Politecnico di Torino

Dams & Reservoirs DAY 2025

Water and Energy security for Europe

OPEN DAY ON DAMS



Dams and environment: engineering solutions for the future

TORINO , 28 maggio 2025

Experiences in dam monitoring within the Autonomous Region of Valle d'Aosta

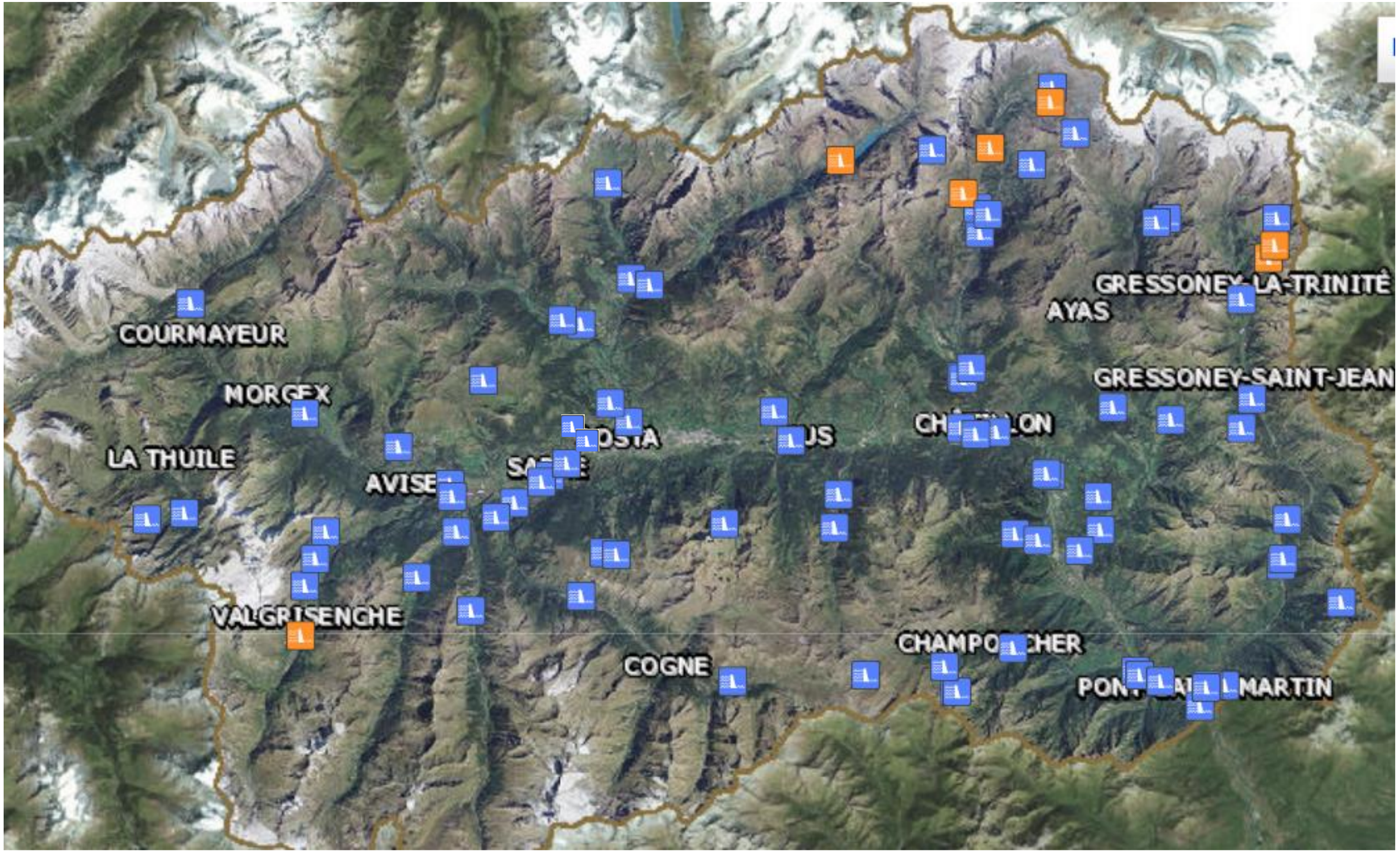
p.ropele@regione.vda.it

ITCOLD – II Concorso Fotografico

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

81 SMALL DAMS

6 LARGE DAMS



DAMS LEGISLATION IN AOSTA VALLEY

REGIONAL LAW
LR 29 march 2010 n. 13

IMPLEMENTING REGULATION

DGR n. 33
22.01.2024
(ex DGR n. 2073
30.07.2010)



Design, construction, testing and operation of new dams



Regularization of existing dams in the regional territory



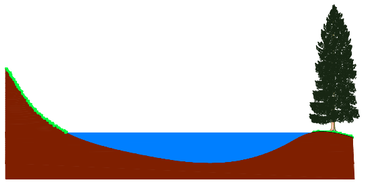
classification of dams into risk categories

VOLUME < 1,000,000 cubic metres

HEIGHT < 15 metres

EXCLUSIONS FROM REGIONAL LEGISLATION

Natural lakes and basins created entirely below ground level are excluded



Hanging tanks are excluded



Hydraulic river regulation works are excluded



Dams on watercourses that determine a **volume** of the reservoir **< 5,000 cubic metres** and whose **height < 2 metres** are excluded

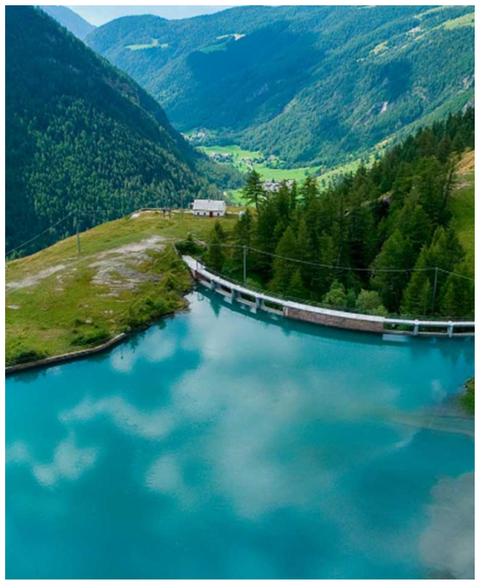
Basins with a **volume** of the reservoir **< 1,500 cubic**

