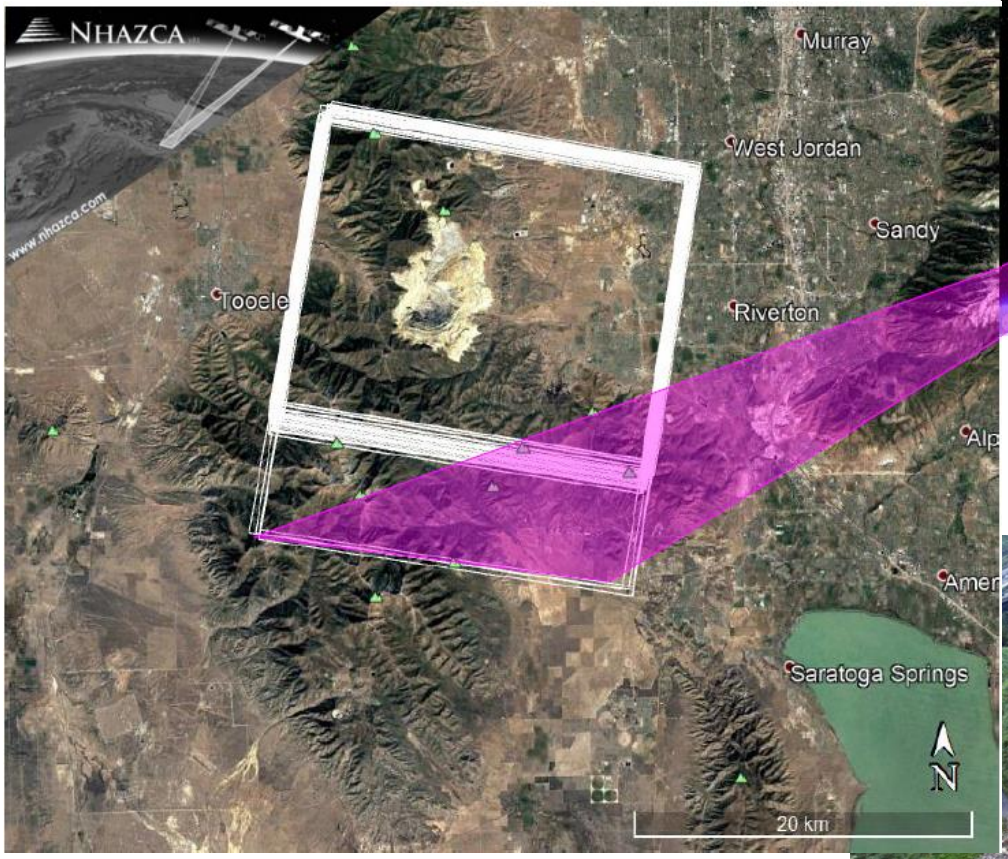
REMOTE SENSING

In Structural & Geotechnical Monitoring



By:

Reza Ghiami

KIYANMEHR Co.

NHAZCA
NATURAL HAZARDS CONTROL AND ASSESSMENT

KIYANMEHR
EYES WIDE OPEN

KIYANMEHR.COM

Structural Health Monitoring

1:

Contact onitoring

2:

Remote ensing

The Philosophy of

REMOTE SENSING

To better observe of some phenomena, must stay to watch from far!

NAZCA Lines
In Peru

Covering an area of nearly 1,000 sq. kilometers, there are about 300 different figures, including animals and plants. Composed of over 10,000 lines, some of which measure 30 meters wide and stretch more than 9 kilometers, the figures are most visible from the air or nearby hilltops.

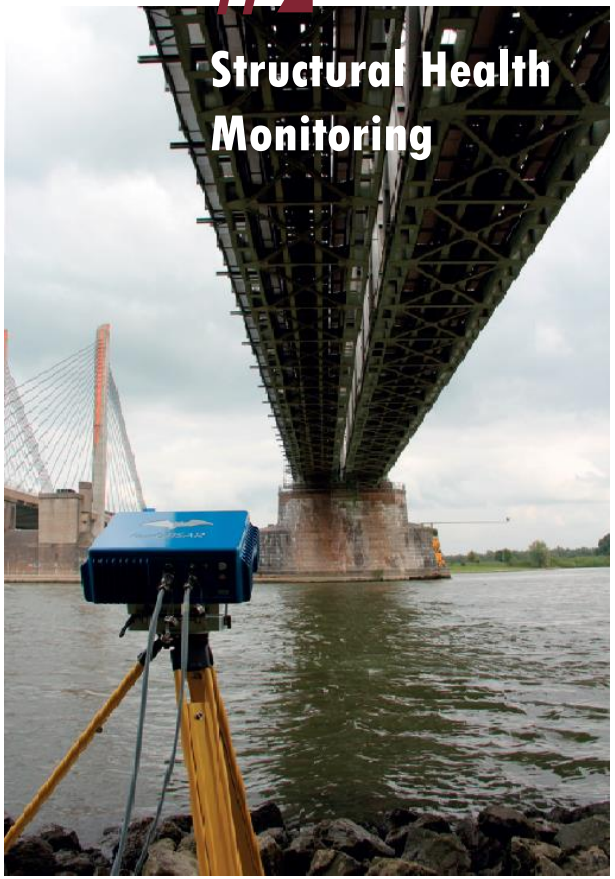
The Application of

Remote Sensing Methods

In Structural Health Monitoring

#1

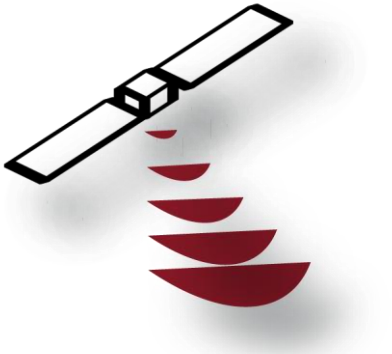
#2



#3

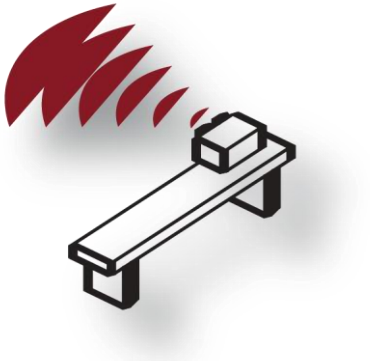
The Principal Technologies of

REMOTE SENSING



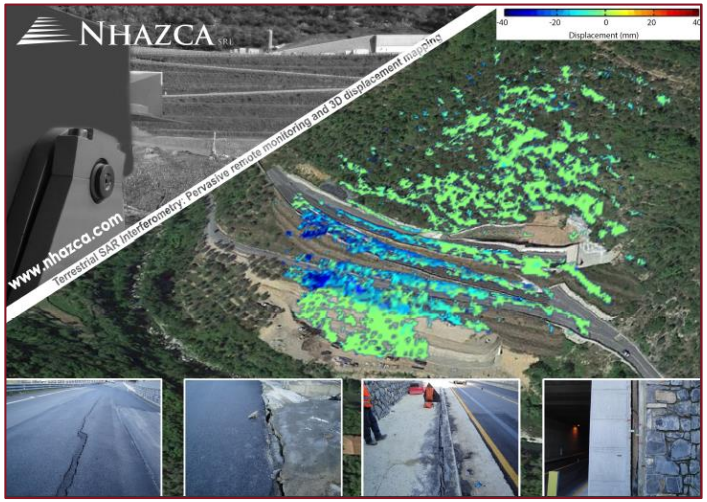
Advanced Satellite InSAR

Laser Scanner

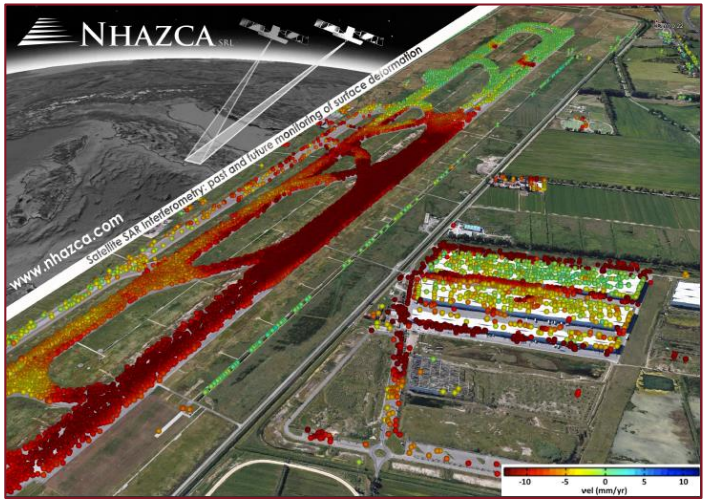


Terrestrial Radar
(SAR, RAR)

