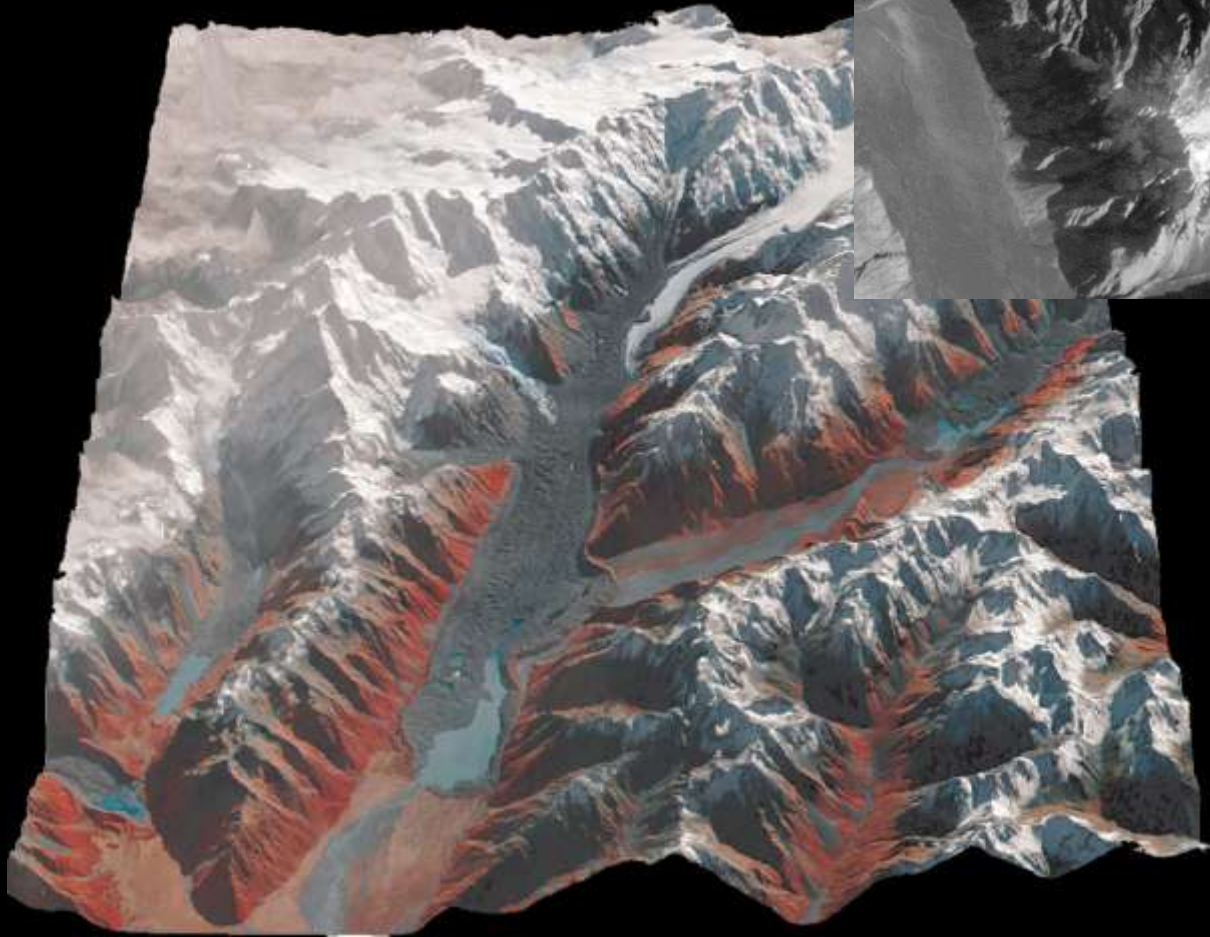
1975

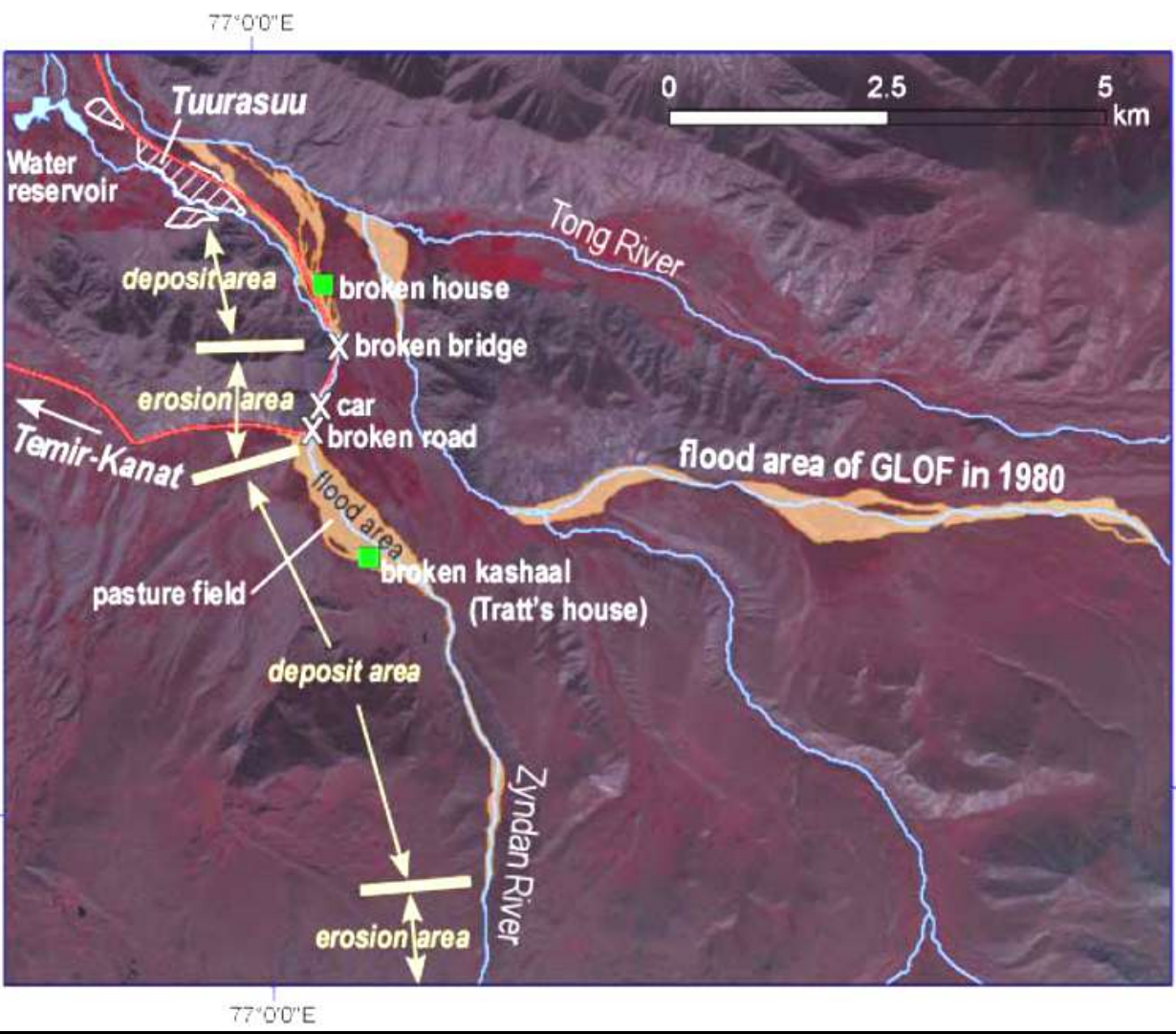
