UC 1091

Landslide geomorphometric analysis based on high resolute TLS data

Eng. Stefano CREPALDI Ph.D.

Prof. Marina DE MAIO

Spin Off

ISE-NET

POLITECNICO DI TORINO 1859 1906

INDEX

- What is the problem?
- Where is it?
- The type of data
- The Methodology
- Results
- Conclusion

Target

1) Evaluate the potential of TLS relief in the field of environmental monitoring
2) Evaluate benefits and integration with features tracking analysis techniques in GIS application

The TLS technology has been experienced to evaluate:

- **Surface evolution (shapes and volumes)**

- **Increase the level of knowledge of the investigated area with additional generated data**

Strategy

1. Literature and references
2. Introduction to the case study
3. Classification techniques and monitoring of landslides (TLS)
4. Processing techniques DTM /DSM in ArcGIS
5. Features tracking analysis
6. Planning of relief
7. Pre - processing of TLS data
8. Analysis and processing in ArcGIS environment for detect primary geomorphometric parameters
9. Integration between Matlab and ArcGIS 10.2 with features tracking techniques, for the study of dynamic processes

To test the method and reproducibility , we have chosen the Mont de la Saxe Landslide

Study Area


Aosta Valley (ITALY)
Administrative center | Aosta
Territory Area (Km²) | 3.263.00
Population | 125000
District | 1
Municipality | 74
Région Autonome
Vallée d'Aoste
Regione Autonoma
Valle d'Aosta

Where we are?

La Saxe landslide (Courmayeur, Aosta Valley, Northern Italy)

- **Surface:** **150.000 m^2**
- **Width:** **350m**
- **Lenght:** **500m**

What is the problem?

In the last decade the rockslide have had a major phase of acceleration.

The rockslide affects the extreme south western tip with, an estimated volume of about 8x 10^6 m^3

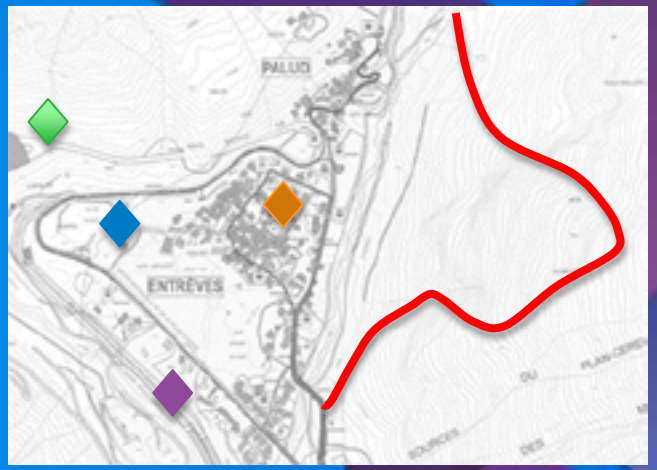
The study area is strategically important because it is located near:

Mont Blanc Tunnel

The newest Skyway Monte Bianco

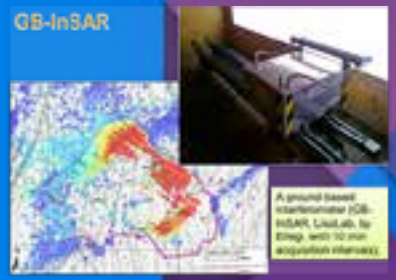
Entreves village

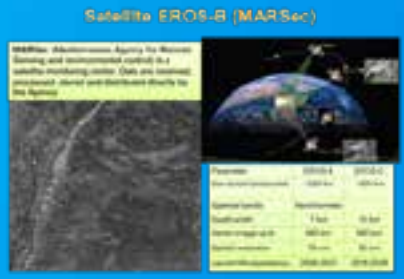
Torino-Aosta Hightway



The type of monitoring data

- GPS
- Total Station
- Laser scanner
- GB-InSAR
- Satellite
- Geochemical
- Geology
- Hydrogeology
- Drilling
- Photo
- Ppt or Pdf





Features Tracking Analysis

The speed of moving, estimate from digital images or multi-temporal correlation images, are increasingly technique applied in different fields of research