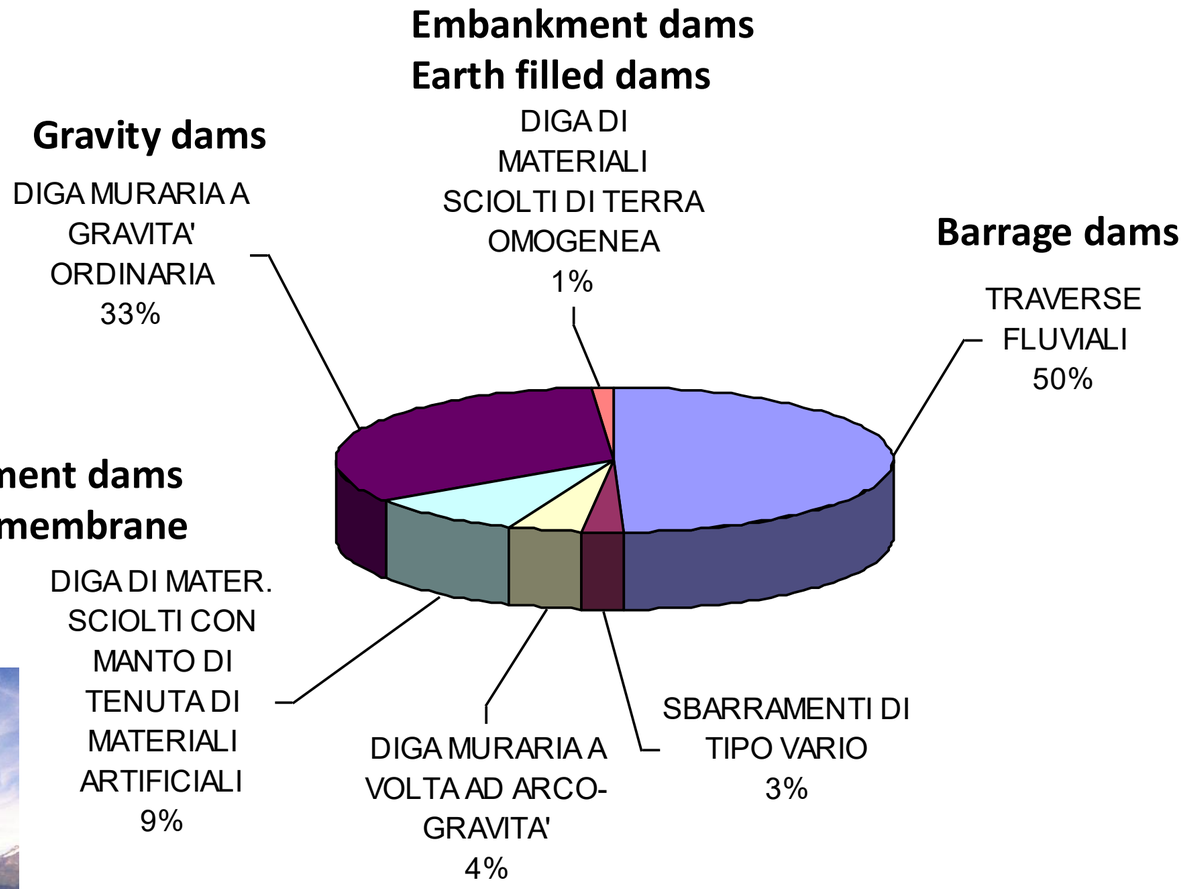
CLASSIFICATION BY TYPE



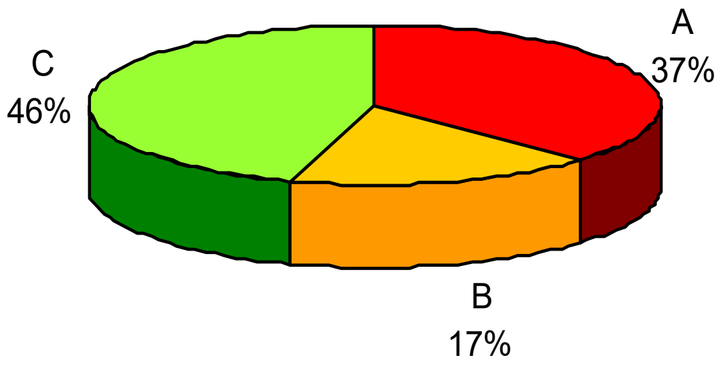


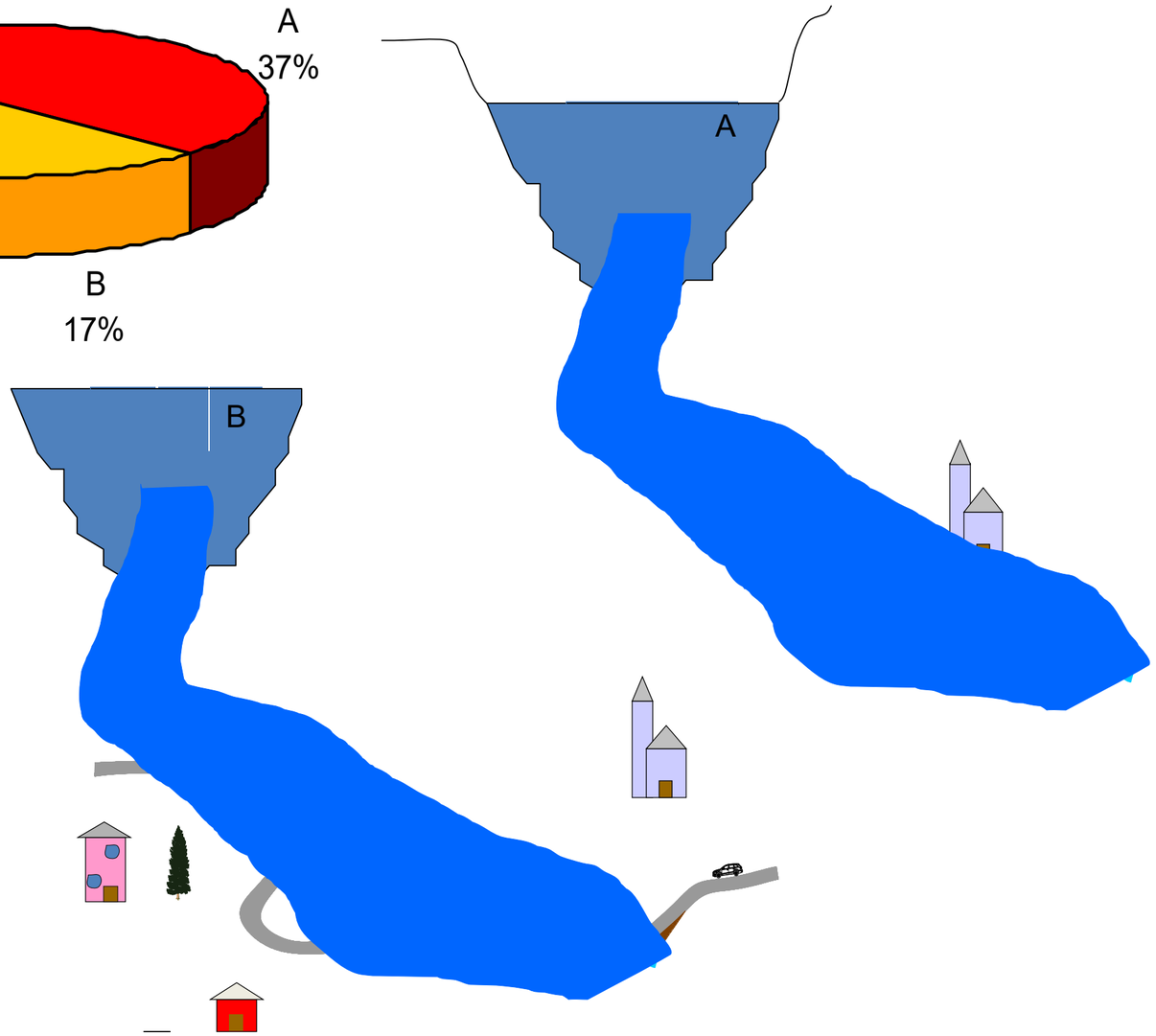




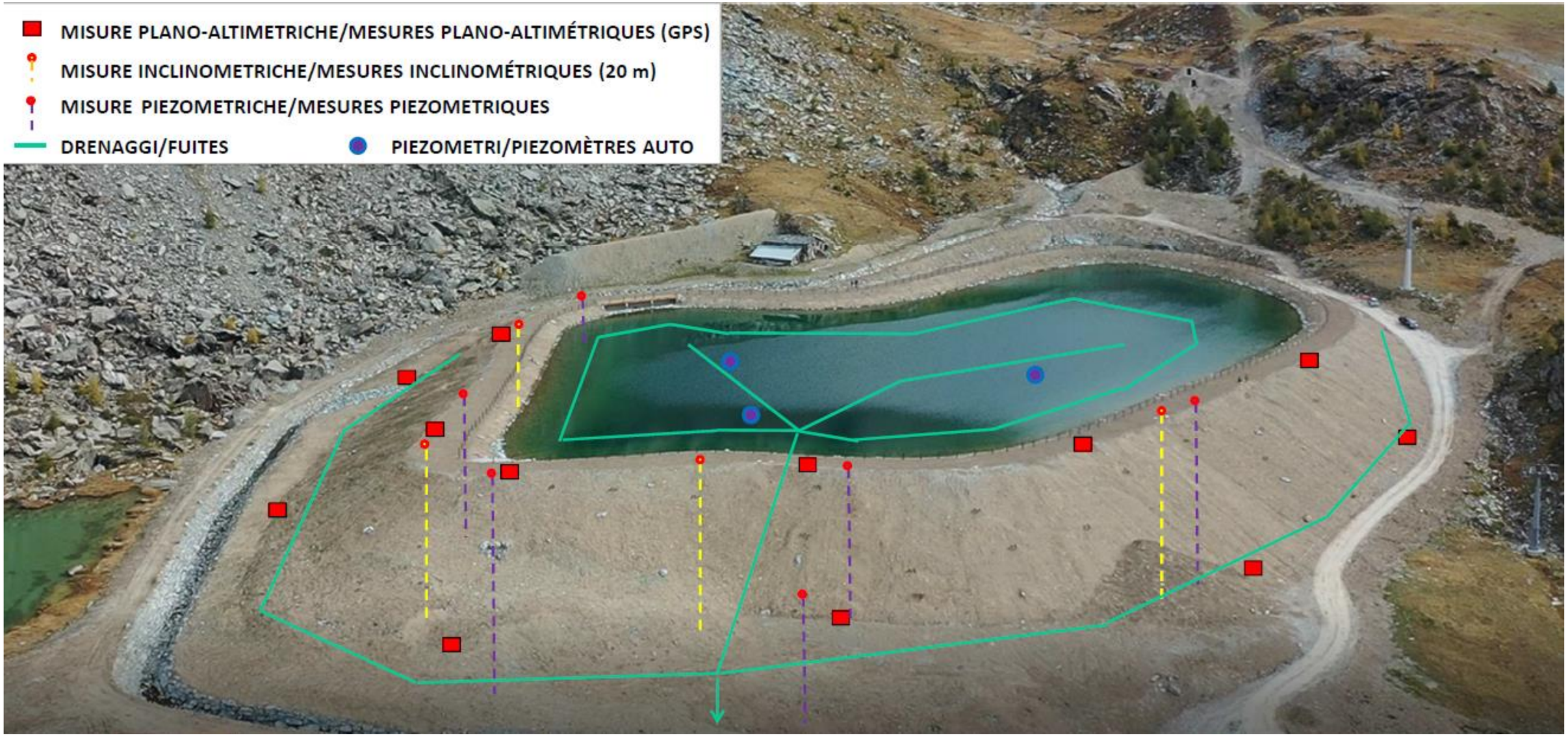


CLASSIFICATION BY RISK CATEGORIES





FOURCARE MONTEROSA SKI AREA (AYAS) - Embankment dam with geomembrane



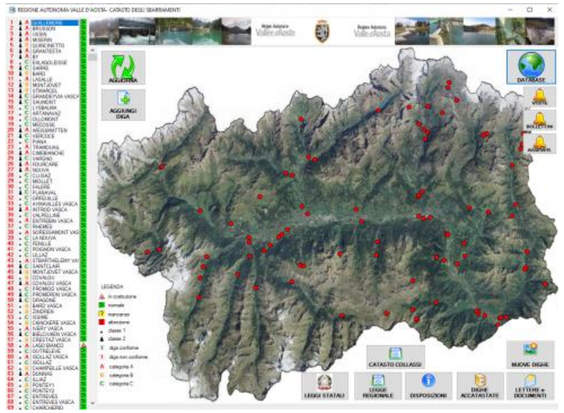
FOURCARE MONTEROSA SKI AREA (AYAS) - Embankment dam with geomembrane



CRITICAL ISSUES IN THE SMALL DAMS MANAGEMENT

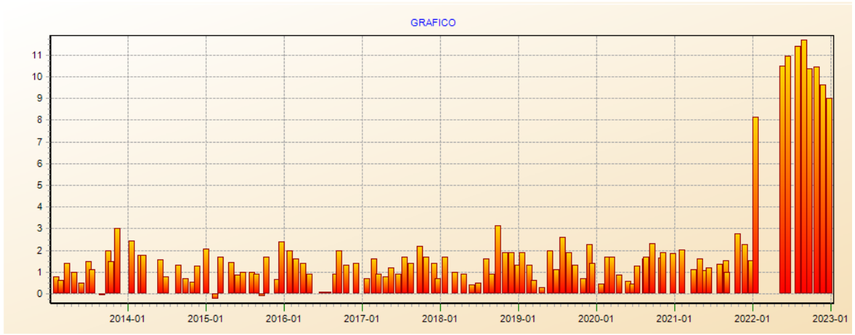
The owners of the dams send monitoring data from 211 sensors in addition to:

- 162 Certifications (every 6 months)
