*EGU 2017, Vienna, 25-04-2017, CR3.4/NH8.6 - Risks from a changing cryosphere*

# Slope instabilities occurred at high elevation in the Italian Alps in 2016:

## Regional landscape fragility and meteorological situation

**Marta Chiarle[1], Daniele Cat Berro[2], Luca Mercalli[2], Giovanni Mortara[1], and Guido Nigrelli[1]**

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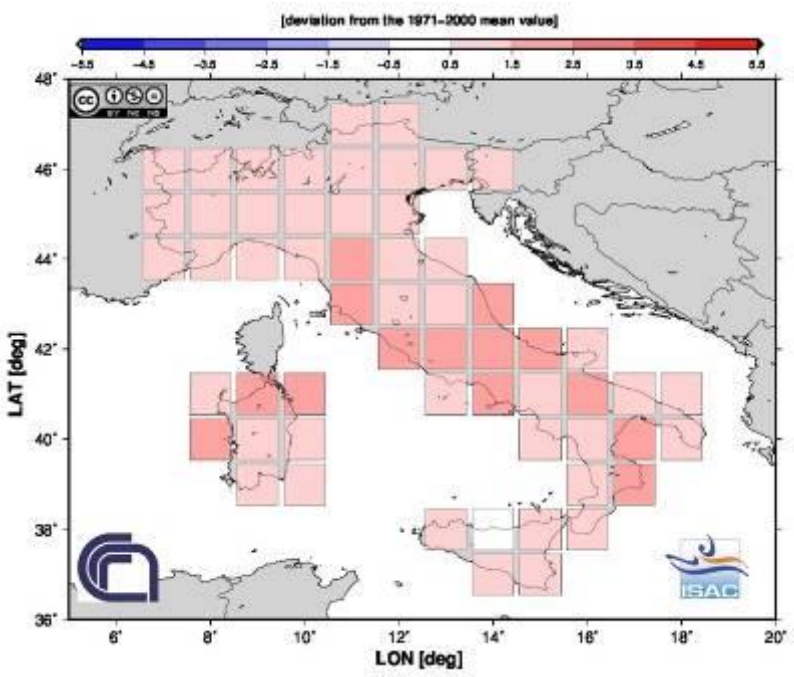
*[2]SMI, Moncalieri (TO), Italy (info@nimbus.it)*

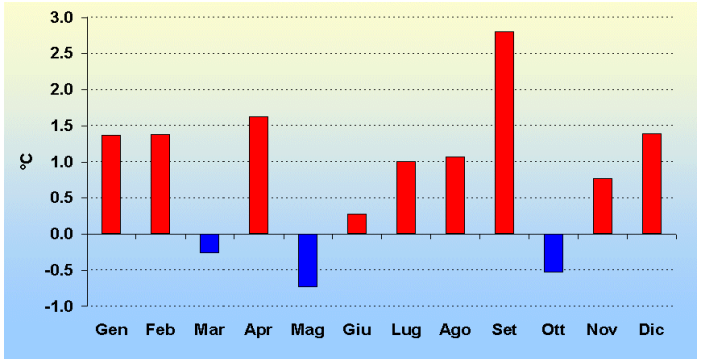
# Climatic situation

Earth's 2016 surface temperatures were the warmest since modern recordkeeping began in 1880, according to NASA and NOAA, i.e. the third year in a row to set a new record.

On the whole Northern Italy, the year 2016 was again among the hottest in the last centuries, although less exceptional than the yrs 2014 and 2015: in almost all the long time series (more than 2 centuries) the year is located **between the 4th and the 6th place**, with average anomalies ranging mostly between **+0.7 and +1.5 ° C**.

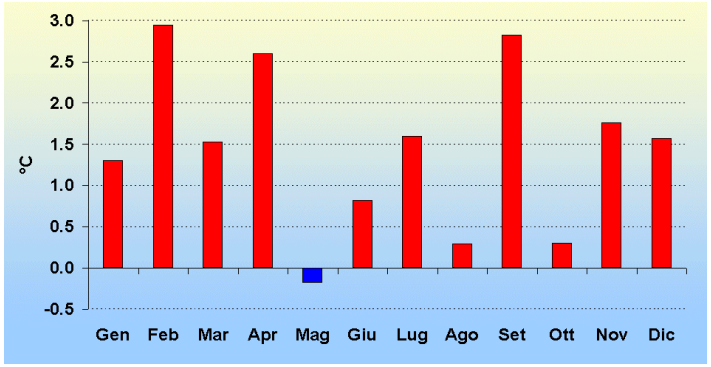



*http://www.isac.cnr.it/~climstor/climate/latest_year_TMM_met.html*




Torino (NW Italy)

*Monthly temperature anomalies in 2016 (SMI, 2017)*

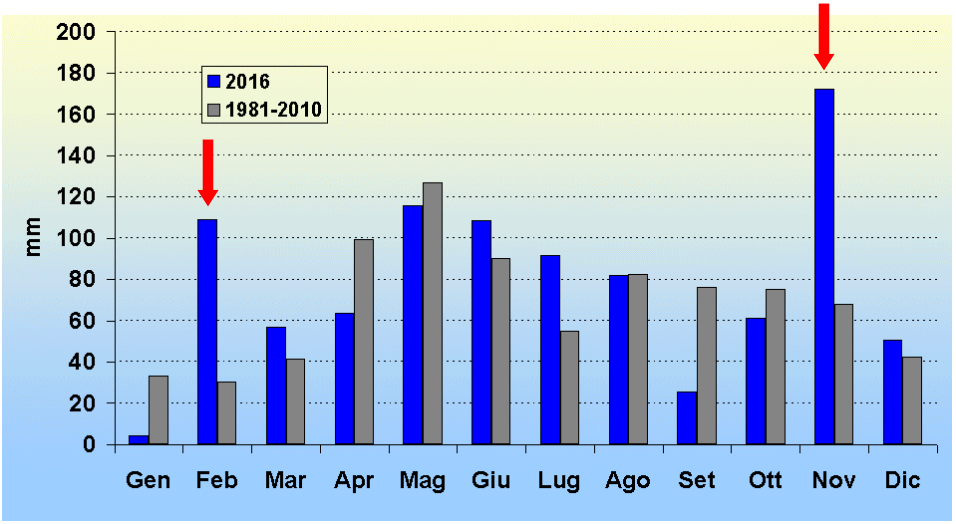



Rovereto (NE Italy)

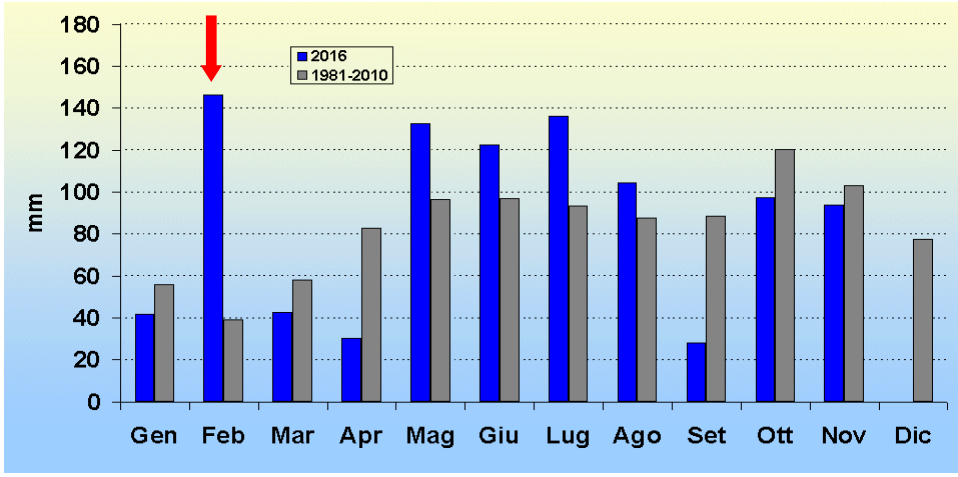
# Climatic situation

Total annual precipitation was quite in the mean values (-3% for the whole Italy); however, some notable monthly and local anomalies of opposite sign have been registered, such as the **droughts** of January, late summer and December, which was extraordinary in the North-East, and the **floods** of the end of November in the North-West.