UiO : University of Oslo

Image correlation software CIAS

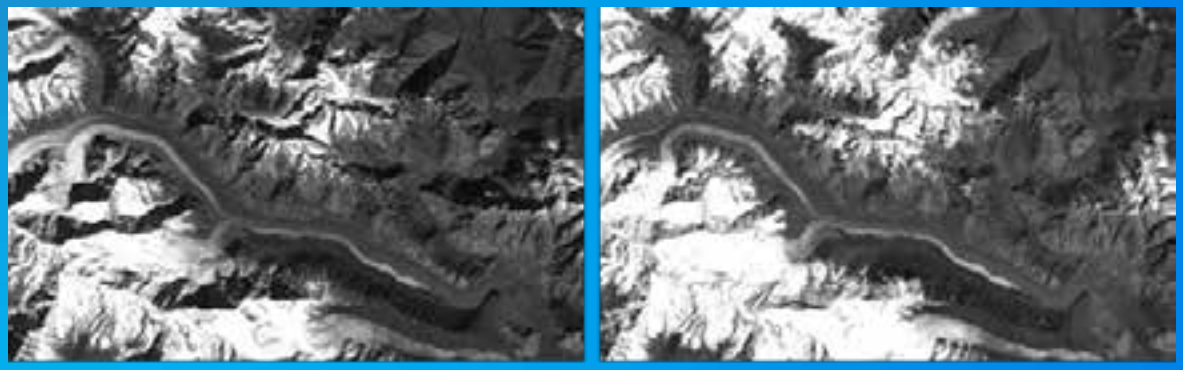
time-resolved digital particle image velocimetry (PIV)

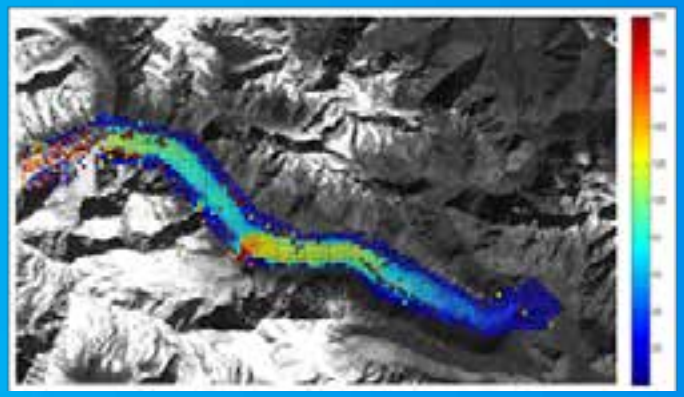
UNIVERSITY OF COPENHAGEN
Centre for Ice and Climate
Niels Bohr Institute

image georectification and feature tracking toolbox (ImGRAFT)

ImGRAFT

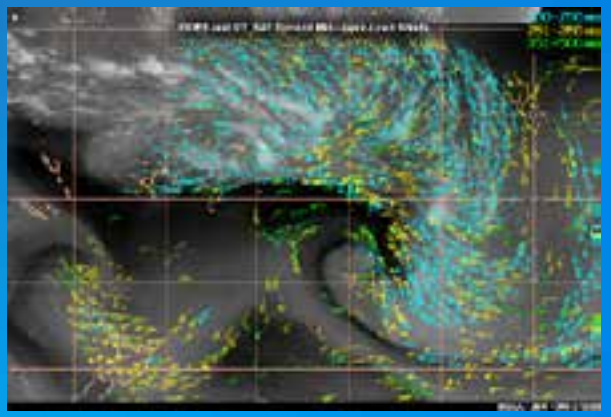
ImGRAFT is an opensource image georectification and feature tracking toolbox for MATLAB.