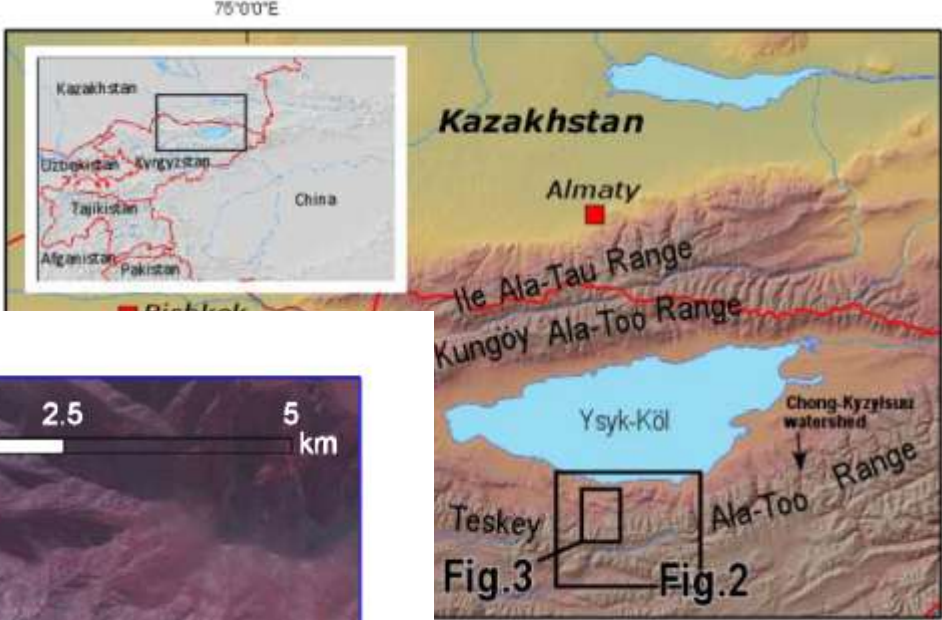
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