*Monthly precipitation anomalies in 2016 (SMI, 2017)*

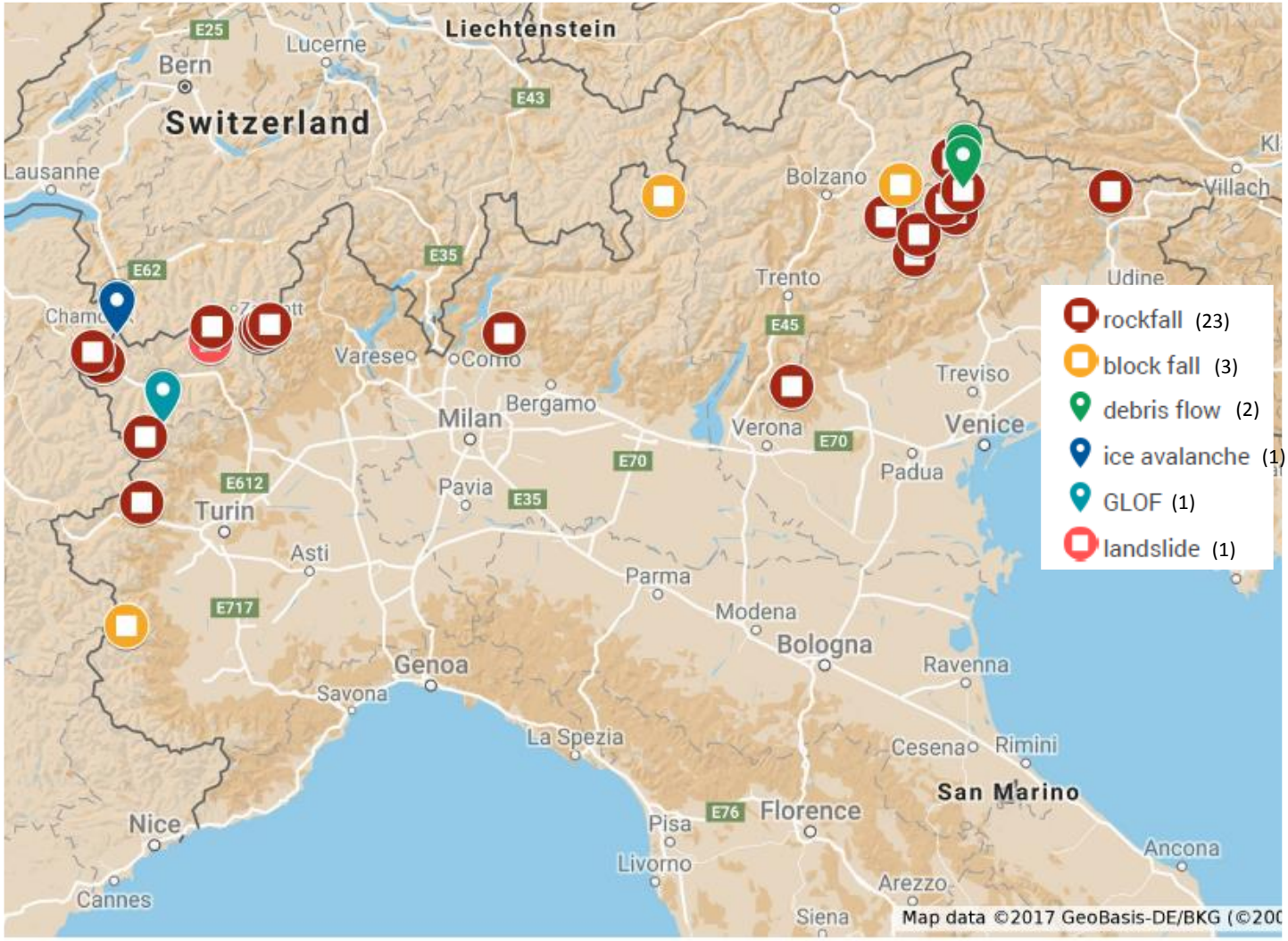



Torino (NW Italy)




Rovereto (NE Italy)

# Spatial distribution of the 2016 natural instability events above 1500 m a.s.l. in the Italian Alps




total: 31 slope instability events

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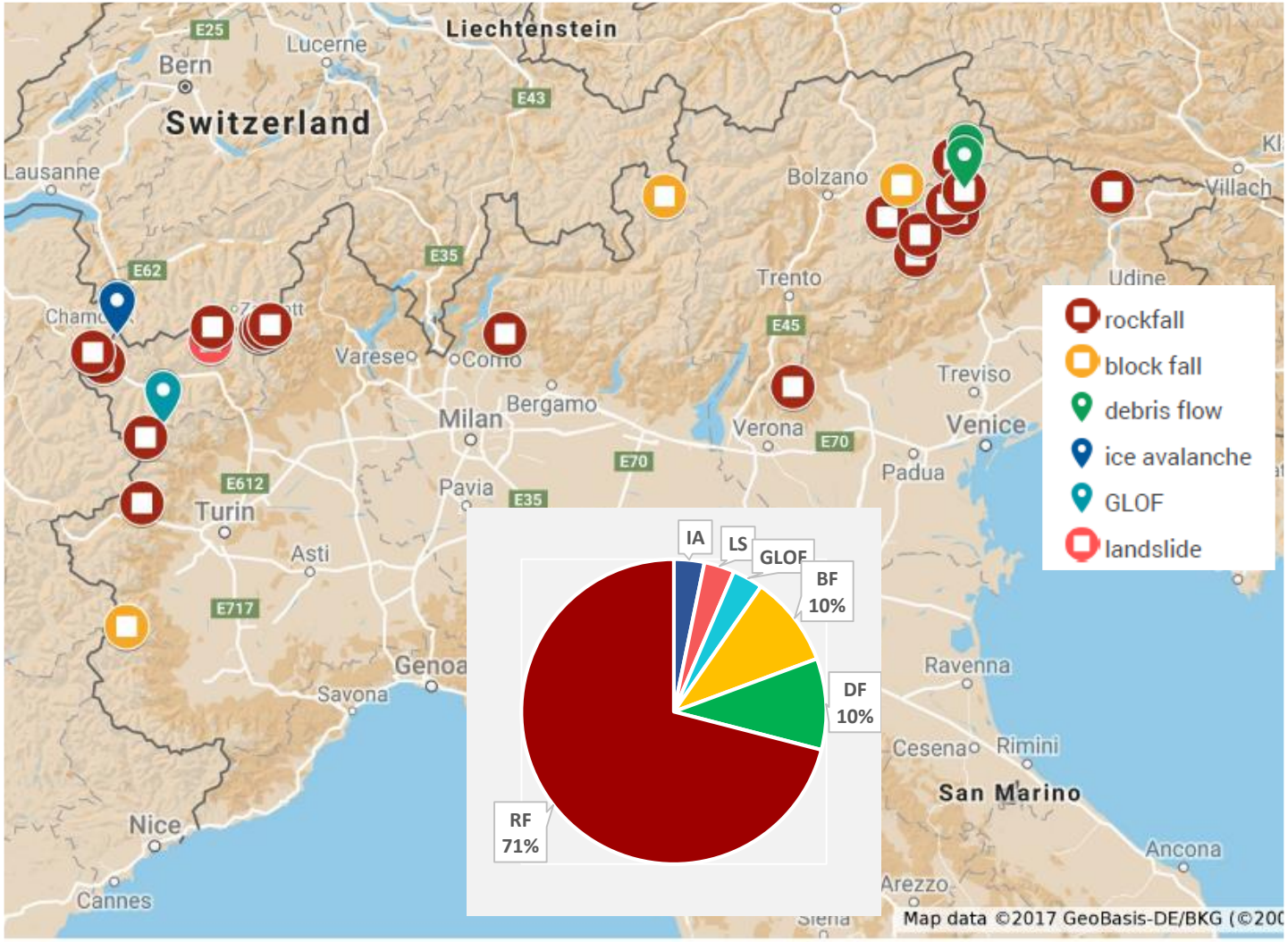


