Institute for Applied Remote Sensing

LEMONADE

Sensor data integration for landslide monitoring

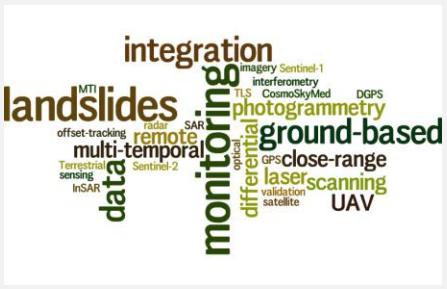
Romy Schlögel[1], Benni Thiebes[1], Abraham Mejia-Aguilar[1], Mehdi Darvishi[1], Fabio Remondino[2], Isabella Toschi[2], Martin Rutzinger[3,4], Thomas Zieher[3,4]

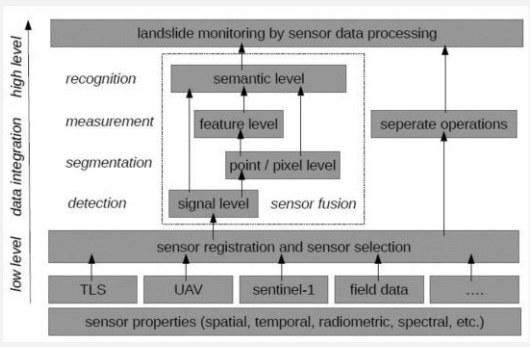
(1) Institute for Applied Remote Sensing, EURAC Research, Viale Druso 1, 39100 Bolzano, Italy
(2) 3D Optical Metrology (3DOM) unit - Bruno Kessler Foundation (FBK), Trento, Italy; (3) Institute for Geography, University of Innsbruck, Austria;
(4) Institute for Interdisciplinary Mountain Research, Austrian Academy of Sciences, Innsbruck, Austria.
Contact person: romy.schloegel@eurac.edu; project website: lemonade.mountainresearch.at

1. LEMONADE – LandslidE MONitoring And Data intEgration

Scope of research

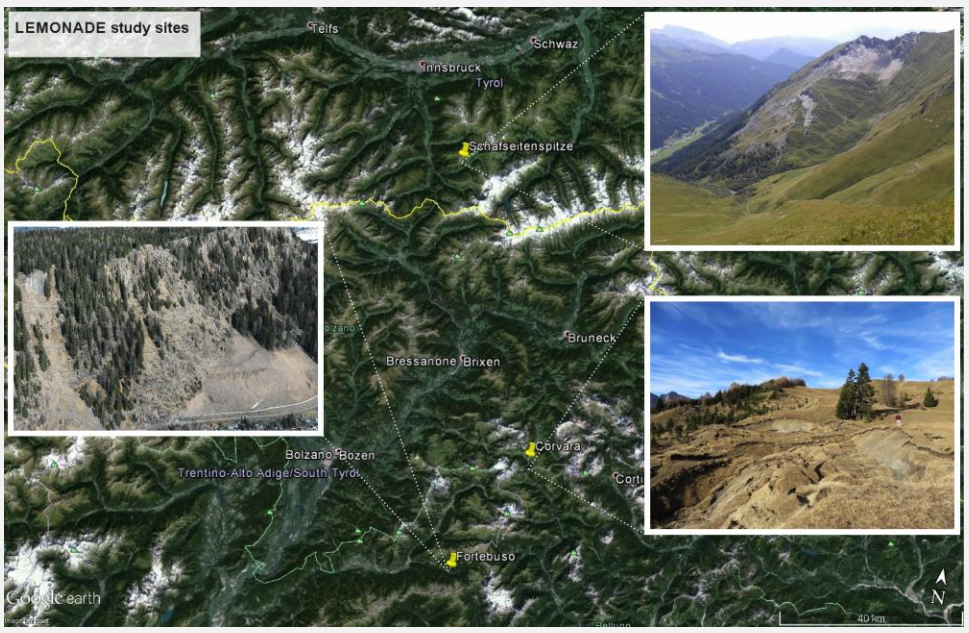
- Application and integration of ground- and satellite-based monitoring techniques, data and results
- Determination of most efficient monitoring techniques for different landslide types





From Luo et al., (2011) Theories, Applications, and its Perspectives. IEEE SENSORS JOURNAL 11 (12).

2. Study sites



3. Methods

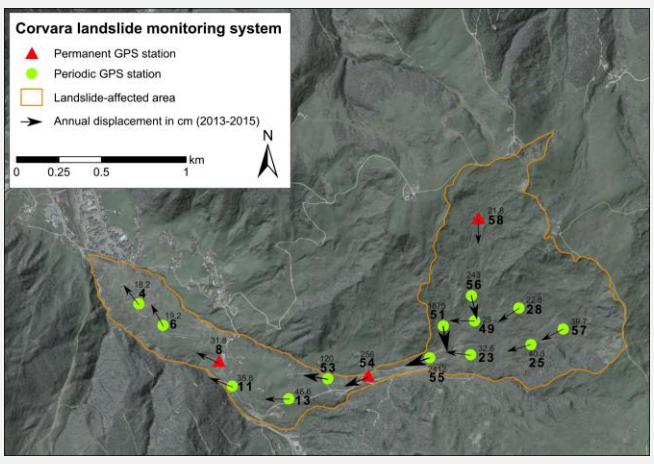
- 3 permanent GPS 13 targets, with X-band corner reflectors (monthly since 2013)
- Terrestrial laser scanner (TLS) – 3 views (yearly, 1st in June 2016)