This code, prepared by the Centre for Ice and Climate allows to process a large quantity data in hazardous environments by satellite image

Features Tracking in Satellite Image



A key component of these software is the need to employ :

- High-resolution DEM (functional for the stages of geo- rectification images)
- LIDAR or TLS systems allow the identification of extra ground control points
- The captured data can (with the right post-processing) result in a wide range of quantitative and qualitative information useful in the analysis
- The post-processing requires a considerable amount of steps to transform images into meaningful and comparable data , such as velocity vectors

issues identified

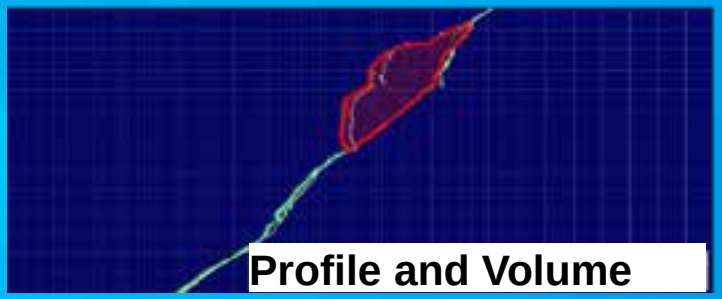
- Satellite images required a robust alignment processing
- The processing takes long time to finish the analysis
- Weather conditions affect the analysis (cloud cover)

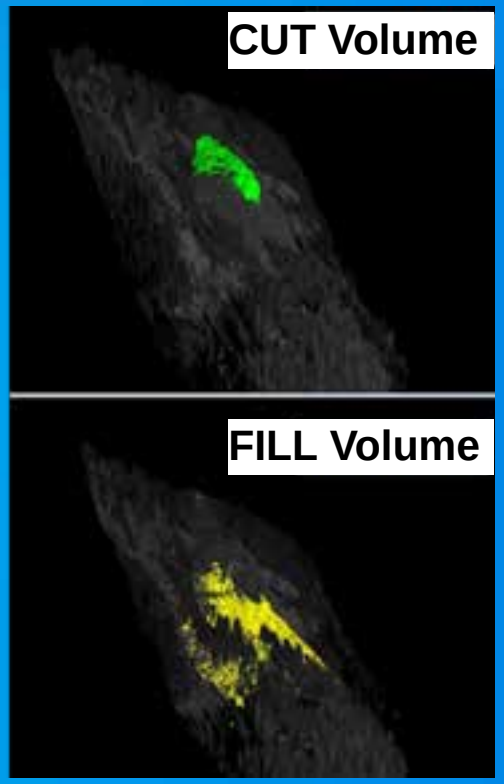
Laser Scanner Survey

The scans were performed using a 3D laser scanner device VZ – 4000 model, produced by Riegl Laser Instrument Systems courtesy of ISE - NET S.r.l. SpinOff of Politecnico di Torino

Maximum measurement distance : 4000 m ;
Shooting area : ± 30 ° vertical and 360 ° horizontal
Accuracy : 15 mm
Minimum vertical step scan : 0.002 °
Minimum horizontal step scan : 0.002 °
Speed scan : up to 147,000 points / second (200Khz)
Divergence beam : 0.14 mrad

Laser Scanner Survey OUTPUT

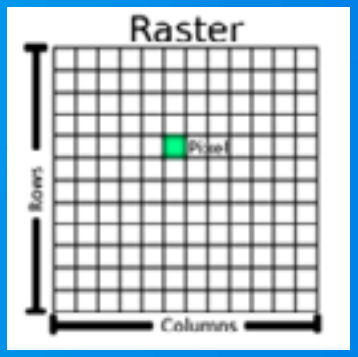




G.I.S Spatial Analysis

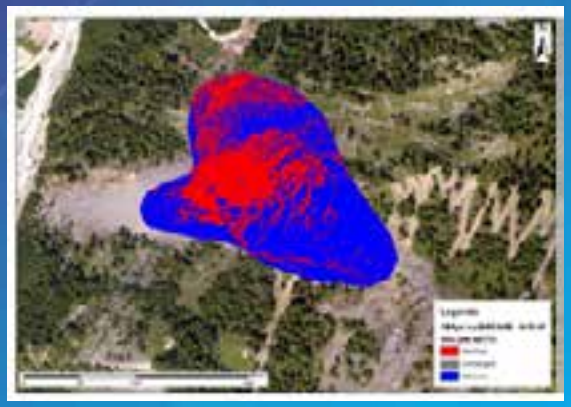
The spatial information can be encoded through two main types of data:

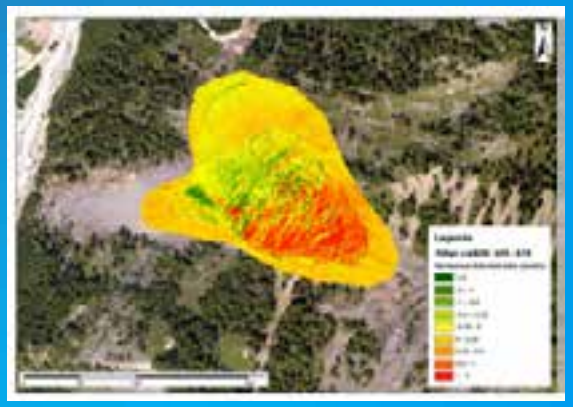
- Vector
- Raster

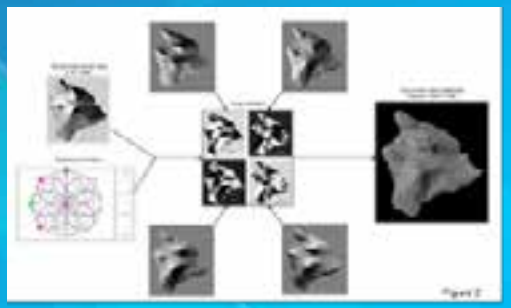


The DTM (Digital Terrain Model) represents the topography altitude of the area through a regular matrix of heights

TLS dataset in GIS Spatial Analysis and tools







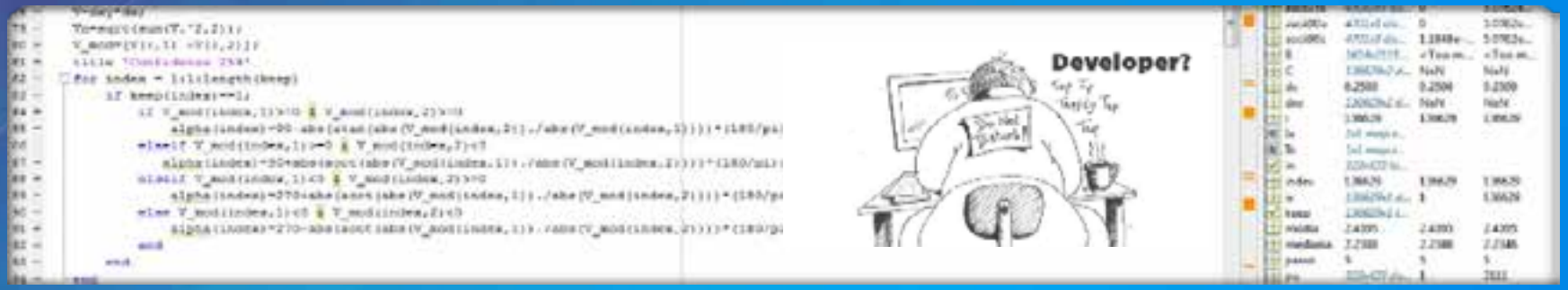
Hillshade

Swiss method of Hillshading

Improving the Hillshade representative quality function in ArcGIS 10.2 to increase the confidence level.