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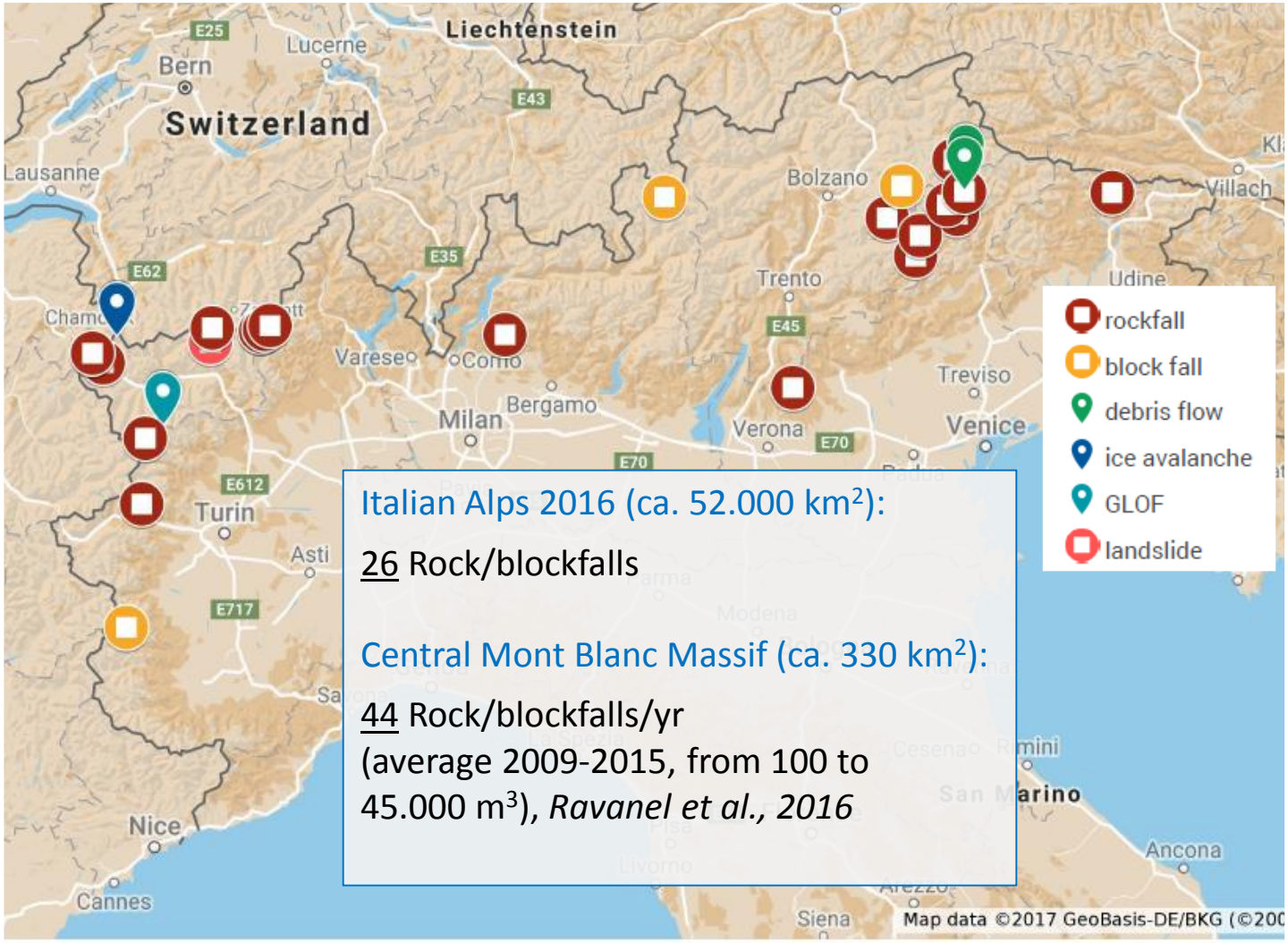
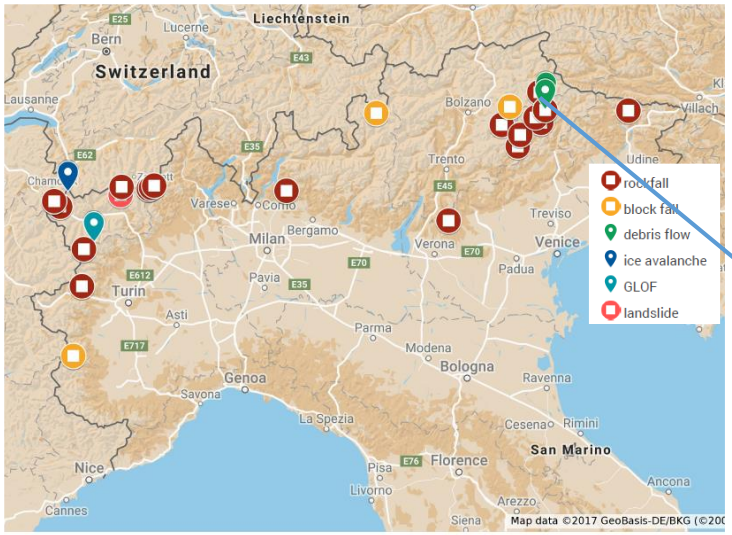