- 126 Registration bulletins
- Discharge comunications
- Work comunications
- Discharge organs test communications
- ….



DIGITAL DATABASE TO MANAGE AND CONTROL ALL DATA AND DOCUMENTS

DATA ARE UPLOADED DIRECTLY BY THE OWNER ON A DEDICATED WEB SITE



Satellite Interferometry

Radar sensors mounted on specific satellites transmit radar signals toward the earth, some of which reflect off objects on the ground, bouncing back to the satellite.

Satellite interferometry provides the deformation rate along the line of sight (LOS)

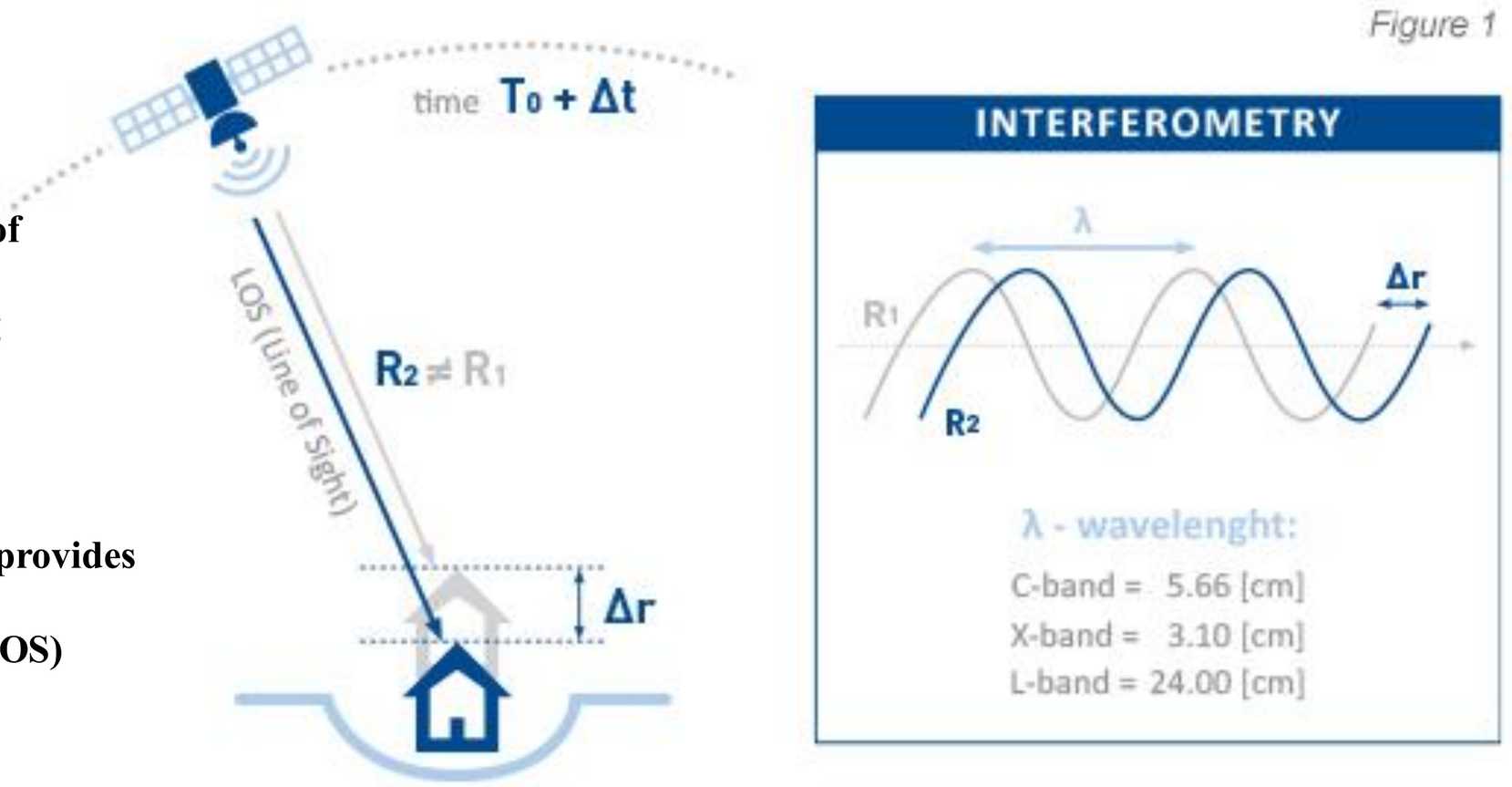
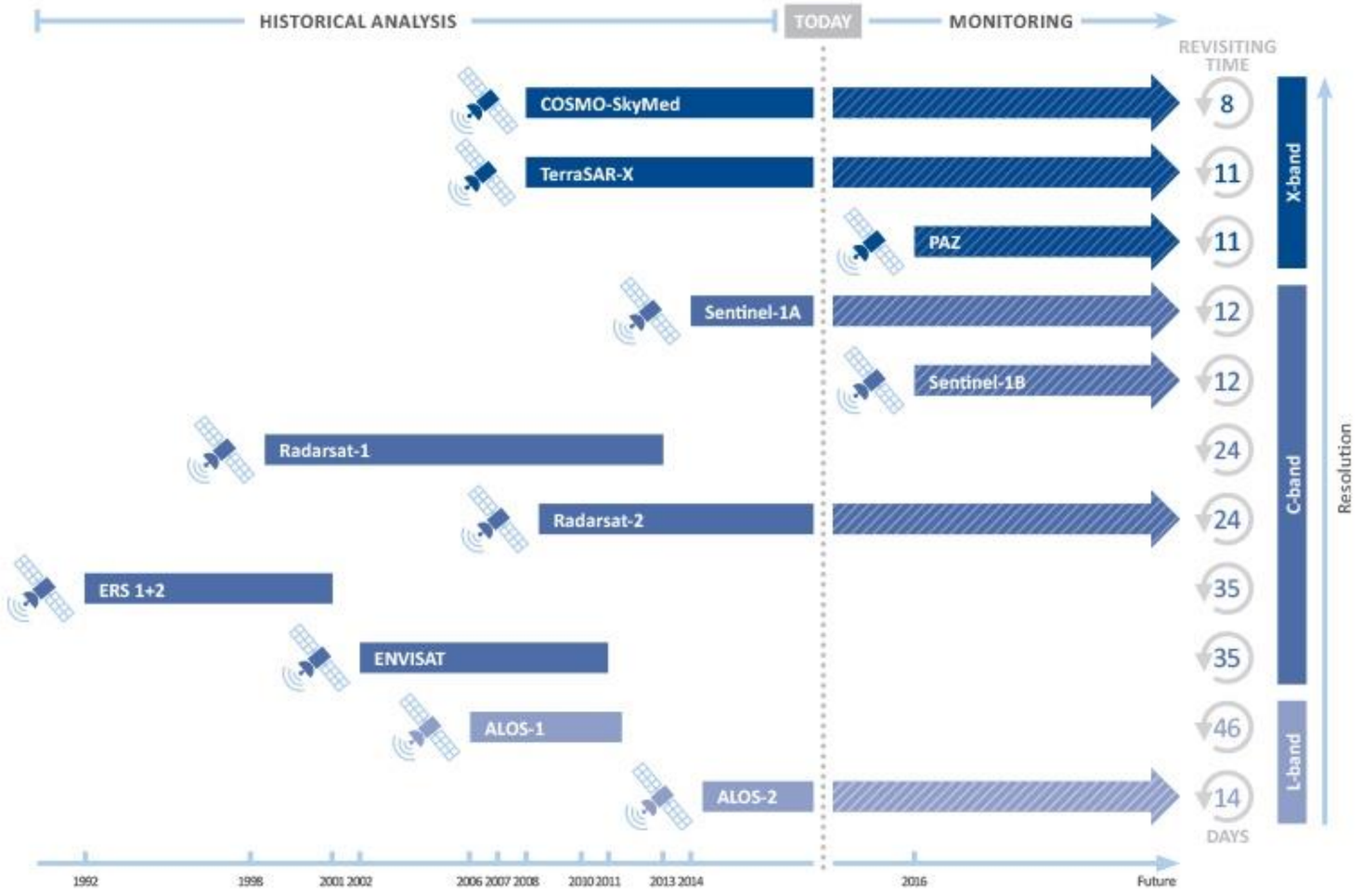


