SURFACE DEFORMATION MONITORING WITH SENTINEL-1

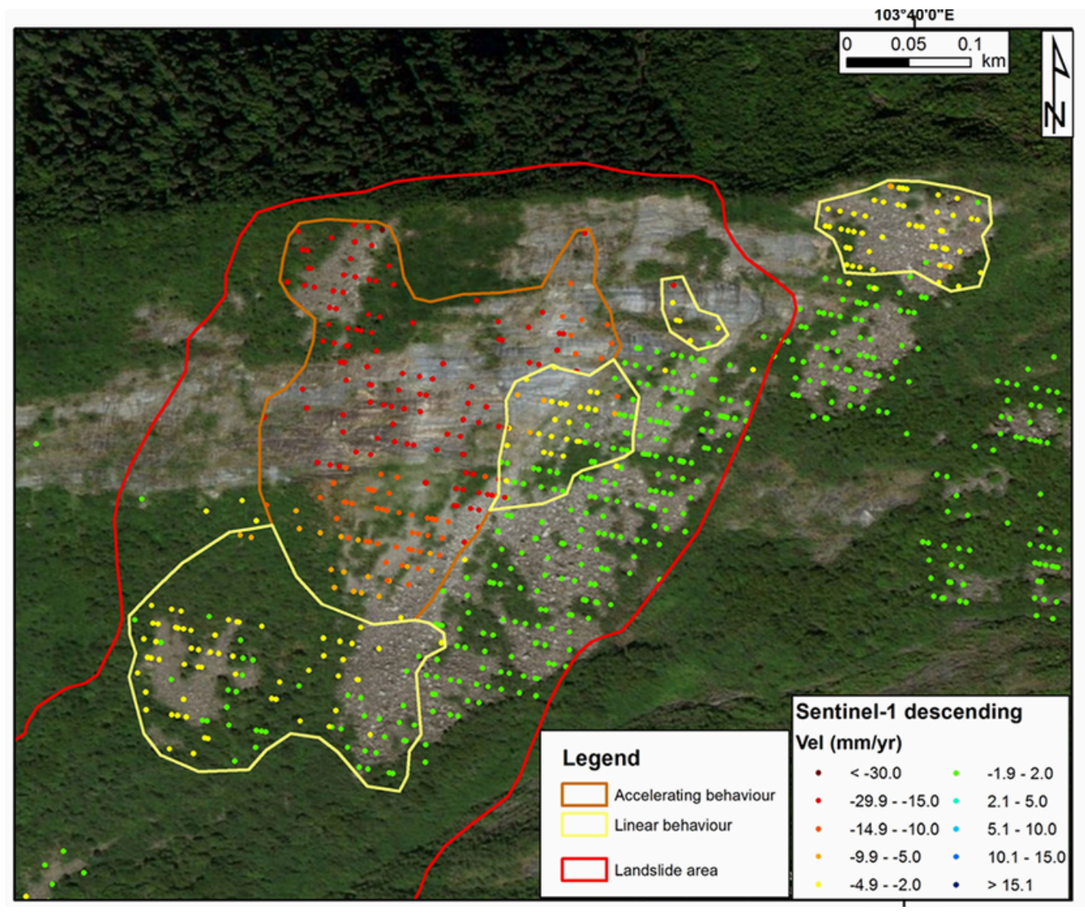
SATELLITE OVERVIEW

*The dual-satellite Sentinel-1 mission, managed by the European Space Agency (ESA) and the European Commission, began in 2014. The mission, comprised of two satellites (Sentinel-1A and Sentinel-1B), orbit the Earth 180 degrees from each other and at an **altitude of 693 km**. Equipped with a C-SAR imaging system and laser data transmitter, these satellites provide unprecedented spatial coverage and revisit times, delivering comprehensive imagery of the entire Earth surface to the European Data Relay System every 6 days.*

SENSOR

*Sentinel-1 boasts an all-weather, day-and-night **synthetic aperture radar (SAR)** instrument recording imagery with long-wavelength **C bands** (3.75 to 7.5 cm) with up to **5m resolution** and up to a **400-km footprint**. SAR measures distances by recording the time it takes for microwave energy pulses to return to the sensor after striking the Earth's surface and can detect*