# Types of processes



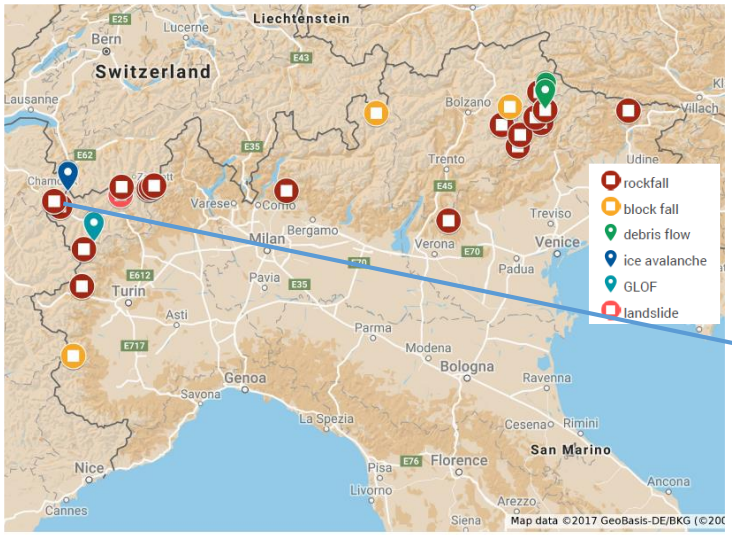

**The Piccola Croda Rossa rock-fall/avalanche**
**August, 19th**

**2850 m a.s.l.**
**600.000-700.000 m³**

*Photo: Geological Office of the Bolzano Province*

*Ice in the rock fractures*

# Types of processes



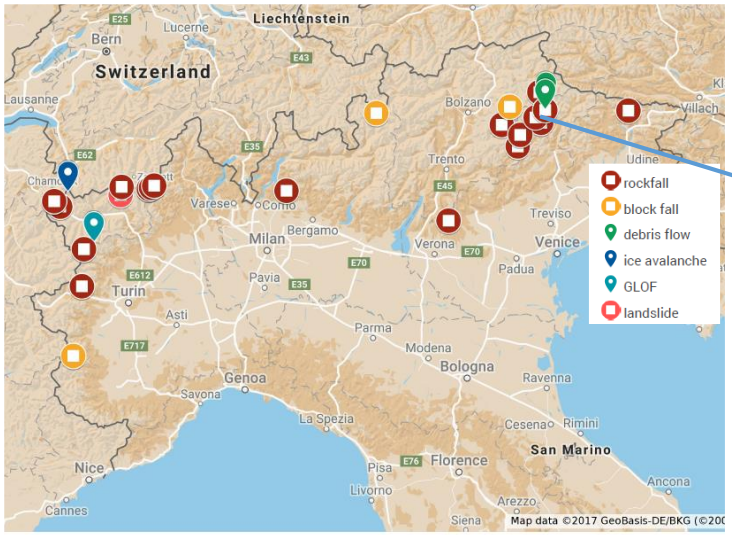

**The Sperone della Brenva rockfalls**
**September, 28-29th**

**3650 m a.s.l.**
**10.000-35.000 m³**

*Photo: Catasto Dissesti Regionale SCT – Valle d'Aosta*

*Ice in the rock fractures*

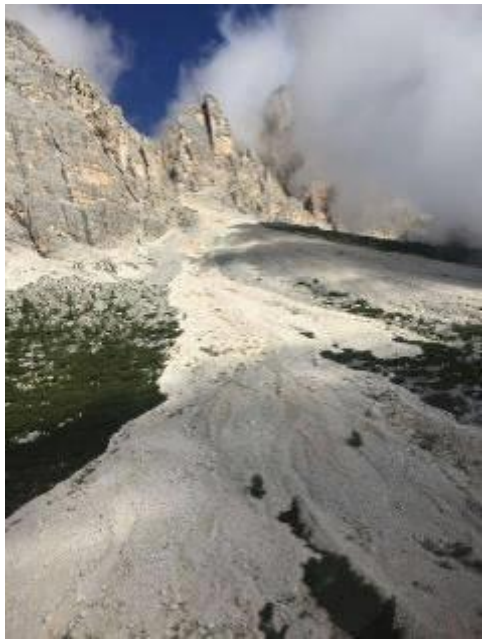
# Types of processes




**The Monte Pelmo debris flow**
**August, 19th**

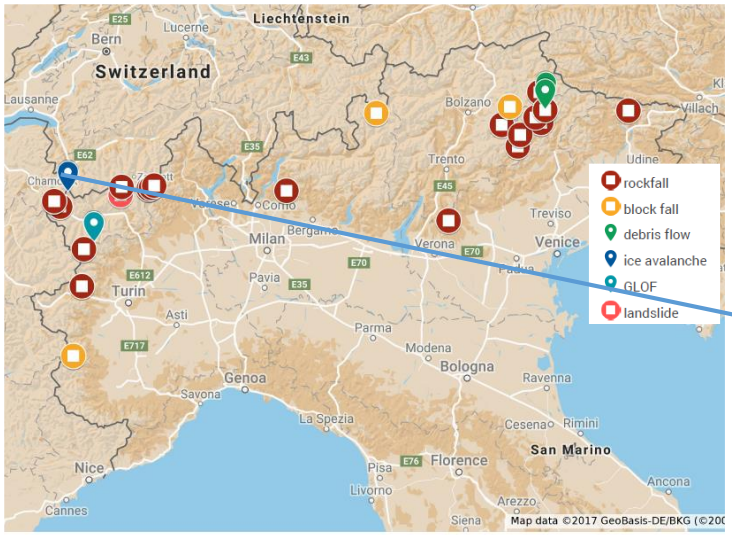
**2200 m a.s.l.**

*Firn in the source area, under debris*



*Photos: Soccorso Alpino e Speleologico Veneto*

# Types of processes

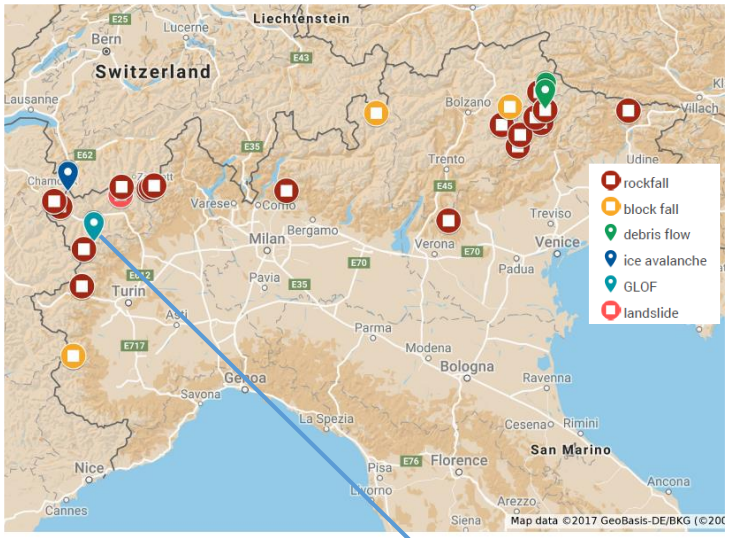



**The Triolet Glacier ice-avalanche**
**July, 25th**

**about 3000 m a.s.l.**

*Photo: Rifugio Dalmazzi hut keeper*

# Types of processes

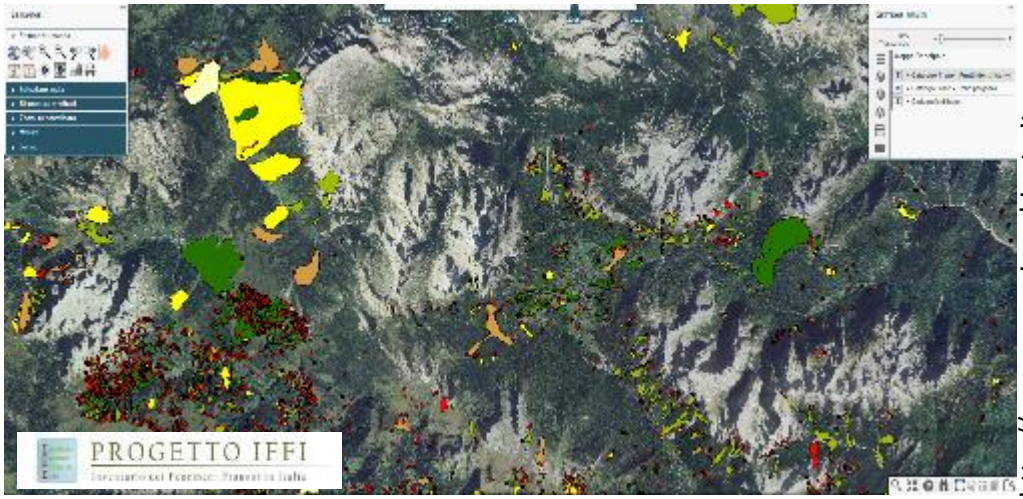



**The Grand Croux GLOF**
**August, 14th**

**2700 m a.s.l.**
**50.000-70.000 m³** (source: FMS)

*Photo: www.meteogiuliacci.it*

# A few comments about data mining




http://www.pcn.minambiente.it


http://geonavsct.partout.it/pub/geodissesti

27/7/2016 Cade una grande frana da Cima Pape in Agordino - Cronaca - Corriere delle Alpi

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Sei in: BELLUNO > CRONACA > CADE UNA GRANDE FRANA DA CIMA PAPE IN...

