SliDEM

EGU General Assembly 2022

An open-source Python package for DEM generation and landslide volume estimation based on Sentinel-1 imagery

Read the abstract here:

https://meetingorganizer.copernicus.org/EGU22/EGU22-693.html

EGU 2022 | Session: GM2.8

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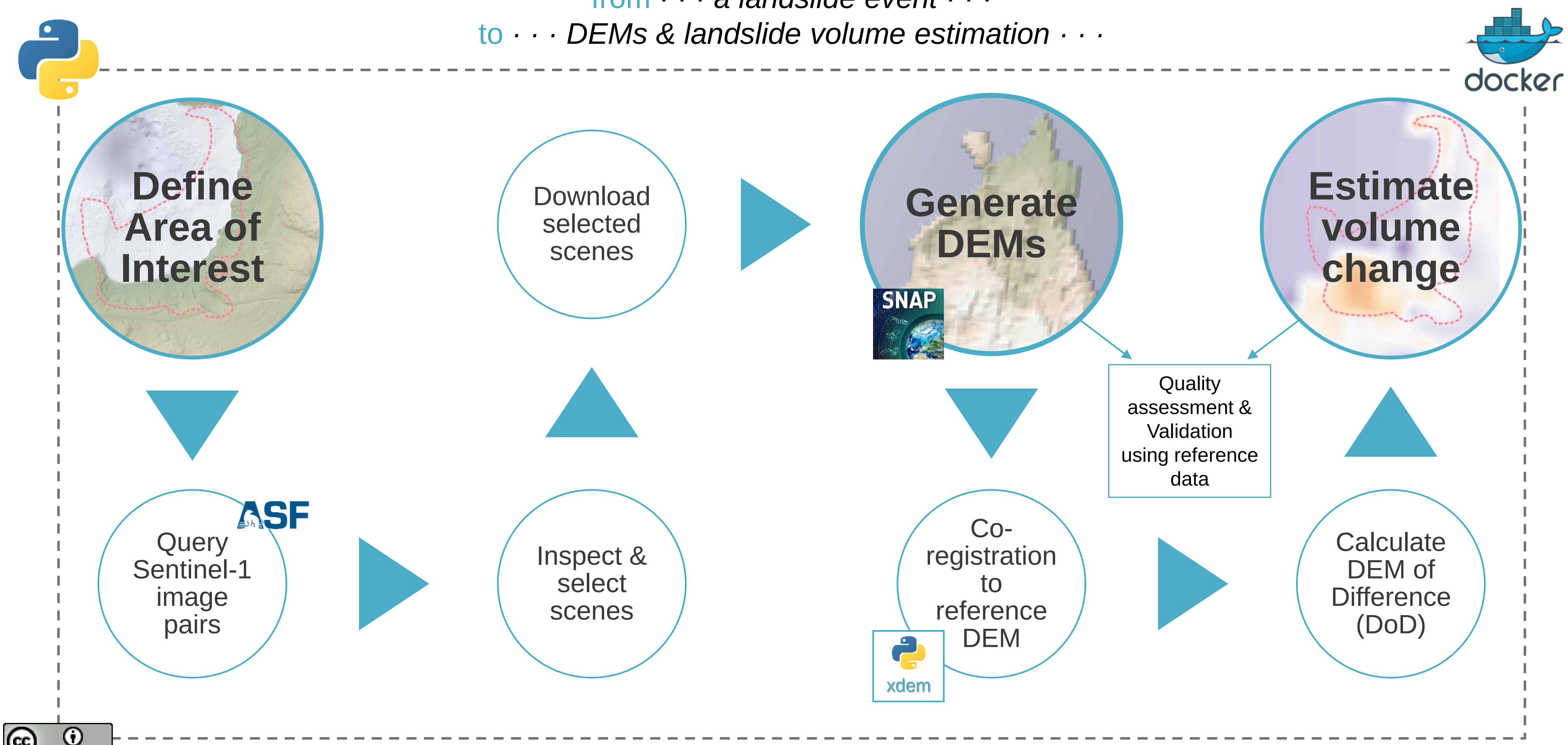
Conceptual workflow

from · · · *a landslide event* · · ·
to · · · *DEMs & landslide volume estimation* · · ·