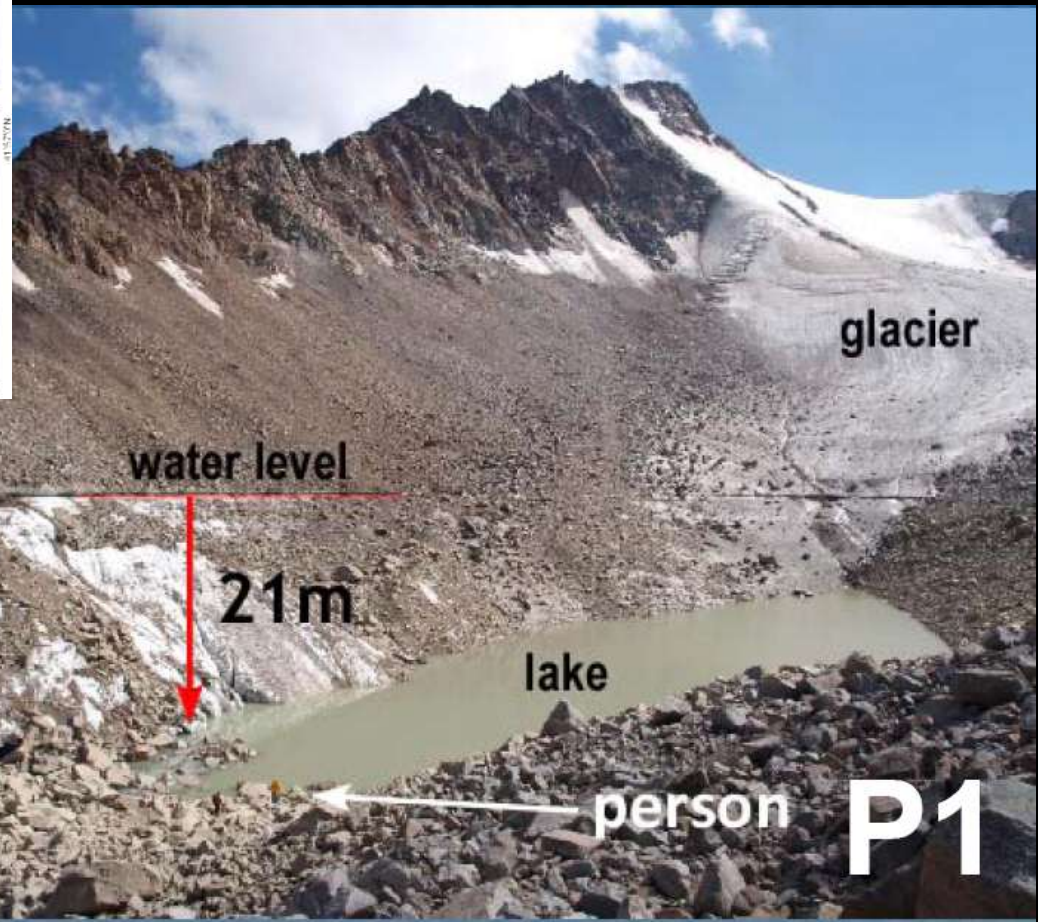
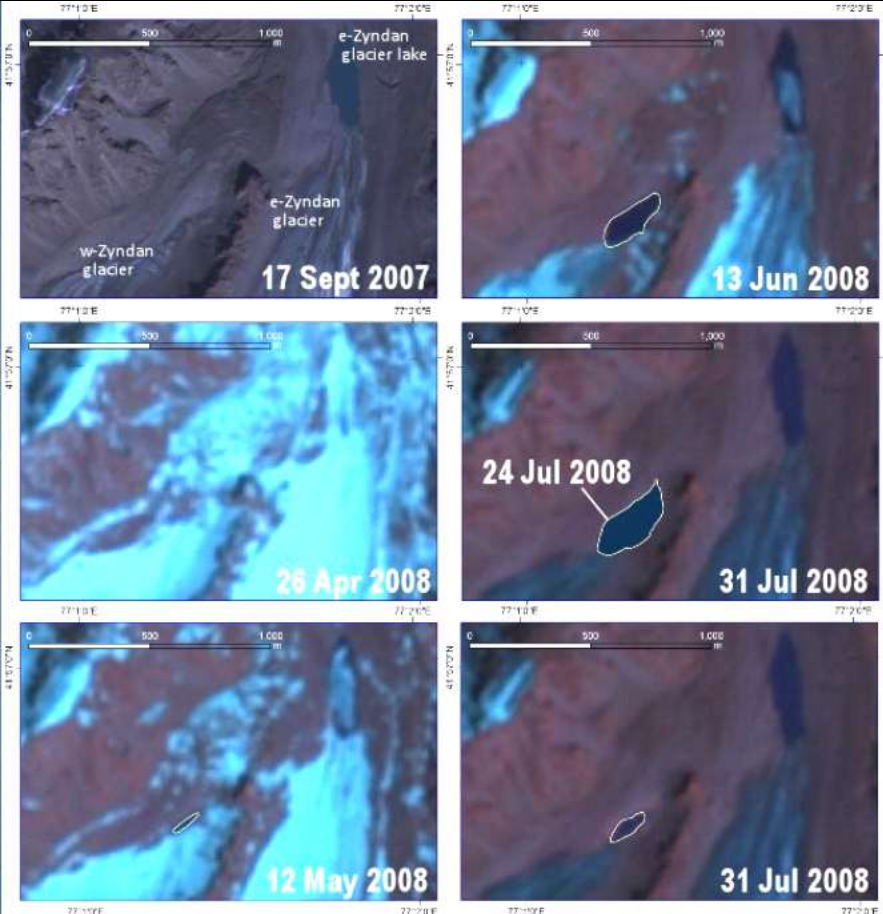