MONTAGNE FRAGILI

## Cade una grande frana da Cima Pape in Agordino

*Boato fortissimo sentito in tutta la zona di Canale, un mese fa c'era stato un altro smottamento. Sulla montagna è rimasta una ferita di terra rossa*

FRANA

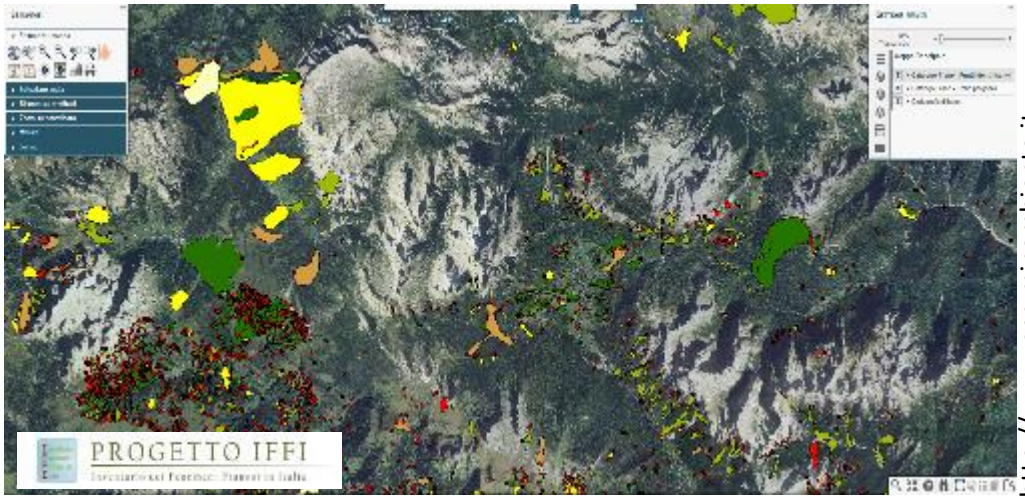
26 luglio 2016

103 Condividi | Tweet 0 | G+1 0 | LinkedIn 0 | Pinterest

CANALE D'AGORDO. Un boato fortissimo, poi una nuvola di fumo. È ciò che gli abitanti di Canale e delle frazioni hanno sentito e visto ieri alle 16.55 prima di realizzare che una frana era scesa dal Cima Pape che fa parte del gruppo delle Pale di San Martino.

- *Regional heterogeneity in data collection, filing, distribution*
- *Focus on inhabited areas and infrastructures*

# A few comments about data mining




http://www.pcn.minambiente.it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*Action CensiCro – «PermaDataRoc» Project*

*Ravanel et al., EGU 2016 - High morphogenic activity in the permafrost-affected rock walls of the Mont Blanc massif during the 2015 summer heat wave*

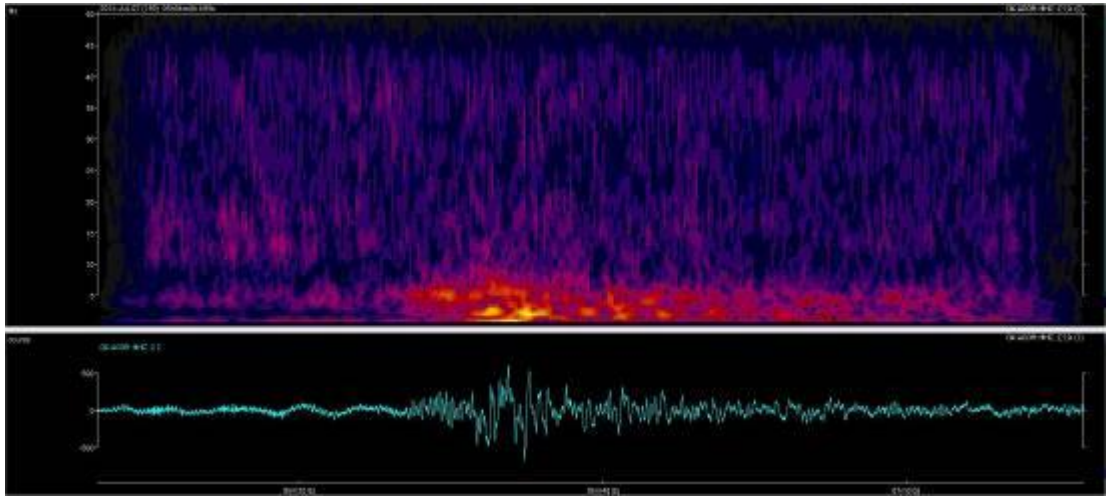
A few comments about data mining

New tools:

https://cervinia.panomax.com/matterhorn,
11/08/2016 h. 11.20

*Nigrelli et al. (2017) - The altitudinal temperature lapse rates applied to high elevation rockfalls studies in the Western European Alps. Theoretical and Applied Climatology, online First, DOI: 10.1007/s00704-017-2066-0.*

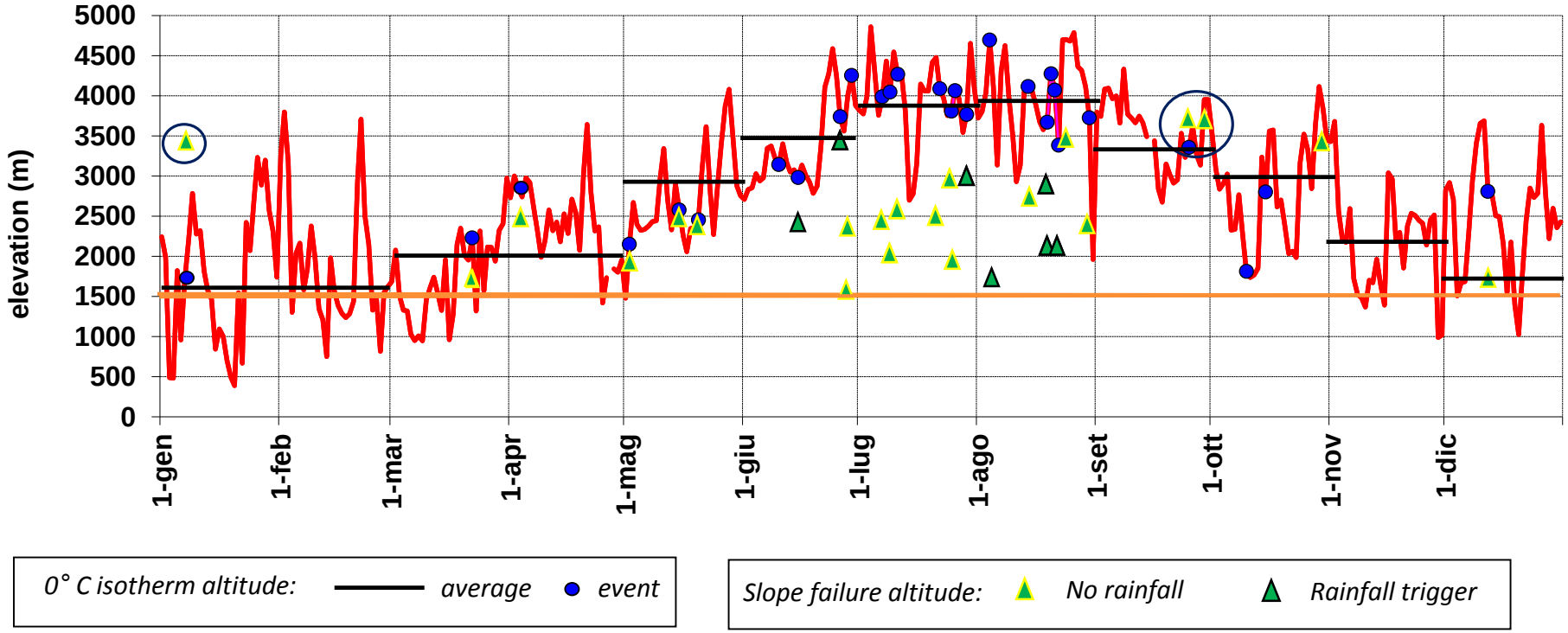
Cima Lastei, rockfall of 11/07/2016
Spettrogramma della stazione AGOR
http://www.protezionecivile.tn.it/territorio/



