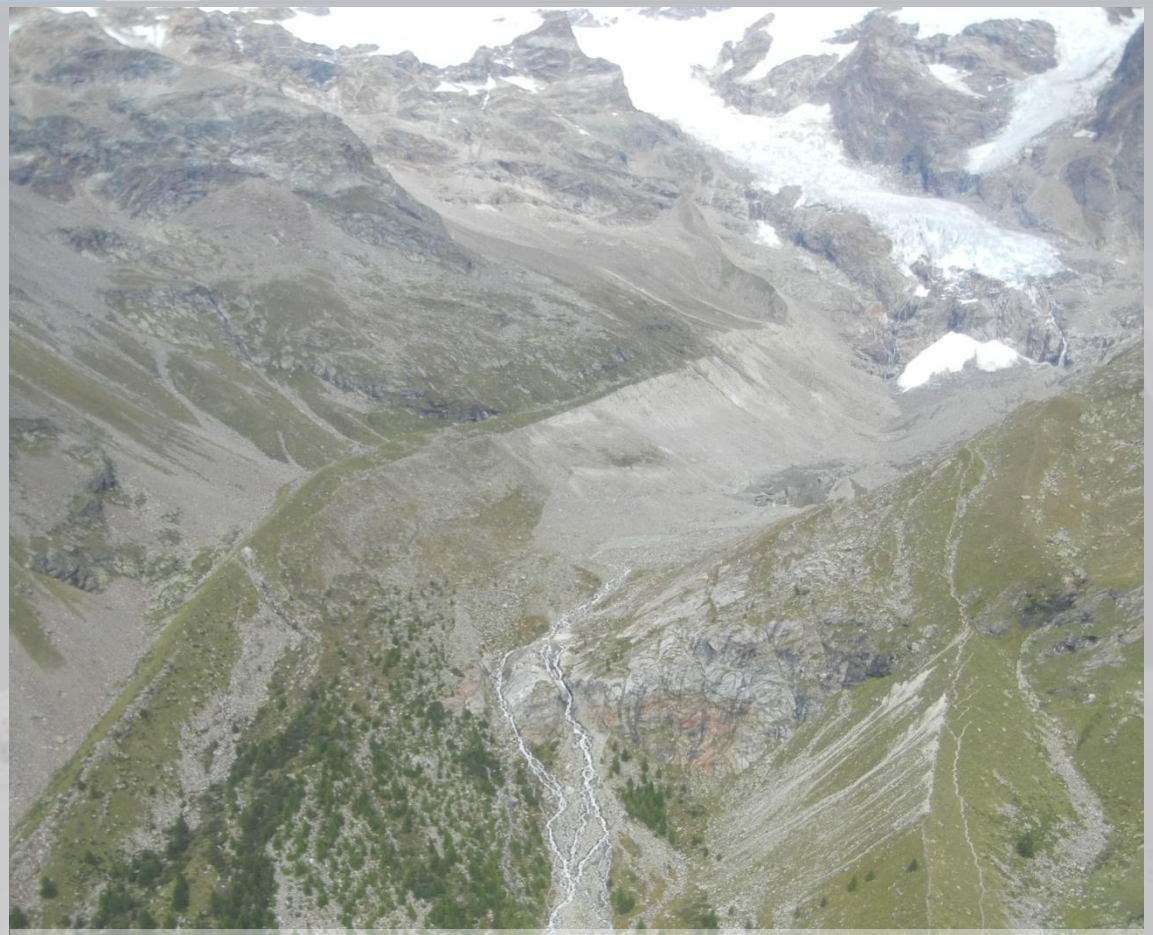


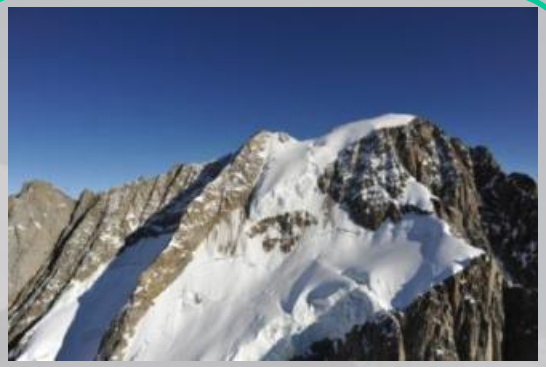
A MONITORING PLAN FOR GLACIERS EVOLUTION AND GLACIERS-RELATED RISK IN AOSTA VALLEY

FONDAZIONE MONTAGNA SICURA
MONTAGNE SÛRE

Région Autonome Vallée d'Aoste
Regione Autonoma Valle d'Aosta

Glacier breakdown

Glaciers-related hazards types



Hanging Glaciers icefalls – ice avalanches

Glacial lakes outburst floods

Hanging glaciers icefalls

- Unbalanced cold hanging glaciers (loose mass by dry calving) (ex. Grandes Jorasses 1998):
  - Periodic icefalls (not "if" but "when");
  - Related processes: ice avalanches, trigger of snow avalanches

Allalingletscher breakdown (VS,CH),30 august 1965-88 people killed (fromM.Funk)

Glacier breakdowns

- Temperate or polythermal glaciers
- Sliding induced by geometry + waterflow at the bed-ice interface (ex.Allalingletscher,1965,2000);
- related processes: ice avalanches (large volumes),triggering ofsnow avalanches.

Tête Rousse Glacier,1892 (C.Vincent)

Glacial lakes outburstfloods (GLOFs)

- Outburst floods from glacial lakes (periglacial, epiglacial,…)(ex.Belvedere Glacier) or from inner water pockets (ex.TêteRousse);
- sudden, often unexpected event;
- related processes:debris flows,floods.

Pra Sec Glacier debris flow,1998 (Chiarle et al,2008)
"Lago effimero"BelvedereGlacier(G.Mortara-CNR-IRPI)

Rochefort Glacier, 2003

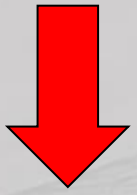
Tête Rousse Glacier,1892. Cavity resulting from an outburst flood; catastrophic flood propagated downstream and killed 175 people. In 2009-2010 a new growing cavity was detected by means of geophysics and prevention measures were taken to empty the cavity and avoid risk (from C.Vincent,in GlaRiskAlp Alcotra project)

Front of Rochefort glacier after the outburst of an inner water pocket in 2003.Such events are frequent especially in spring/summer season and result in debris flows or floods on the stream below, often reaching the valley road. At the state of the art,no methods can be reasonably applied to detect water accumulation and forecast outburst

Inner water reservoirs are usually difficult to detect, unless they are known from previous events: forecasting of outburst floods from these cavities is therefore difficult or impossible especially at a regional scale

Characteristics of glaciers-induced phenomena:

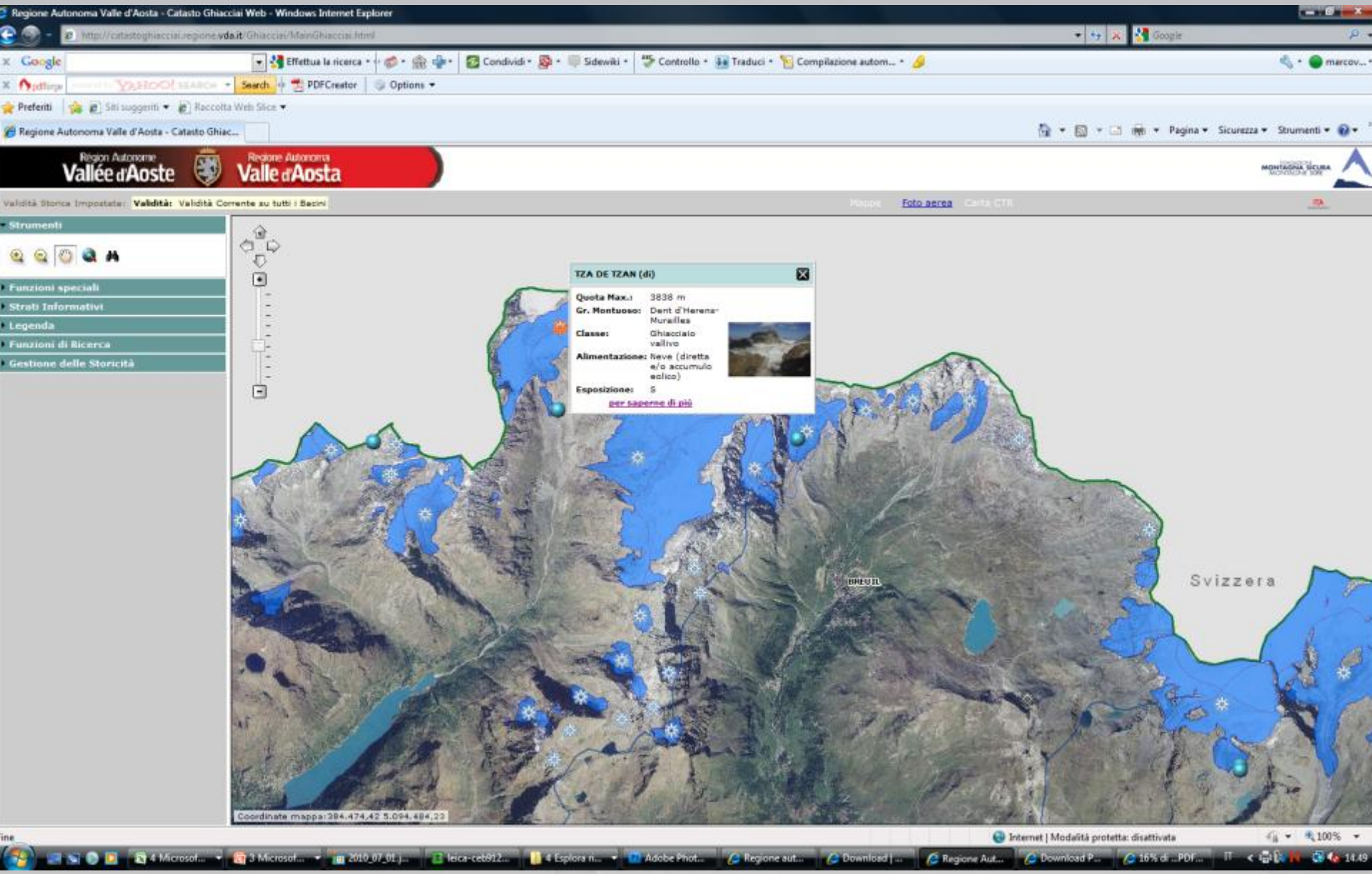
- low frequency, high magnitudo;
- sudden, often unexpected;
- long distance propagation;
- very fast propagation (avalanches: 50-300 km/h ; debris flows: 80-90 km/h).



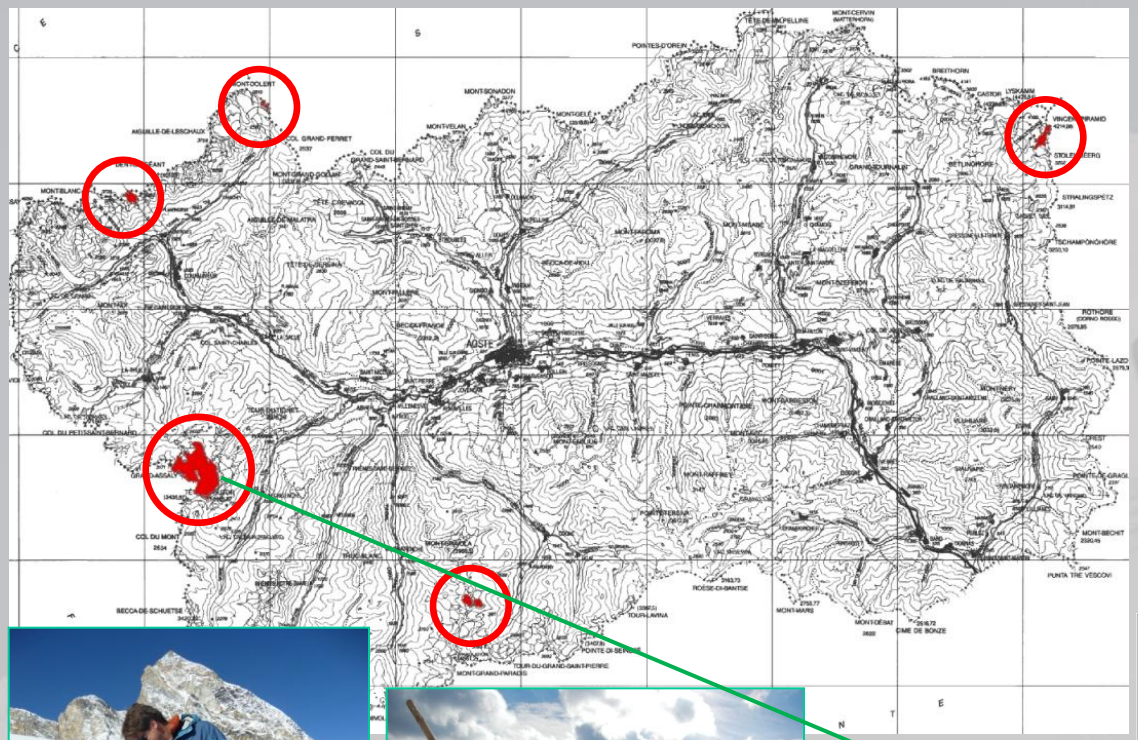
HIGH RISK FOR INHABITED AREAS, INFRASTRUCTURES,TOURISTIC SETTLEMENTS

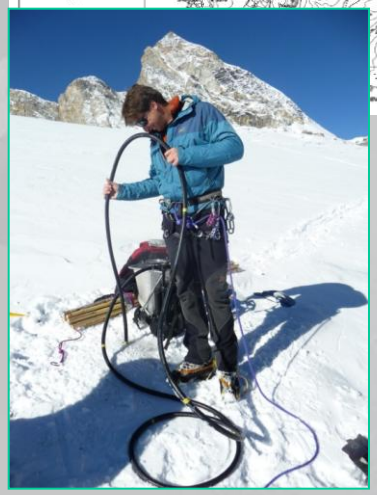
- About 200 glaciers in a 3200 sq km surface
- several glaciers are nearby inhabited areas (touristic settlements) or infrastructures;
- many basins have snow-glacial water supply – effect of glaciers on flood or debris flow dynamics
- rapid recent glaciers evolution due to climate warming such as:
  - -Glaciers extent changes 185 km2 in 1975 → 153 km2 in 1999 → 135 km2 in 2005;
  - -detachment and rapid melting of ice tongues; -
  - -developement of new glacial lakes;
  - ...

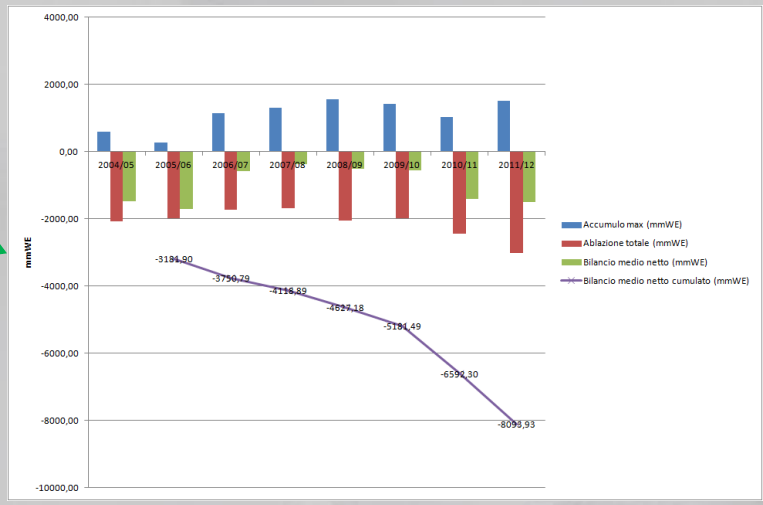
Glaciers and glacial lakes Inventory (last update 2005-06, waiting for new data)