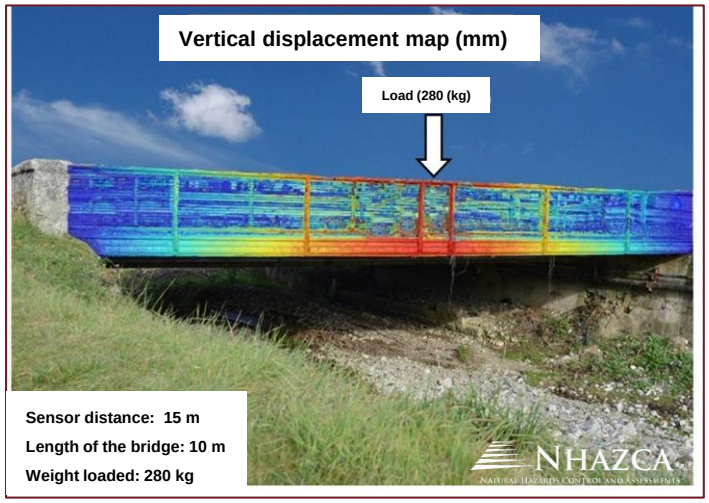
PhotoMonitoring



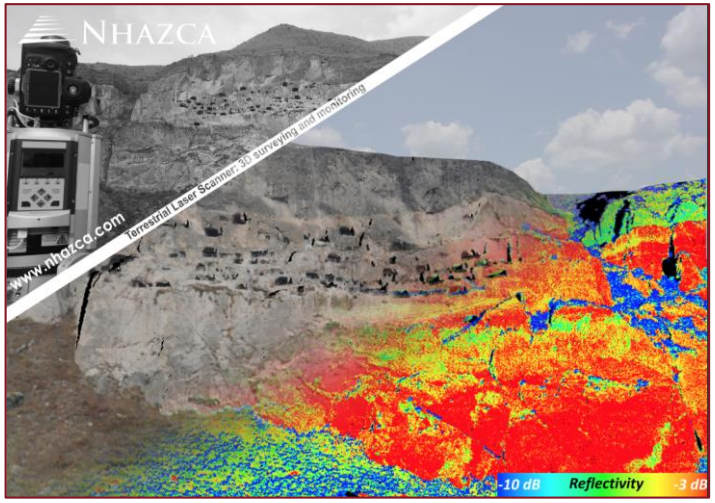
Terrestrial SAR Interferometry



Satellite SAR Interferometry

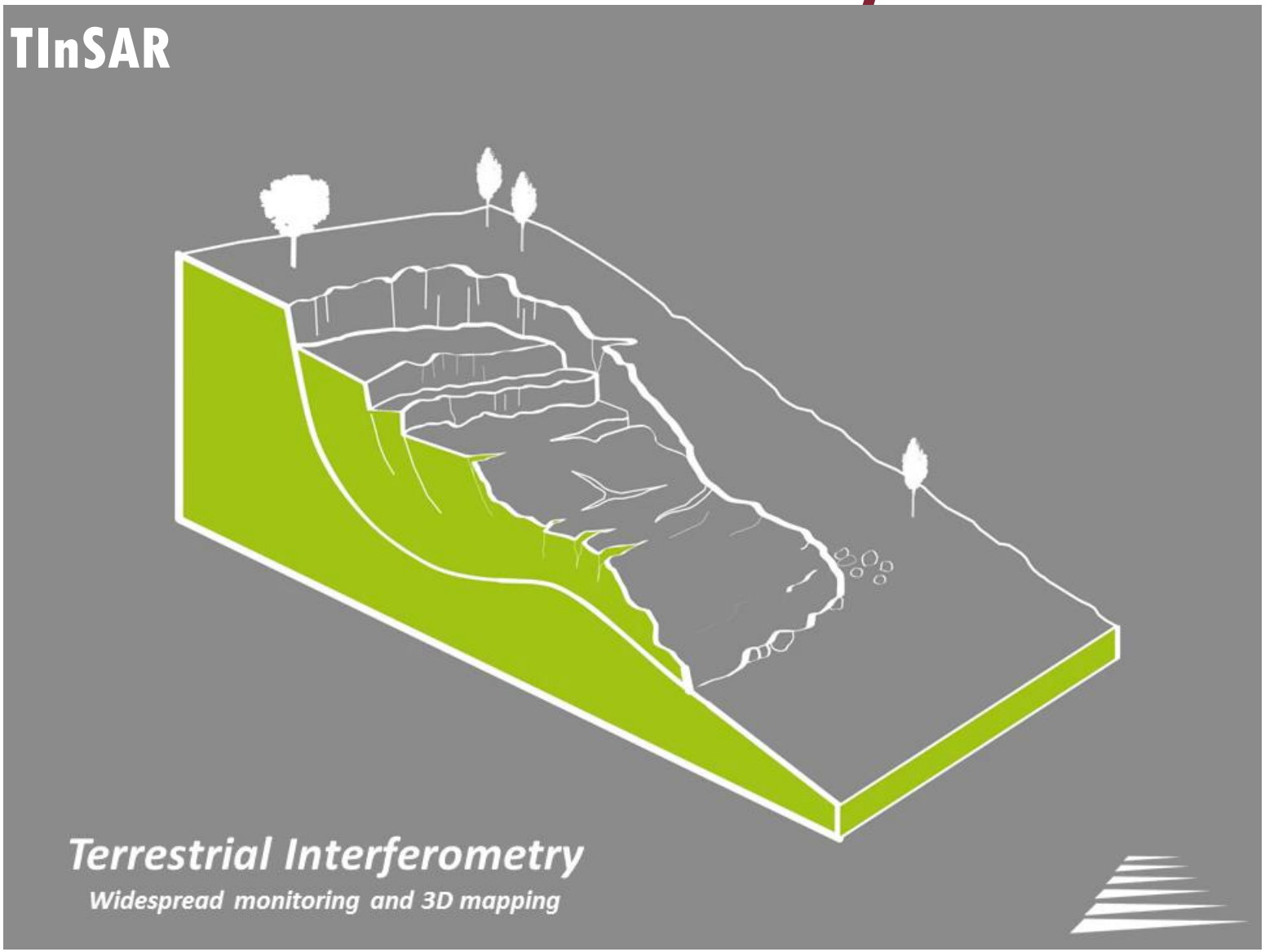


PhotoMonitoring



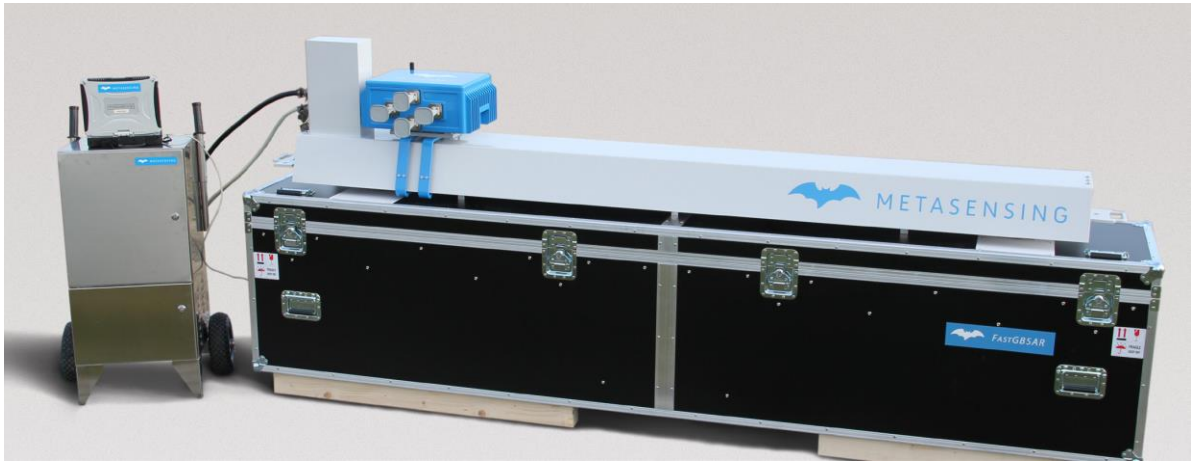
Terrestrial Laser Scanning

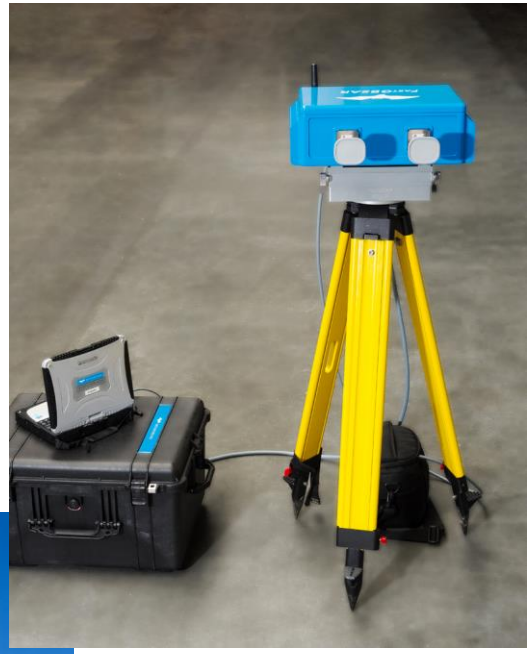
Terrestrial SAR Interferometry



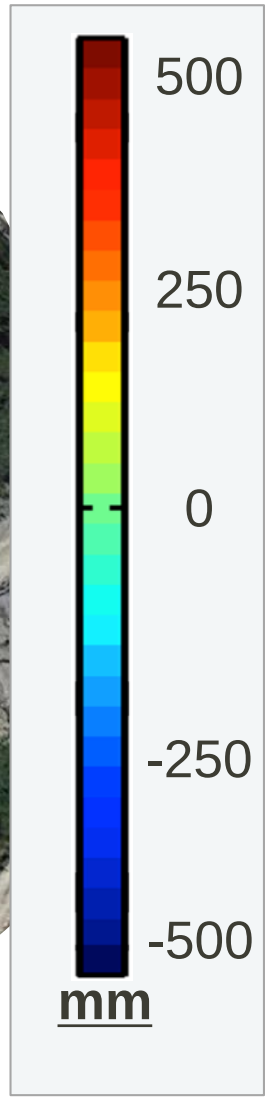
The Types of

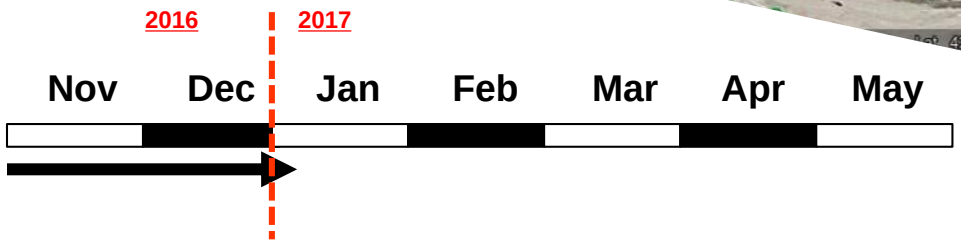
Terrestrial Radars

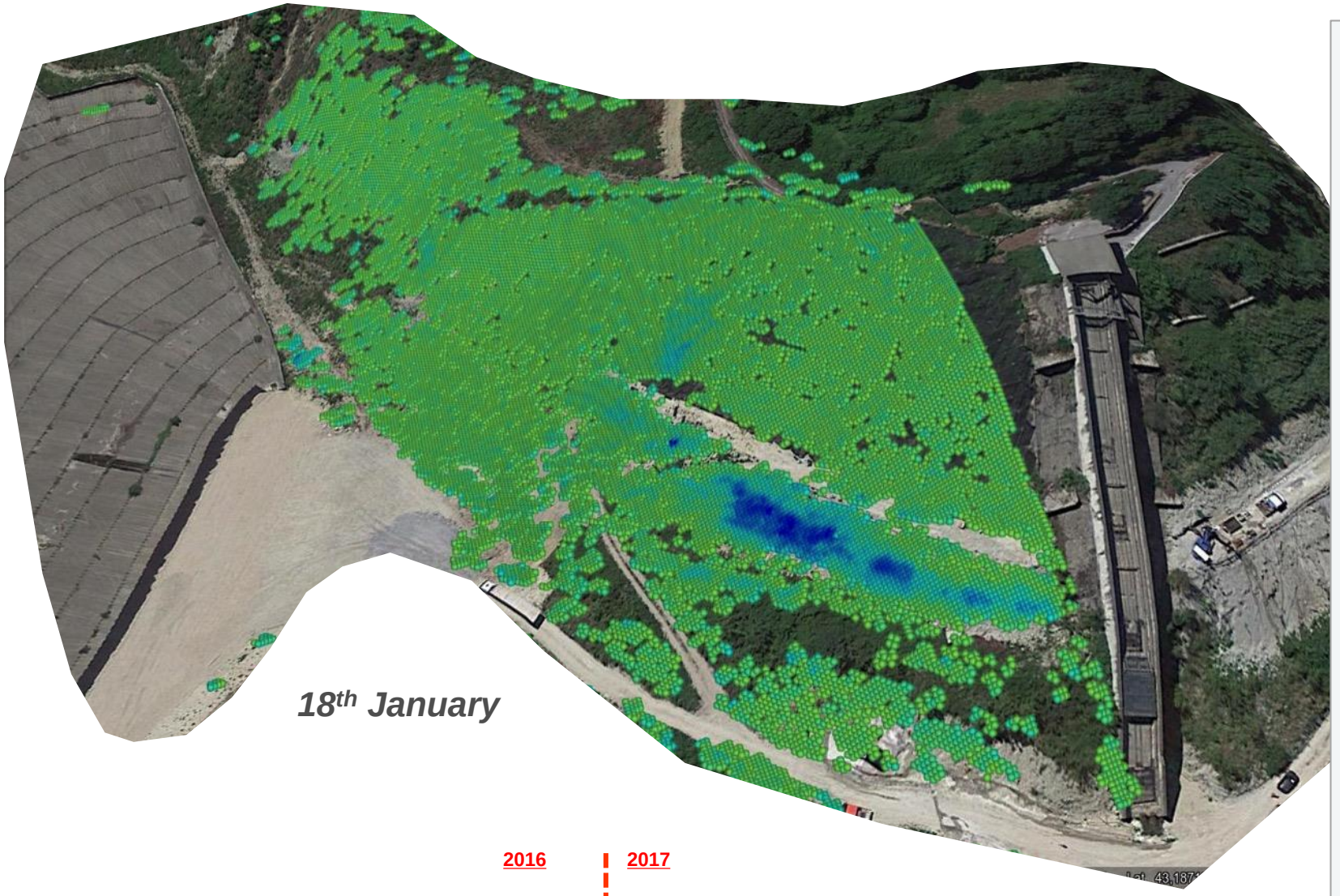


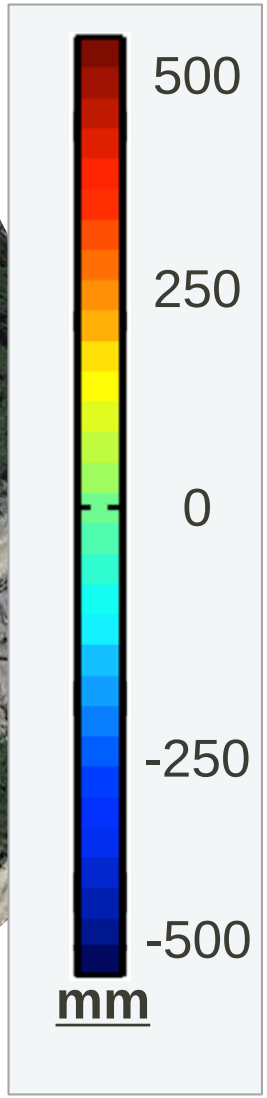


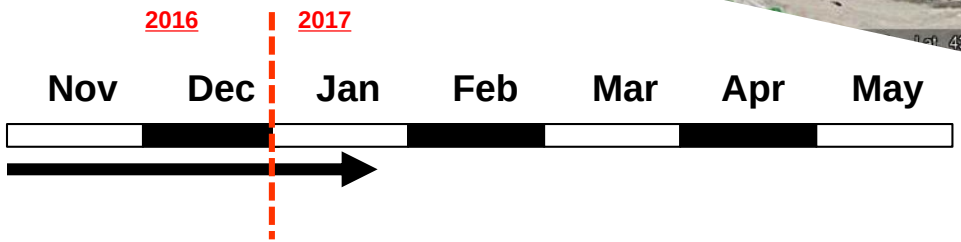
#1 Monitoring the deformation of slopes in real time