Figure 1

A schematic showing the relationship between ground displacement and signal phase shift. The numeric value of the wavelength λ (3.10 cm) is that used by the COSMO satellite operated by the European Space Agency (ESA).

Synthetic Aperture Radar (SAR) systems

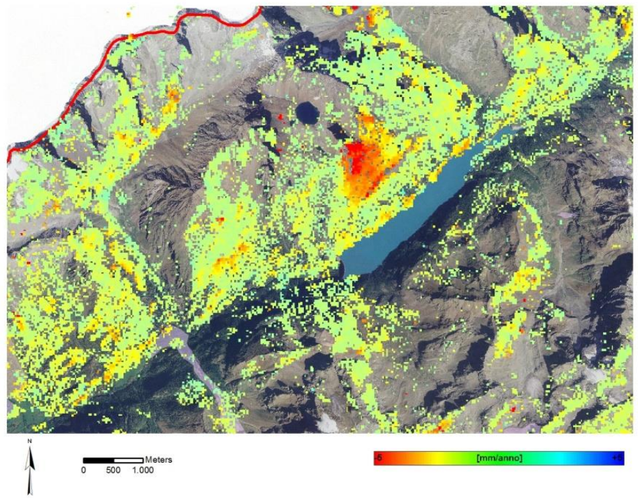
InSAR
Remote sensing tool
that measures ground displacement



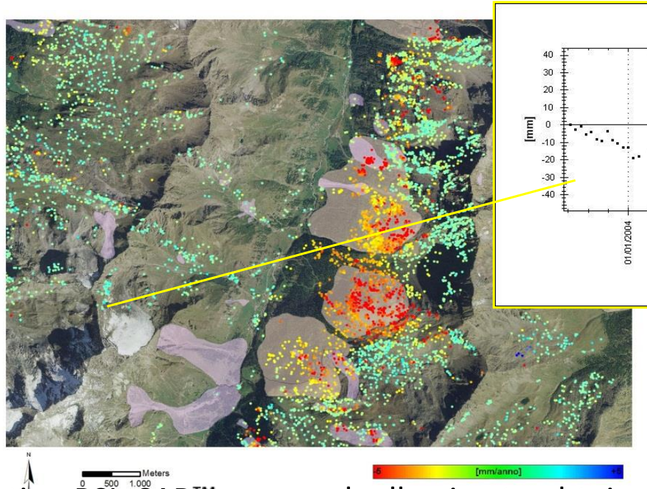
As clouds do not obstruct the passage of the satellite signal, satellite platforms mounting Synthetic Aperture Radar (SAR) systems can function 24 hours a day, 365 days per year.

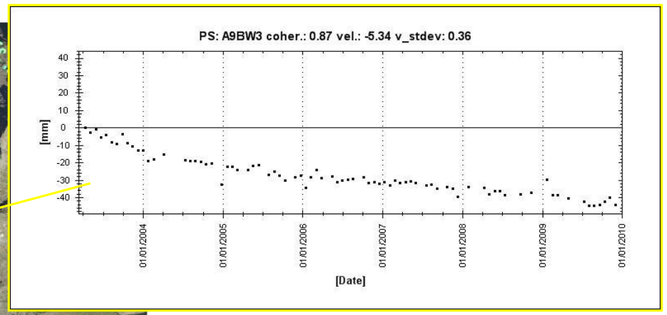
SqueeSAR Analysis: Typical Outputs

Raster data: maps of average annual displacement speed



Vector data: Point values of annual mean displacement speed in ESRI© shapefile format