Glaciers evolution: mass balance







Glaciers evolution

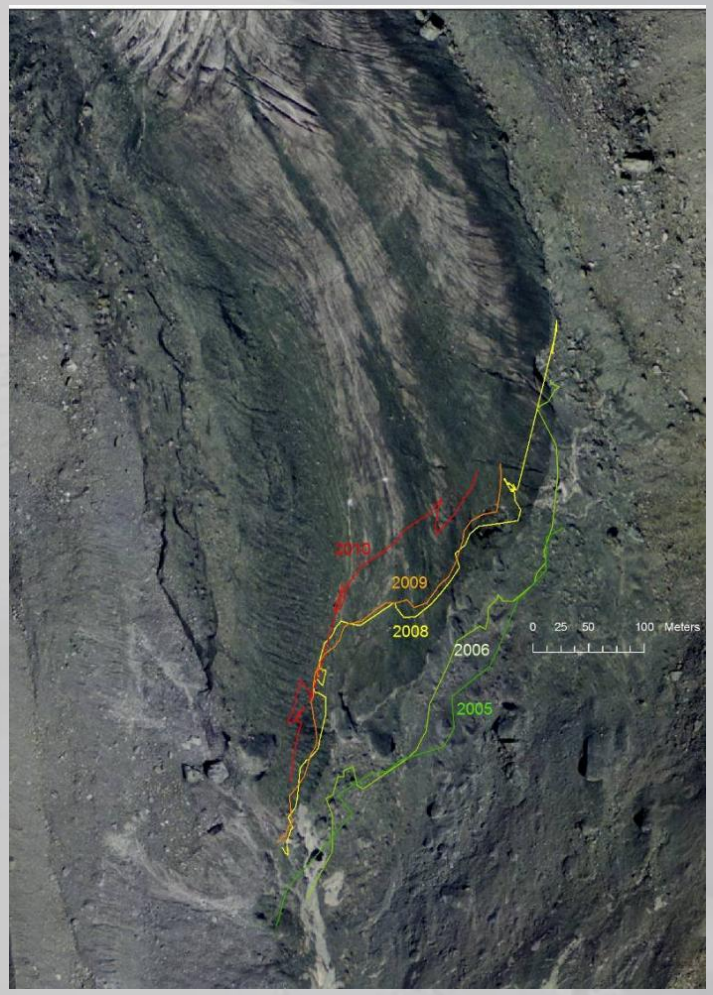
Cherillon (Valtournenche)

Tzanteleina (Rhêmes Notre Dame)

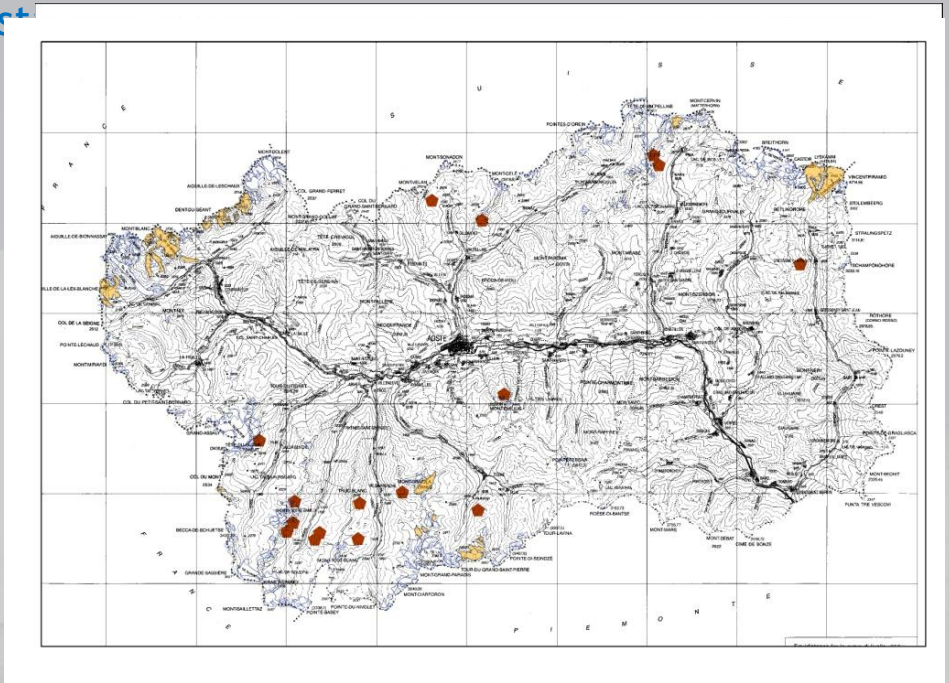
Mont Gelé
(Ollomont)

Glaciers evolution

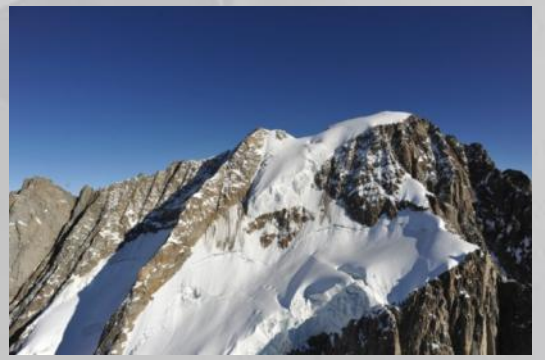
Verra Grande (Ayas)

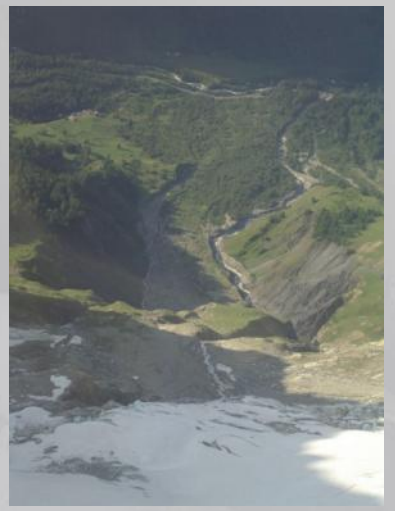


Glacial risk in Aost

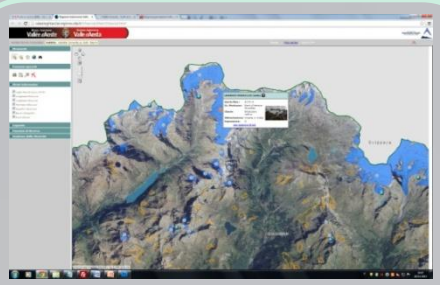


Glacial risk monitoring plan set up by Fondazione Montagna sicura on behalf of R.A.V.A. Geological service



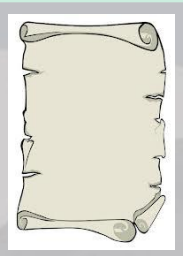


GLACIER-RELATED RISK MONITORING PLAN IN AOSTA VALLEY



Glaciers and glacial lakes inventory

GRIDABASE – GLACIORISK



Historic data, scientific papers

Regional database of instabilities

Geomorphological analysis (GIS)

Qualitative risk assessment

Inventory of "dangerous" glaciers

- geodatabase and monographies
- annual update: images by helicopter, image analysis,