*With such quick revisit times and high spatial accuracy, Sentinel-1 is a fantastic tool for monitoring **land surface deformation**. Sentinel-1 imagery has proven its worth in a wide variety of surface deformation studies.*



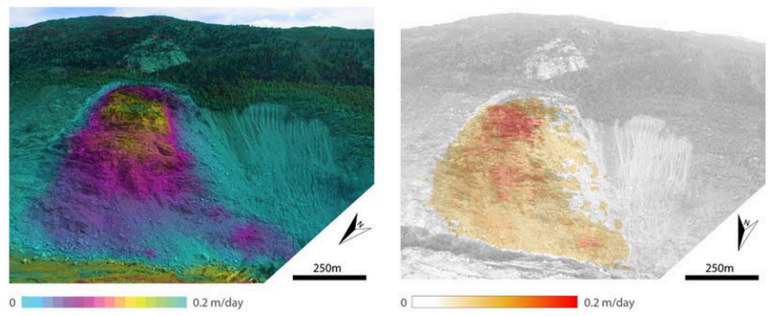
Monitoring hillside instability in Mao County, China with Sentinel-1 imagery Intrieri et al. (2017). The areas delineated with warmer colors indicate more quickly degrading soil stability.

IMAGERY USE CASE

- *In 2017, 100 people died in a landslide in Mao County, China*
- *Post-event analysis of Sentinel-1 data showed signs of terrain failure and led to the creation of classes of deformation behavior*
- *Results proved that satellite data could be used to map unstable areas and monitor landslides. (Intrieri 2018)*

SHORTFALLS

- *Rapid deformation may not be picked up if it occurs within the 6-day window (Manconi 2018)*
- *If the deformation scale is smaller than the spatial resolution of the scanner (i.e. a very small hillside), it may not be picked up in the imagery*



Monitoring Surface Deformation over a Failing Rock Slope with the ESA Sentinels: Insights from Moosfluh Instability, Swiss Alps. Manconi et al. (2018)

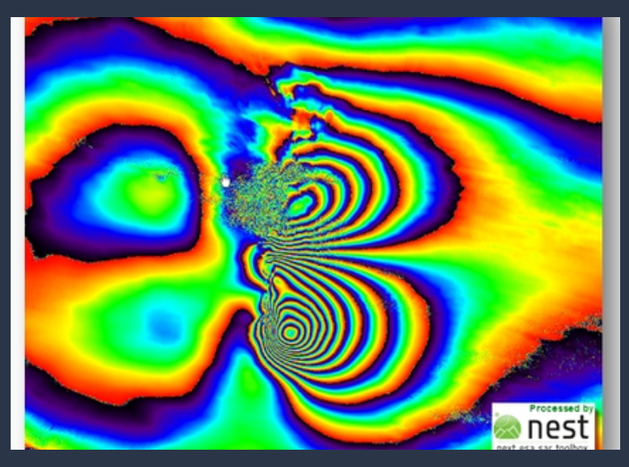
SENSOR

*SAR energy pulses measure distances and can be used to make high-resolution terrain height models. Its **data acquisitions** are **slices** of defined length.*
The SAR acquires data in 4 modes:

- *Stripmap (SM): continuous sequence*
- *Interferometric Wide swath (IW): three swaths*
- *Extra Wide swath (EW): five swaths*
- *Wave (WV): small stripmap scenes*

*The **Terrain Observation with Progressive Scans (TOPSAR)** is a technique where data is acquired in bursts by cyclically switching the antenna beam between multiple adjacent sub-swaths. It provides large swath widths and enhanced radiometric performance.*

***Interferometric SAR (InSAR)** exploits the phase difference between two observations of an area, taken from slightly different sensor positions. It then extracts distance information by generating an interferogram. The deformations are then computed by subtracting the phase shift related to topography.*



Interferogram of Bam, Iran (sentinels.copernicus.eu)