*Manconi et al. (2016), Real-time detection, location, and characterization of rockslides using broadband regional seismic networks, Geophys. Res. Lett., 43, 6960–6967*

# Climatic framework

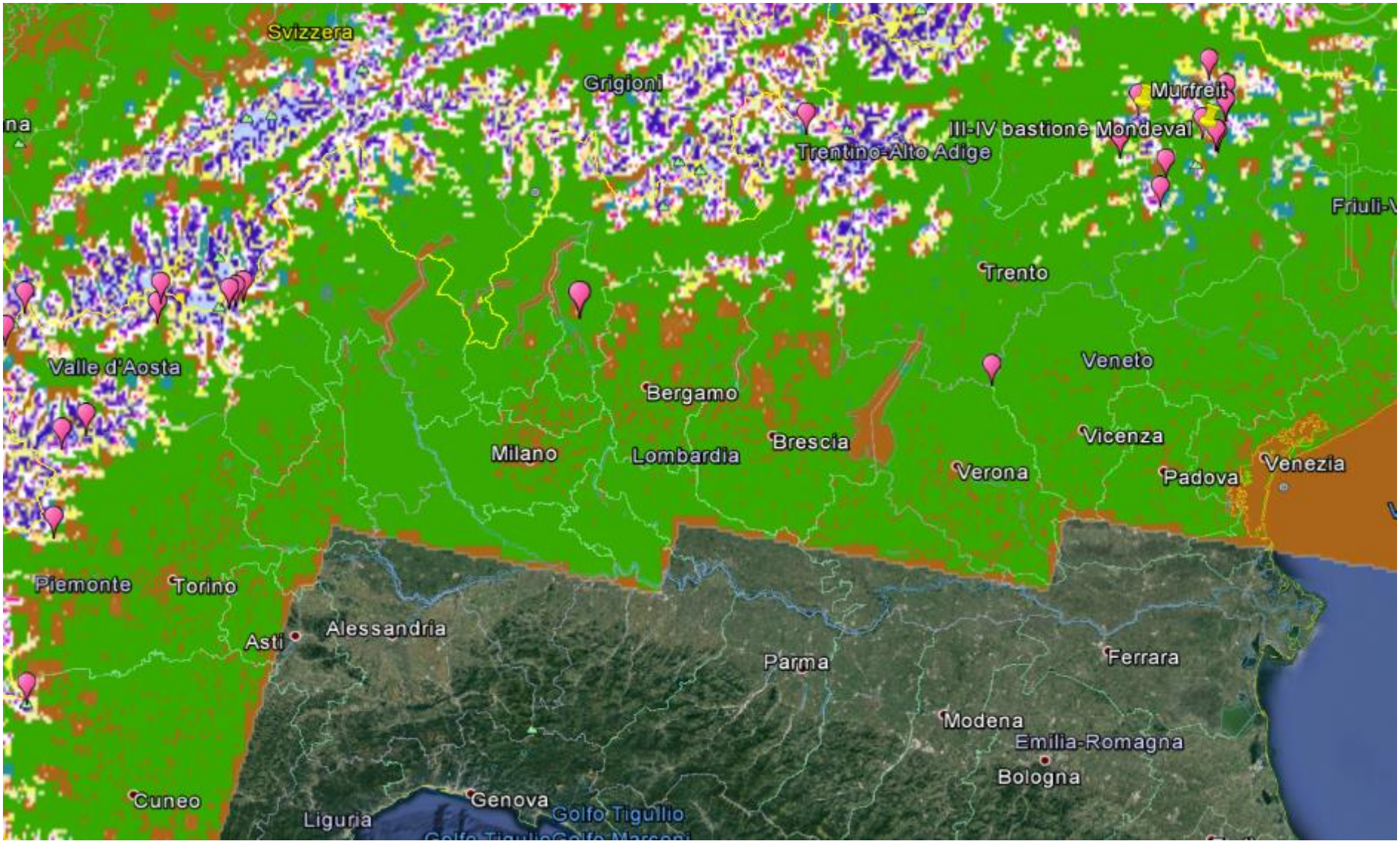
*0 °C isotherm above Milano-Linate Airport in 2016 and slope failure occurrence*




**Paranunzio et al., EGU2017-13227. Climatic conditions associated to the occurrence of slope instabilities in the Italian Alps in year 2016.**

***Hall X5 at board number X5.217. Author in attendance on Wednesday, 26 Apr 2017, 17:30-19:00***

# **Processes distribution on APIM** (*PermaNet Project*)



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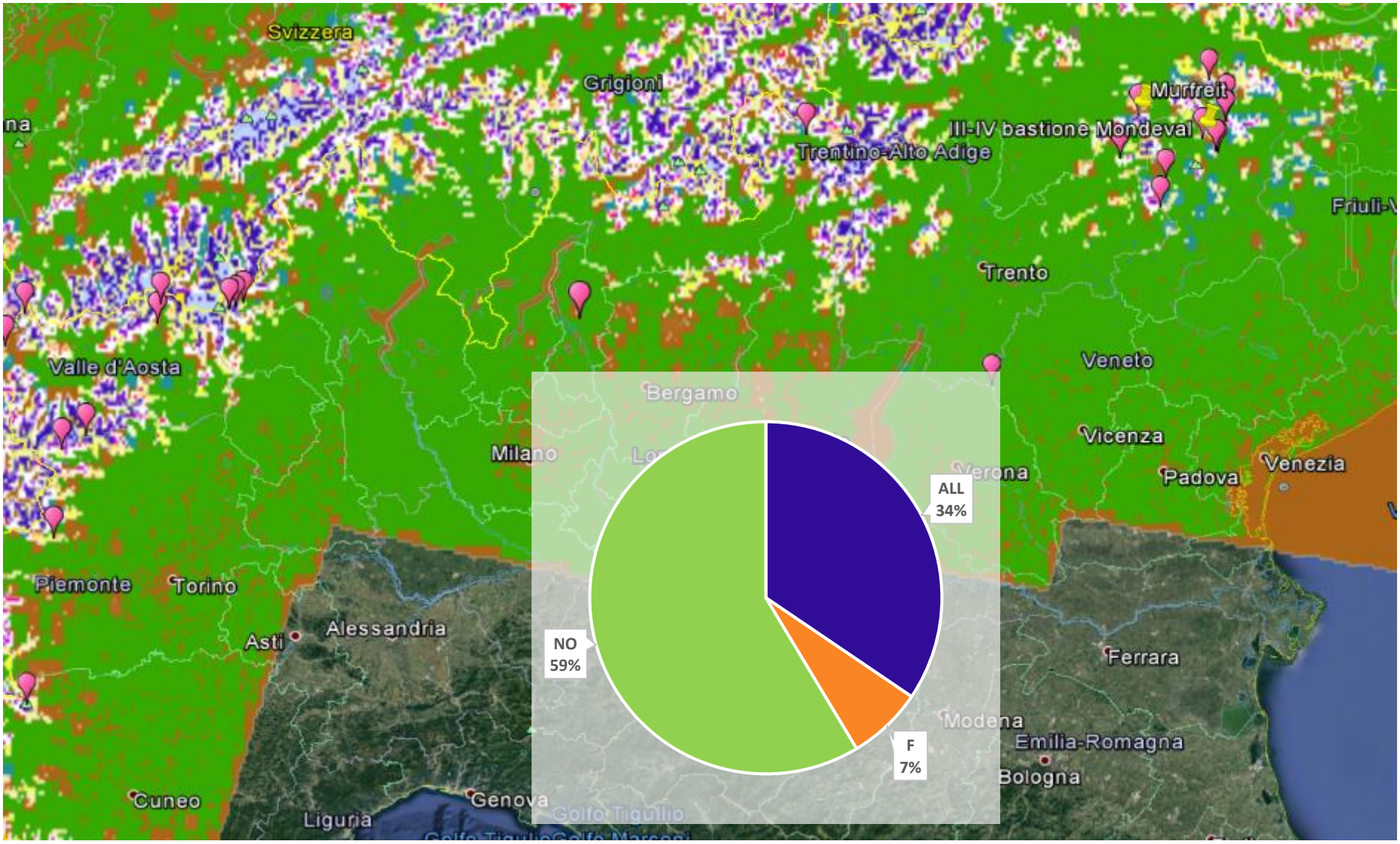

