TECHNISCHE UNIVERSITÄT DRESDEN

# Generation of a Glacier Information System of northern Khumbu Himal for GLIMS

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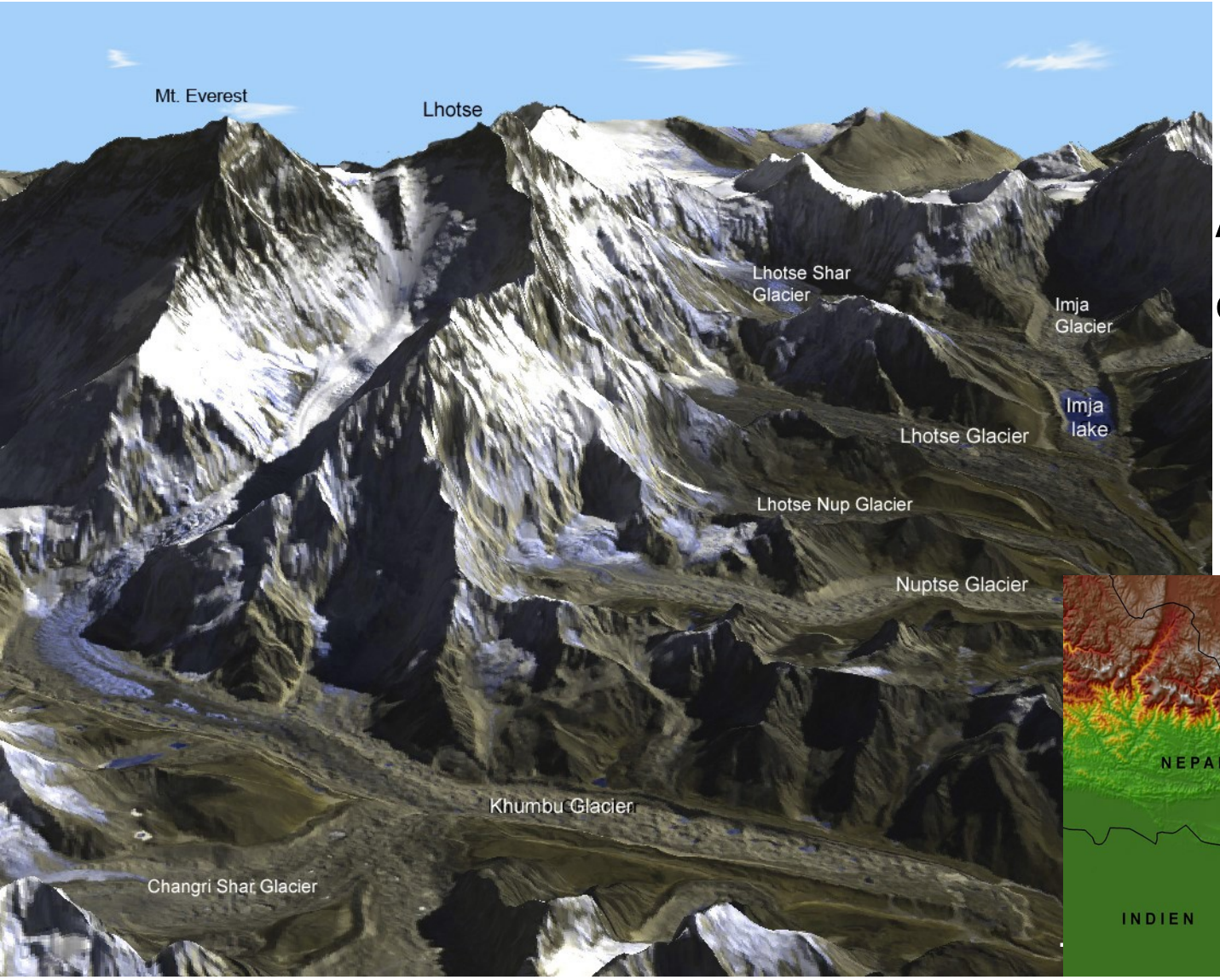
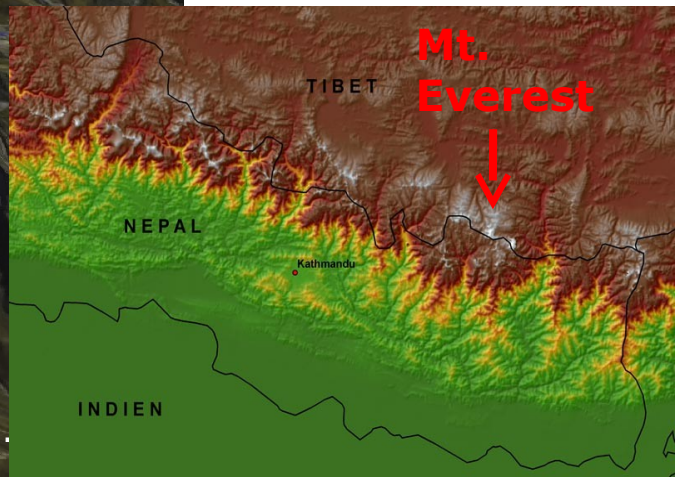
# 1 - Introduction
## Research Area