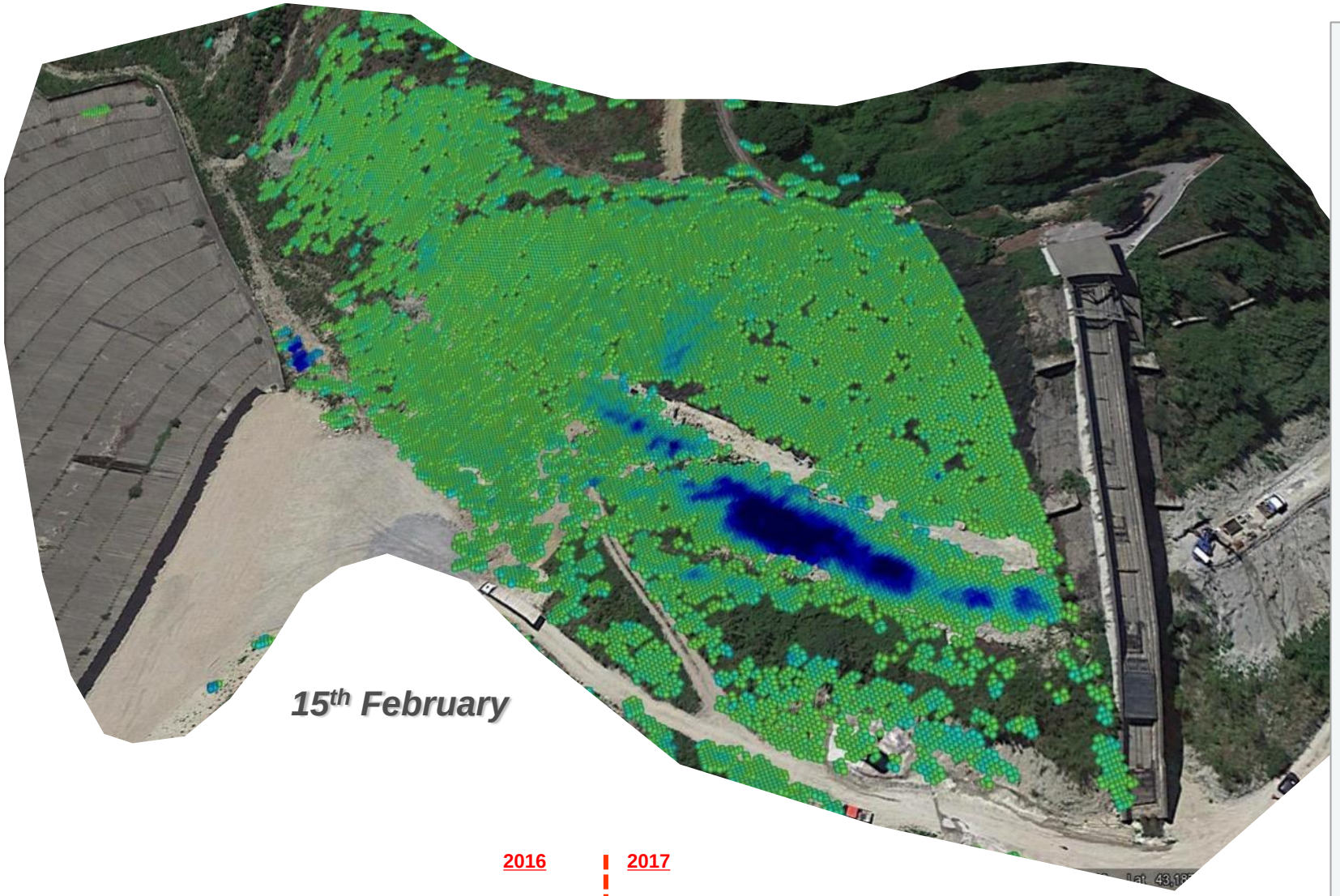


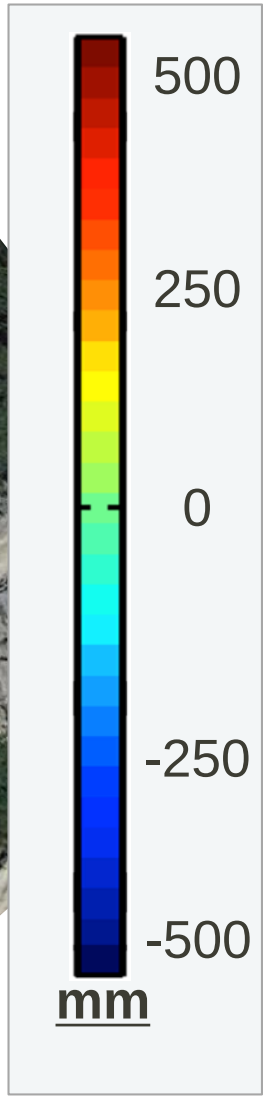


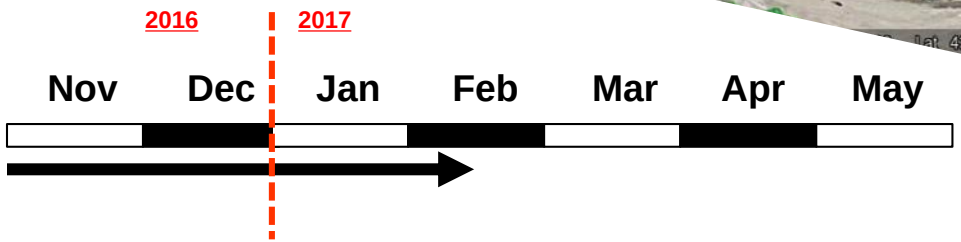

18th January

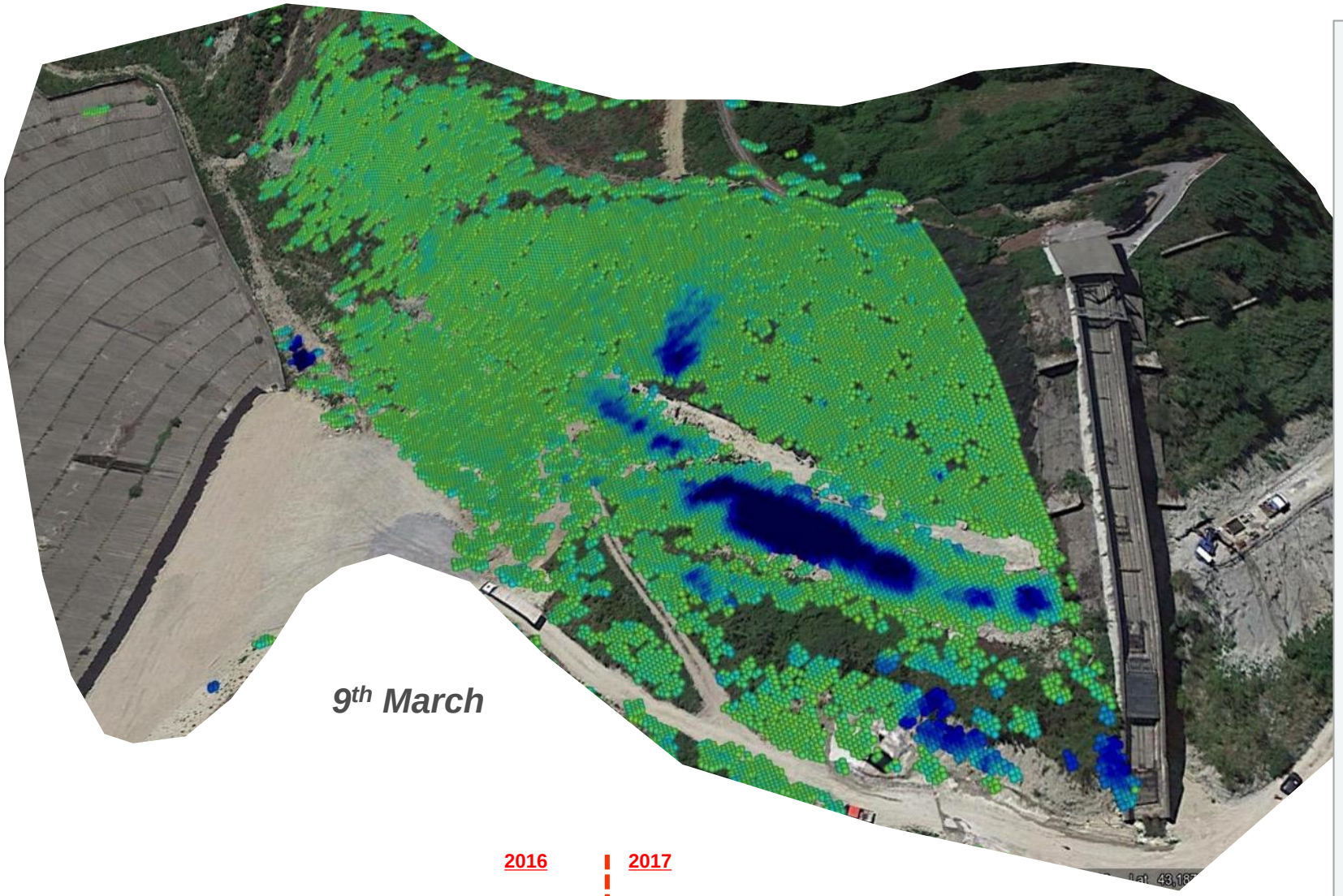

500
250
0
-250
-500
mm

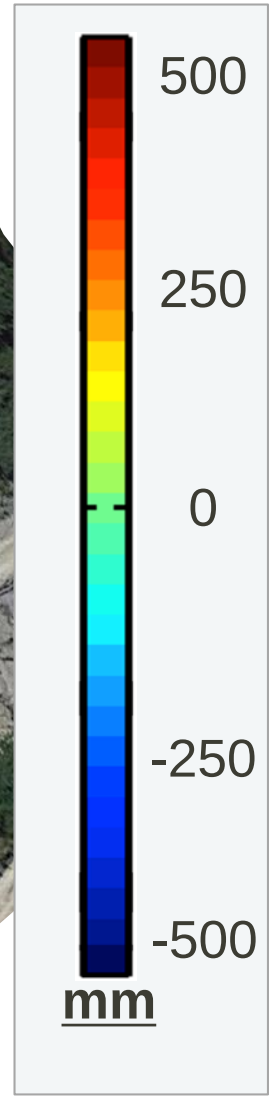

2016
2017
Nov
Dec
Jan
Feb
Mar
Apr
May

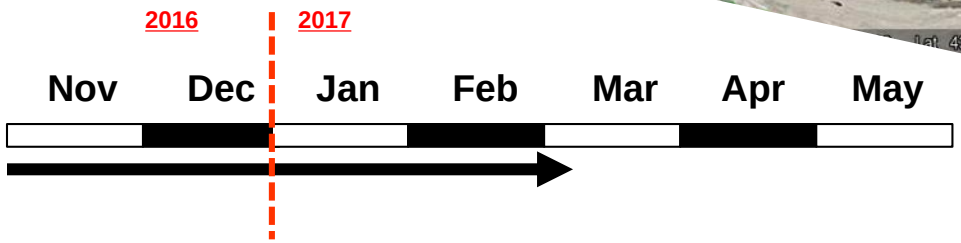

15th February


500
250
0
-250
-500
mm

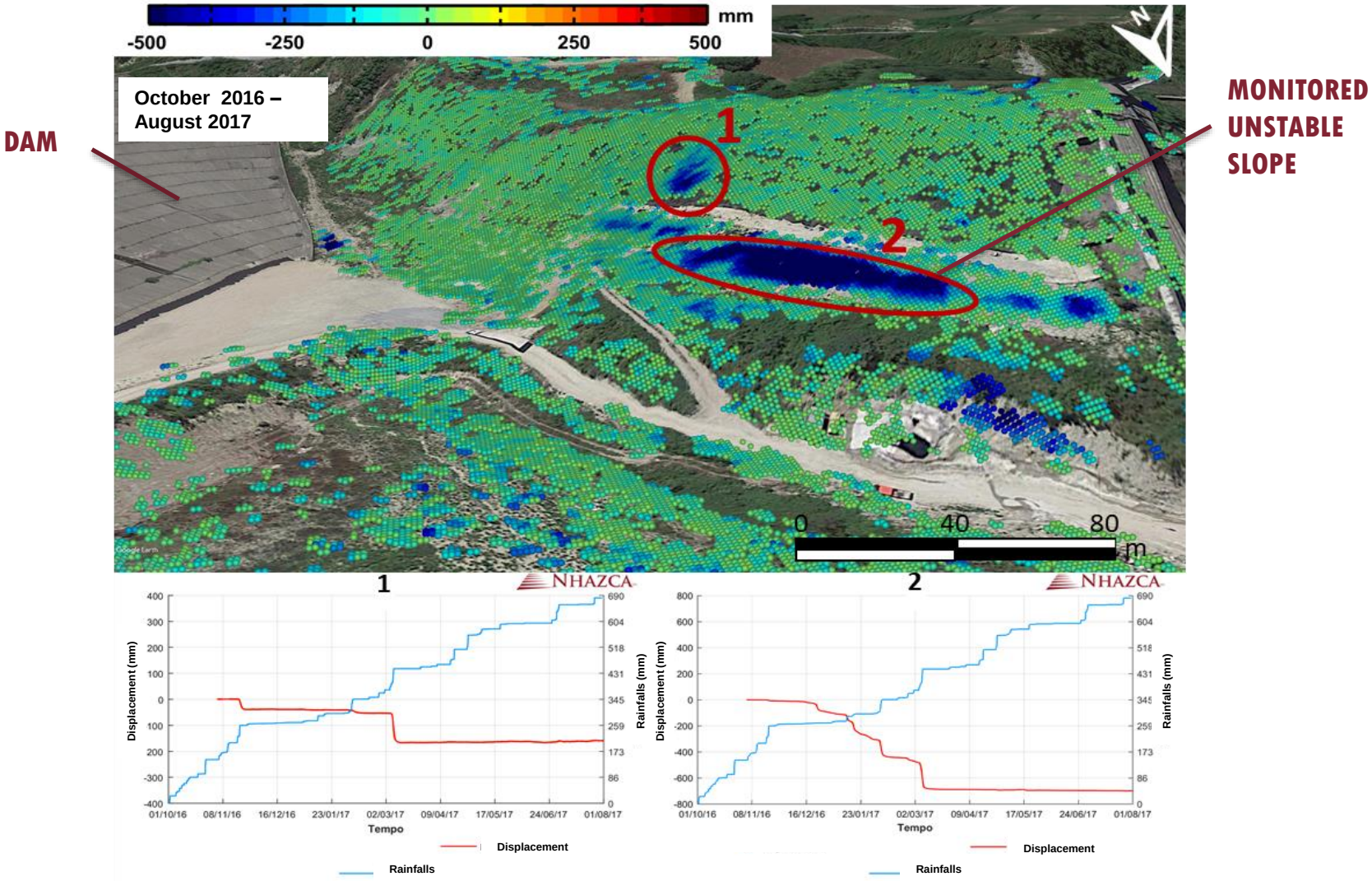

2016
2017
Nov
Dec
Jan
Feb
Mar
Apr
May


9th March


500
250
0
-250
-500
mm


2016
2017
Nov
Dec
Jan
Feb
Mar
Apr
May

The Results:


mm
-500
-250
0
250