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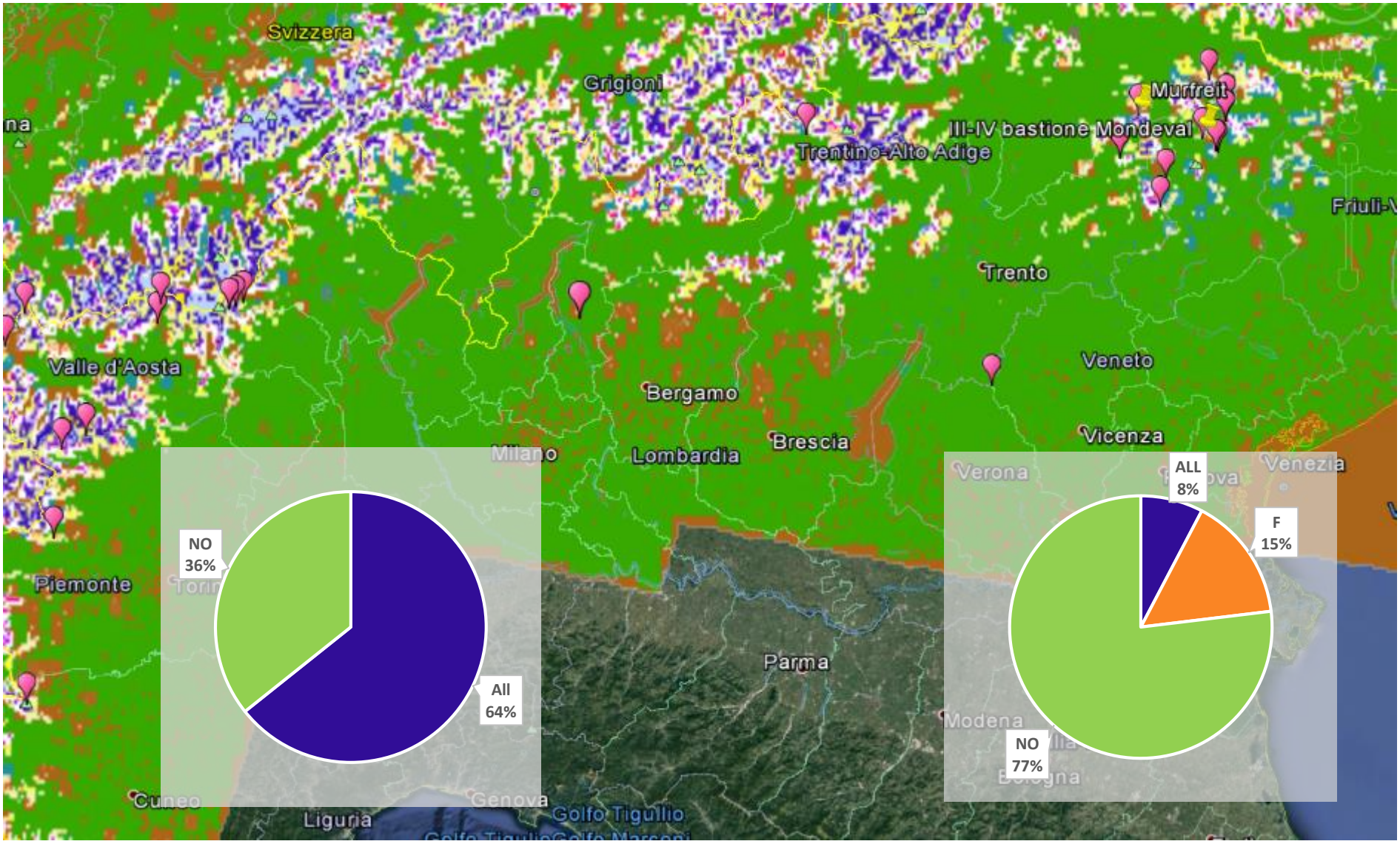
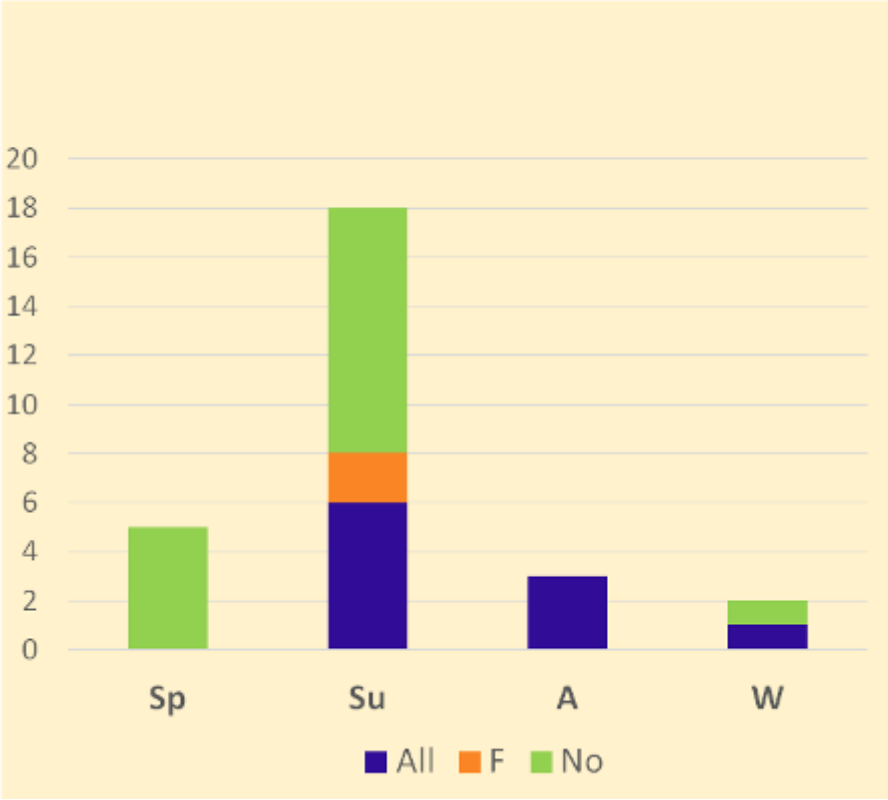