Swiss method tested of hillshading developed by Dr. Mark of the USGS

The Metodology

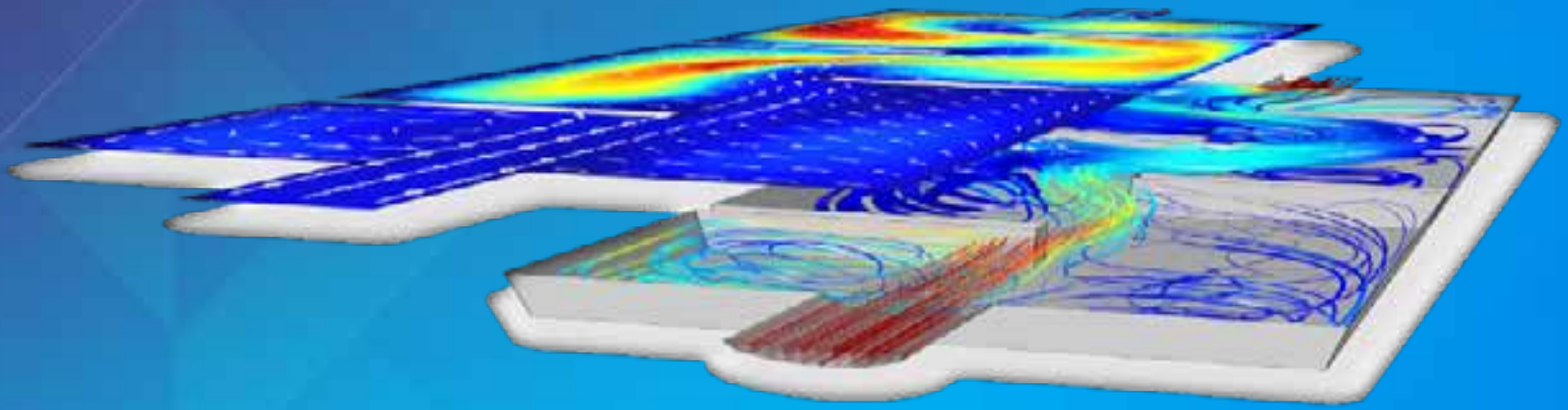


The work performed by the team of Centre for Ice and Climate Niels Bohr Institute, University of Copenhagen was modify in order to :

- Change Matlab code, to manage the raster generated by TLS dataset in ArcGIS
- Integrate the monitoring of the confidence of research points in two datasets of georeferenced images
- Identify the floating window feature for datasets with resolution 0.25 meters
- Prepare maps of layout capable of displaying not only the direction but also the intensity of the movements
- Create a log of the intensity and direction of dx and dy imported in GIS

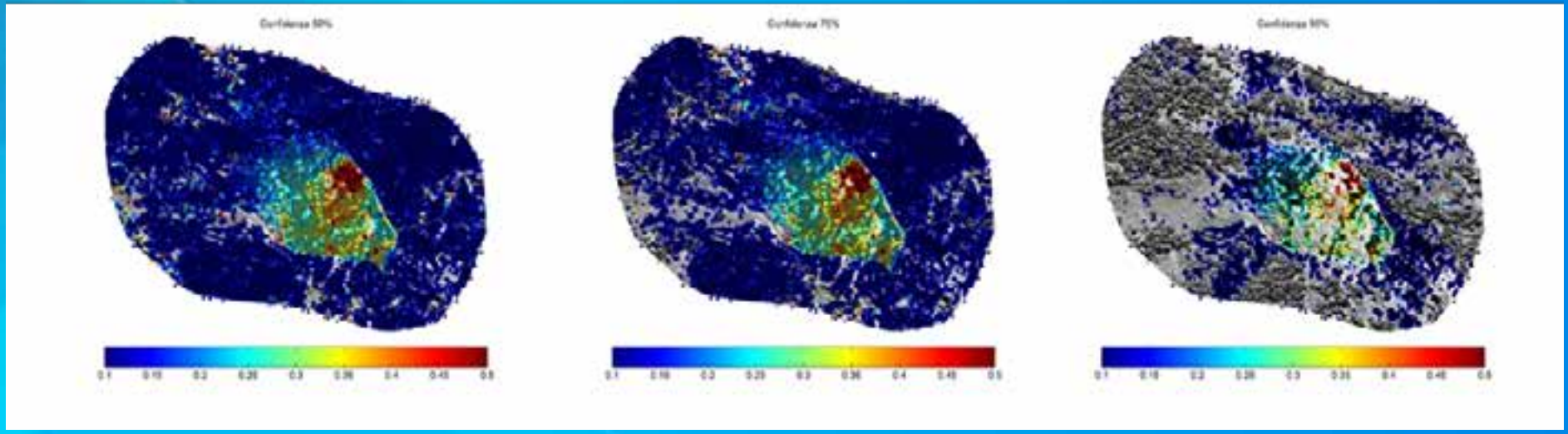
by obtaining :
complete analysis morphodynamics package, developed in MATLAB and compatible with GIS