500
October 2016 – August 2017
DAM
MONITORED UNSTABLE SLOPE
1
2
0
40
80
m
1
NHAZCA
Displacement (mm)
Rainfalls (mm)
Tempo
01/10/16
08/11/16
16/12/16
23/01/17
02/03/17
09/04/17
17/05/17
24/06/17
01/08/17
Displacement
Rainfalls
2
NHAZCA
Displacement (mm)
Rainfalls (mm)
Tempo
Displacement
Rainfalls

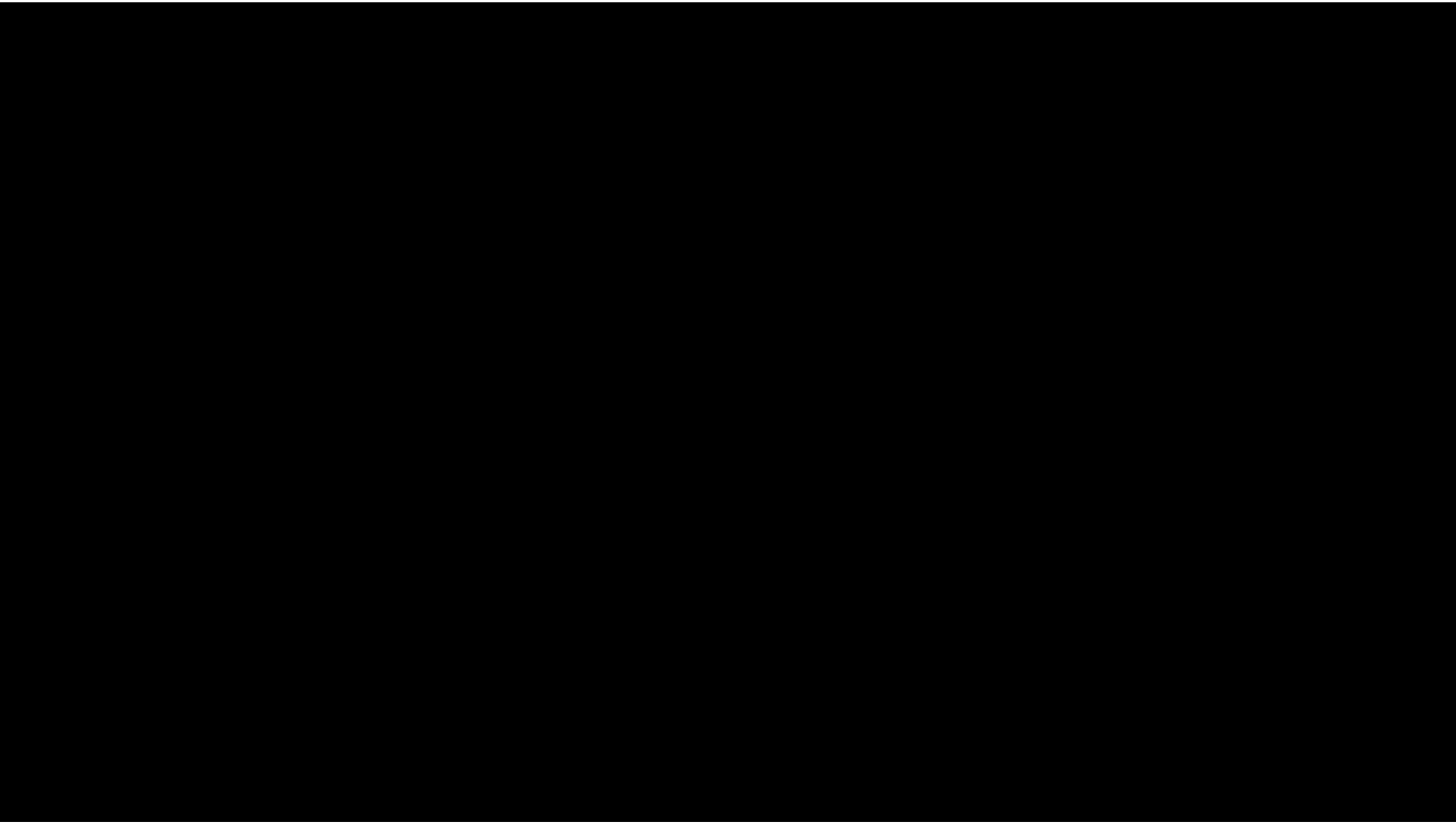
#2 Monitoring embankment stability during remediation works

EMBANKMENT INSTABILITY

Problem solution:

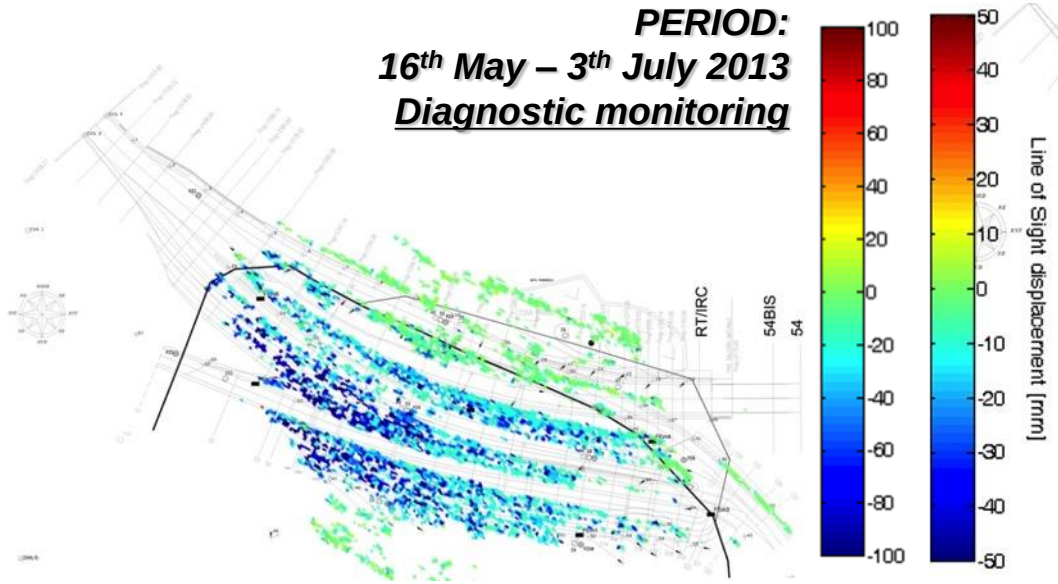
TInSAR

The Results:

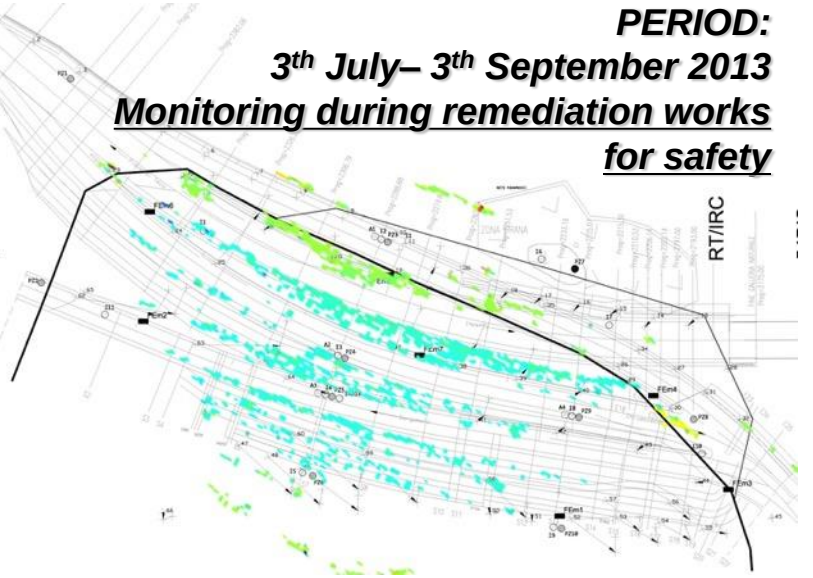


The Results:

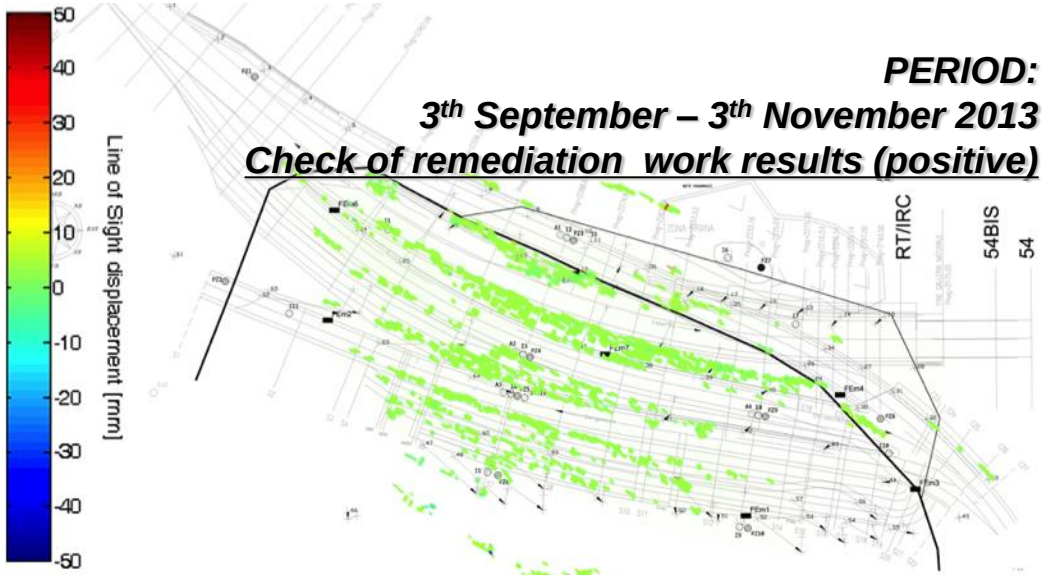
PERIOD:
16th May – 3th July 2013
Diagnostic monitoring



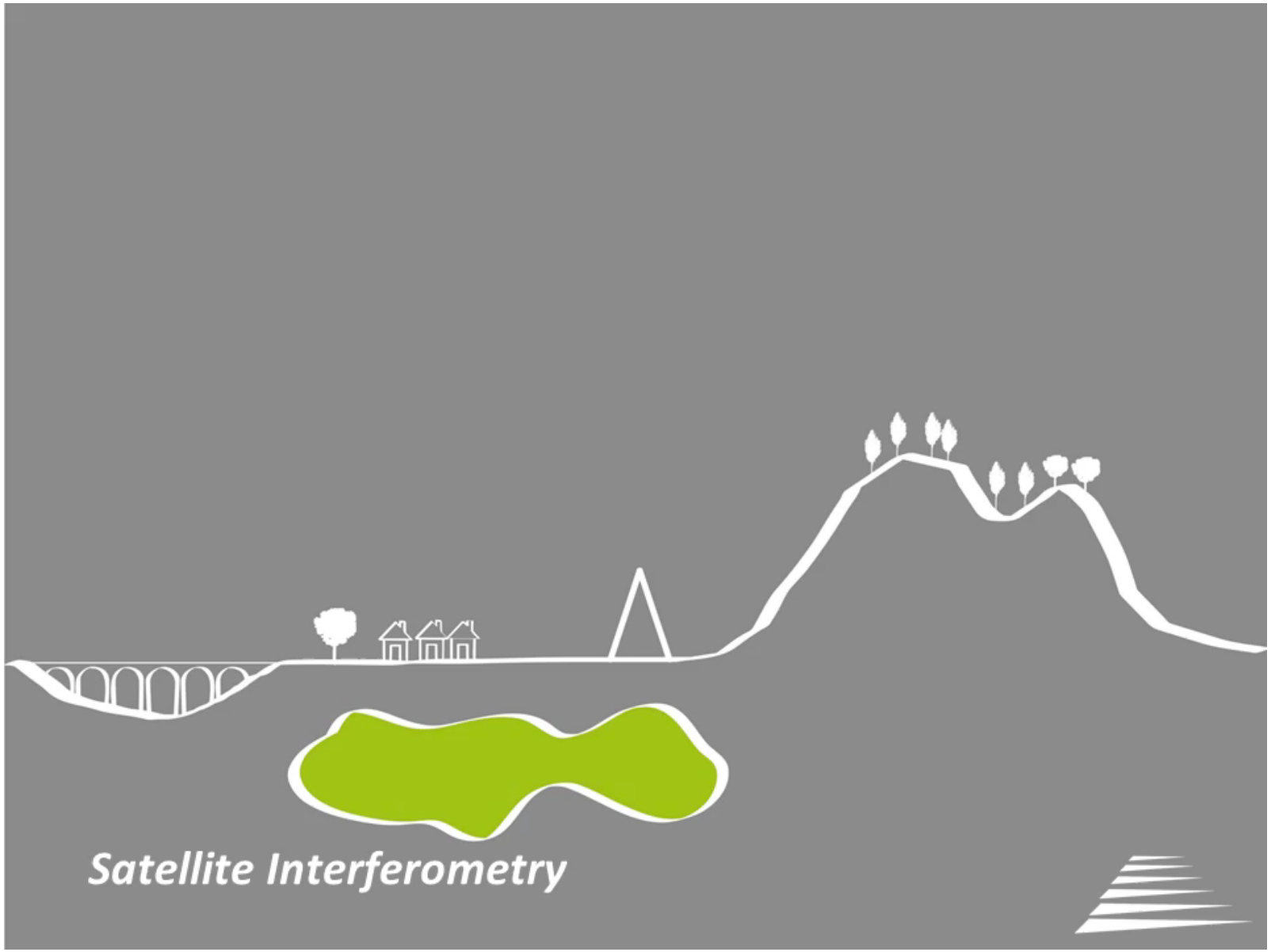
PERIOD:
3th July– 3th September 2013
Monitoring during remediation works for safety



PERIOD:
3th September – 3th November 2013
Check of remediation work results (positive)