# Tasman Glacier

Apr 2000







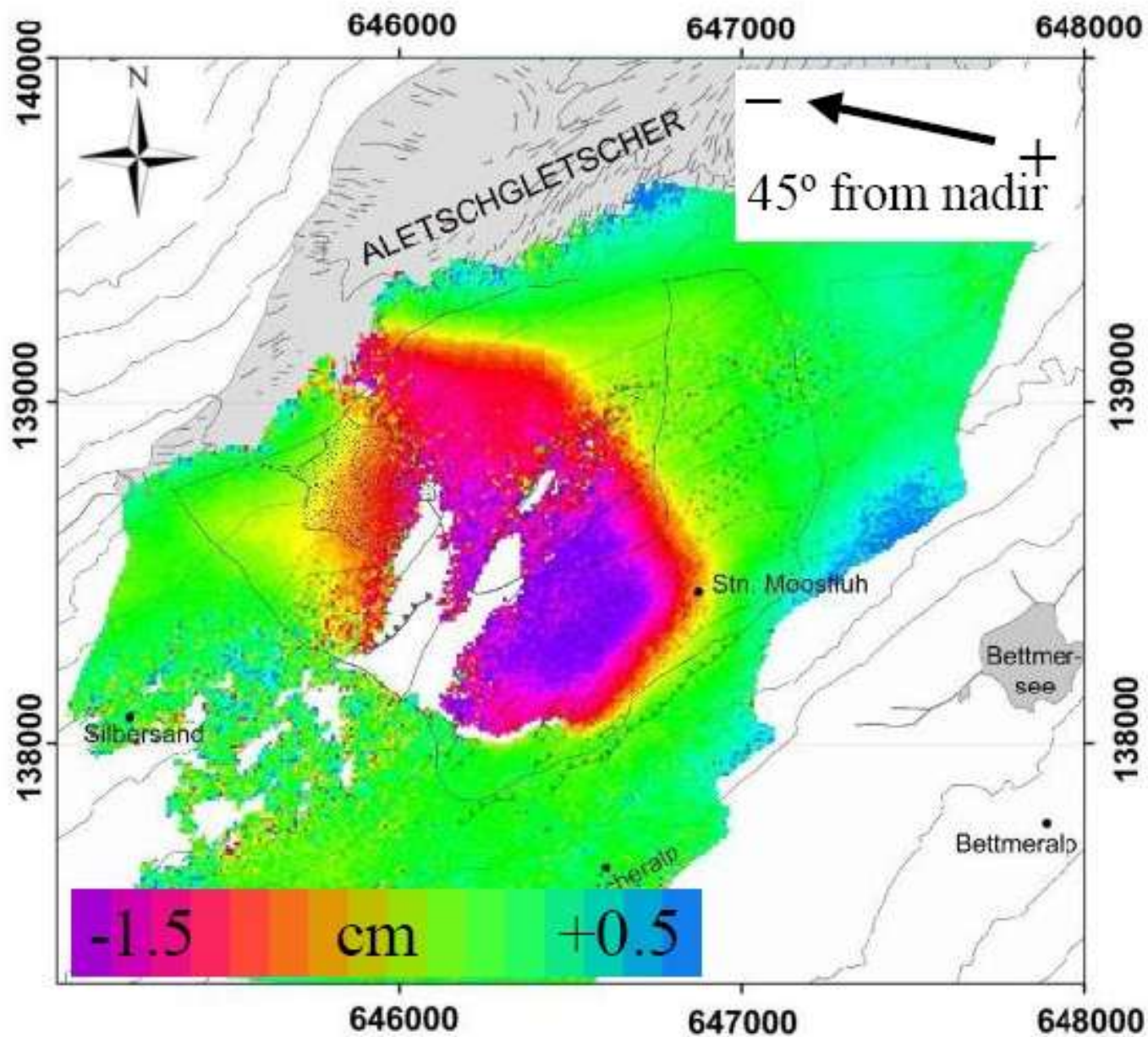


Karakoram

# Radar interferometry



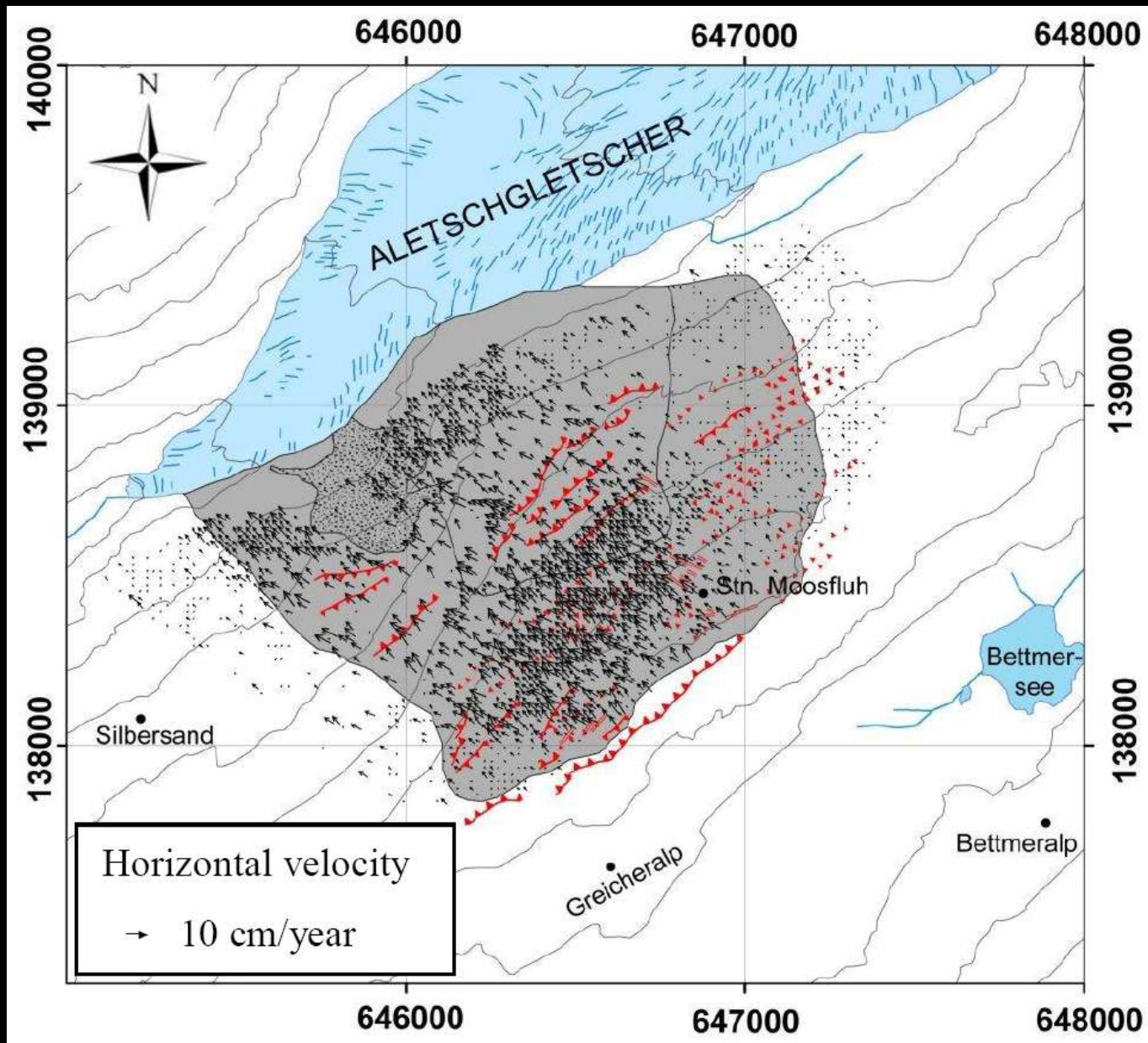
# Radar interferometry (Aug-Sep 2008)