events

Vulnerabiliy

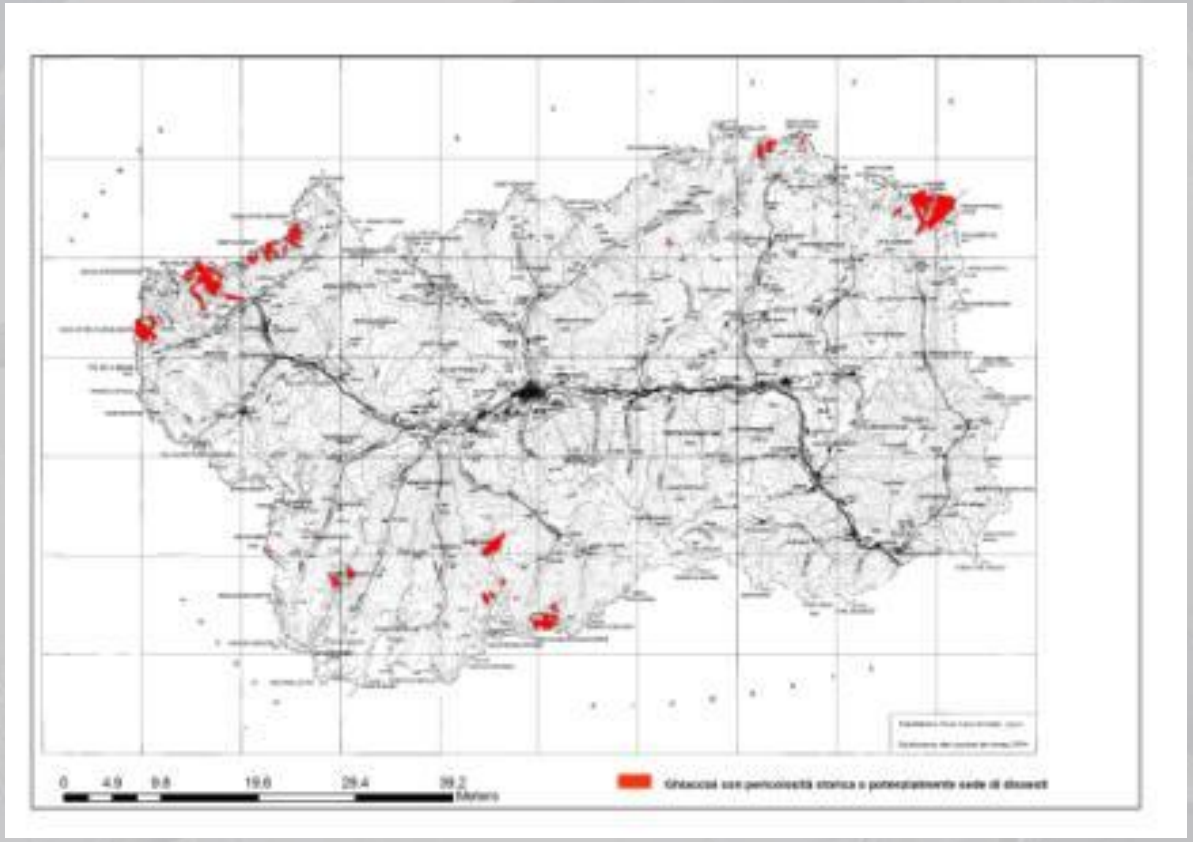
Specific monitoring

Application of high technologies

GLACIER-RELATED RISK MONITORING PLAN IN AOSTA VALLEY

Yearly update of dangerous glaciers inventory

- photographic survey from helicopter (last 2011, 2012, 2013)
- qualitative analysis of images (about 1000/year);
- 12 GLOFs, 10 ice fallsfrom hanging glaciers, temperate glaciers instabilities)
- shared methodology (Valais Canton);
- 4 specific cases monitoring.

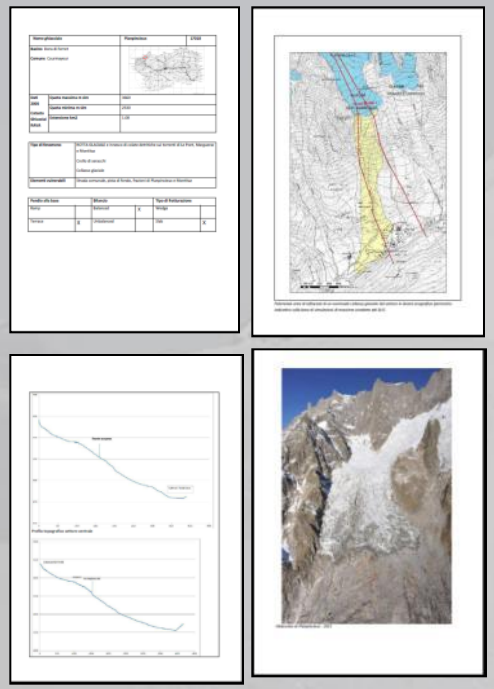


22 “dangerous” glaciers inventoried

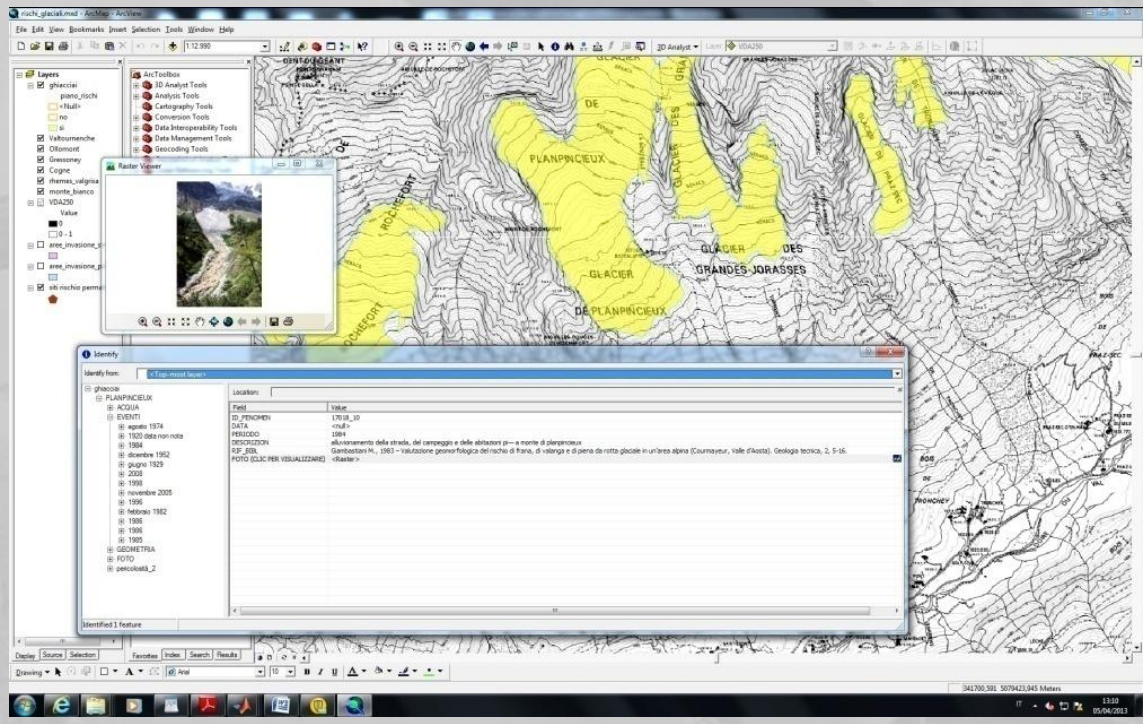
GLACIER-RELATED RISK MONITORING PLAN IN AOSTA VALLEY

Data are stored in:

Data Sheets



Geodatabase



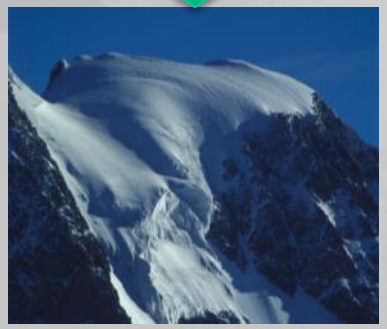
GLACIER-RELATED RISK MONITORING PLAN IN AOSTA VALLEY

Update

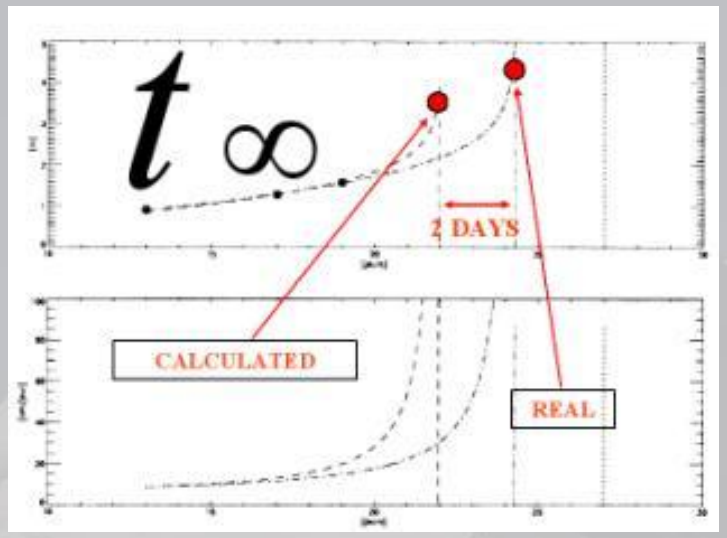
- Yearly photographic survey from helicopter
- Qualitative comparison of images
- Detection of new possibles hazard arising