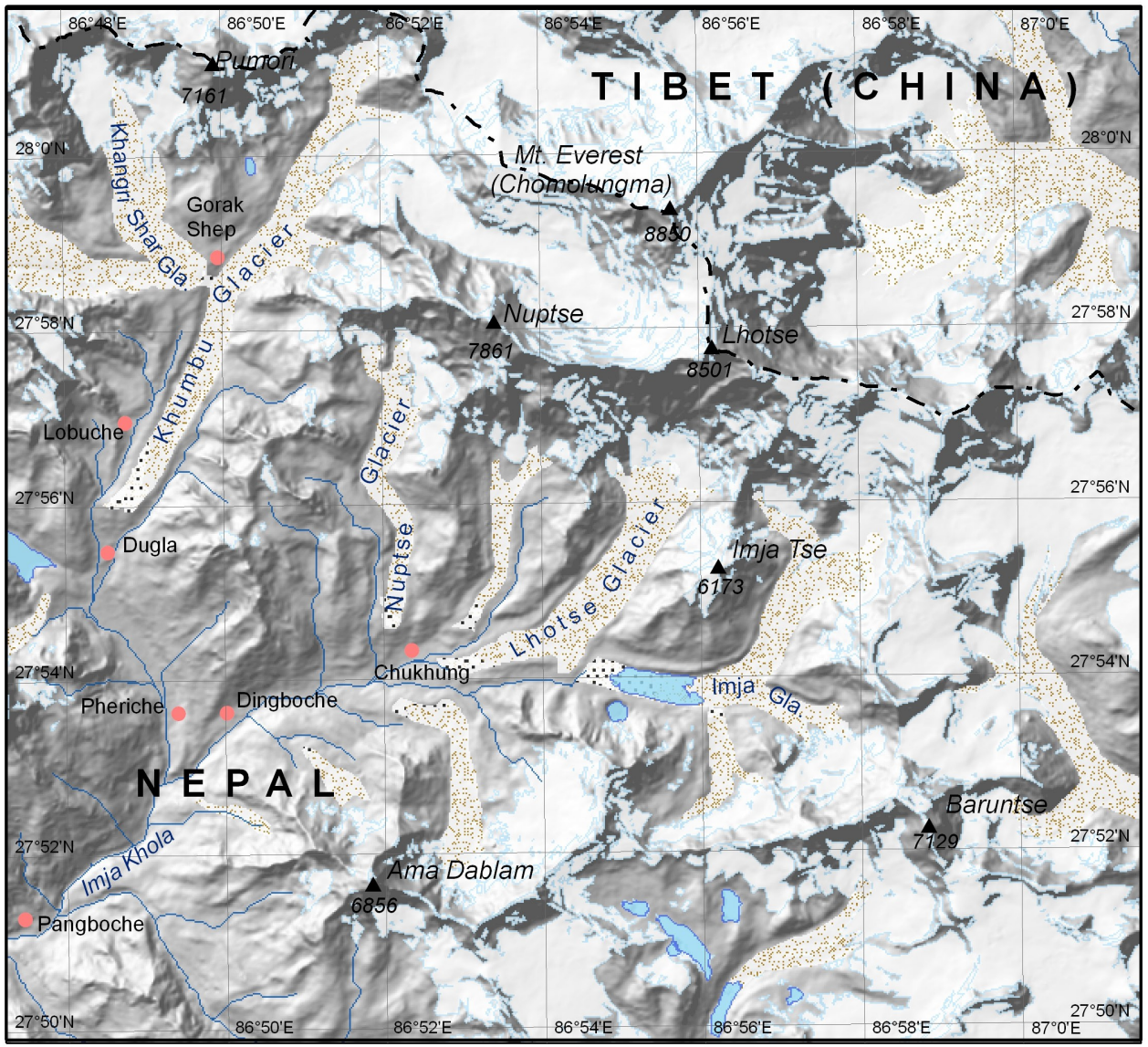

Khumbu Himal

ASTER 3-3-1

on ASTER-DEM



# 1 - Introduction
## Research Area



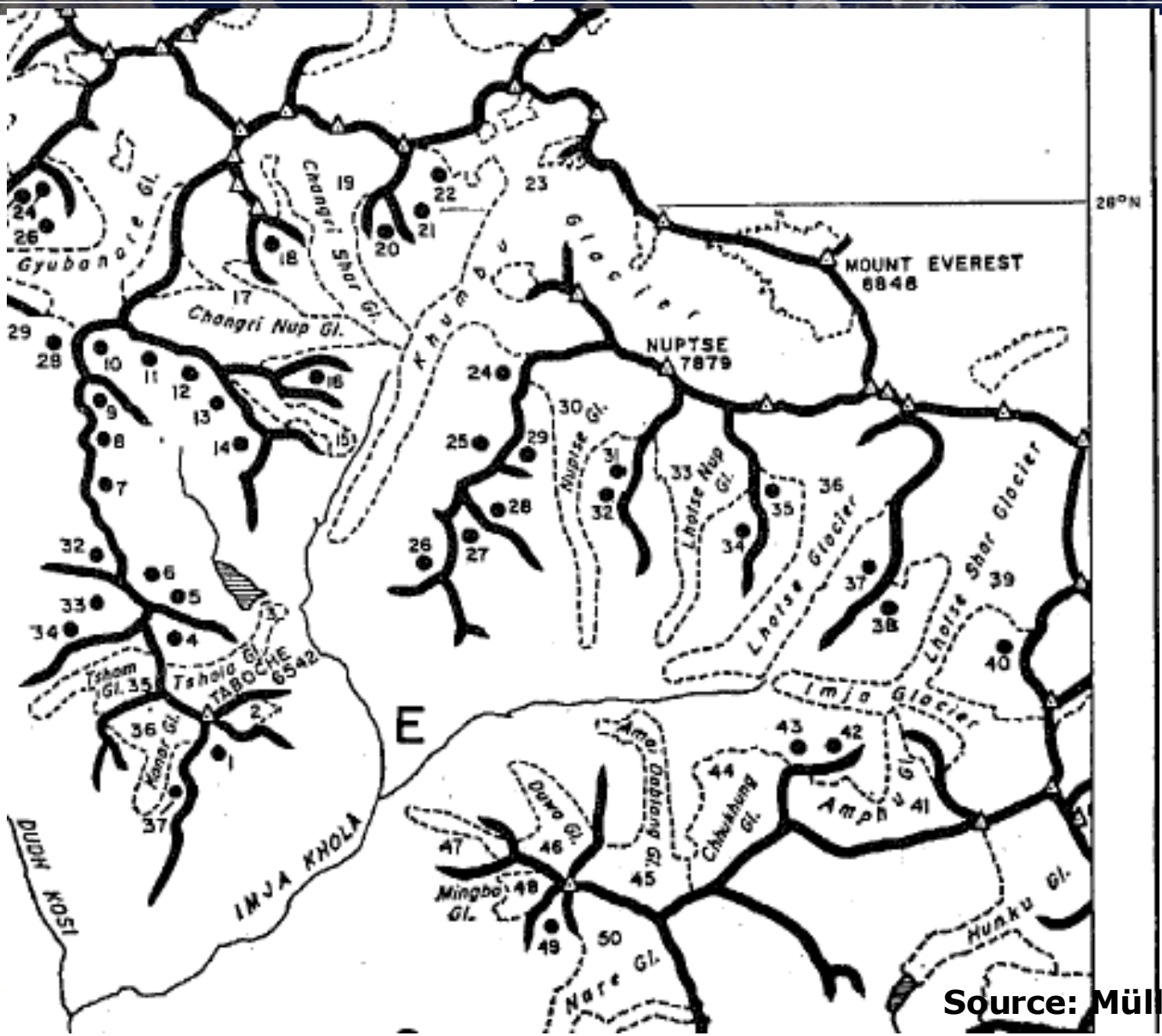

Map: T. Pieczonka, T. Bolch

# 1 – Introduction
## Debris-Covered Glaciers



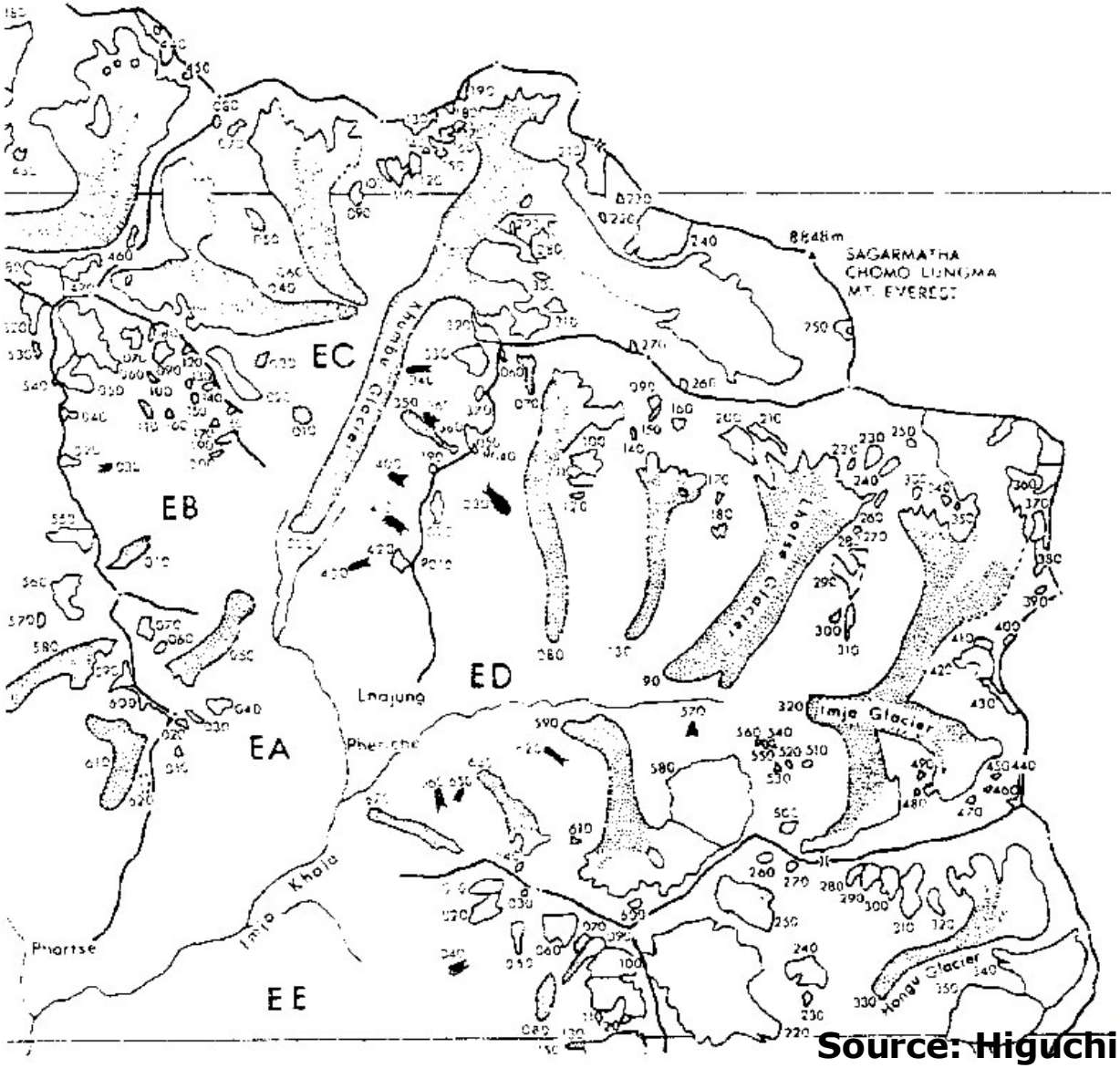
# 2 – Existing Glacier Inventories

## Change of Khumbu