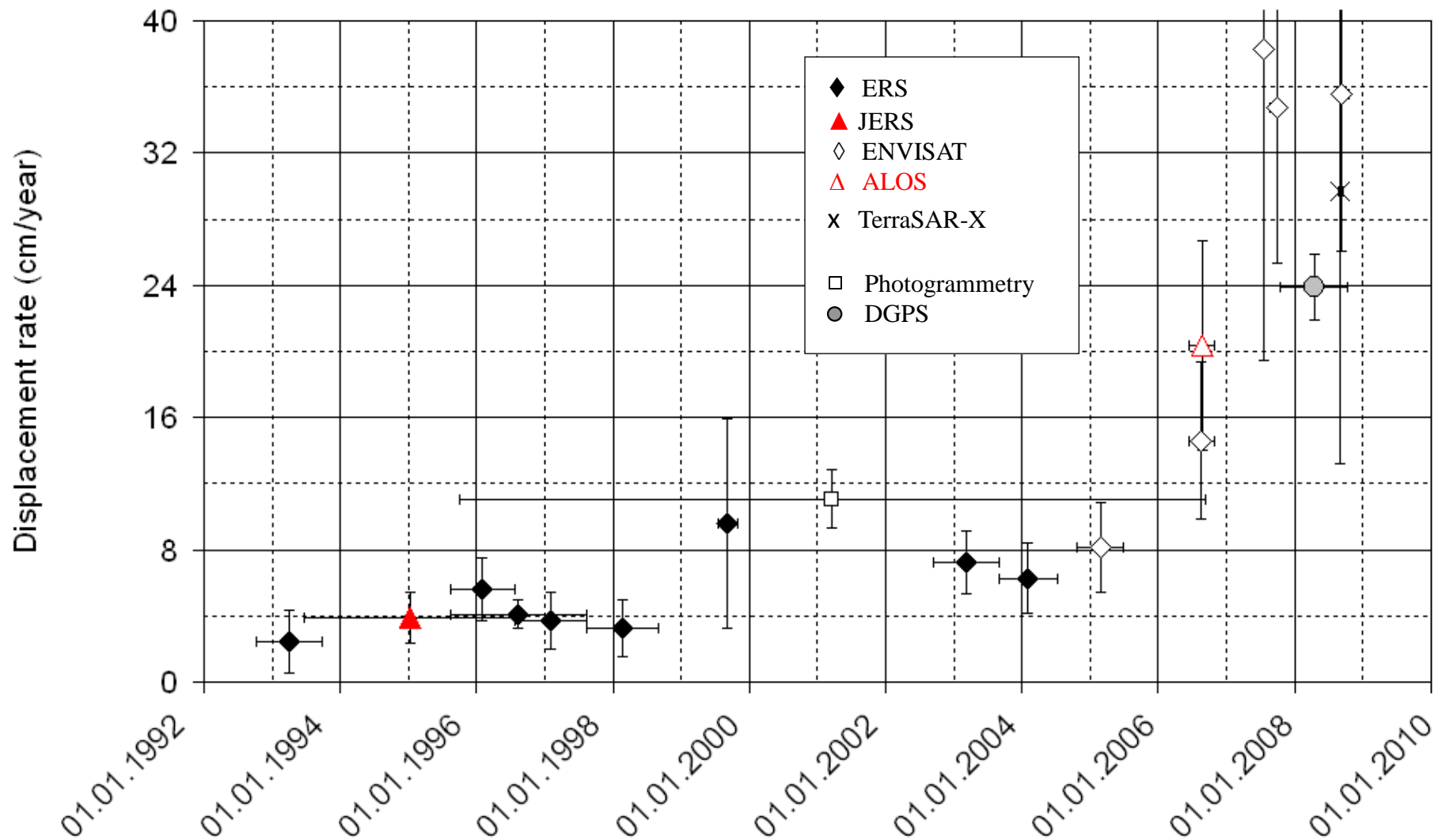
TerraSAR-X 20080822\_20080913

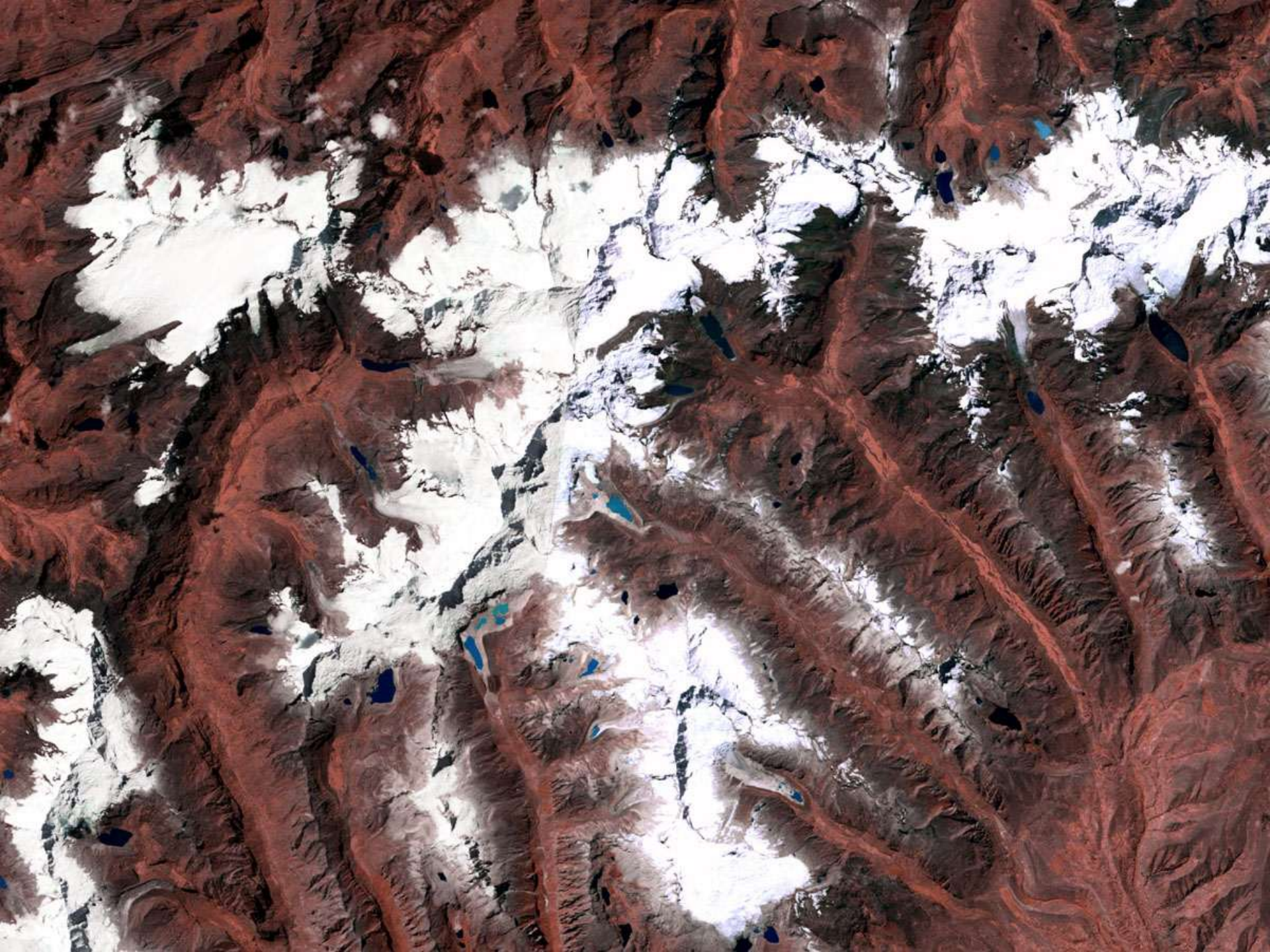


# Photogrammetry (1995-2006)



# Radar interferometry + photogrammetry + GPS







Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image © 2010 DigitalGlobe  
Image © 2010 TerraMetrics