Case-studies in Aosta Valley: Grandes Jorasses Hanging glacier

Umbalanced ramp cold glacier

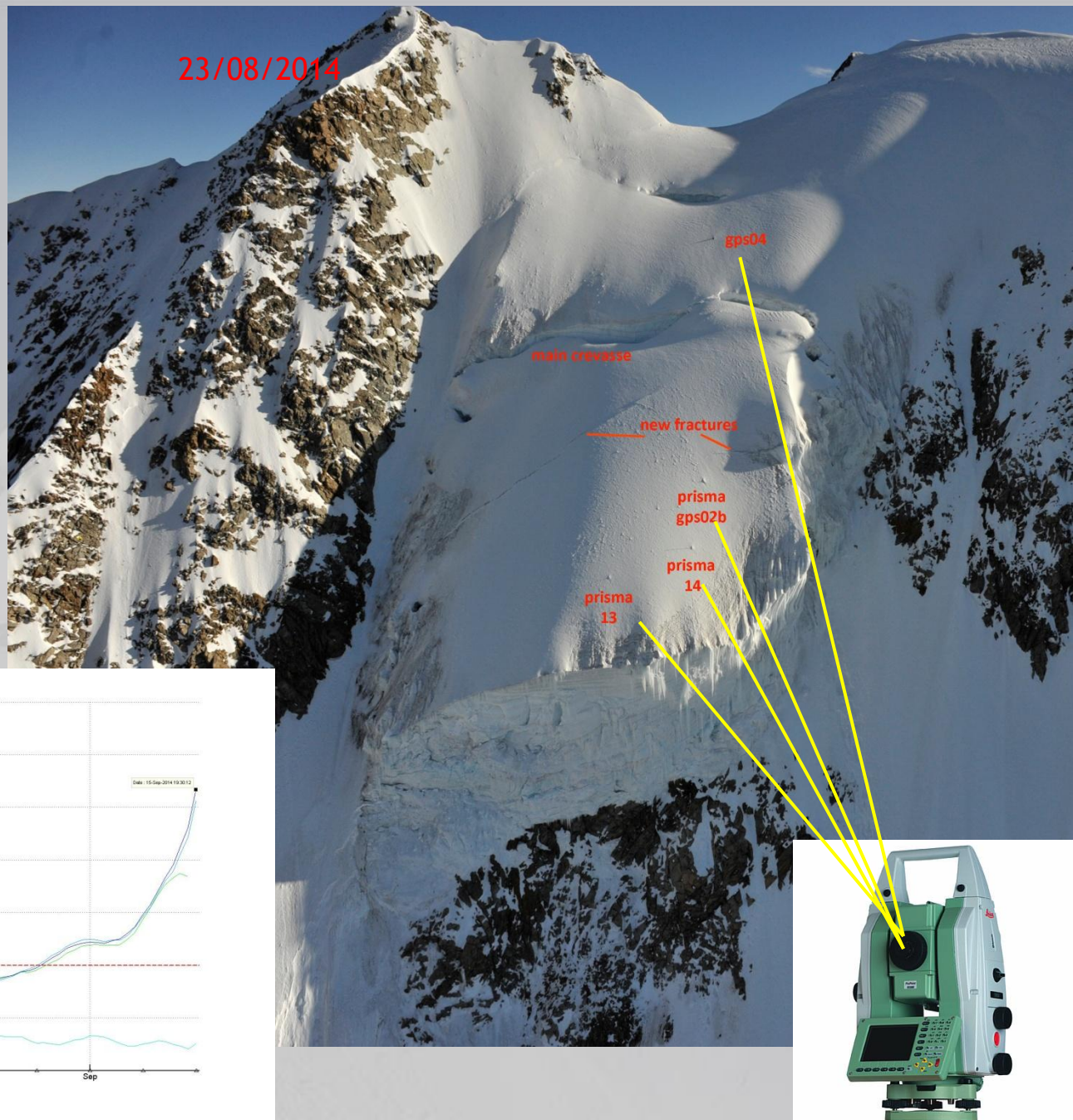


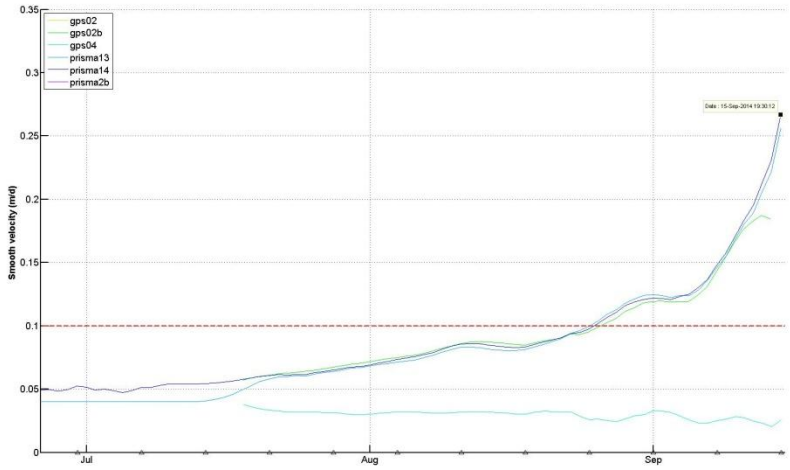
1998



Empirical power low describing accelerating displacement

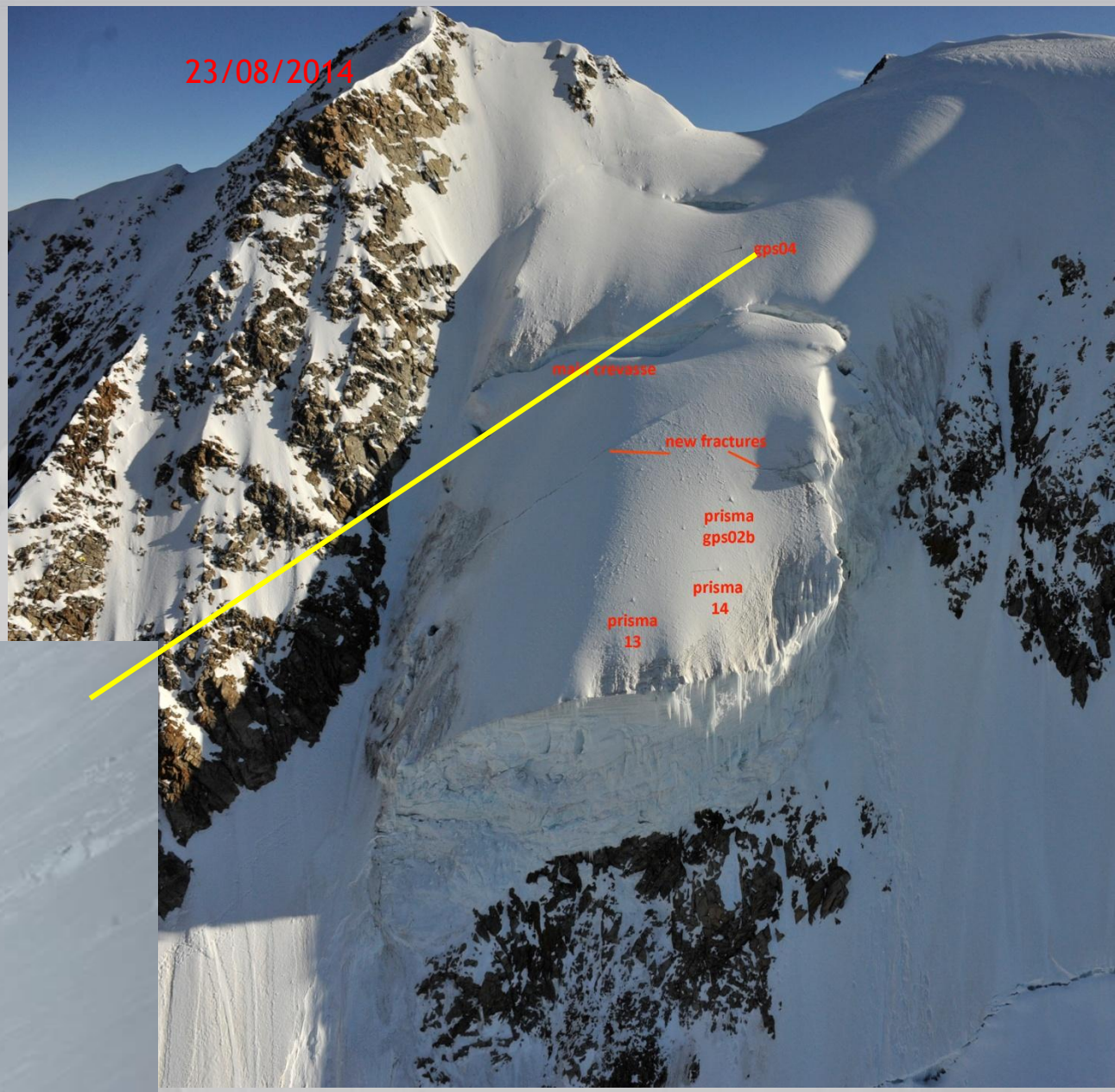
Topographic monitoring system (stakes + RTS)