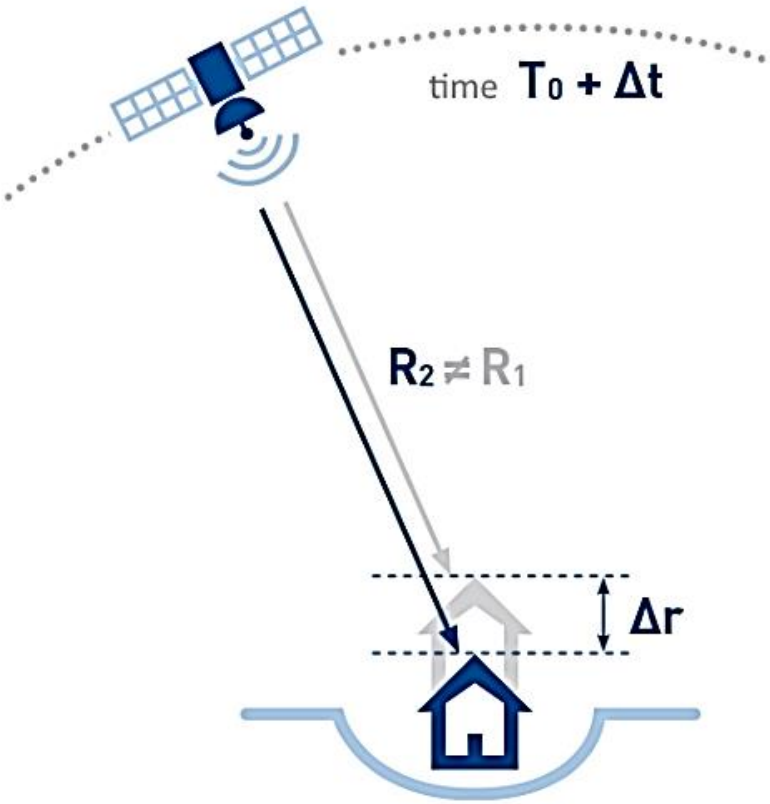


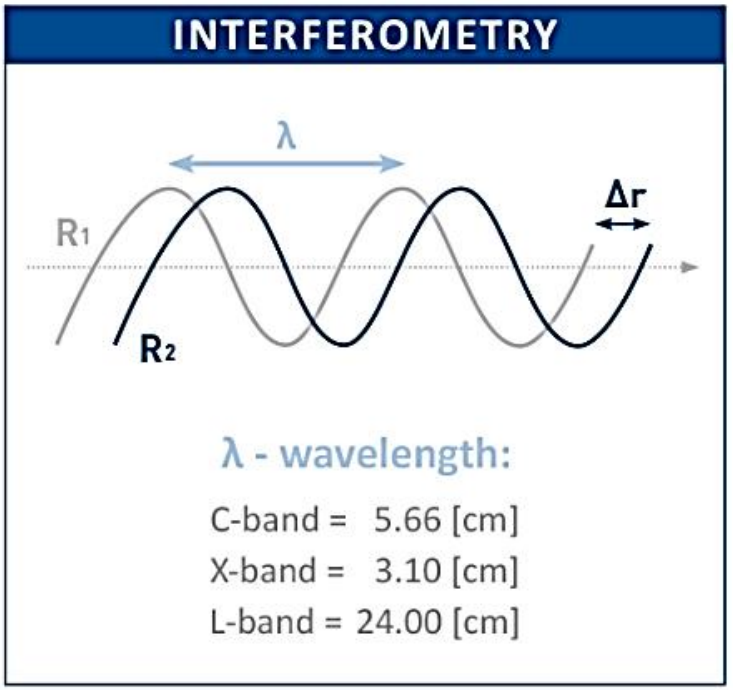
SATELLITE INSAR



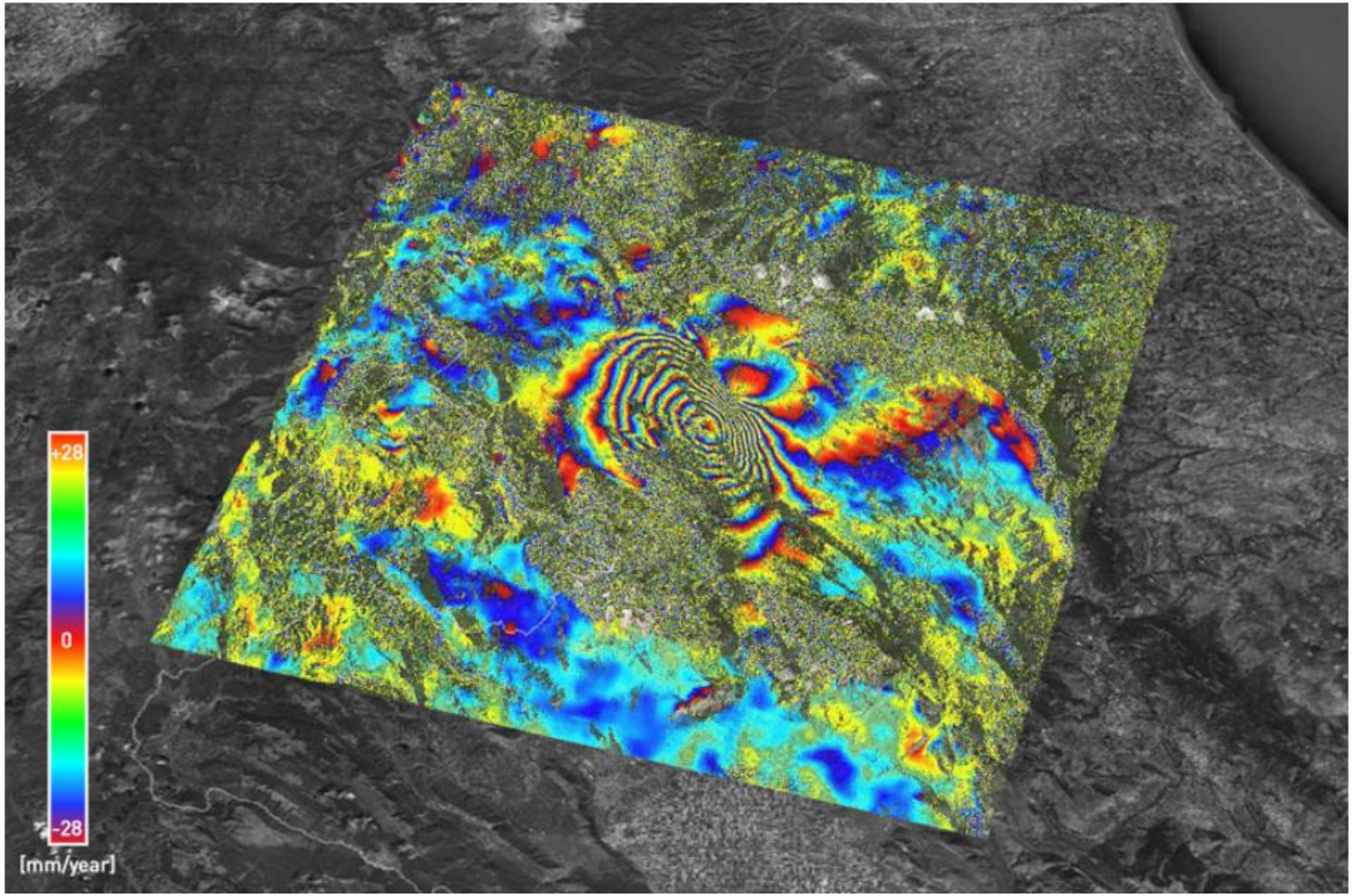
InSAR

Interferometric Synthetic Aperture Radar

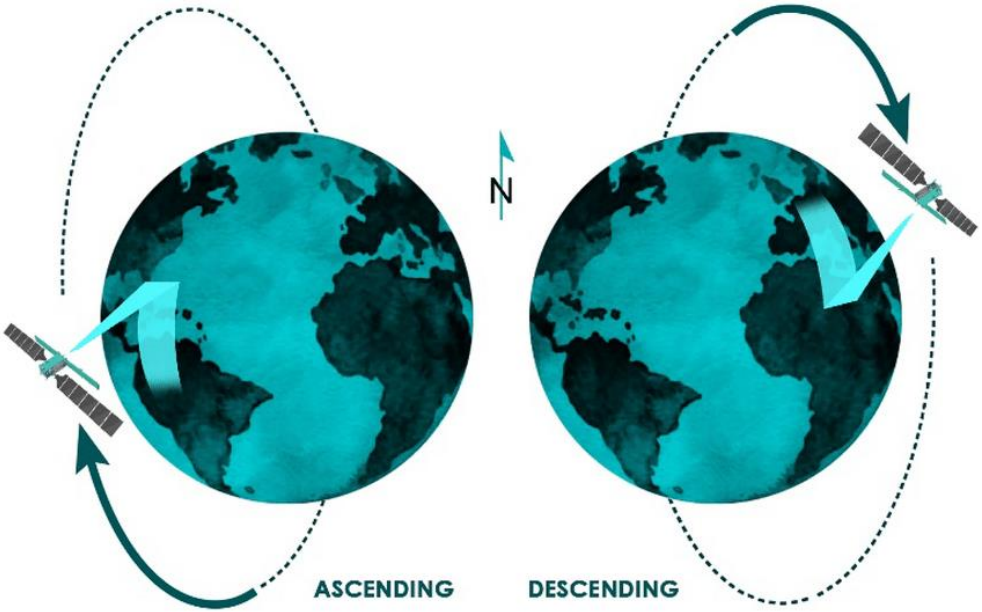


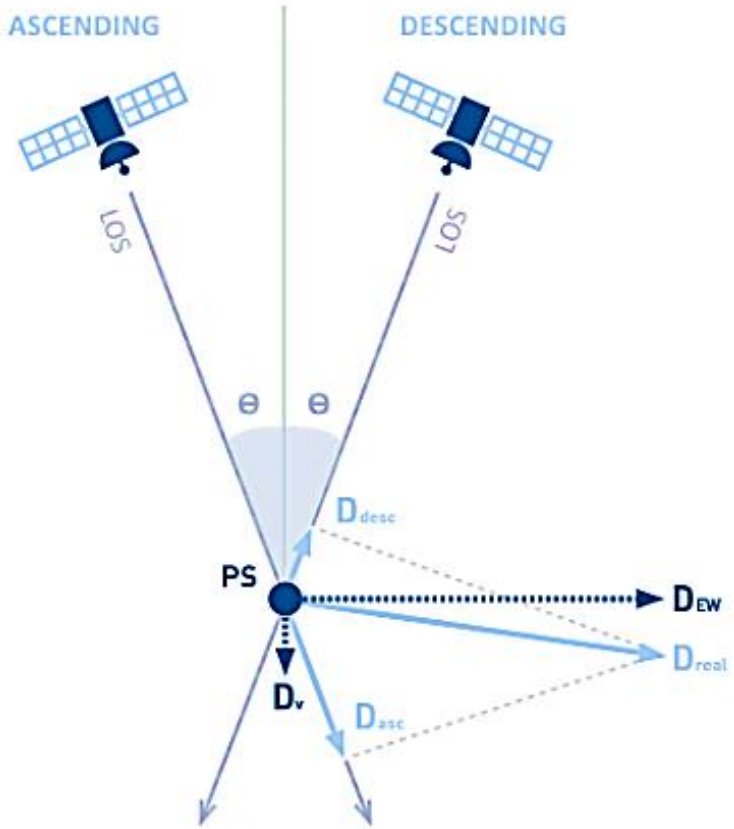


Interferograms



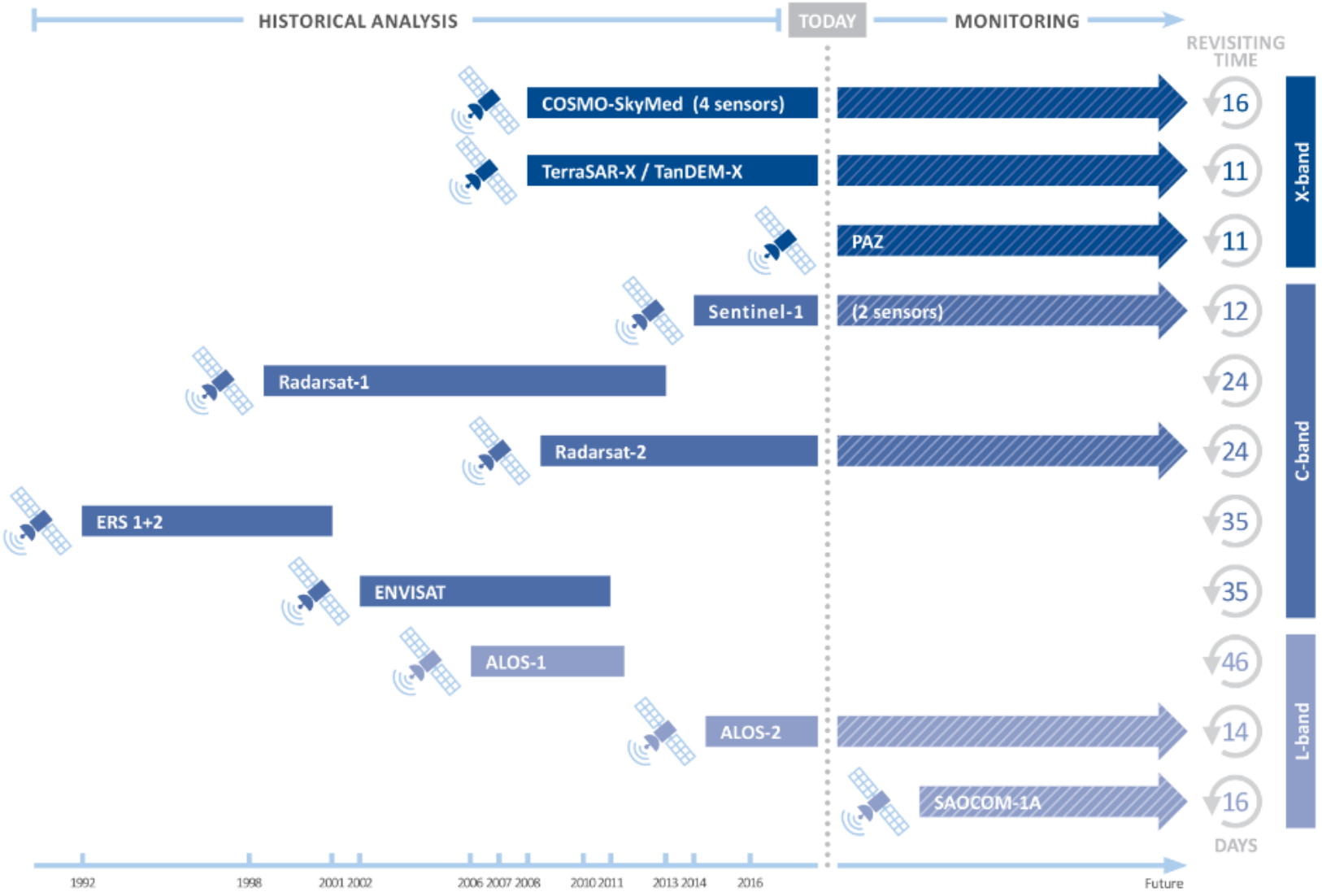
Ascending & Descending Orbits





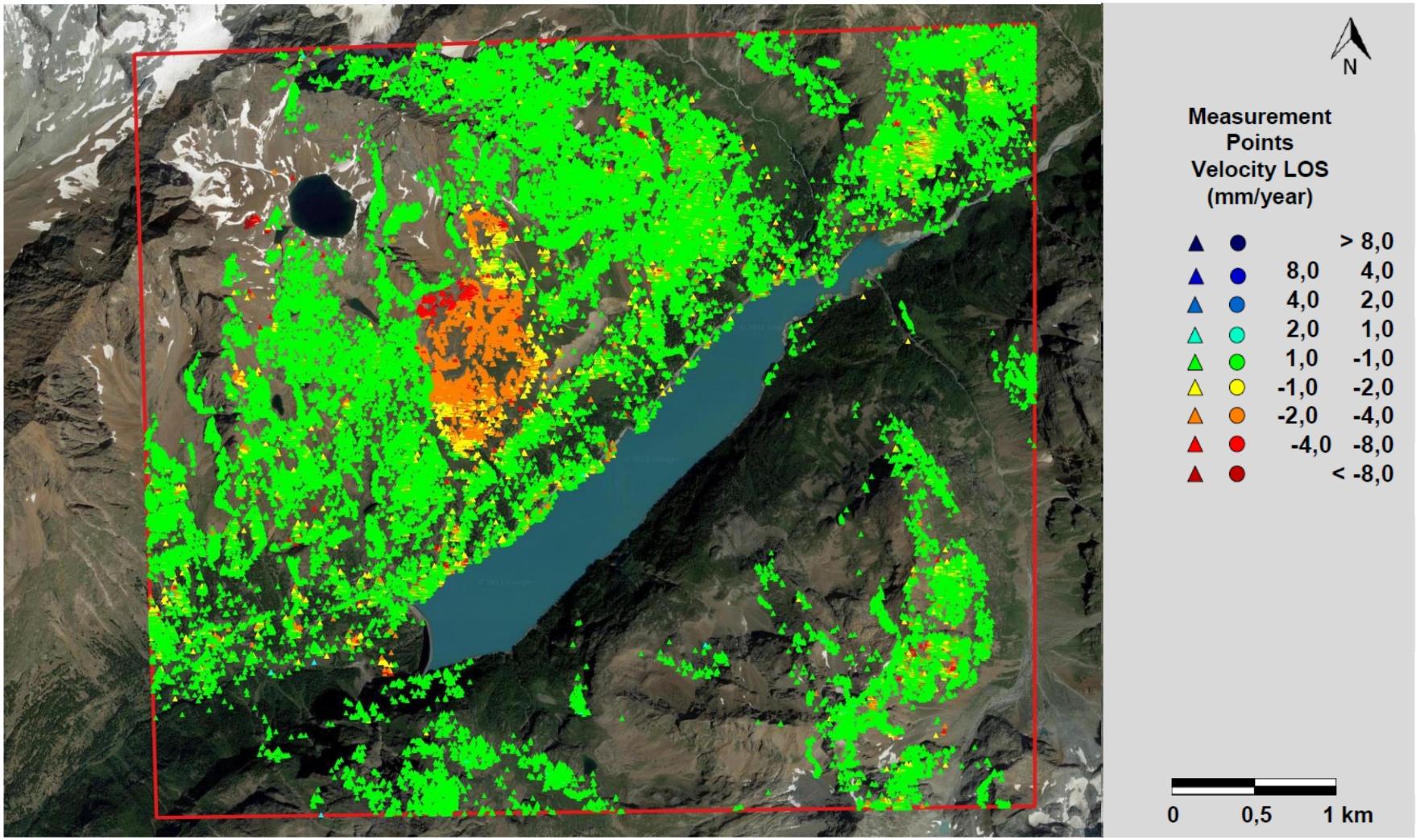
SAR

Satellites