Python package structure

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query.py

- *Input/Parameters:*
  - Start and end date
  - Area of interest
  - Temporal and perpendicular baseline threshold
- *Output:* CSV file with S-1 scenes matching the AOI, time period and baseline arguments, includes link to Sentinel Hub explorer (for visual inspection of AOI)

download.py

- Requires manual pre-selection of image pairs
- *Input/Parameters:*
  - Login data to ASF repository
  - Updated CSV file
  - Download directory
- *Output:* Downloaded S-1 scenes in .zip format

dem.py

- Depends on SNAP, snaphu, `stsa`, `snappy`
- Dependencies are set-up via a Docker image
- *Input/Parameters:*
  - S-1 image pair path
  - Area of interest
    - Polarization
    - DEM for back-geocoding
    - Multi-looking range
    - Tiles and cost mode for snaphu export
- *Output:* Intermediate products and final DEM

quality.py

In progress

- Dem co-registration and statistics calculation
- Depends on `xdem`
- Requires reference DEMs

volume.py

In progress

- DEM of difference (DoD) for pre/post-event S-1 DEMs
- Comparison with reference data

DEM generation pipelines

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dem.py

Pipeline 1	
	1. Get sub-swath and bursts for AOI
	2. TOPSAR split
	3. Apply orbit file
	4. Back geo-coding
	5. Enhanced spectral diversity

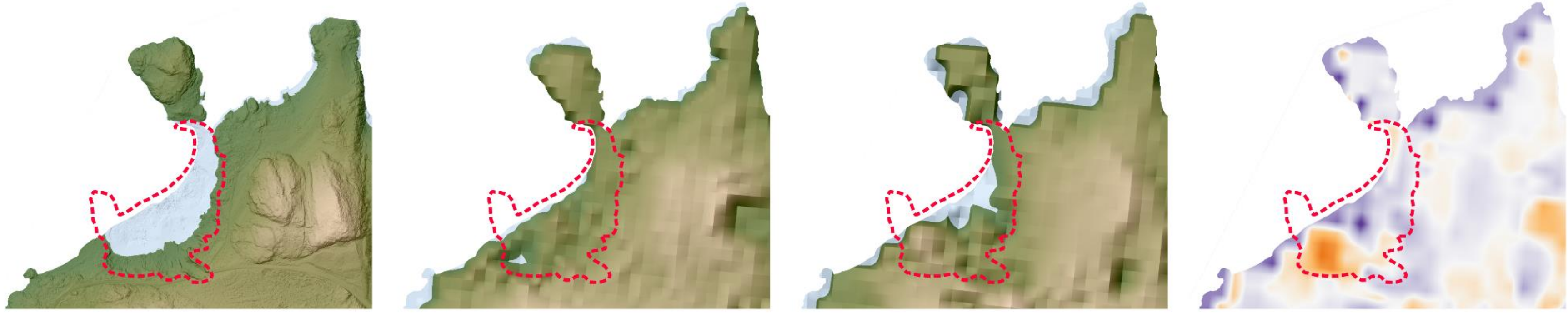
Pipeline 2	
	1. Interferogram
	2. TOPSAR deburst
	3. Topophase removal (optional)
	4. Multi-looking (optional)
	5. Goldstein filtering (optional)
	6. Subset to AOI

Pipeline 3	
	1. Snaphu export
	2. Unwrapping

Pipeline 4	
	1. Import unwrapped phase from snaphu
	2. Phase to elevation
	3. Terrain correction
	4. DEM export to .tif

Case studies: Norway and Austria

DTM based on UAV acquisition	Pre-event DEM based on Sentinel-1	Post-event DEM based on Sentinel-1	DEM of Difference (DOD)
11.09.2021	12.06. & 18.06.2019	05.06. & 29.07.2020	