© 2007 Google™

Pointer 9°13'10.01" S 77°32'48.20" W elev 4463 m

Streaming ||||| 100%

Eye alt 11.01 km  
A. Kaab

# Glacier lake monitoring from high-res SAR



TerraSAR-X 24.4.2010

ääb

- Cases and processes



- New challenges



- Air- and spaceborne remote sensing

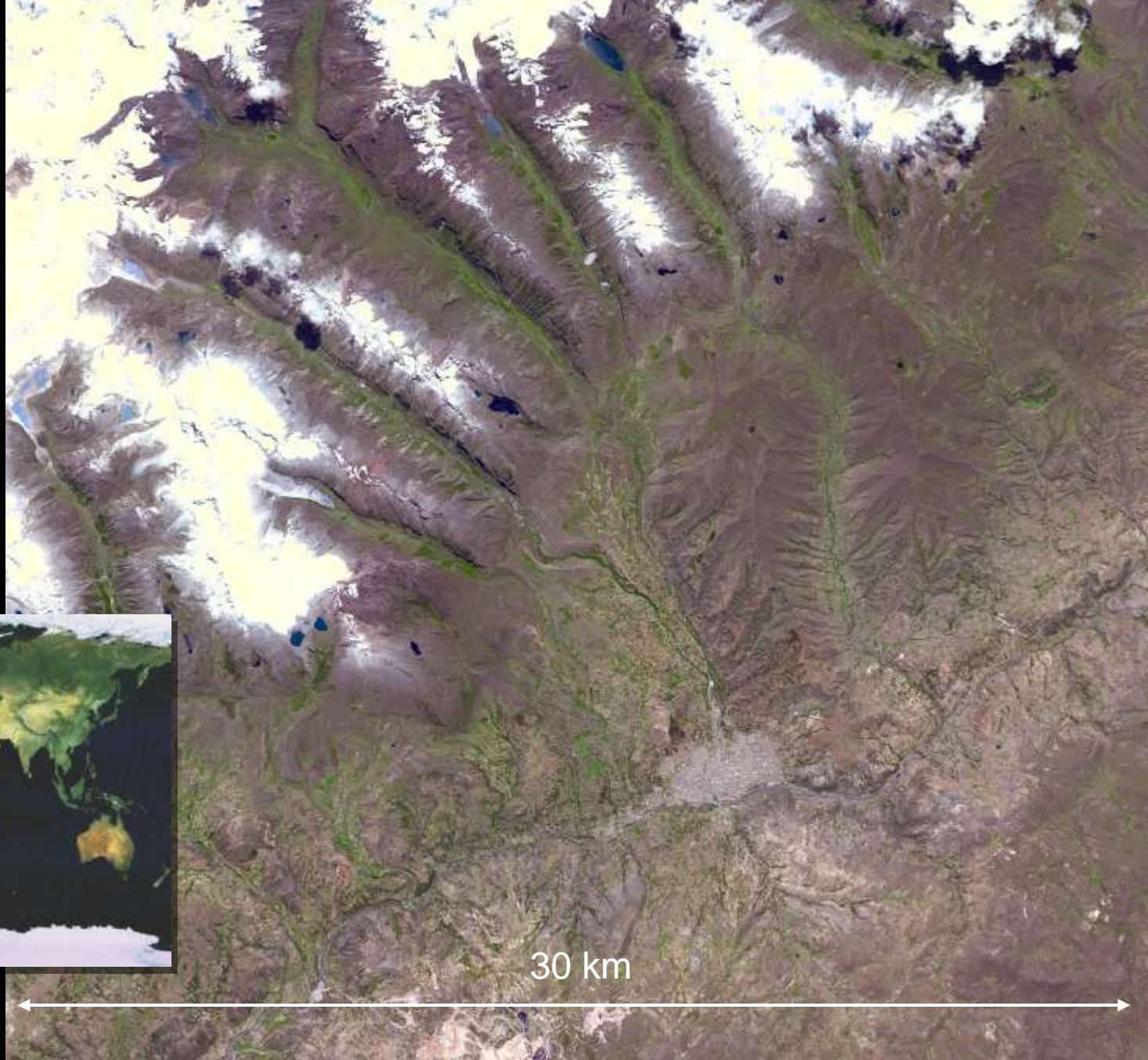


- Final remarks



Cordillera  
Blanca

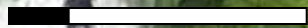
Laguna Palcacocha (Peru): 13 Dec 1941, 4mio m<sup>3</sup>, ca. 6000†