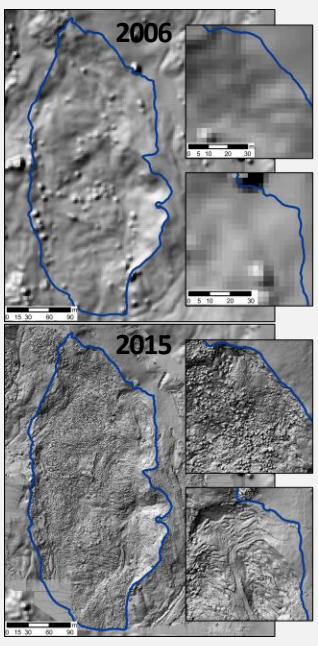
- Unmanned Aerial Vehicle (UAV) – 5 flights of 20 min each, 70 m flight height and 1 m/s flight speed, photos taken every 2 seconds with 3 exposures (yearly, 1st in August 2015, 2nd in June 2016)
  Processing in Pix4D for point cloud generation
- Persistent Scatterers Interferometry and offset tracking techniques for 35 X-band CosmoSkymed images (between 2013-2015)
- Small Baseline Subset (SBAS) technique for 16 C-band Sentinel-1 images of 2015 (SARscape)

4. Preliminary results - Corvara Landslide

GPS monitoring (2013-actual)

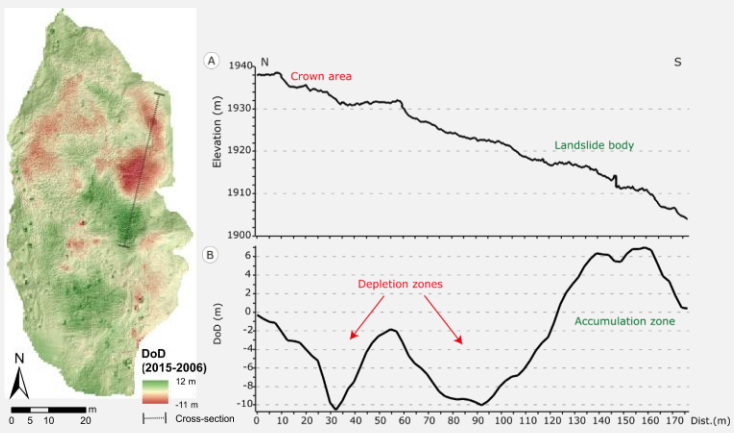
- Displacement directions: E(N)-(N)W and N-S
- Translational regime at upper and middle parts; accumulation at the toe
- Velocity rate: up to 10 m/year at the middle and and between a few cm to 1 m/year in the other parts





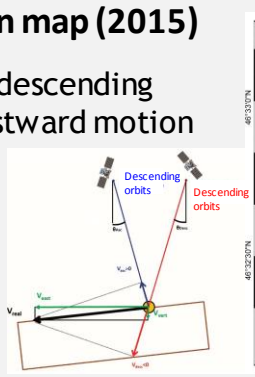
UAV – Difference of DEMs (DoD; 2006-2015)

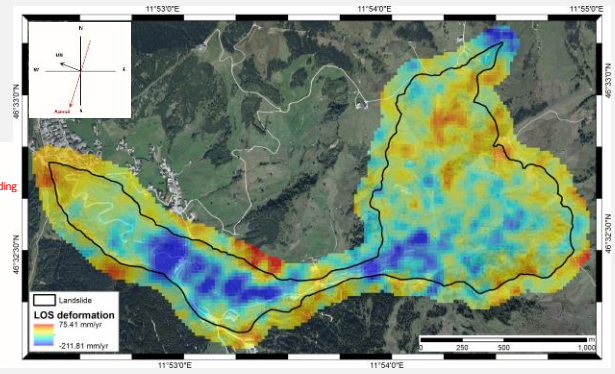
- Elevation changes of up to 12 m (>1 m/year)
- Retrogressive growth of the landslide of 30 m within the last 4 years (ca. 8 m annual growth)



Deformation map (2015)

- Interest of descending track for westward motion





- Negative phase differences in translational and accumulation regimes
- Maximal deformation rate of 0.21 m/year for a 6-month period (between February and September 2015).

5. Conclusion - Outlook

- **GPS measurements** give a continuous monitoring of the landslide with various directions of displacement and velocities.
- **UAV flights** gave valuable products for DoD (and further photogrammetry analysis) but is weather-depending. Uncertainties are due to the vegetation and monitoring of the targets position.
- A small **Sentinel-1 dataset** (descending track) is already able to provide a coherent deformation map using SBAS but more images are needed to improve the accuracy (and coherence).
- Further analyses will include independent data integration.

Kindly funded by:
EUROPAREGION EUREGIO Tirol Südtirol Trentino Tirolo Alto Adige Trentino