0 200 400 600 m

Landslide area

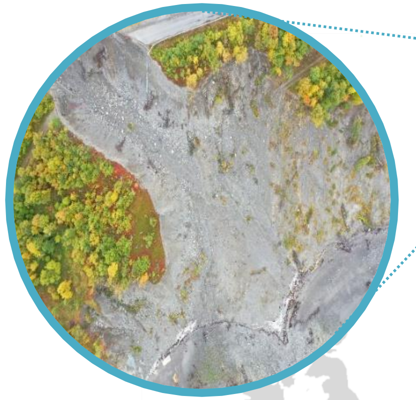
Water

Elevation

0 m 150 m

Elevation difference

-100 m 100 m



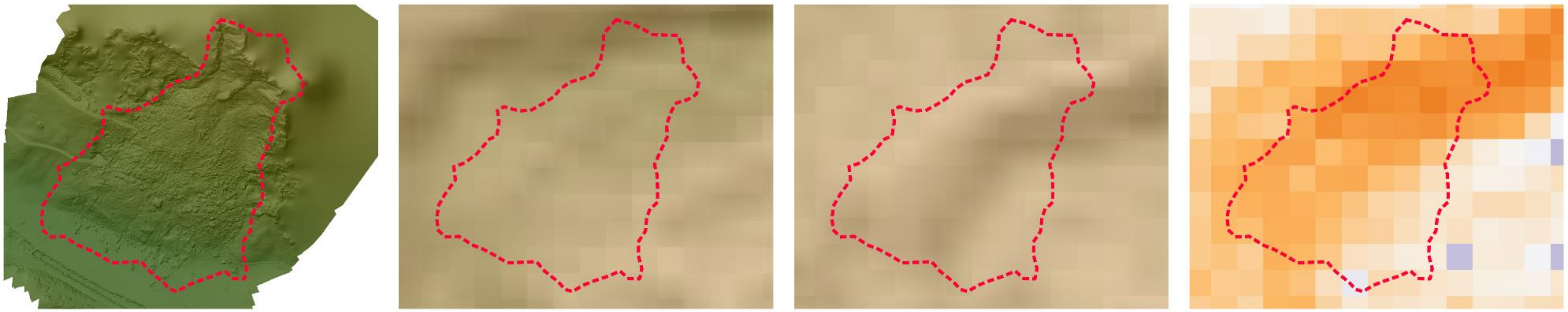
Quick clay landslide in Kråknes, Alta

70°01’40“ N, 23°03‘51“ E

Event:

03.06.2020: 600 000 m³

15.10.2021	30.08. & 05.09.2018	26.07. & 01.08.2019	



0 100 200 300 m

Landslide area

Elevation

1 000 m 1 700 m

Elevation difference

-50 m 250 m

Rockfall in Hüttschlag, Großarl valley

47°09’58“ N, 13°16’17“ E

Events:

26.03.2019: 2 500 m³

16.07.2019: 5 000 m³

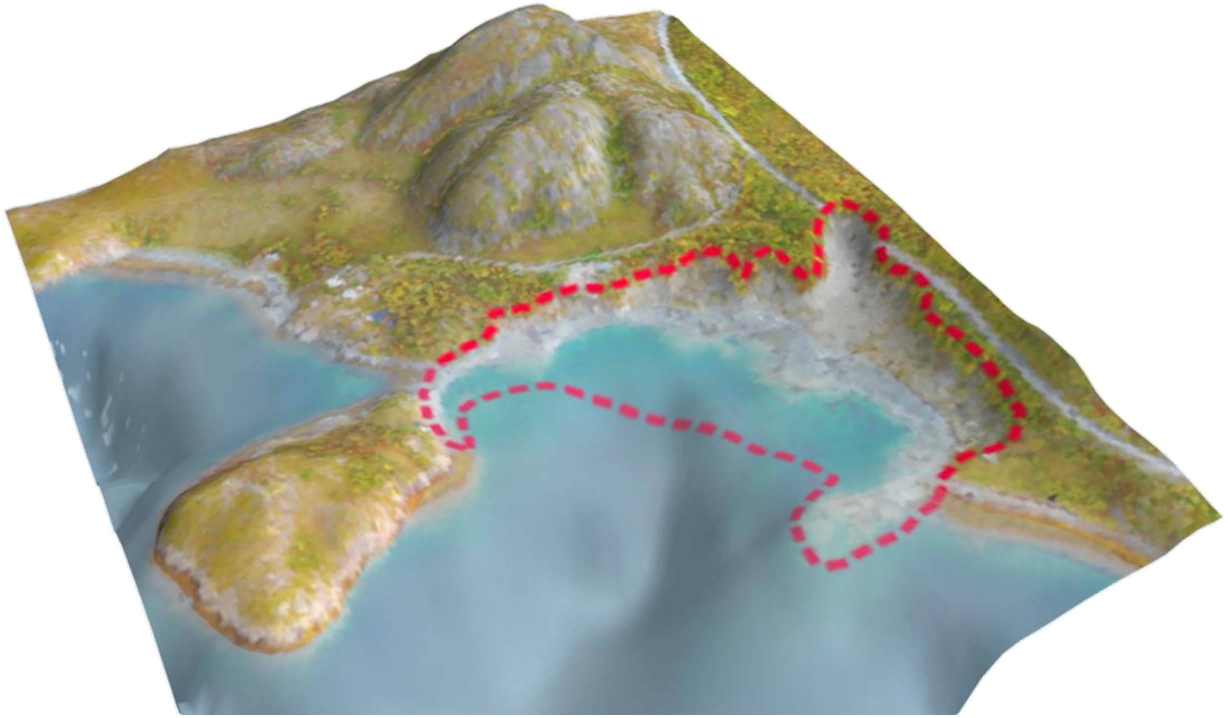
24.10.2019: 15 000 m³

Total: 22 500 m³

Case studies: Kråknes, Alta, Norway

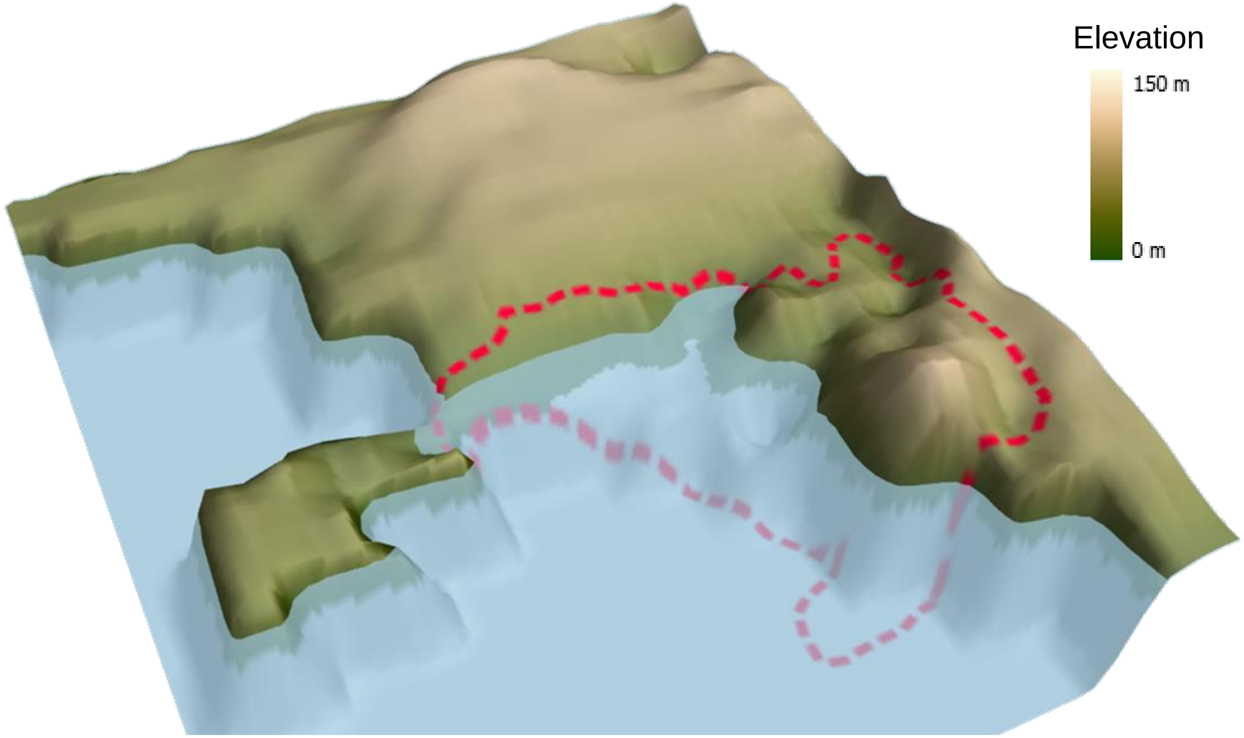
Orthophoto and DTM hillshade based on UAV acquisition