Glacier/Mt. Everest




**Source: Müller (1970)**

# 2 – Existing Glacier Inventories




Source: Higuchi et al. (1980)

# 2 – Existing Glacier Inventories

**Source: Mool et al. (2001)**

# 3 – New Glacier Inventory

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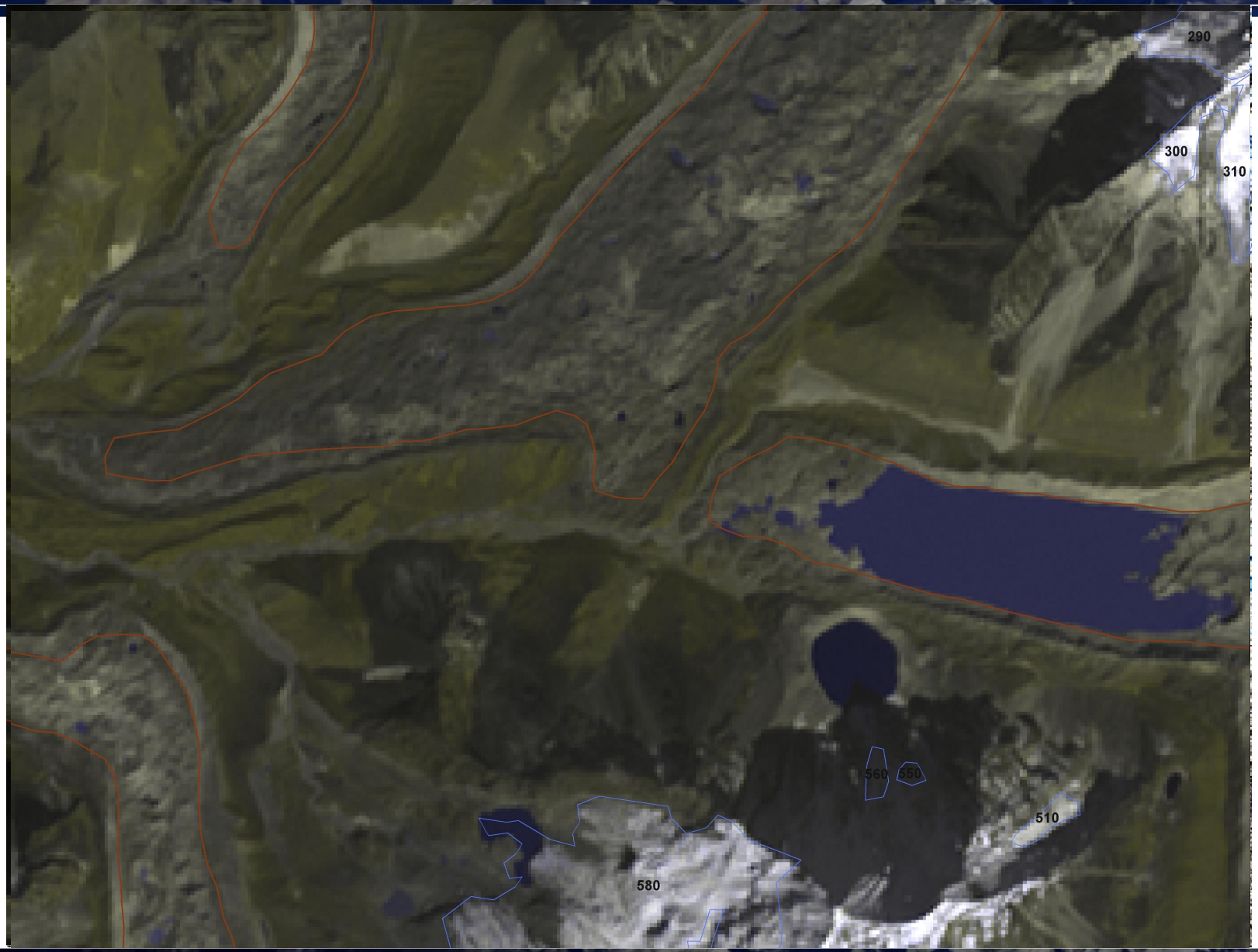
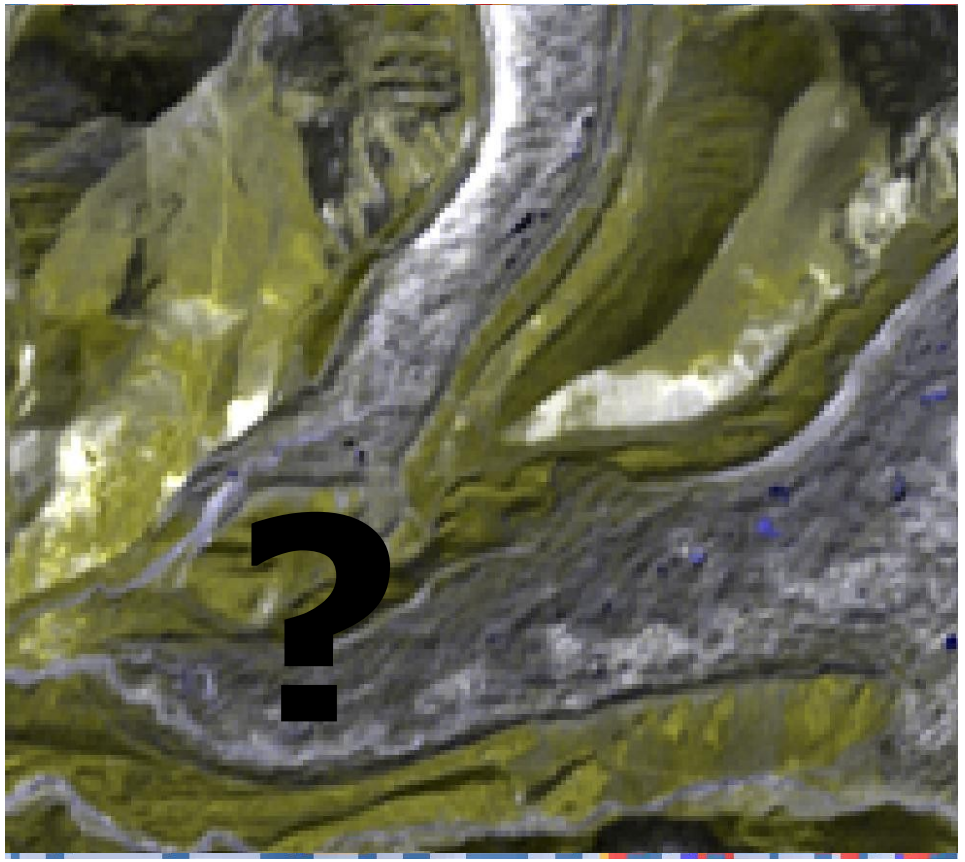