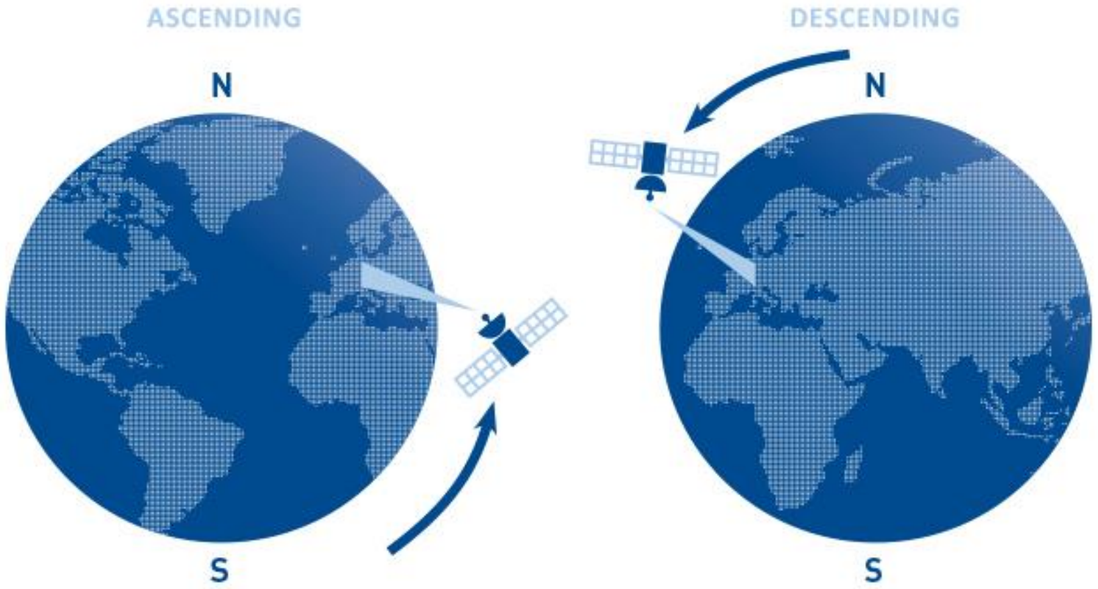


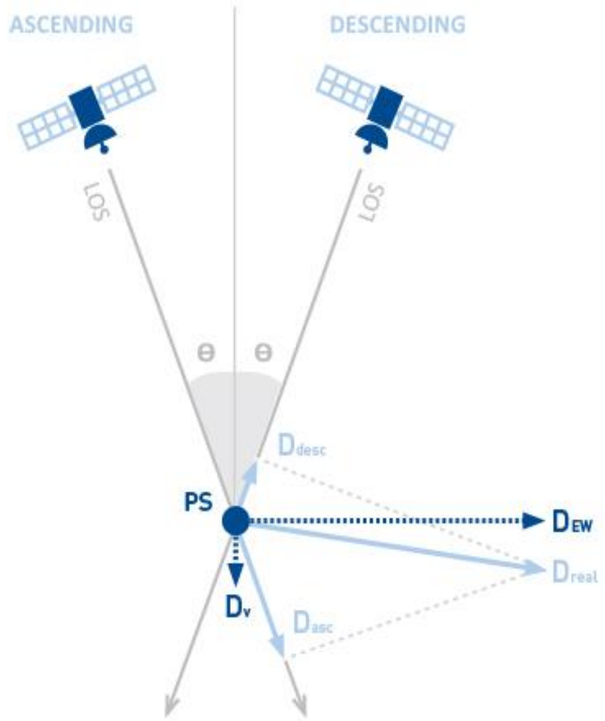


Displacement time series

SqueeSAR™ developed by POLIMI and TRE (Ferretti et al. 2011), represents the second generation PSInSAR™ approach allowing to obtain a significant increase of measurement points over non-urban areas by exploiting signal returns from two families of ground measurement points on the Earth's surface:
Permanent Scatterers (PS): radar targets characterised by high reflectivity values, generating very bright pixels in the SAR scene, usually corresponding to individual buildings, metallic objects, pylons, penstocks, antennae, outcrops, etc.
Distributed Scatterers (DS): radar targets usually corresponding to many adjacent pixels in the SAR image, all exhibiting a very similar radar signature and where temporal decorrelation phenomena, though present, still allow the retrieval of displacement data. These signals usually correspond to rocky areas, detritus, non-vegetated areas.

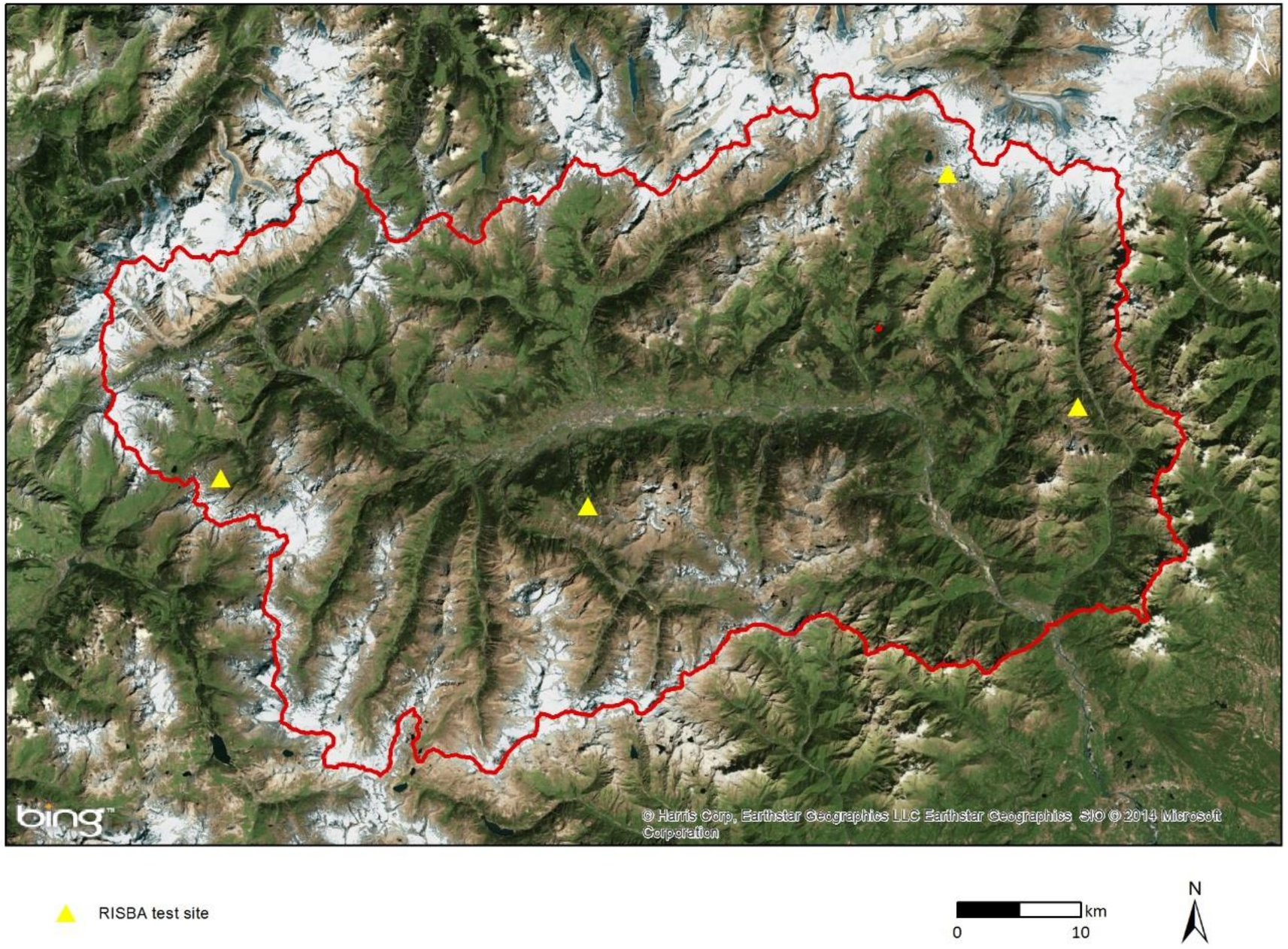
Two acquisition geometries: ascending and descending





Results obtained from the processing of an ascending and a descending dataset over the same meausurement point can be combined to give separate estimates of the vertical and E-W displacement components

The monitored basins are located in four ski areas within Regione Autonoma Valle d'Aosta:
Gressan (Pila),
Gressoney-Saint-Jean (Weissmatten),
La Thuile (Gran Testa)
Cervinia (Cime Bianche)



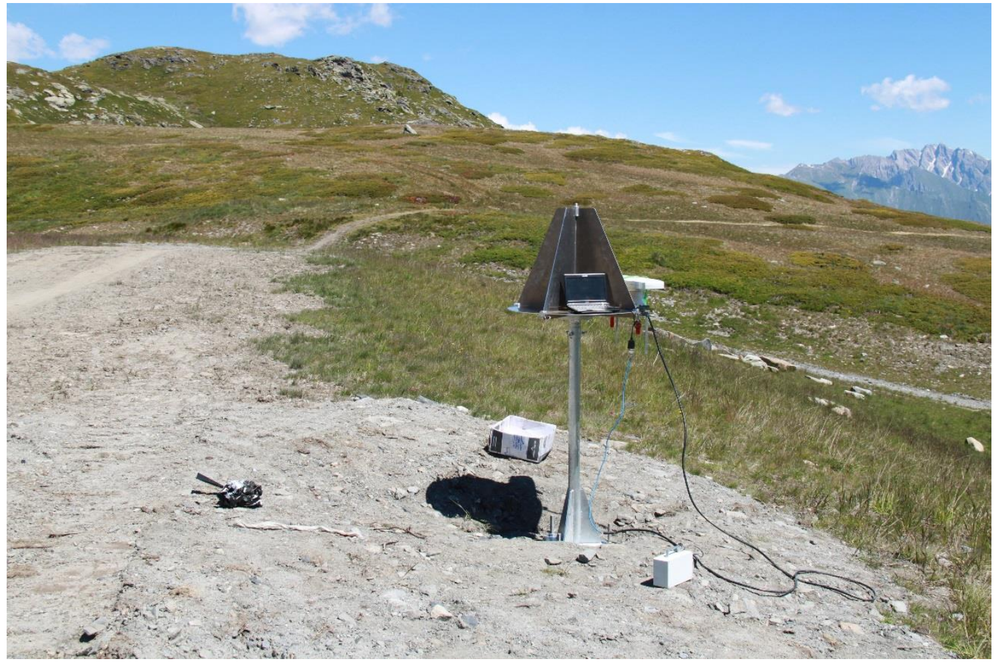
Progetto RESBA: Artificial Reflector



View of a dual geometry X-band Artificial Reflector without snow cover, during the orientation carried out by using a GPS compass.