11.09.2021



Post-event DEM and its hillshade based on Sentinel-1

05.06. & 29.07.2020



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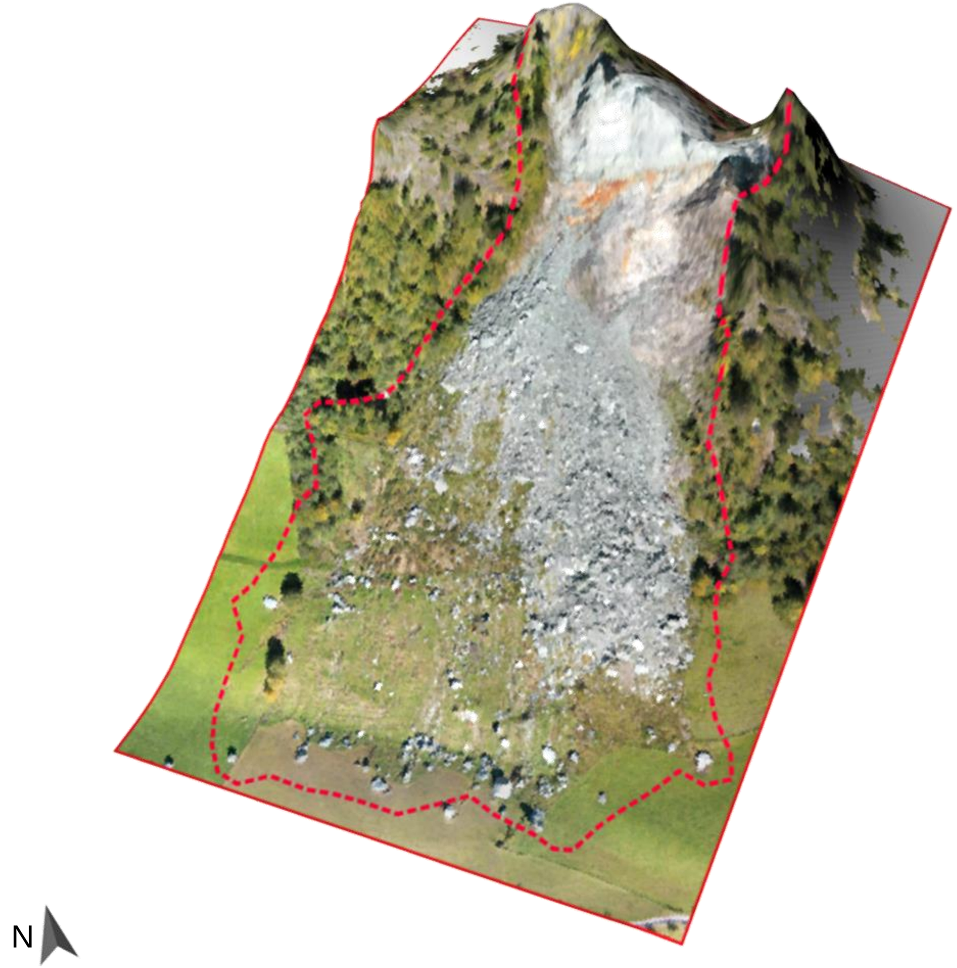
Case studies: Hüttschlag, Großarl valley, Austria