Experimental system with GNSS receivers

GPS



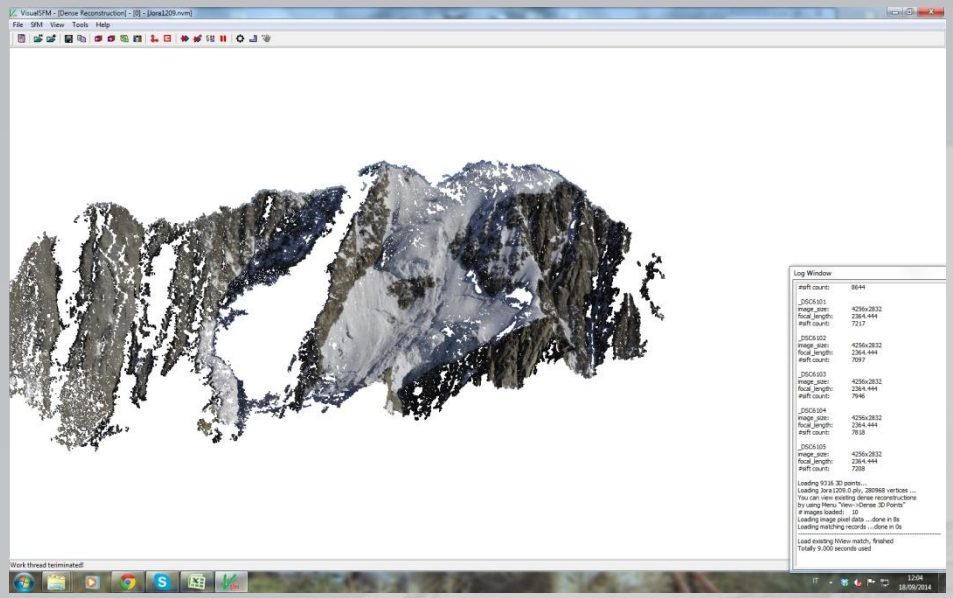
Automatic photogrammetric cameras

- Assessment of volumes
-Qualitative change detection for correlation

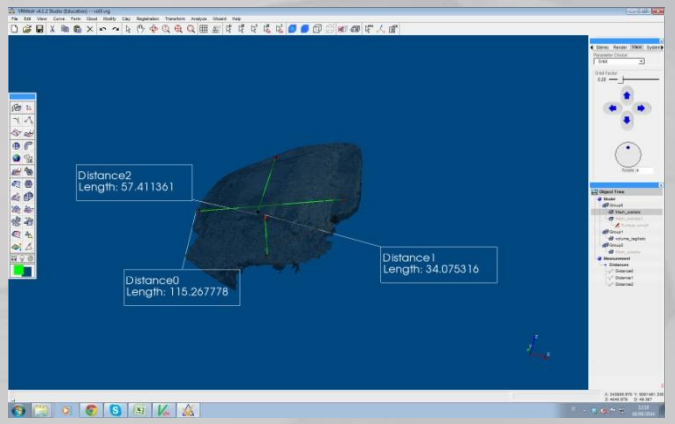
Automatic photogrammetric cameras

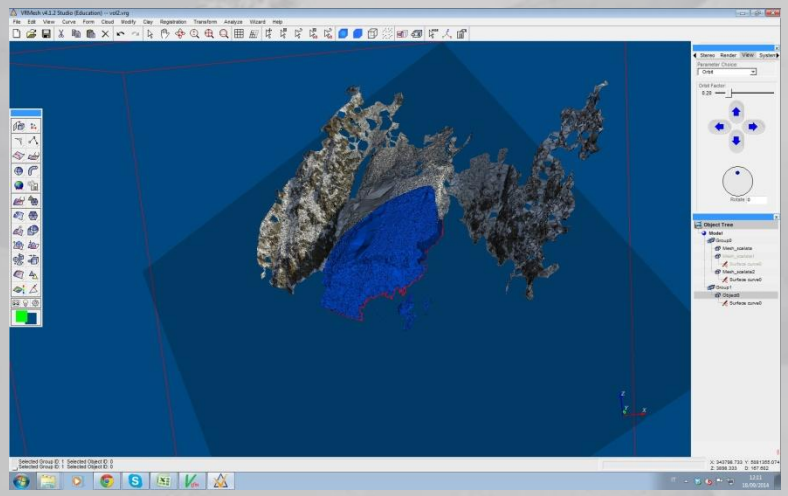
- Assessment of volumes
- Qualitative change detection from image correlation

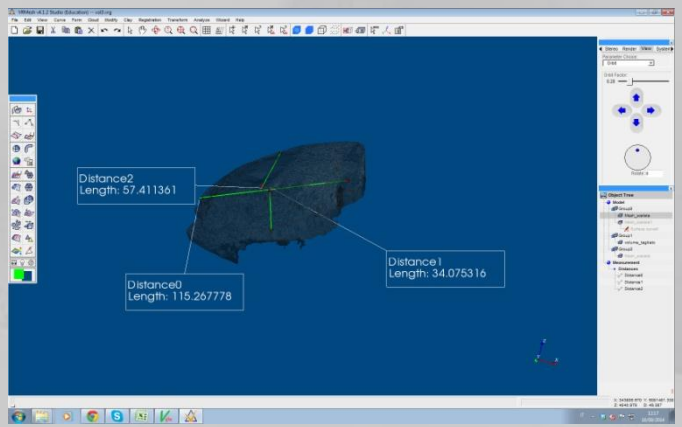
Automatic photogrammetric cameras



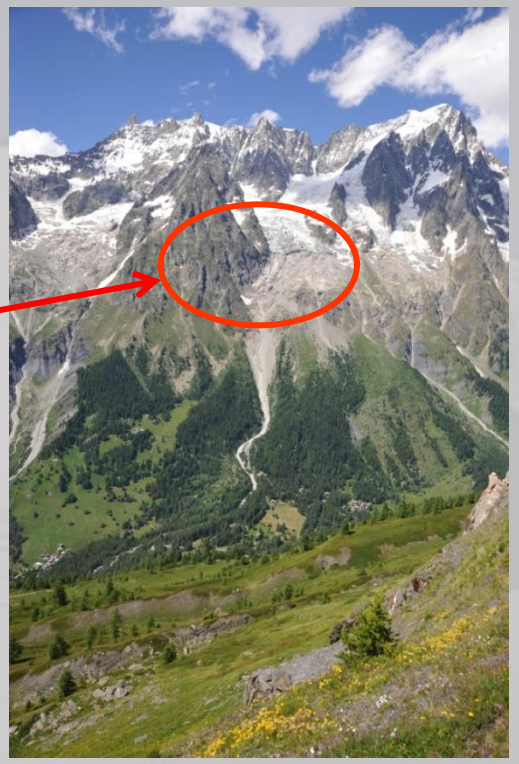
- Assessment of volumes
- Qualitative change detection from image correlation