# 3 – New Glacier Inventory

## Glacier Delineation

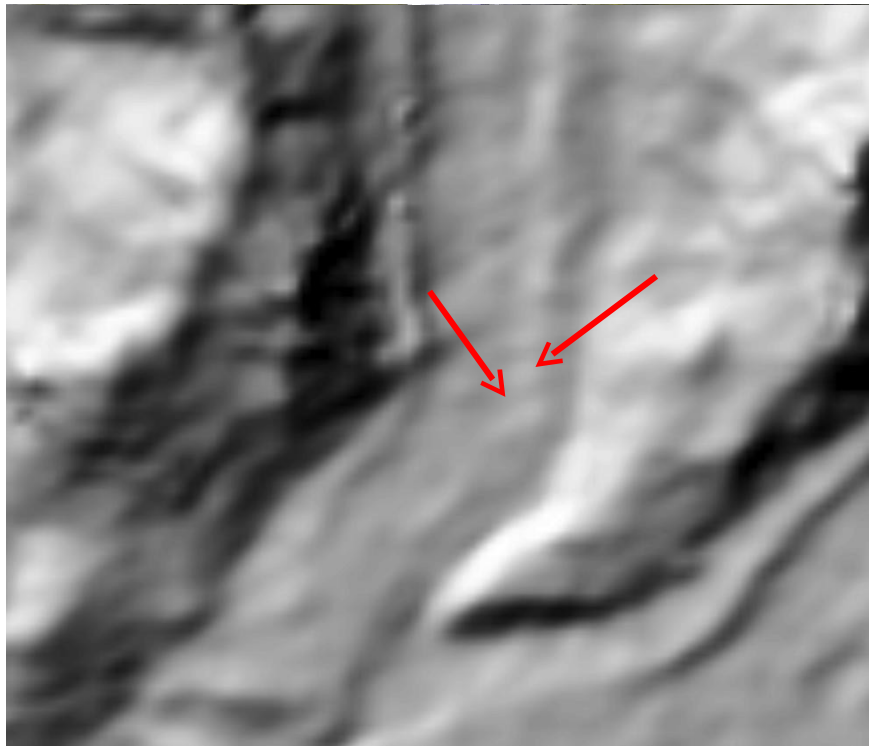
- Identification of Front Parts of Glacier Tongues: Difficult, even in the Field

# 3 – New Glacier Inventory

## Data and DEM from ASTER

- ASTER DEM Resolution:
  Too low for Exact Identification of Glacier Margins



# 3 – New Glacier Inventory

## Automated Delineation of Debris-Covered Glaciers

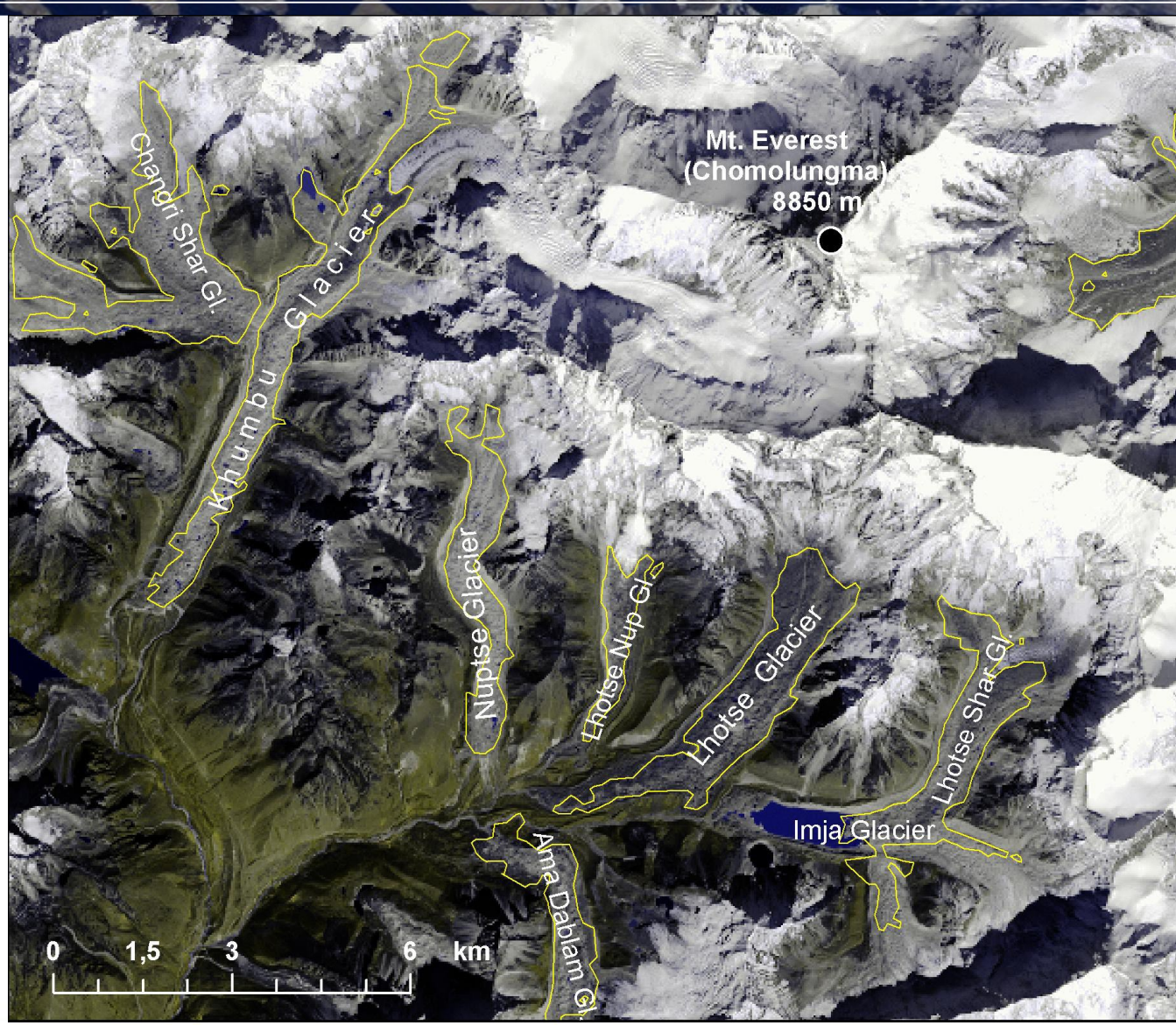
## Results

Deviation from Reference only

~ 5%

Main Problem: Correct Delineation of Front Parts of Glacier Tongues

Clean Ice more problematic due to Snow cover




Bolch & Buchroithner (in Press)