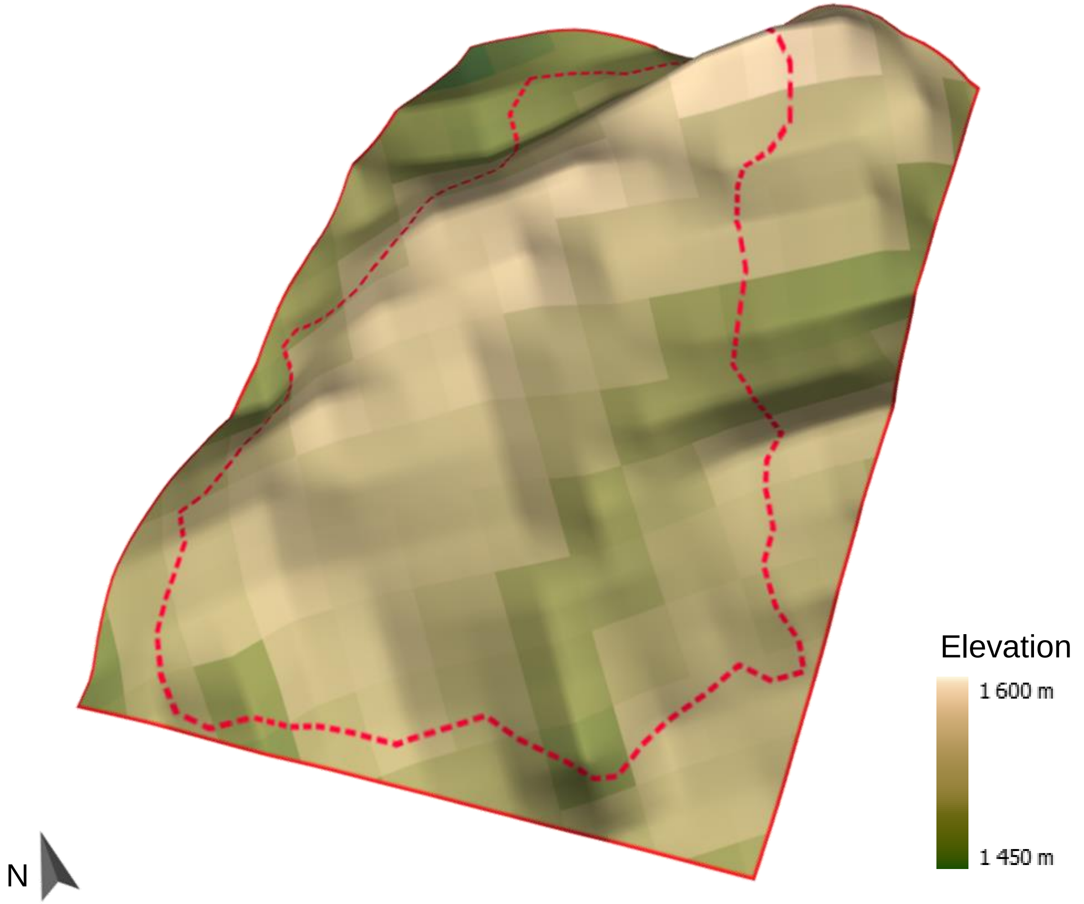
Orthophoto and DTM hillshade based on UAV acquisition

15.10.2021



Post-event DEM and its hillshade based on Sentinel-1

26.07. & 01.08.2019



Case studies: Norway and Austria

AOI	Pre/Post-event	Dates	Pass	Path	B_{perp}	B_{temp}	Coherency	Error (NMAD)	Estimated volume
					(m)	(days)		(m)	(m^3)
Kråknes, Alta, Norway	Pre-event	12.06. & 18.06.2019	Descending	95	139	6	0.88	12.04	S: 2 515 604.9 A: 905 941.2 B: 1 609 663.7
	Post-event	05.06. & 29.07.2020	Ascending	87	141	54	0.84	56.38	
Hüttschlag, Austria	Pre-event	30.08. & 05.09.2018	Ascending	44	152	6	0.87	233.44	S: 6 142 370.3 A: 6 138 485.6 B: 3 884.6
	Post-event	26.07. & 01.08.2019	Ascending	44	192	6	0.84	221.12	

B_{perp}: Perpendicular baseline
B_{temp}: Temporal baseline
NMAD: normalized median absolute deviation, compared to reference DEM stable areas after co-registration (Deramping approach), computed with `xdem`
Estimated volume: for landslide area, sum (S), above (A) and below (B) baseline

Remarks:

- In Norway:
  - Flatter areas seem to result in good quality DEMs
  - Relative to each other, DEMs generated from Sentinel-1 have similar values for stable areas
- In Austria:
  - DEM generation still needs improvements regarding quality
  - Values are overestimated, stable areas have differing values for pre- and post-event DEMs
  - Influenced by the steep topography

Acknowledgements

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FFG Promoting Innovation.

Z_GIS

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