# Seasonal distribution of events

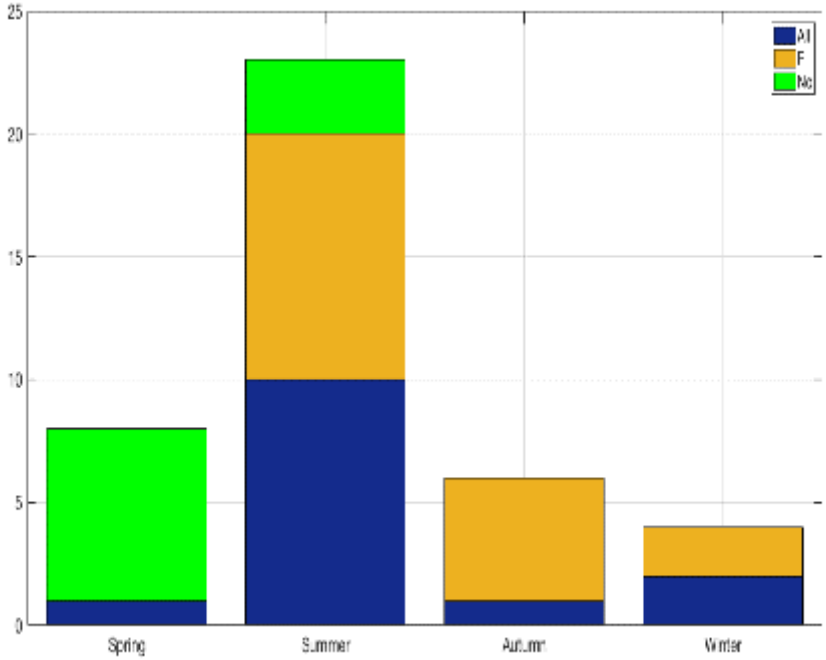
## Northern Italy 2016




*31 slope instabilities, including different process types and rainfall-triggered events*

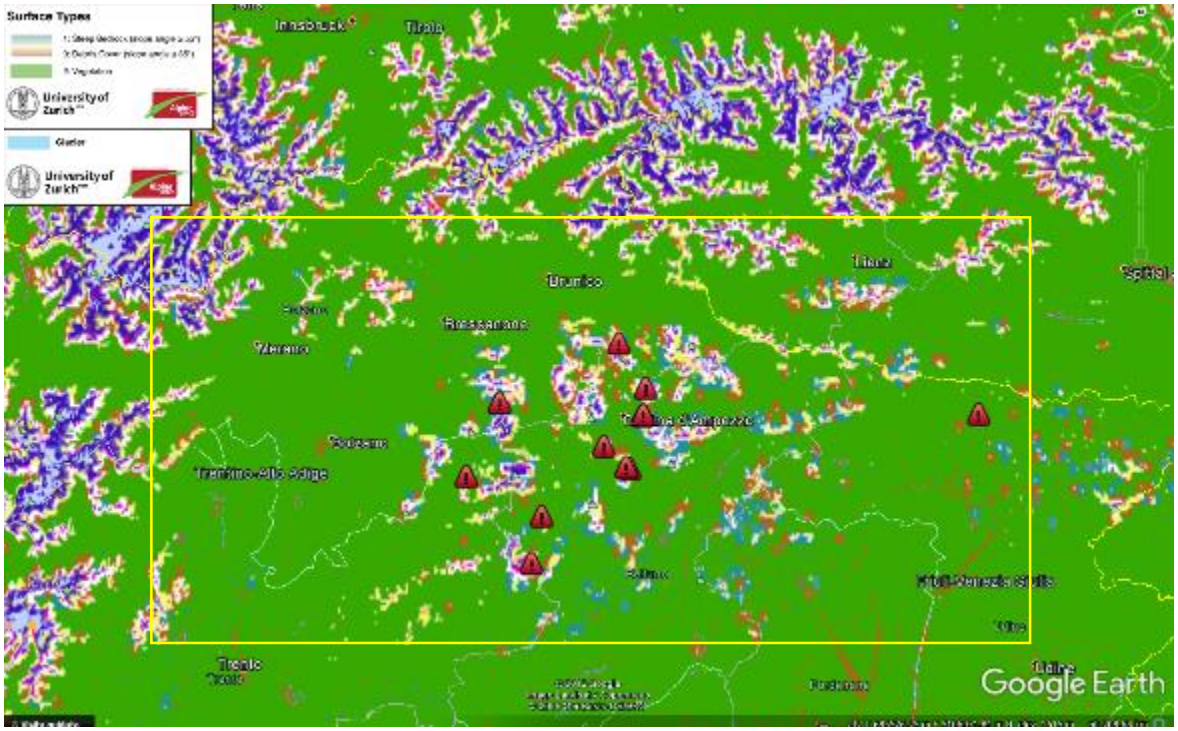
## Northern Italy 1997-2013

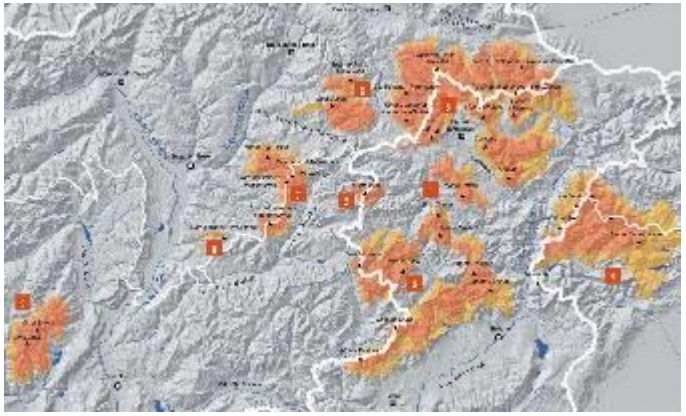
***(Paranunzio et al., 2016)***




*41 rock-falls/avalanches, not triggered by precipitation*

# Regional landscape fragility



## Conclusions - 1

Despite technological advances and increased awareness of the effects of CC on natural instability, in particular in high-altitude environments and in particular after the hot summer 2003, in Italy the systematic documentation of natural instability events on the whole territory is still not considered a priority.

In 2004 we presented at this same venue geomorphological processes triggered by the hot summer 2003. After almost 15 years, we still don't have statistically reliable data about the spatial and temporal trends of occurrence of natural instability processes, especially at high altitudes, despite many evidences that these are among the most sensitive areas to climate change.

In this context, scientific institutions still maintain a leading role in documenting environmental changes taking place as a result of climate change, and in maintaining the awareness of the authorities and of the public on these topics.

## Conclusions - 2

The analysis of the case studies presented here are in agreement with the findings of previous studies (Paranunzio et al., 2016), and in particular:

-Rock-falls/avalanches are the dominant instability process at high altitude in the Italian Alps;

-Temperature plays a key role for the initiation of slope instabilities;

-The slope instability events concentrate in the NW and NE parts of the chain, while the central Italian Alps show little activity;

-Slope instability events in the NW and NE Alpine sectors have different characteristics of occurrence that may correspond to different processes leading to instability, even if in several cases rainfall is the trigger:

-in the NE a crucial role may be played, on the one hand, by snow melt, on the other hand by the degradation of a cryosphere which is no longer in balance with the current climatic conditions;

-in the NW, in addition to snow melt, the dynamics of the active layer of permafrost seems to play a crucial role, jointly with slope changes due to deglaciation.

*The study presented here is part of a wider ongoing study focusing on slope instability processes at high altitude in the Italian Alps in the 2000-2016 period (see also Paranunzio et al. at EGU 2017)*

# Thanks for your attention

For additional information:

*geoclimalp.irpi.cnr.it*

*www.nimbus.it*