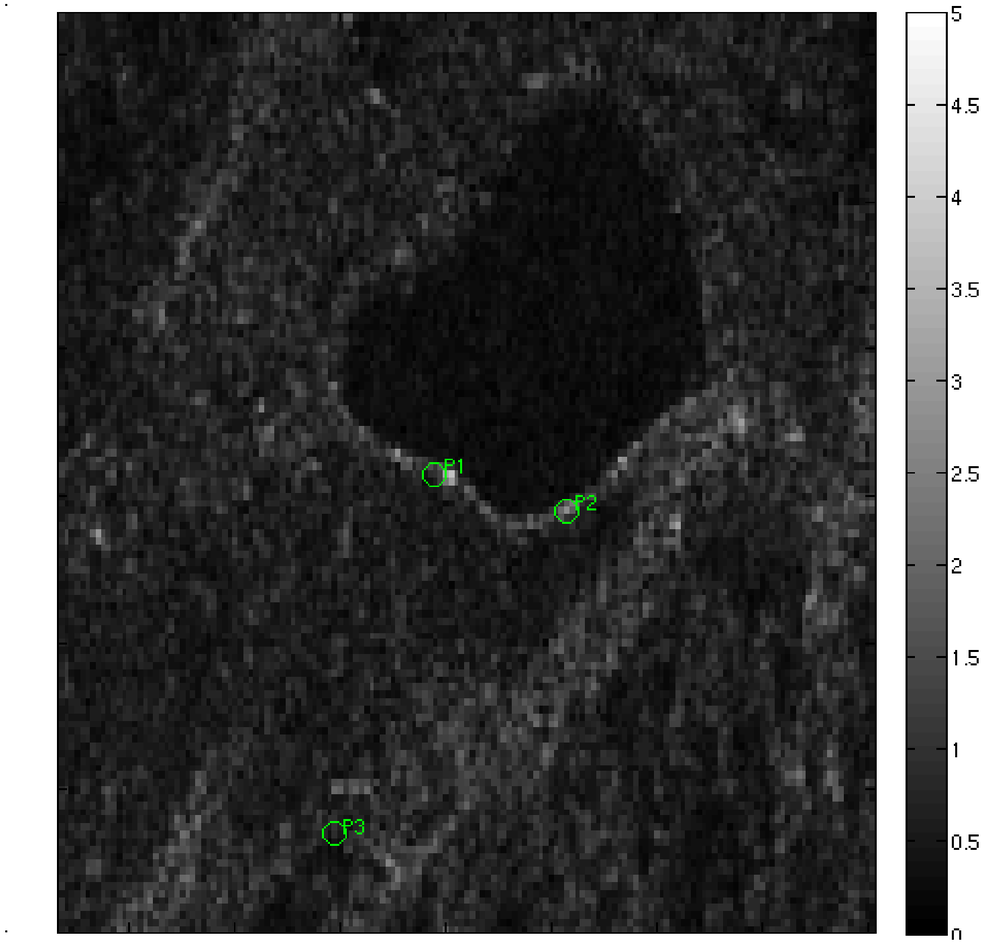


Four water storage basins for artificial snow production were equipped with three ARs each:

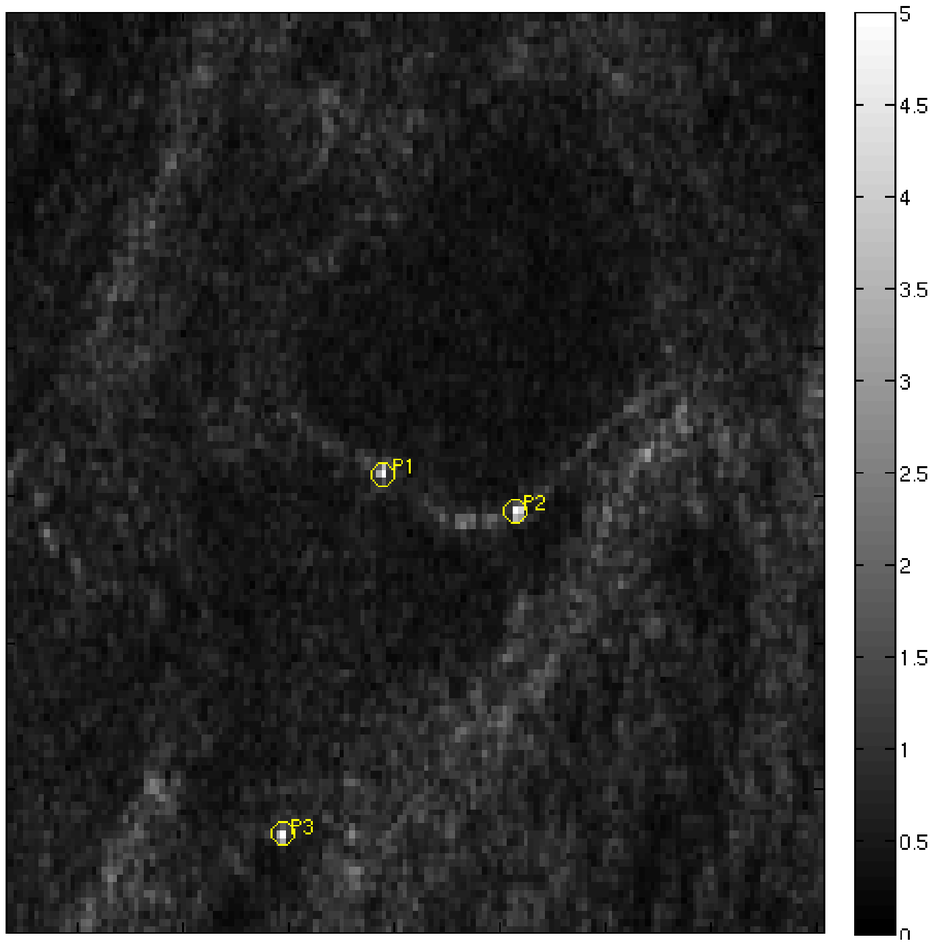
- two ARs are located along the crest of the dam,
- the third one is outside the storage basin area and represents the reference point for each network.

Reflector basements were installed by using concrete bases or fixing the base plate directly on rock with epoxy resins. Once installed, ARs were properly oriented using a level and a GPS compass in order to align the bisector of each reflecting triedral along the E-W direction, so that each AR is visible in both ascending and descending acquisition geometries.

