

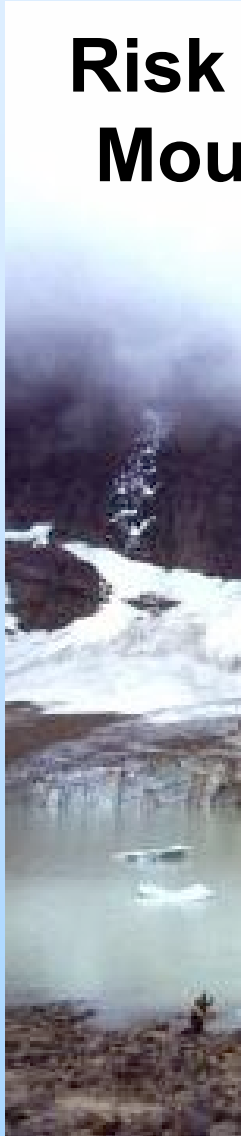
Risk Assessment of Glacier Hazards in High Mountain Areas based on Remote Sensing

- **Glacier Floods**
- Ice Avalanches
- Ice Falls
- Glacier Length Variations

Level 1: Detection

Level 2: Assessments of potential hazards

Level 3: Detailed investigations



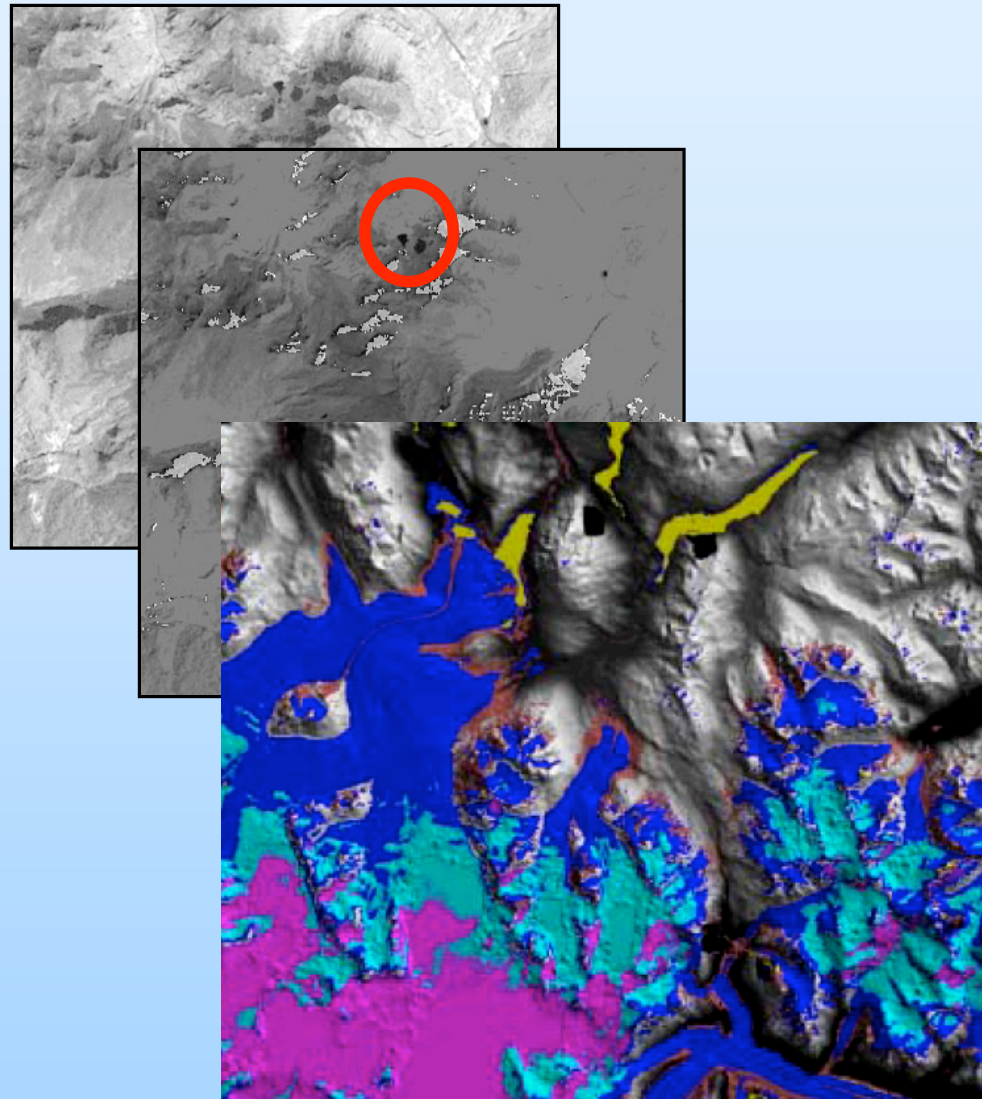
Lake Detection

$$\text{NDWI} = \frac{\text{NIR} - \text{Blue}}{\text{NIR} + \text{Blue}}$$