Case studies in Aosta Valley: Planpincieux Glacier

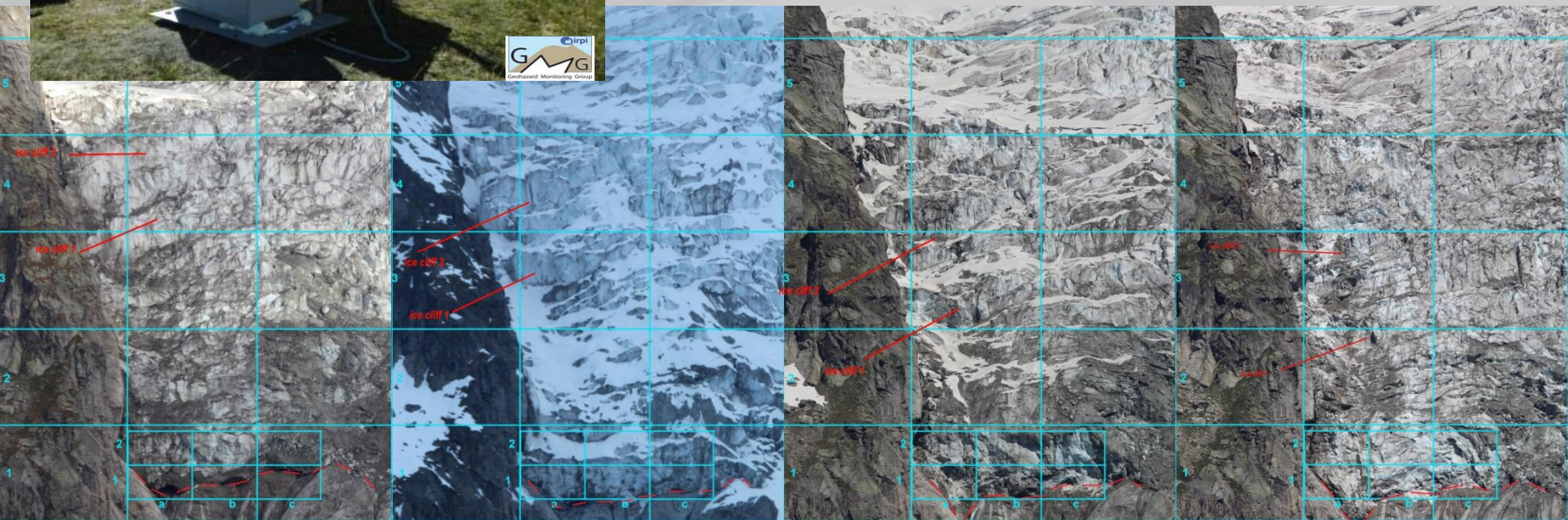


Temperate ramp glaciers

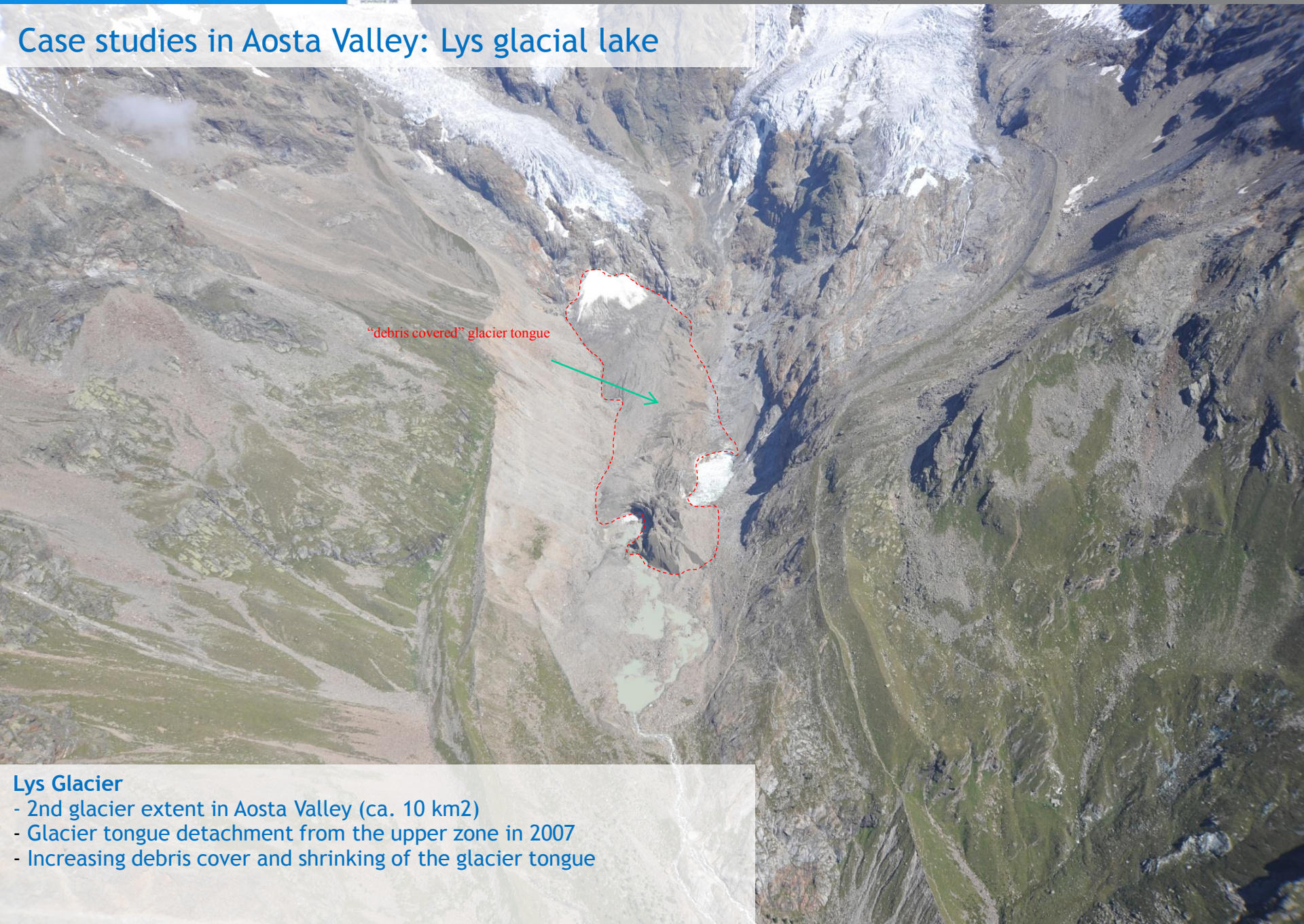
- at the state-of-the-art knowledge there is no forecasting model by means of thresholds on measurable parameters;
- according to some authors and numerical modeling (back analysis), morphological changes produce a few days before a breackdown (changes in subglacial water flow, widening crevasses) (Faillettaz, Sornette & Funk, 2011; Faillettaz, Funk, Sornette, 2012);
- a qualitative photographic monitoring system is going to be installed in order to detect and evaluate morphological changes; remote monitoring due to hard on-site operating conditions (cooperation with NRC);
- test of photographic monitoring methods to be applied in similar cases;

qualitative long term survey, coupled with numerical modeling ⇒ detection of critical parameters/signs to achieve forecasting skill ???

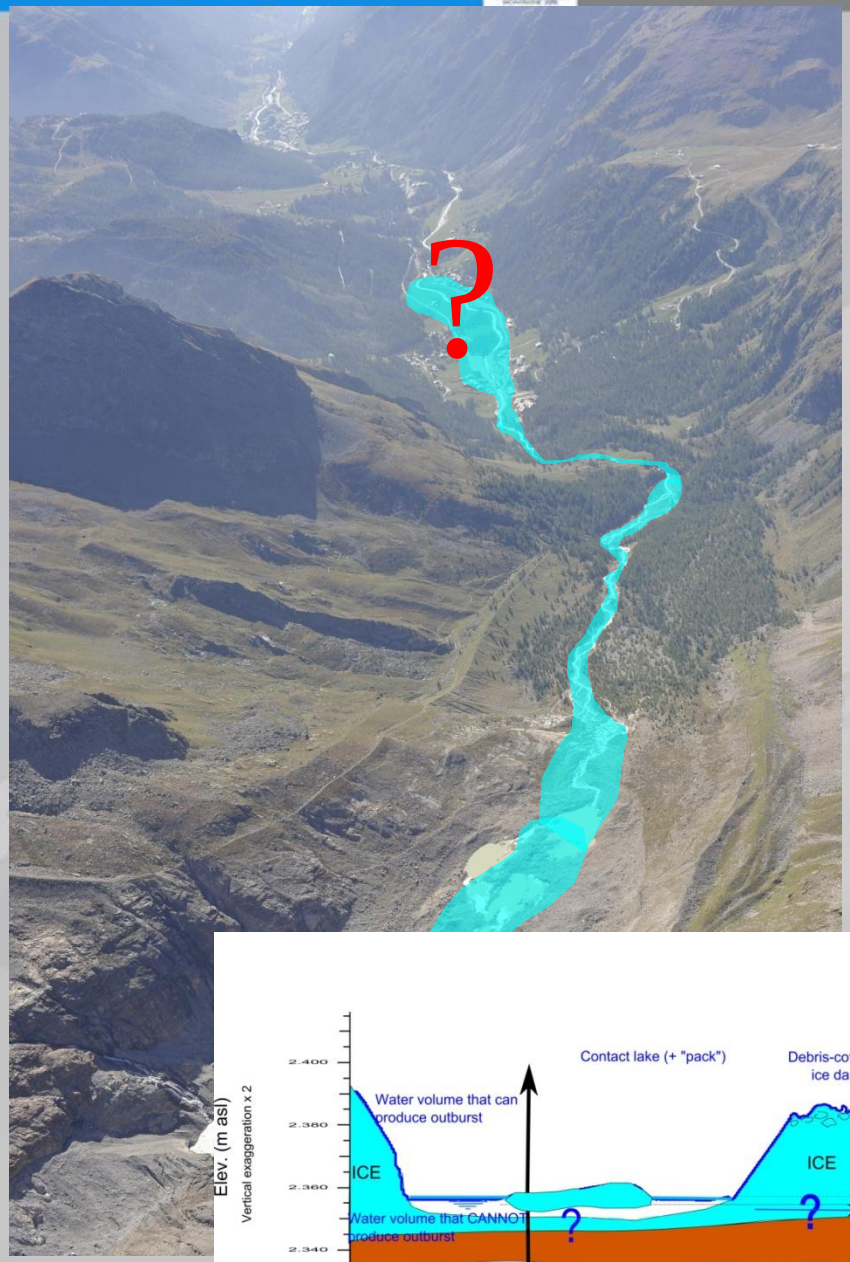
Case studies in Aosta Valley: Planpincieux Glacier