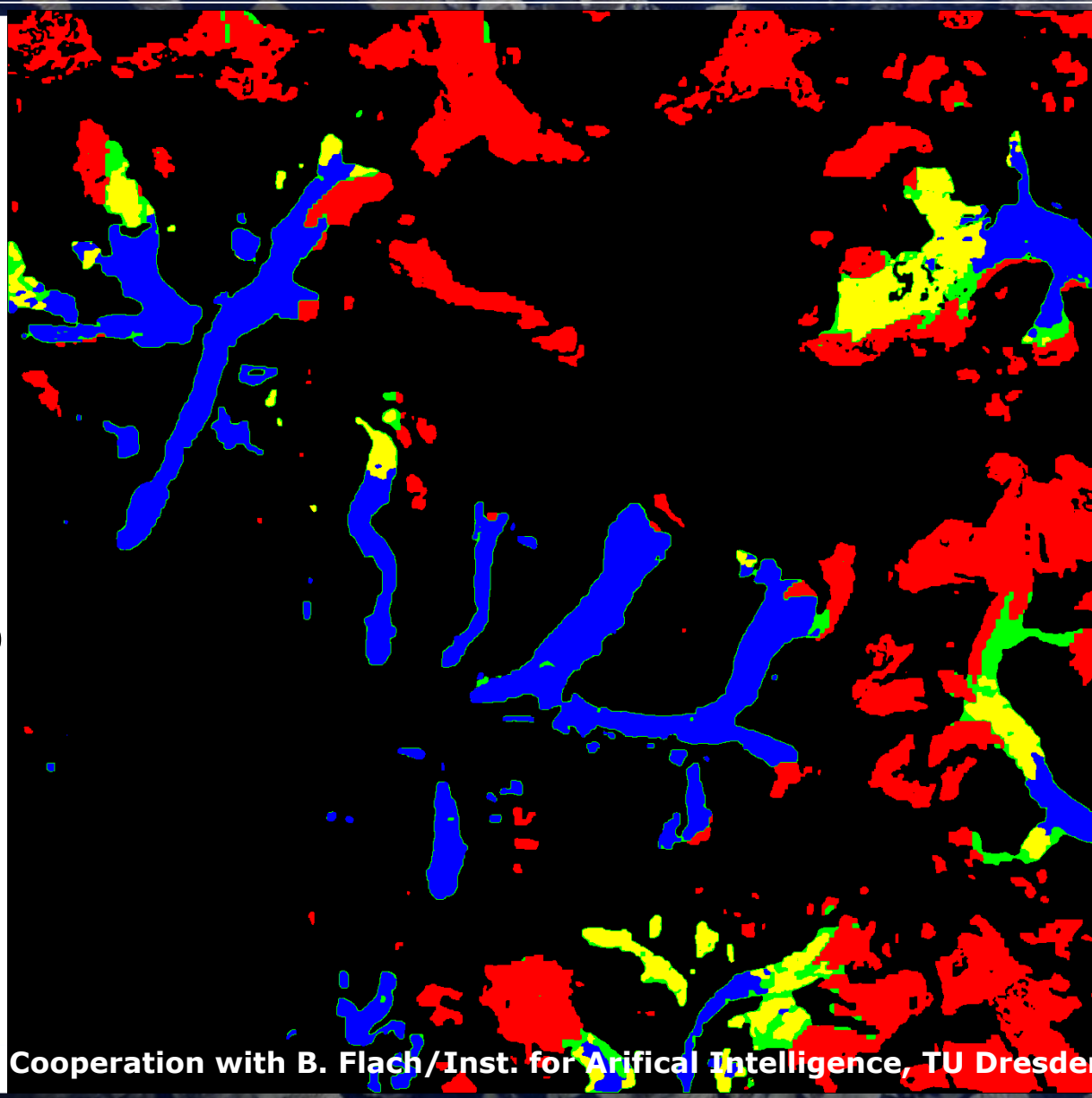
# 3 – Delineation of Debris-Covered Glaciers