$$\text{Norm. Ratio} = \frac{\text{NIR}}{\text{Blue}}$$

Classification Results

	Wet Snow
	Snow
	Bare Ice
	Water
	Ice covered with Soil



Potential Hazards

- **High Resolution Data**

- **Data Fusion**

- **Change Detection Analysis**

 - Lake area and size

 - Rate of growth

- **Assessing Physical Parameters of Dams**

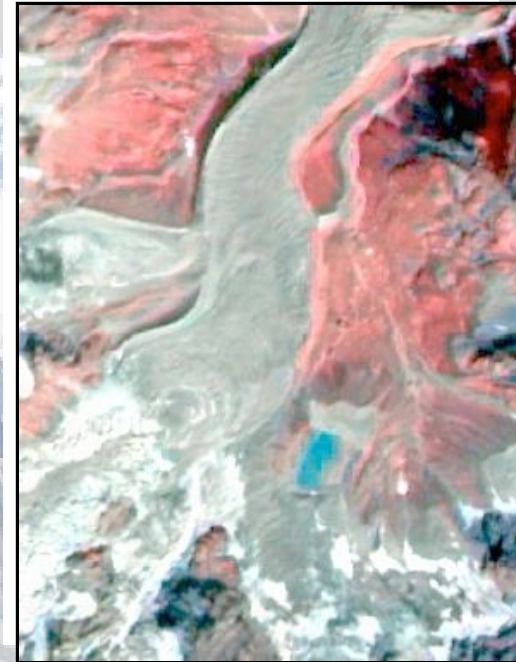
 - Dam type, stability, weight and height

 - Surrounding geometry

- **Additional Band Information**

 - Vegetation (NIR)