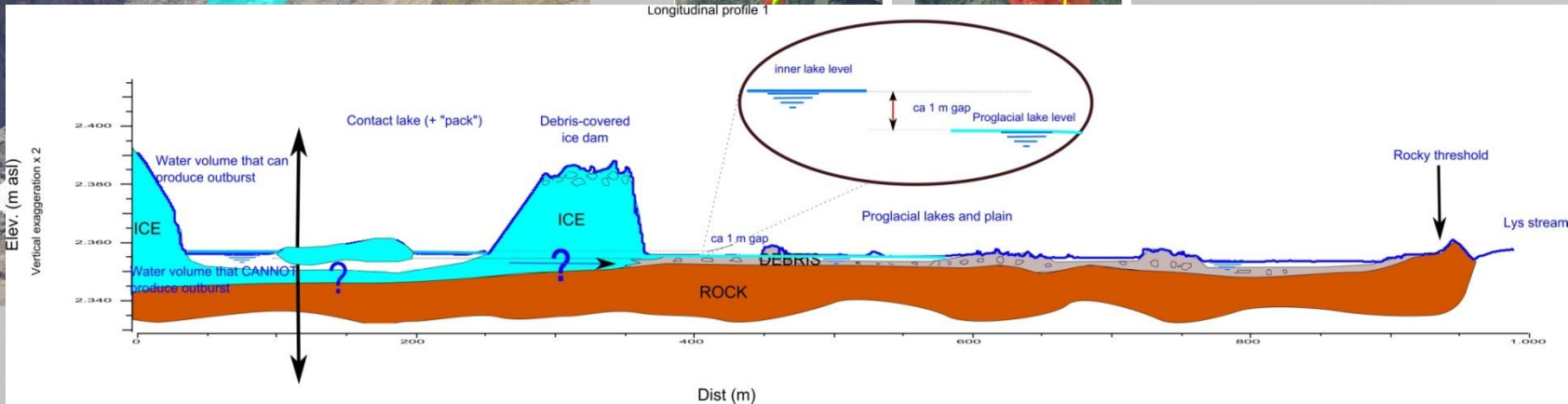
Case studies in Aosta Valley: Lys glacial lake



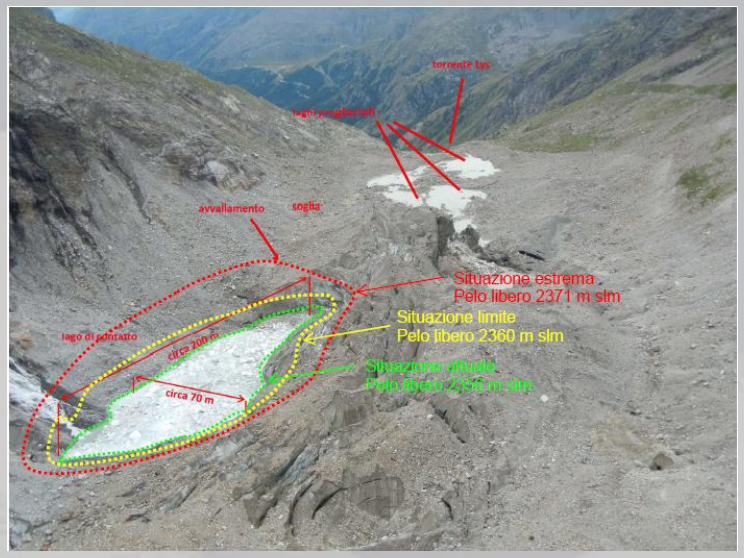
Lys Glacier
- 2nd glacier extent in Aosta Valley (ca. 10 km2)
- Glacier tongue detachment from the upper zone in 2007
- Increasing debris cover and shrinking of the glacier tongue

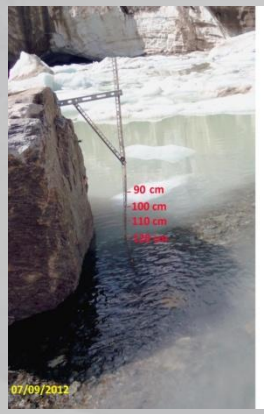

?


torrente Lys
avvallamento
soglia
Situazione estrema
Pelo libero 2385 m slm
Situazione limite
Pelo libero 2360 m slm
lago di contatto
circa 200 m
circa 70 m


Longitudinal profile 1
Elev. (m asl)
Vertical exaggeration x 2
2.400
2.380
2.360
2.340
Water volume that can produce outburst
ICE
Water volume that CANNOT produce outburst
Contact lake (+ "pack")
Debris-covered ice dam
ICE
?
?
inner lake level
ca 1 m gap
Proglacial lake level
Proglacial lakes and plain
ca 1 m gap
DEBRIS
ROCK
Rocky threshold
Lys stream
0
200
400
600
800
1.000
Dist (m)

Case studies in Aosta Valley: Lys glacial lake





- Glacial lake developed in the last years after glaciers retreat;
- dammed by a debris-covered ice dam;
- likelihood of a sudden release and possible flood effects down valley have been evaluated;
- a large water release, generating floods or debris flow down valley, is almost unlikely to occur;

- ice dam definitely melt in august 2014.

Lago glaciale del Lys

Université Européenne d'Eté sur les risques naturels 2014 - N°2
Università Europea d'Estate sui rischi naturali
Universidad Europea de Verano de Riesgos Naturales

Questa sessione formativa è organizzata nell'ambito del progetto Interreg IV Alcotra « RiskNET », con il sostegno finanziario della Région Rhône-Alpes, della DREAL Rhône- Alpes e della Regione autonoma Valle d'Aosta.

Rischio indotto dal collasso di sbarramenti naturali e dallo svuotamento di accumuli idrici in alta quota in un contesto di cambiamento climatico

- ***Data:*** dal 22 al 26 settembre 2014
- ***Luogo:*** *Gressoney-La-Trinité* (Valle d'Aosta, Italia)
- ***Organizzatori:*** *Pôle Alpin Risques Naturels (PARN)*
  Fondazione Montagna sicura – Montagne sûre
- ***Il pubblico***: *gestionari dei rischi naturali, tesisti o dottorandi nell'ambito del tema de corso, provenienti da Spagna, Italia, Svizzera o Francia*
- ***Programma***: *corsi teorici (1,5 gg) e studio di un caso (3,5 gg)*

  Tematica e caso studio: caratterizzare la pericolosità creata dai laghi glaciali del Lys (valle di Gressoney) e dalle loro possibili evoluzioni, con i dati disponibili o prevedendo nuovi studi, compresa la valutazione della loro fattibilità tecnica ed economica.

- ***Responsabile pedagogico***: inquadra una squadra di specialisti europei

  Eric BARDOU, Valais, Svizzera
- ***Iscrizioni – Programma – Alloggiamento***:
  sul sito web del PARN dal 3 giugno 2014
  http://www.risknat.org/pages/universites/session2014--2.html

http://www.risknat.org/pages/universites/session2014--2.html

Thanks for your kind attention

...any question?