First results



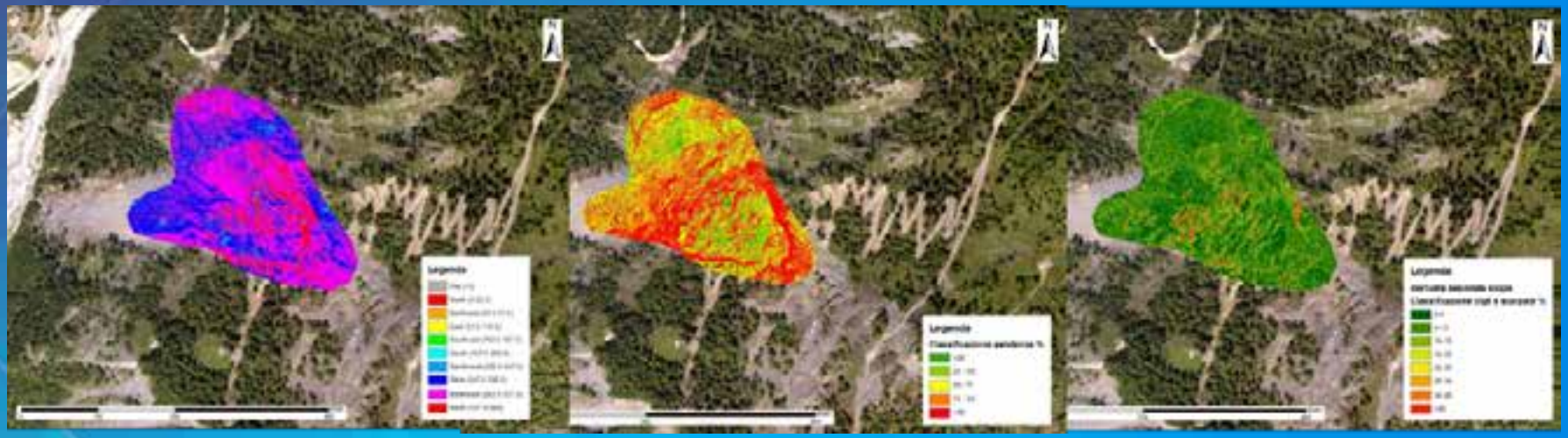
Data processing and analysis of the changes occurred in the selected dataset with different confidences

DSM 4PM DSM 6PM



Improvement of the first result

Main Morphometric indexes analysis



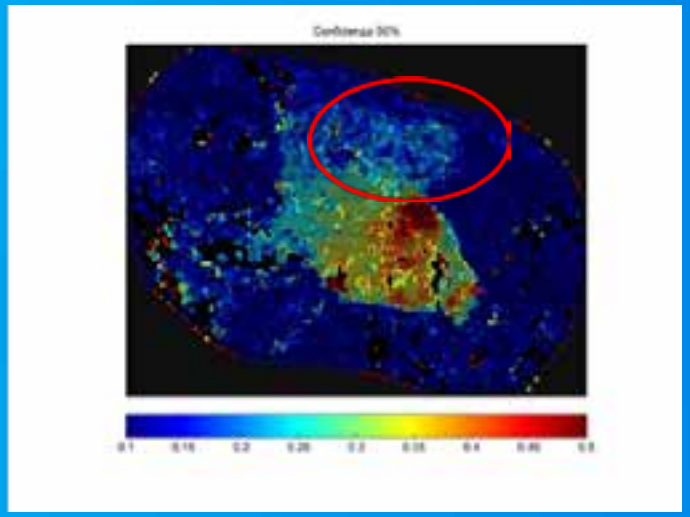
Aspect

Slope

Curvature

DSM

Curvature Hillshade



Conclusion

The analysis of Mont de la Saxe (Courmayeur, AO) landslide made it possible to monitor the evolution of gravitational Morphodynamics integrating the available cognitive framework.

The accuracy of the metric data is still reflected in the fact that the final product (estimated velocity fields) coincides with the automatically total station data

The identification of direction and intensity can indicate a programmatic line of action for the proper emergency management

The technique proposed analysis has led to a zonation of landslide in different sectors and the recognition of acceleration and deceleration phases that characterize the movement.

The processing of the data in a GIS environment, not only allowed the identification of the main morphological indexs (that help to control and influence the evolution of the landslide), but also to highlight morphological abnormalities

“Madness is like gravity, just need a little push”

Eng. Stefano Crepaldi Ph.D.
stefano.crepaldi@polito.it
stefano.crepaldi@ise-net.it

Prof. Marina DE MAIO
marina.demaio@polito.it