 - Debris deposits



Potential Hazards

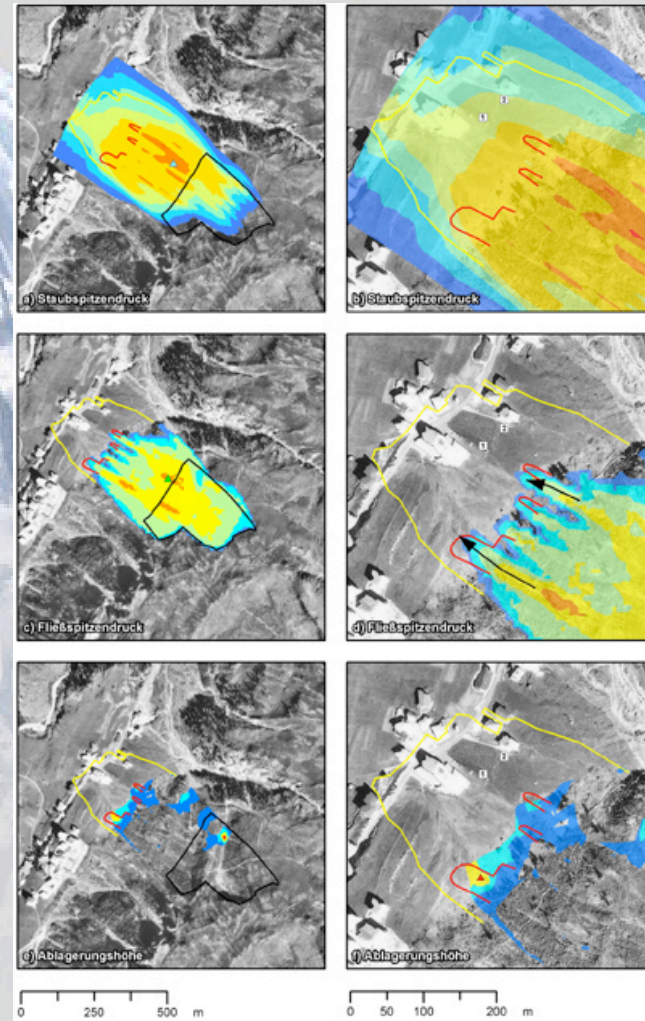
- Photogrammetric Techniques

- Simulation Softwares

SAMOS

ELBA

...

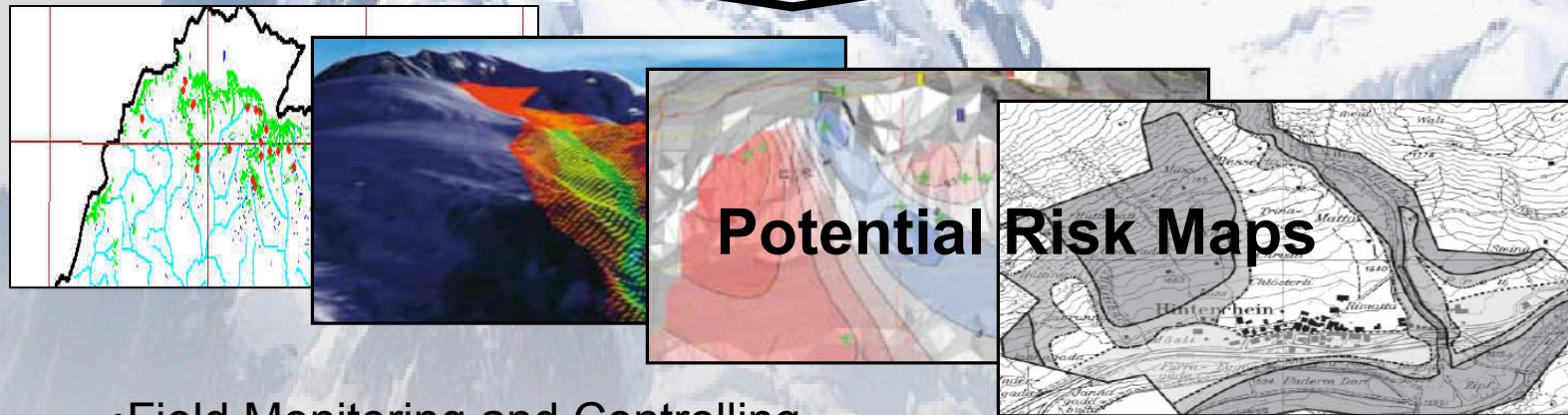


↓ ↓ ↓

Information Fusion in a GIS

Detailed Investigations

Risk Information



- Field Monitoring and Controlling
- Provision for Risks
 - Biological Hazard Management
 - Physical Hazard Management
- Emergency Plans

Reference

HUGGEL, C. et al (2002), “Remote sensing based assessment of hazards from glacier outbursts: Swiss Alp”, Can. Geotech, page 316-330

HÜBEL, J. et al (2001), “Schneeeauswirkungen auf die Raumplanung in alpinen Siedlungsgebieten”, www.landscape.tuwien.ac.at/ttl/

BRANDNER, D. et al (2000), “Snow cover duration maps in alpine regions from remote sensing data”, EARSeI-SIG-Workshop

DOZIER, J. (2004), “Remote sensing of alpine snow cover: Invisible and near-infrared wavelength”, [www.avalanche.org/~moonstone\(...\)](http://www.avalanche.org/~moonstone(...))

KÄÄB, A. et al (2002), “Glacier- and permafrost-related hazards in high mountains (...)”, Dep. of Geography, Zürich www.geo.unizh.ch/~kääb

CHUGGEL, D. (2002), “Assessing potential ice avalanche hazards”, Dep. of Geography, Zürich www.geo.unizh.ch/~chuggel/iceaval.html