AMPLITUDE TEST

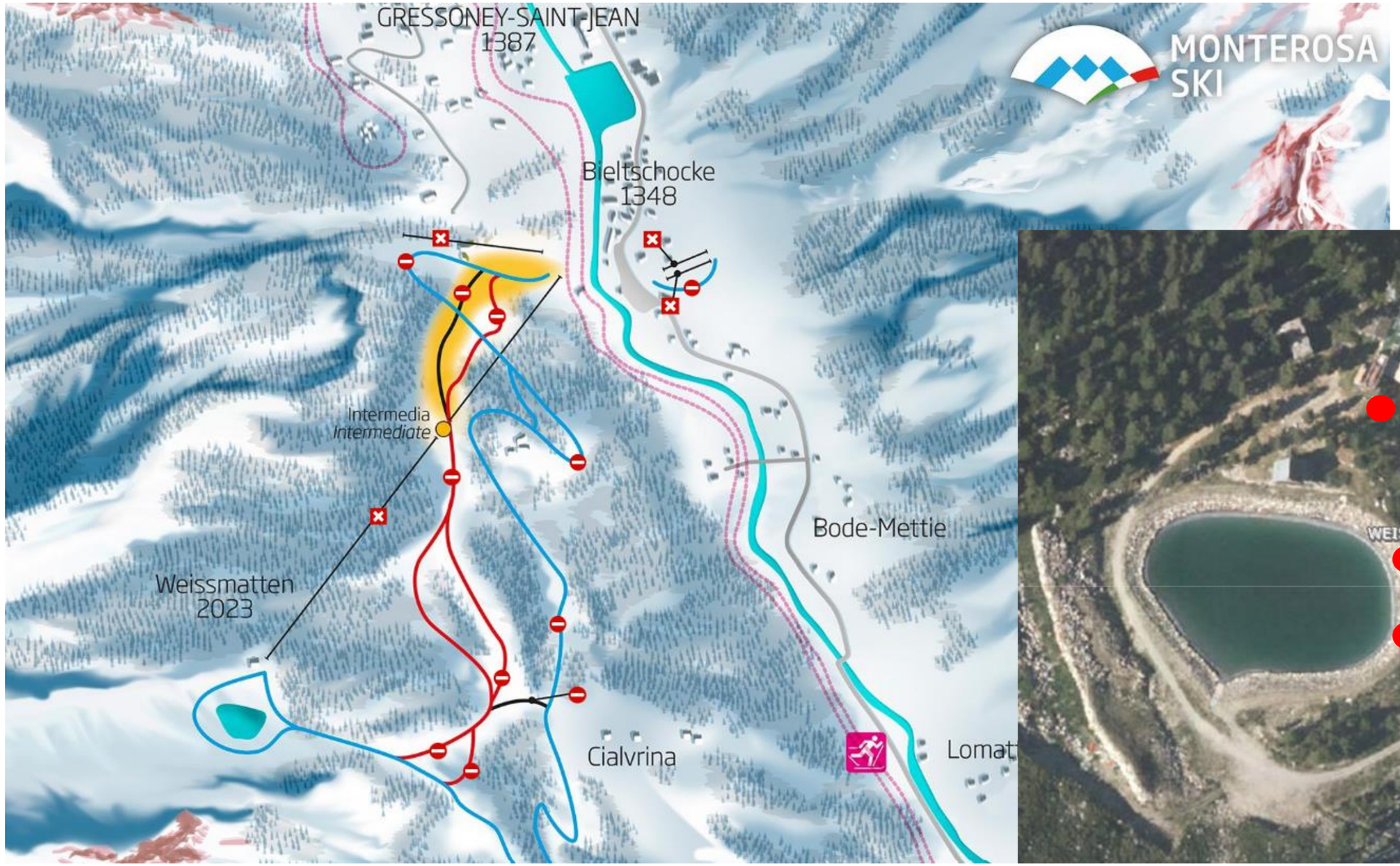


Before installing AR



After installing AR

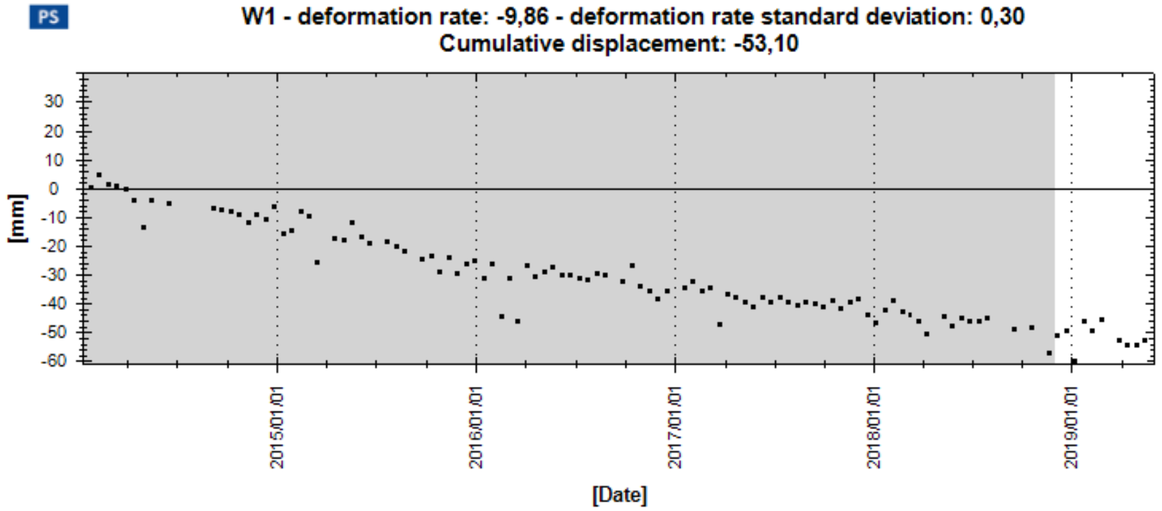
Weissmatten basin – Gressoney Monterosa ski area