# Cordillera Blanca



5 km

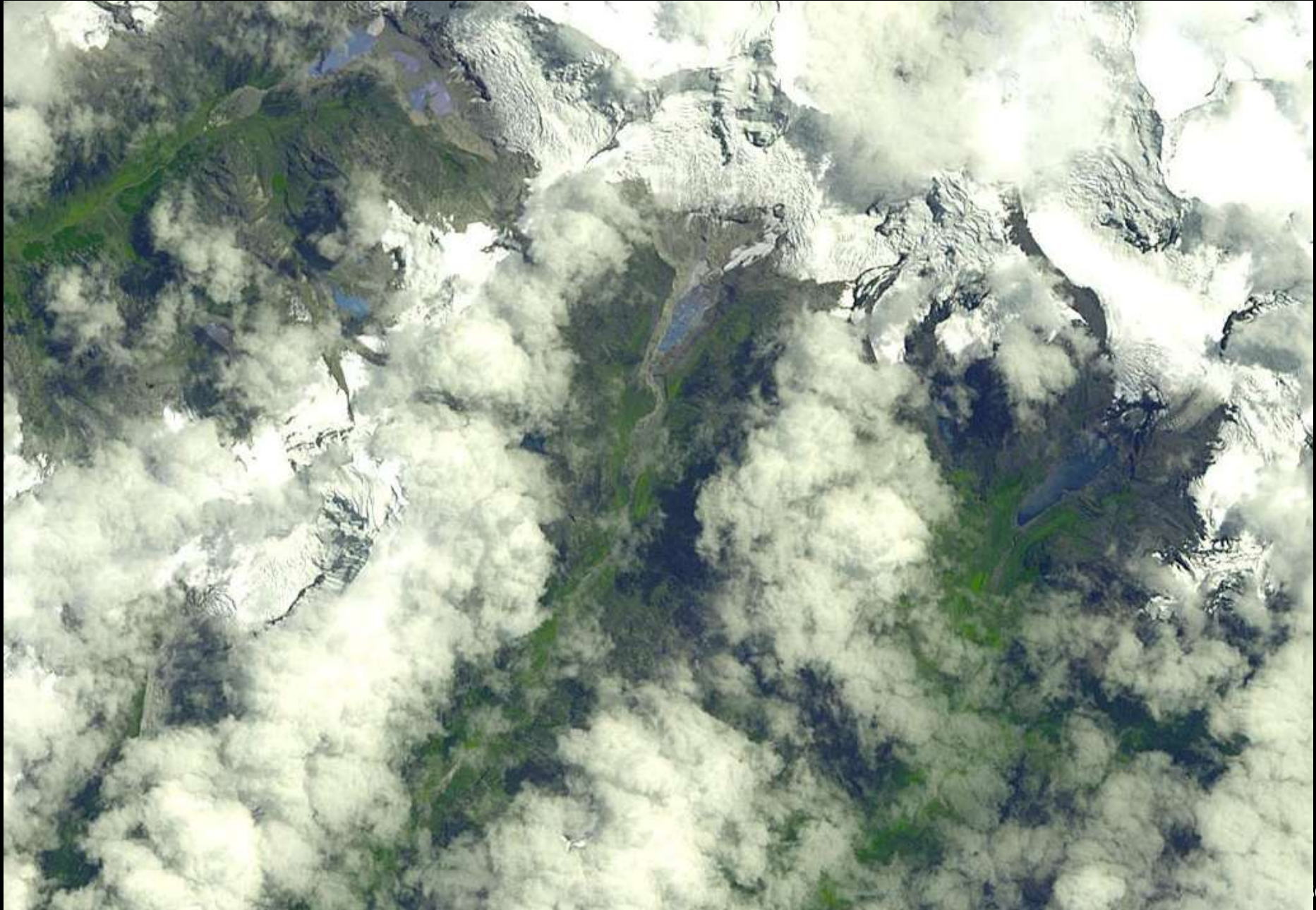




# Cordillera Blanca



# Cordillera Blanca



# Laguna Palcacocha



- Remote sensing (and related modelling) key technology in geohazard management
- Facilitated access to remote sensing data for experts and public
- „Hazard assessment“ by everyone and everywhere
- Socio-economic damage; loss of confidence
- Responsibility

Thank you !