## New Approach

Artificial Intelligence Approach

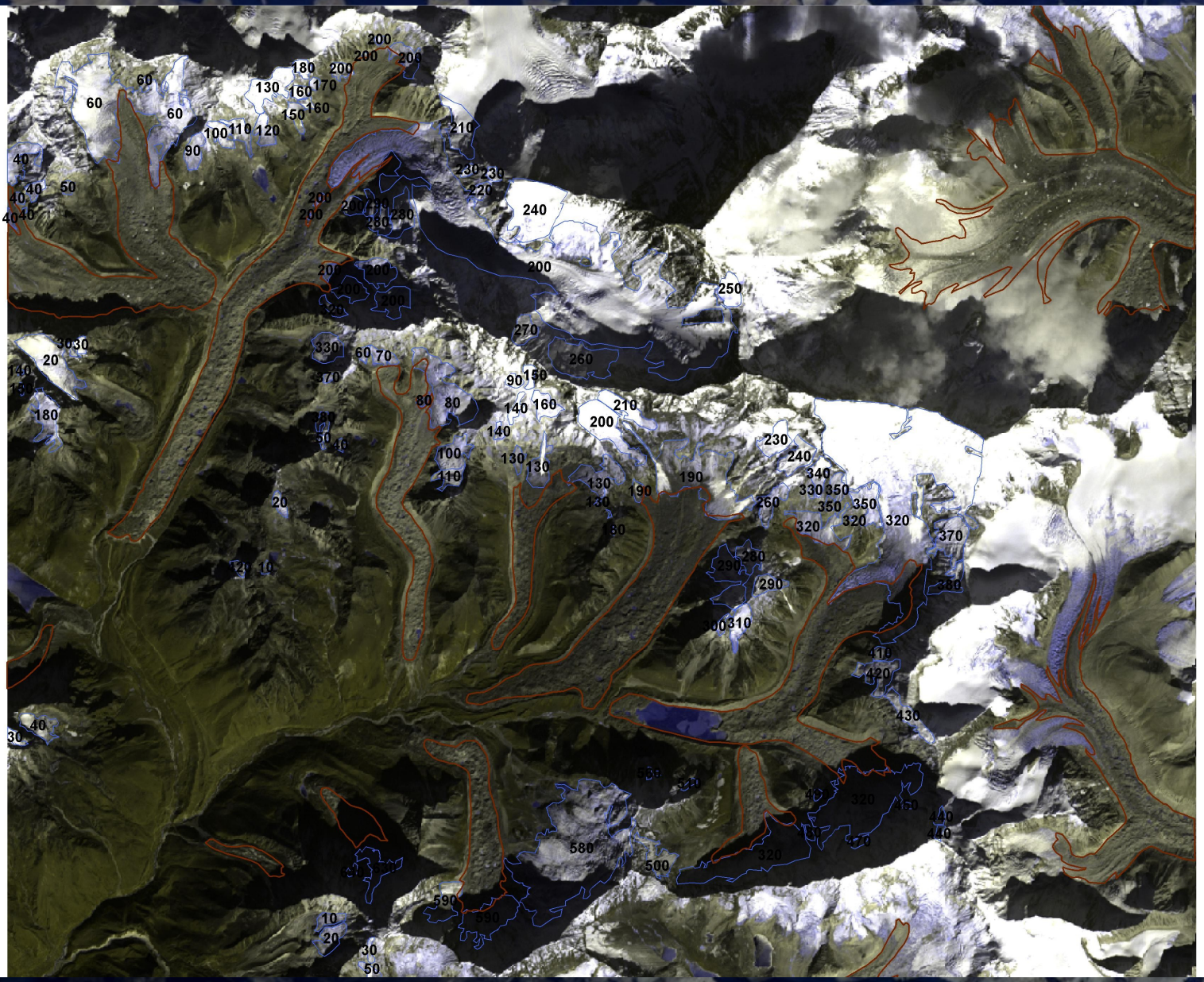
Results

to be Published soo



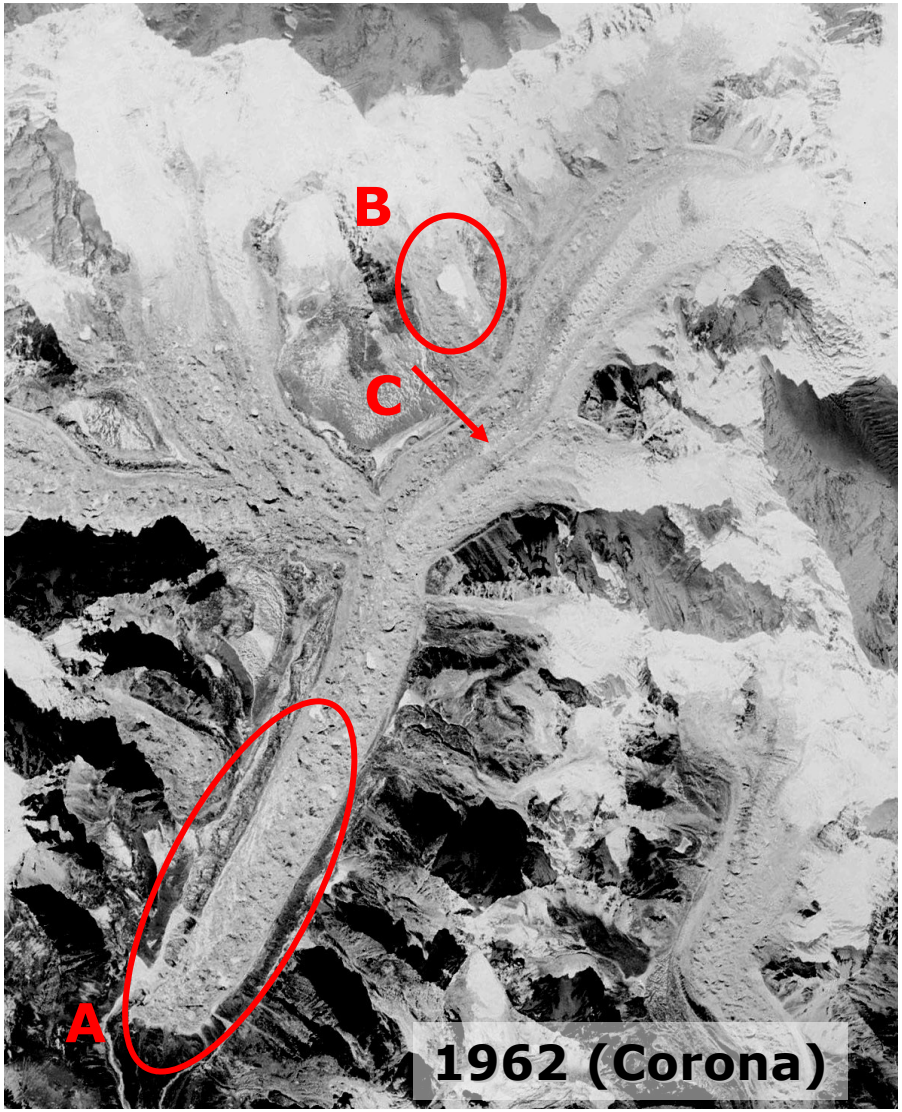
Cooperation with B. Flach/Inst. for Arifical Intelligence, TU Dresde