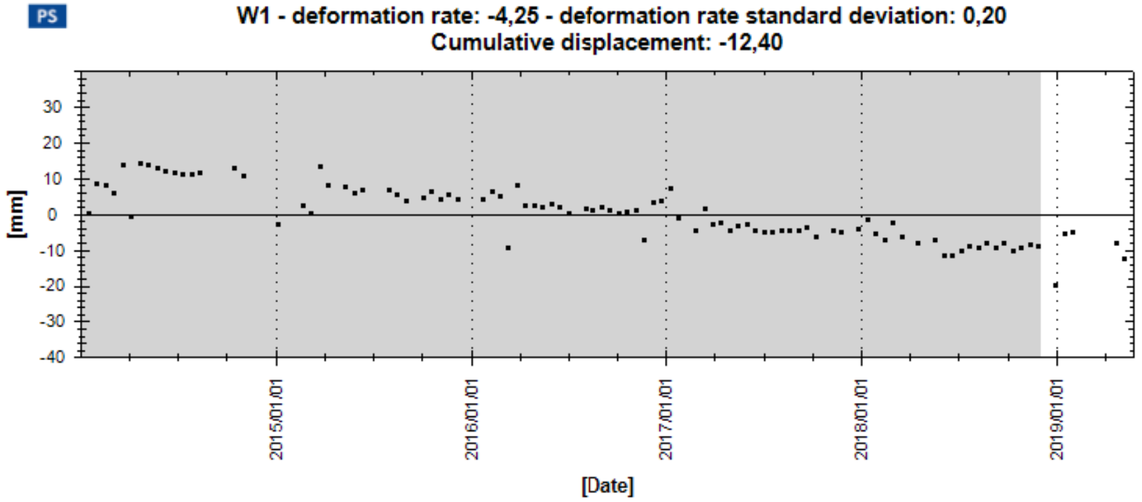


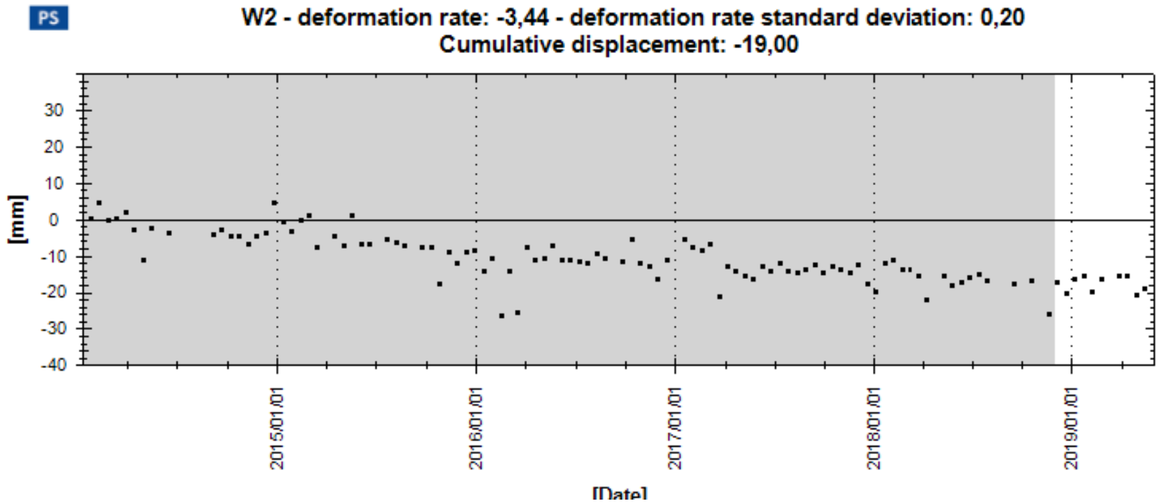
W1, W2, W3 – artificial reflectors

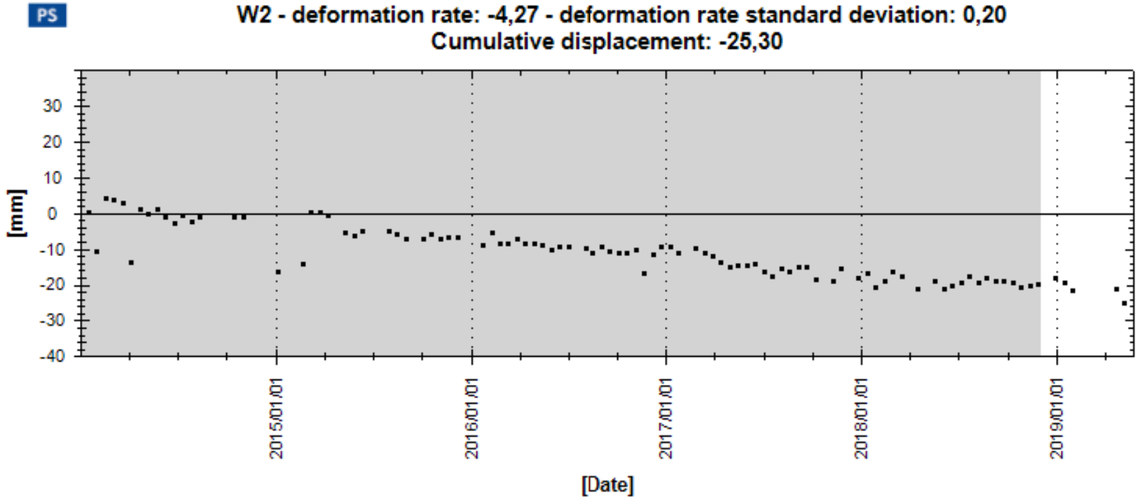


Weissmatten basin – Gressoney Monterosa ski area



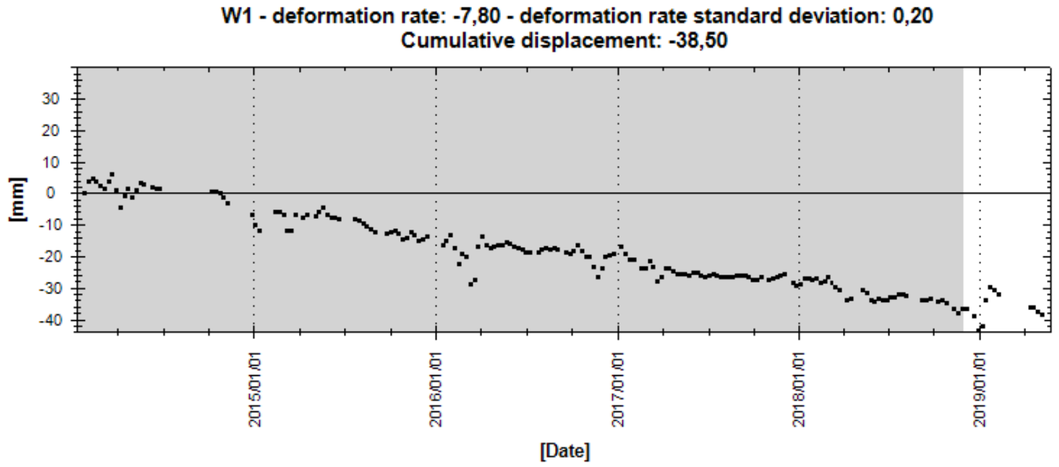


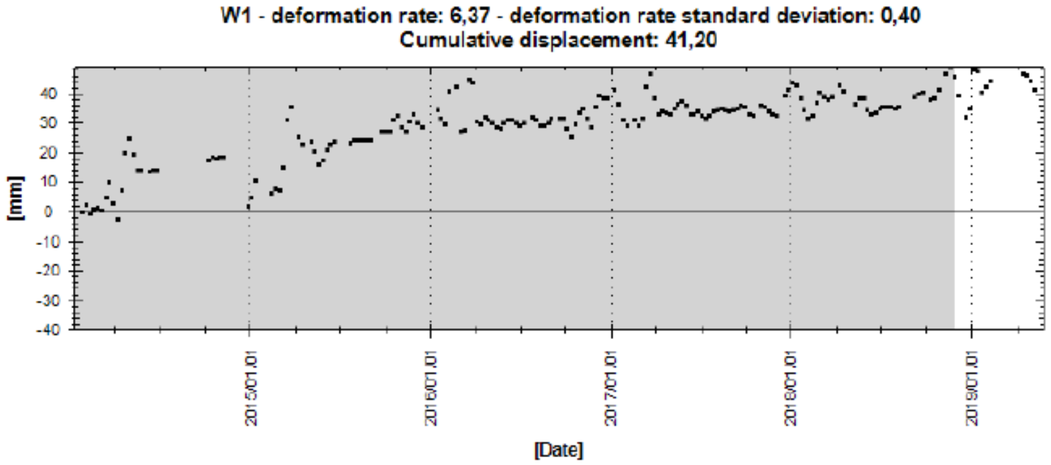


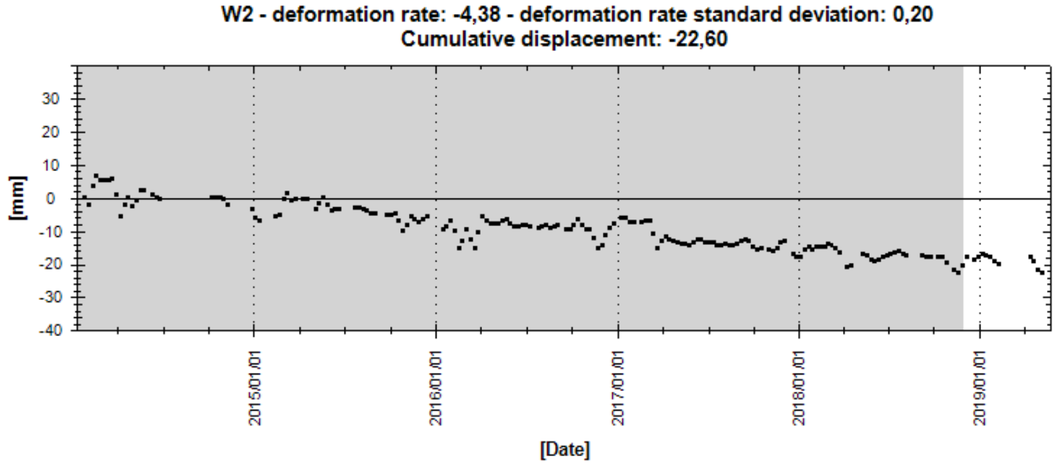


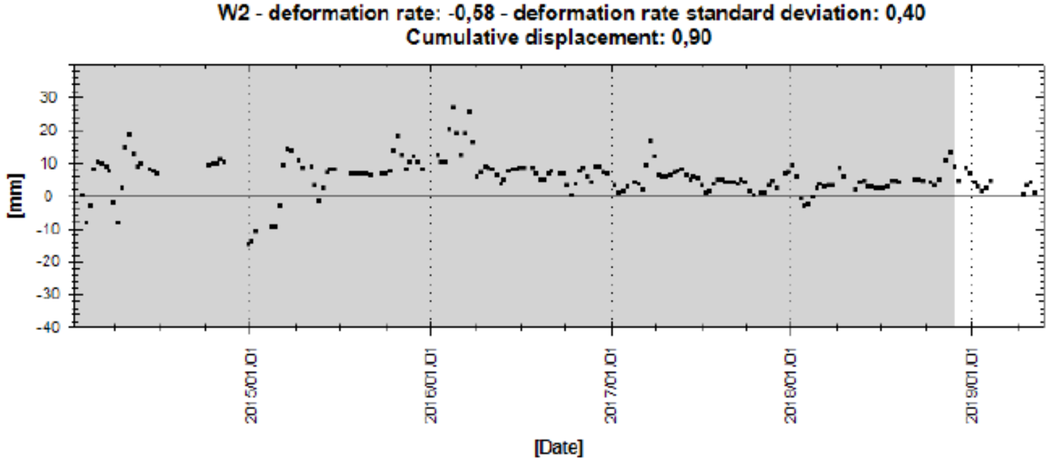
ascending geometry **LOS displacement** **descending geometry**

Weissmatten basin – Gressoney Monterosa ski area









Vertical displacement

E-W displacement

Ongoing project on dams

BECCA

Interreg

Cofinancé par l'Union Européenne
Cofinanziato dall'Unione Europea

France – Italia ALCOTRA

Ecologically sustainable and safe basins, designed for adaptation to climate change

https://www.interreg-alcotra.eu/it/becca-bacini-ecologicamente-sostenibili-e-sicuri-concepiti-ladattamento-ai-cambiamenti-climatici