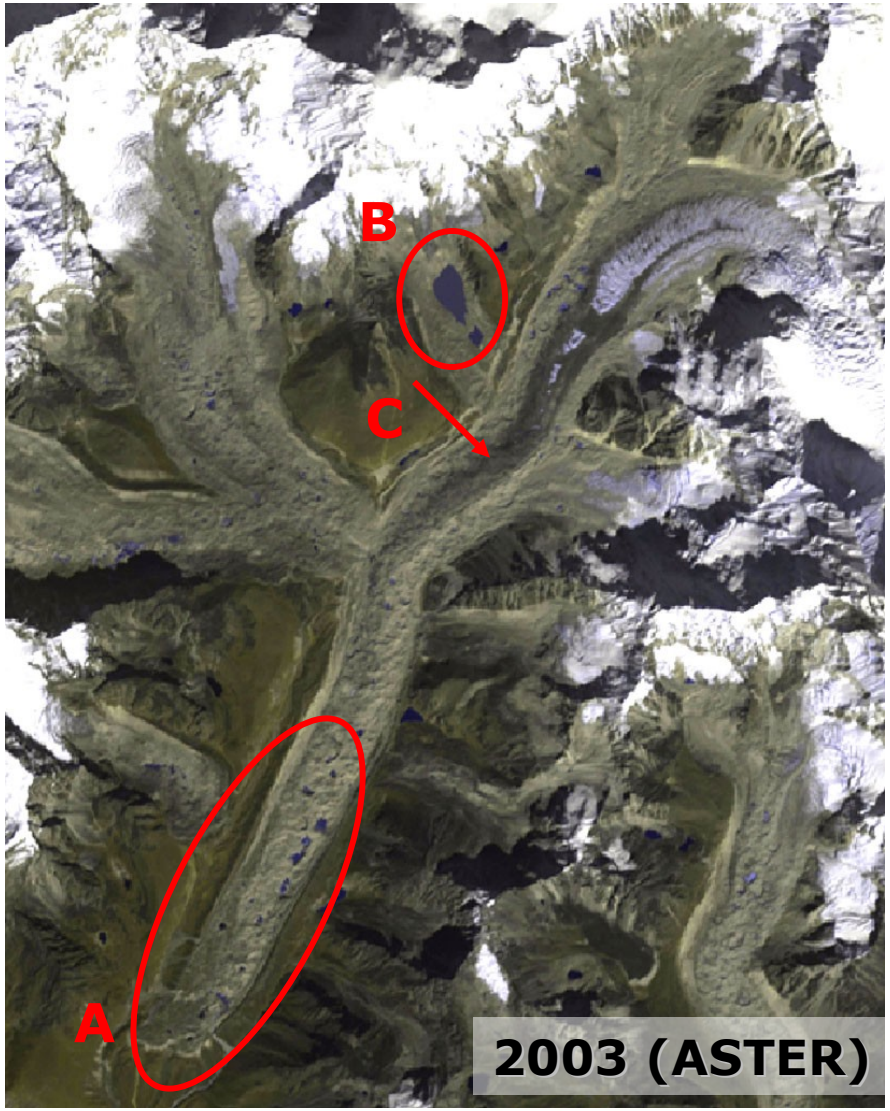
# 3 – New Glacier Inventory



# 4 – Glacier Change

## Change of Khumbu Glacier/Mt. Everest



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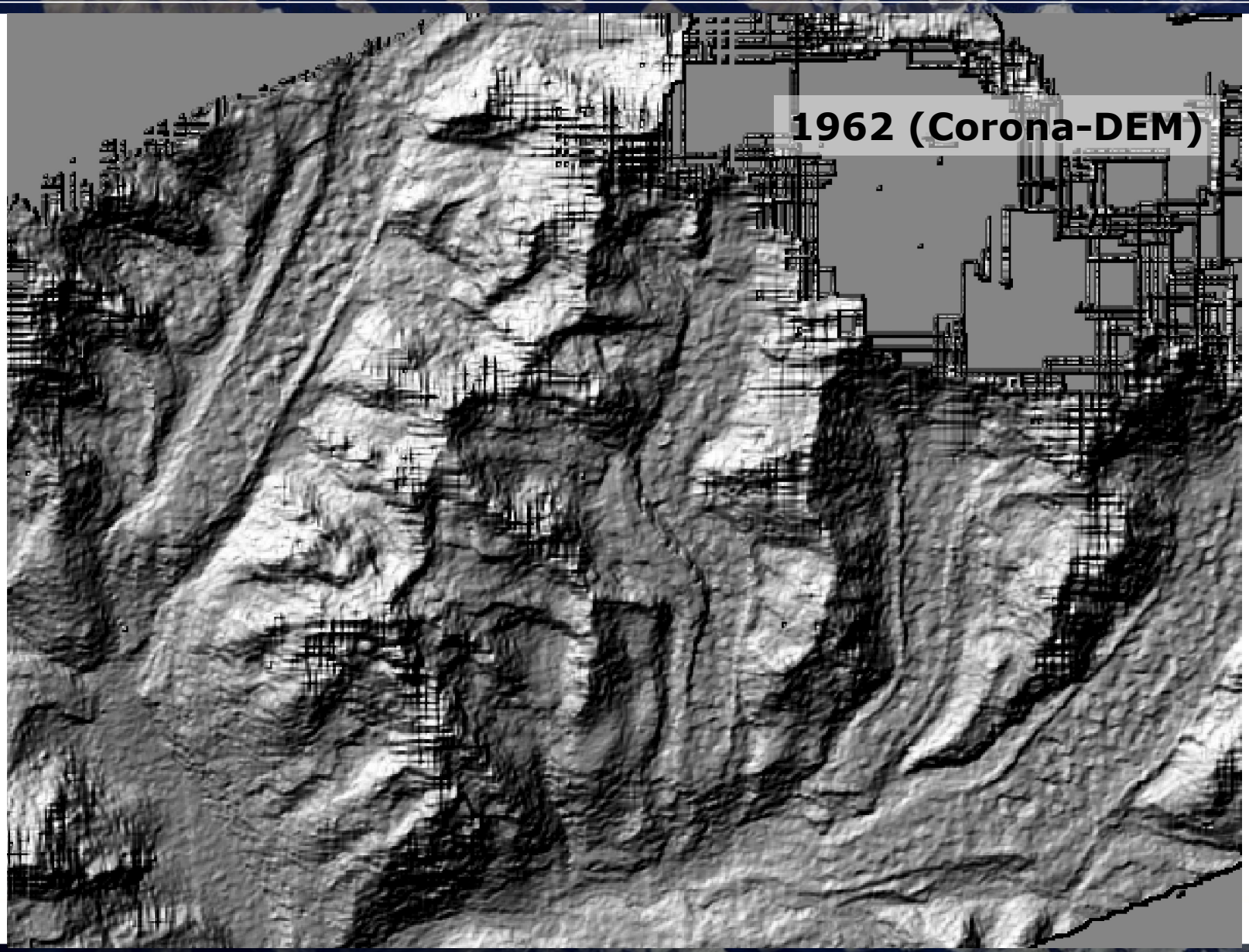

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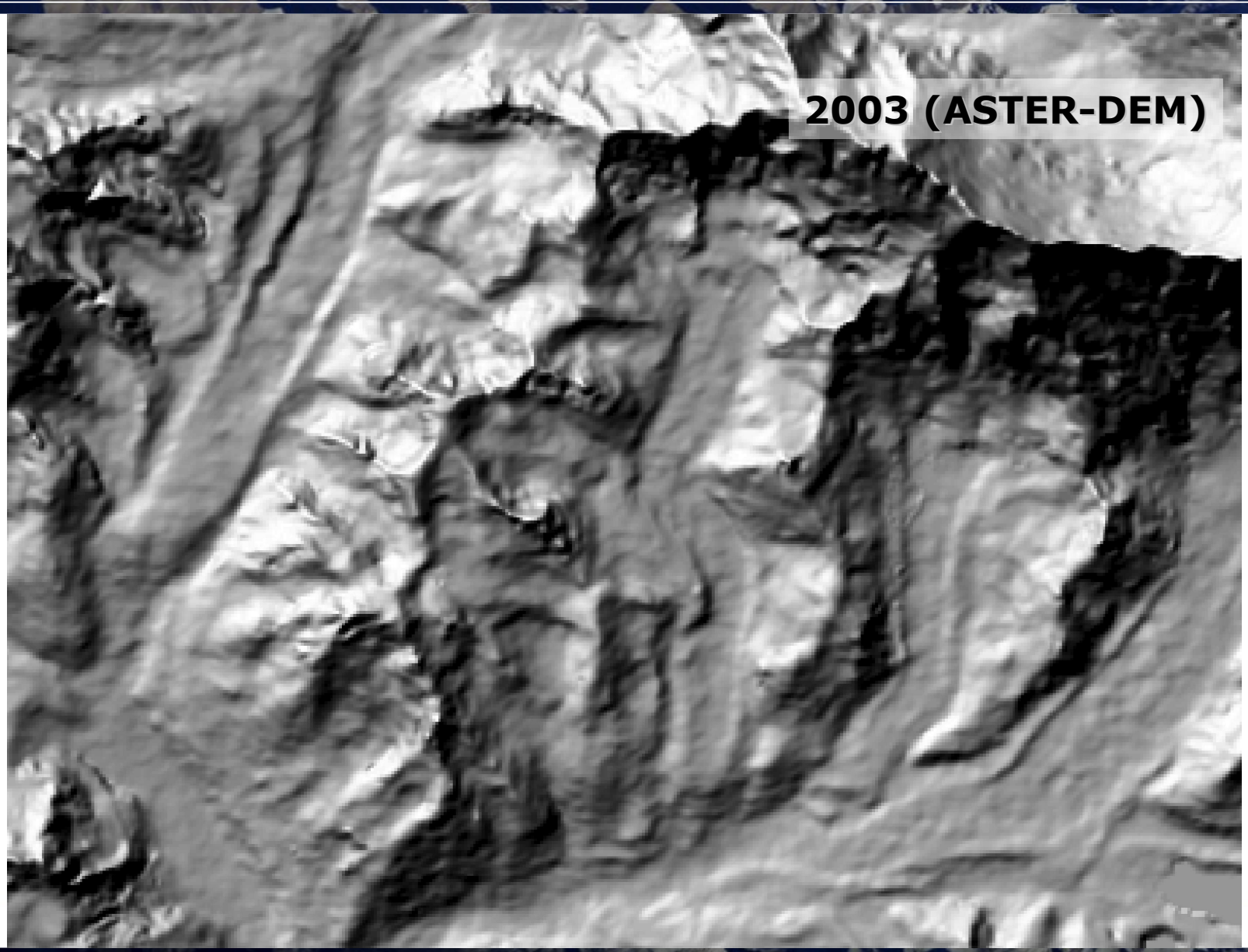
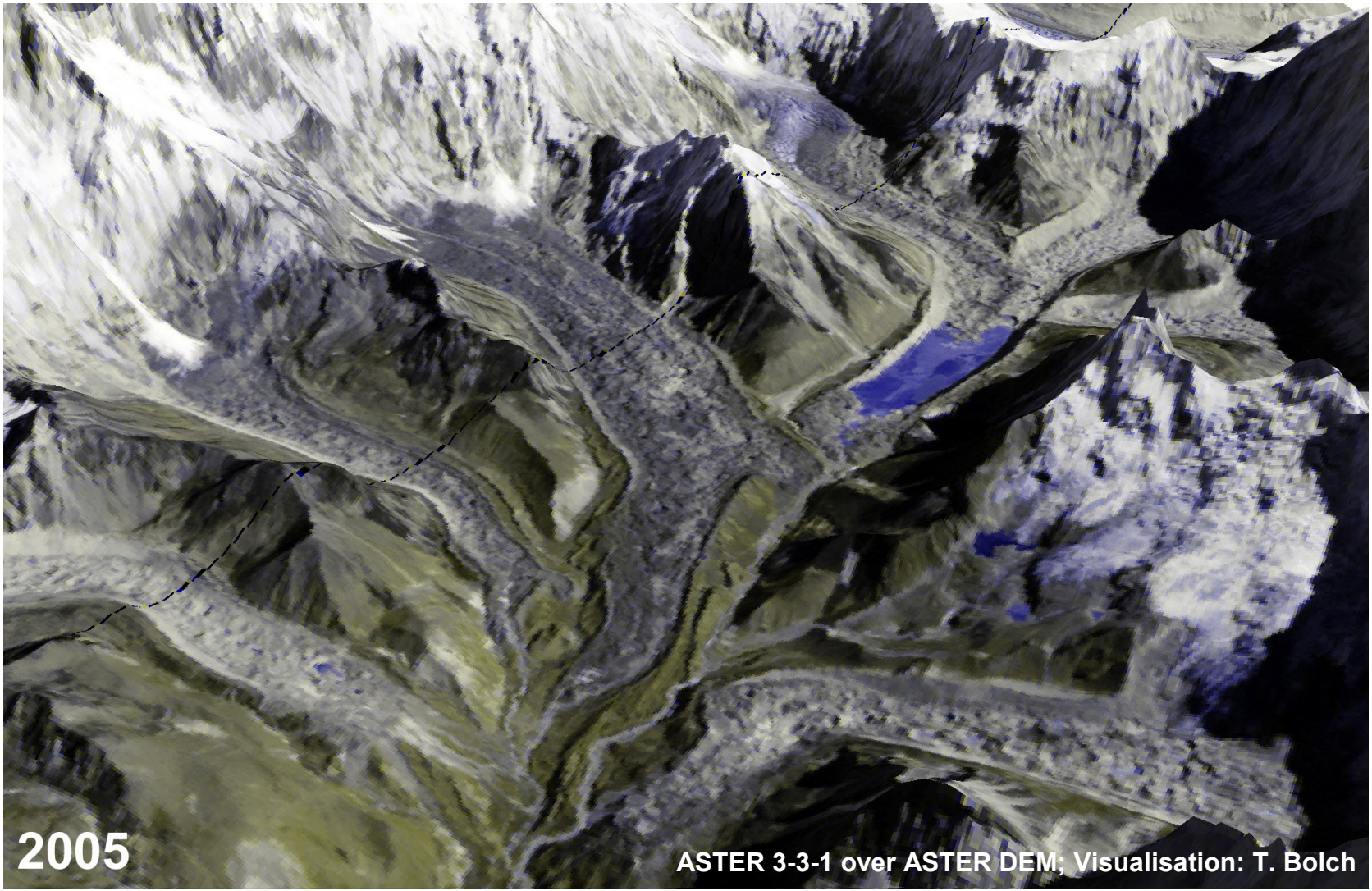


# 4 – Glacier Change
## Glacier Flow Velocity




ASTER 3-3-1 over ASTER DEM; Visualisation: T. Bolch

# *4 – Glacier Change*

## Glacier Flow Velocity

# 5 – Conclusions and Outlook

## Conclusion:

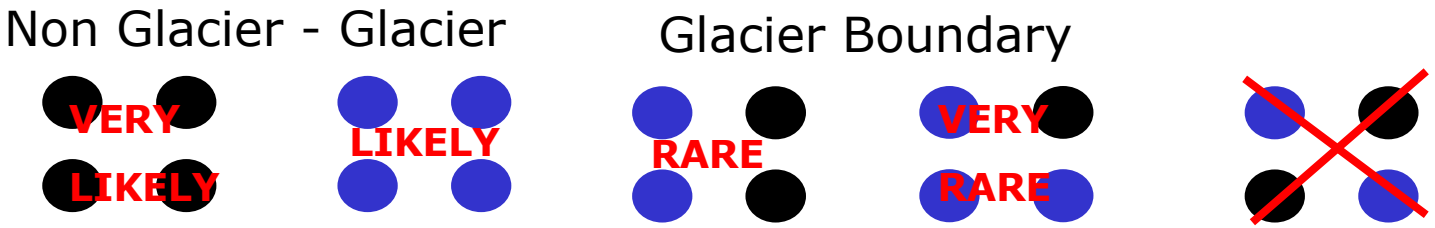
- It is nearly impossible to compare glacier areas with older inventories.
- Glacier delineation is very difficult and with high inaccuracies both in the accumulation zone and the distal part of the debris-covered glacier tongues
- Both Ikonos and ASTER are suitable to calculate glacier flow.
- The use of multitemporal space imagery of different years and resolutions (e.g. Corona, ASTER, Ikonos) is very useful for studing glaciers in detail.
- To be done:
  - Integration of all data and sumission to GLIMS database
  - Detailed Analysis of Glacier Change

# Thank You for Your Attention!

# Artificial Intelligence Approach

- Input data: Visual and Thermal Bands, Slope, Curvatures
- In Addition :

- Overall Probability to be a Pixel of Debris-Covered Glacier << 50 %
- Varying Probabilities of Possible Pixel Combinations




- Learning System: Unsupervised & Supervised

Results? To be Published soon

In Cooperation with B. Flach/Inst. for Arifical Intelligence, TU Dresden

# 5 – Conclusions and Outlook

## Further Activities:

- Evaluation of Presented Models Using Other Study Areas.
- Improvement of Presented Model Using DEMs of Higher Resolution, e.g. Forthcoming TanDEM-X-Mission.
- Calculation of Changes in Area and Volume Using Corona and ASTER.
- Automated Calculation of Glacier Velocity by Feature Tracking.