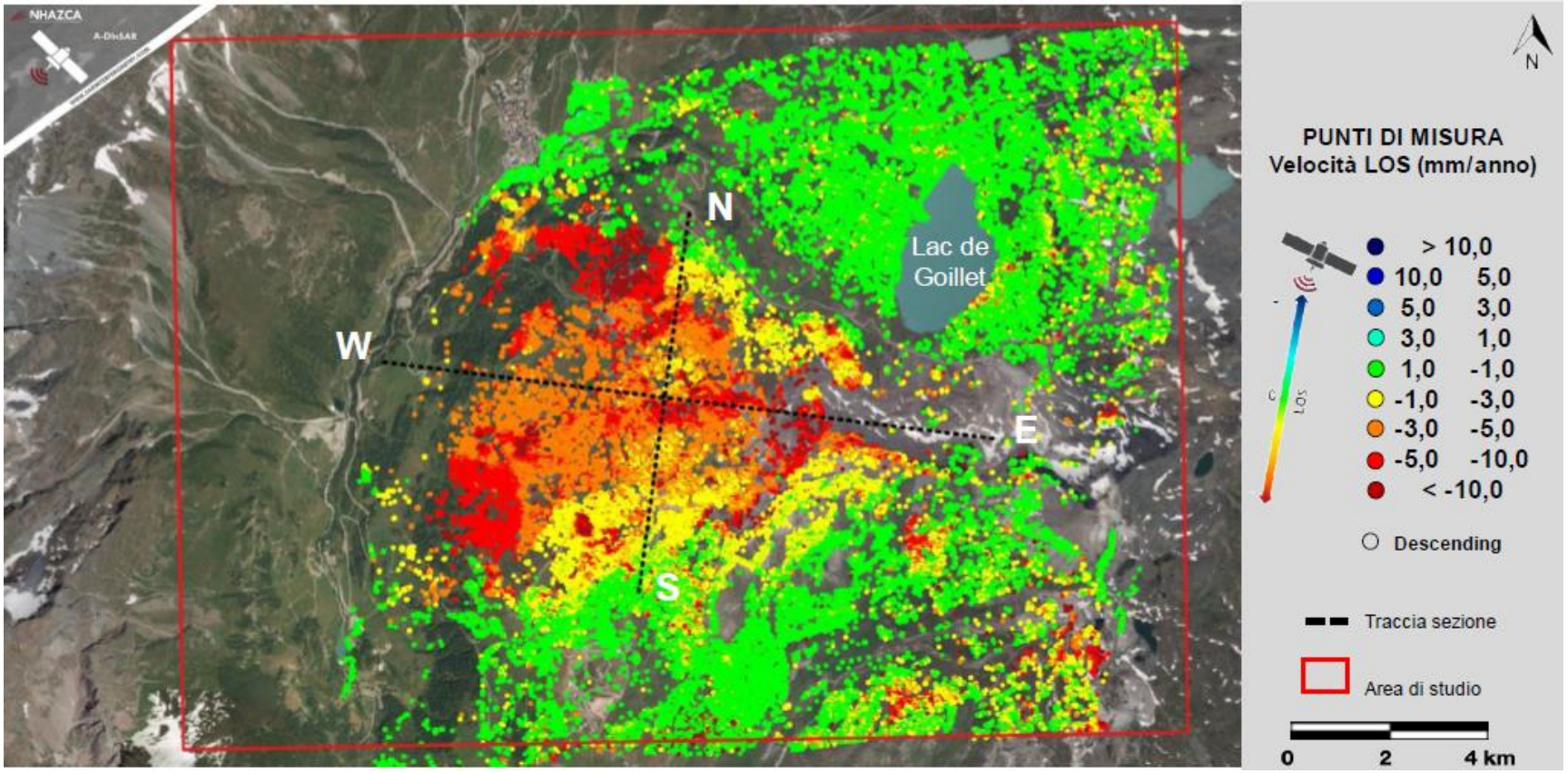


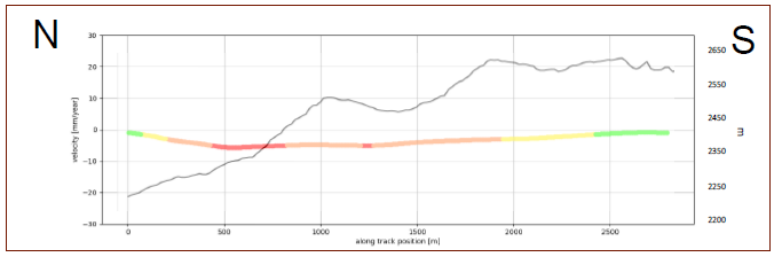
#1 INSAR SCREENING OF SLOPES AROUND DAMS

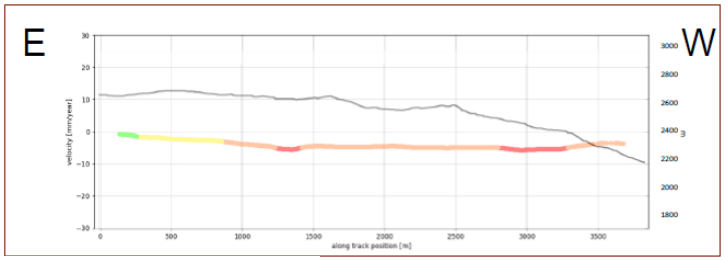
Landslide affecting north-west flank of the dam



#2 Interferometric sections and topographic profile for the analysis of water pipeline





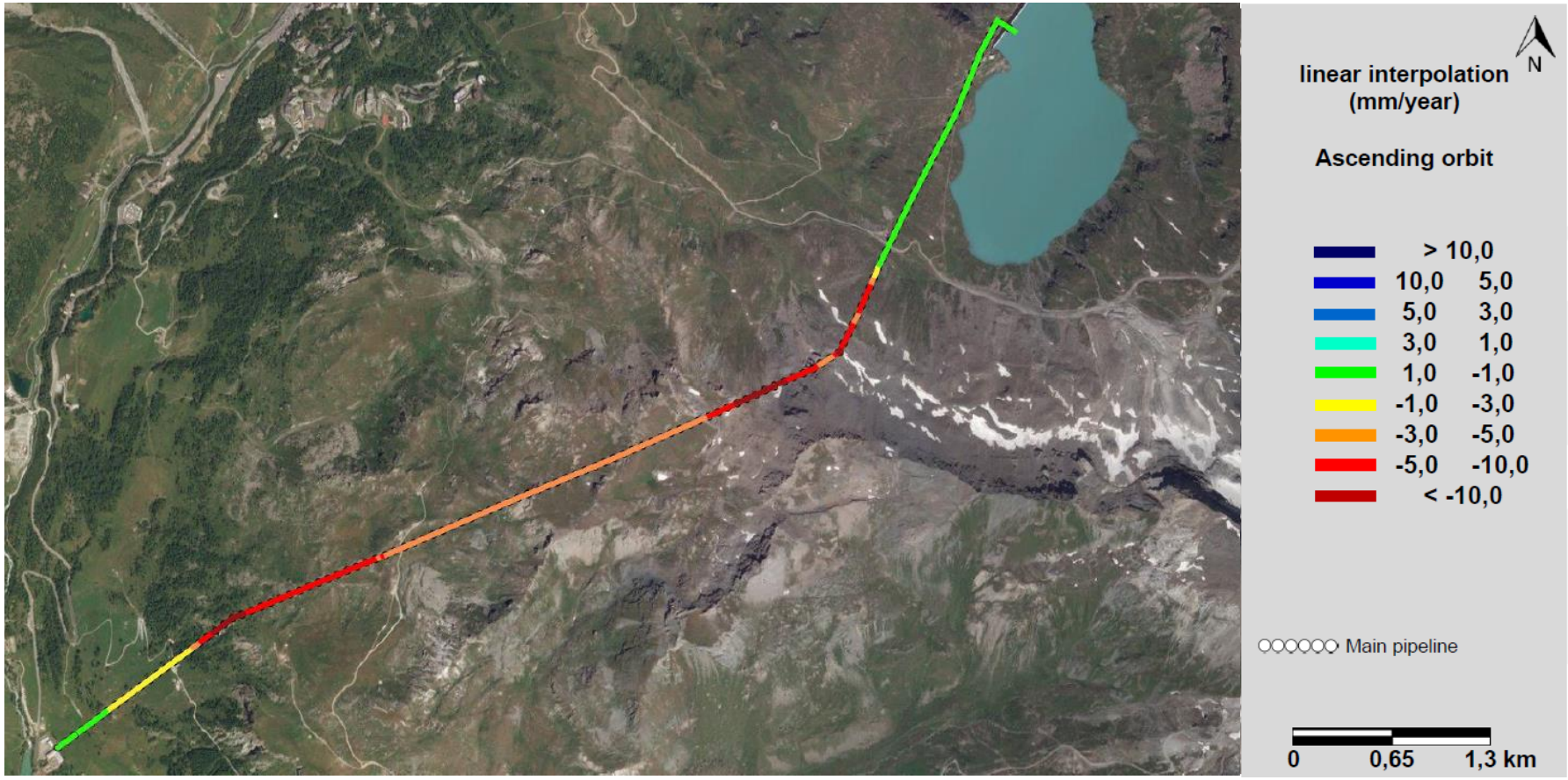


Profilo topografico

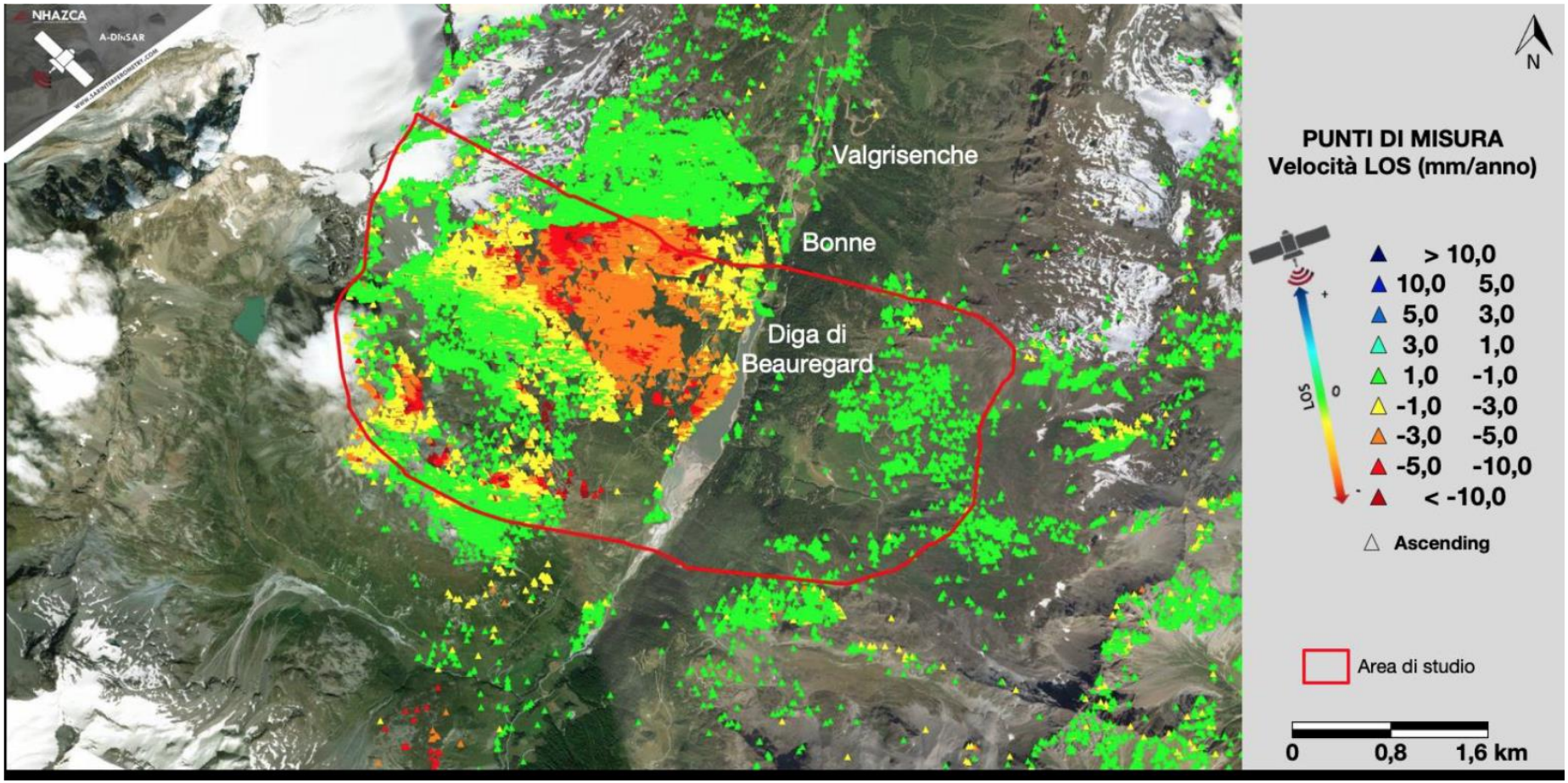
-10,00 mm/anno ±1,00 +10,00 mm/anno

Post-Elaboration:

LINEAR INFRASTRUCTURES

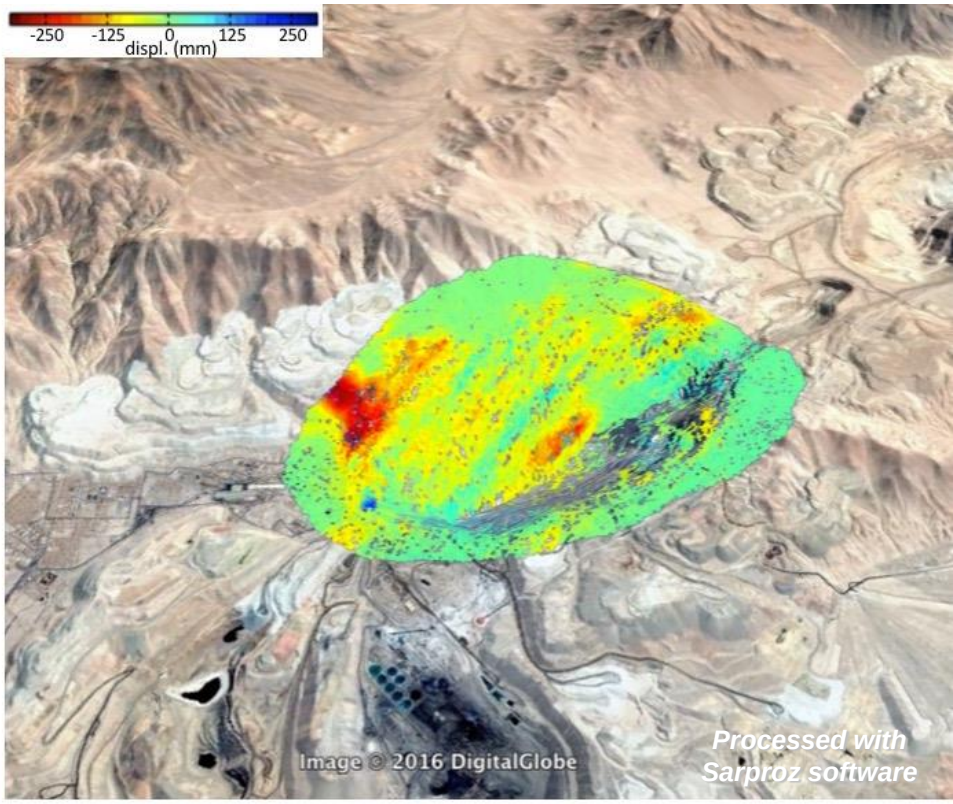


#3 INSAR SCREENING OF SLOPES AROUND DAMS

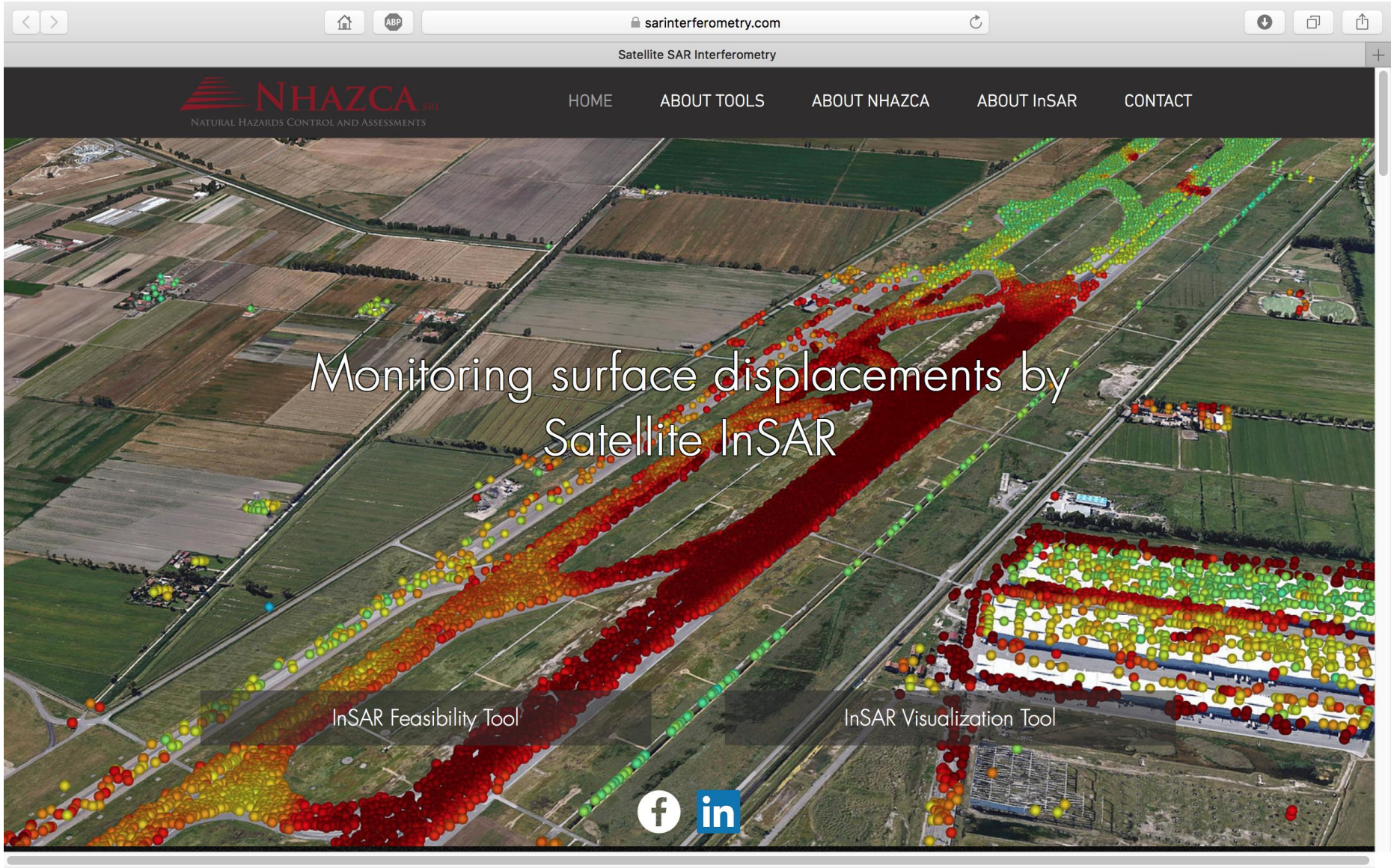


Relevant landslide affecting one of the flank of a dam.
The dam has been demolished and rebuilt in a smaller size!

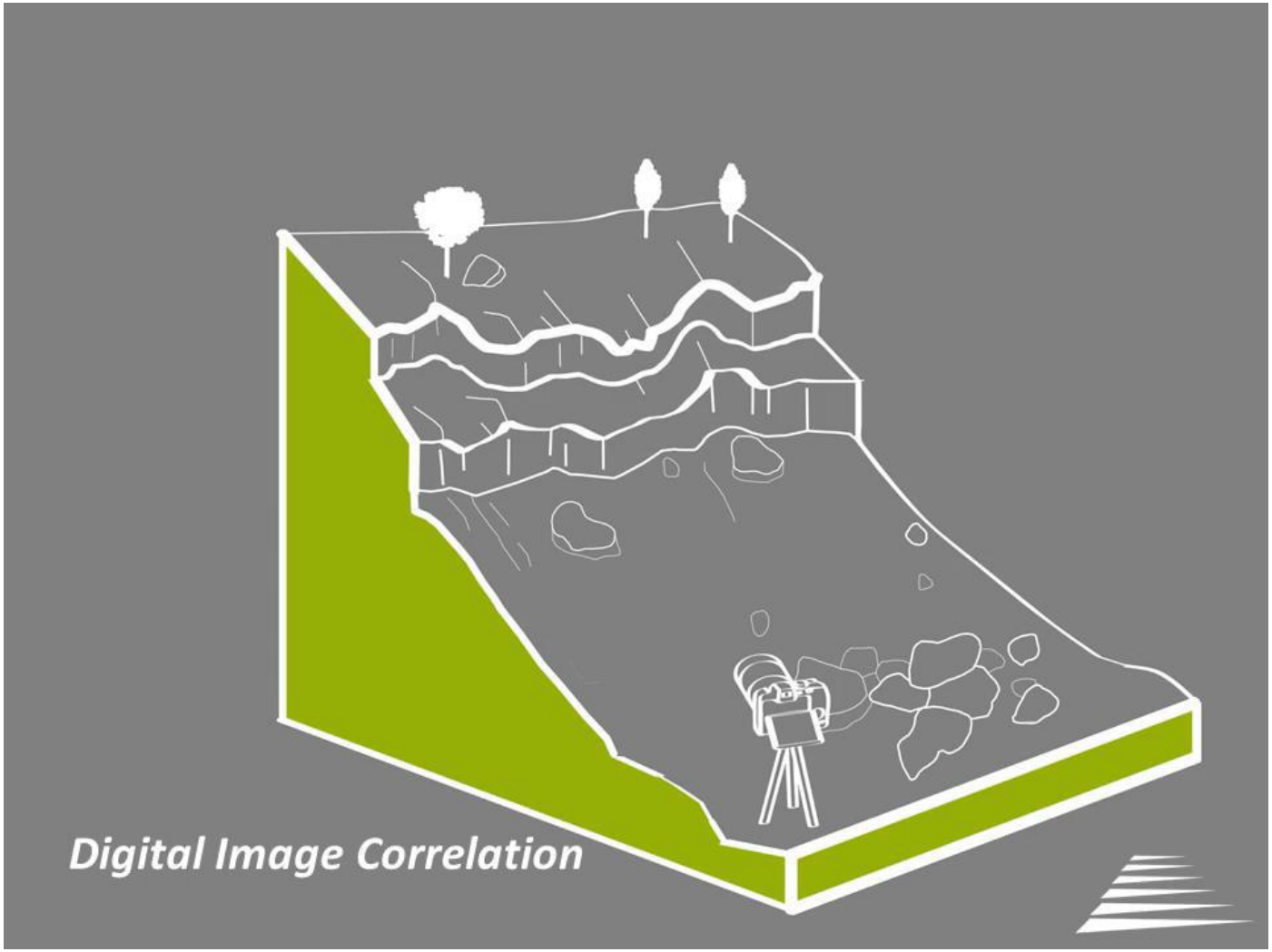
#4 Satellite InSAR results in a mining area



SARINTERFEROMETRY.COM



PHOTOMONITORING



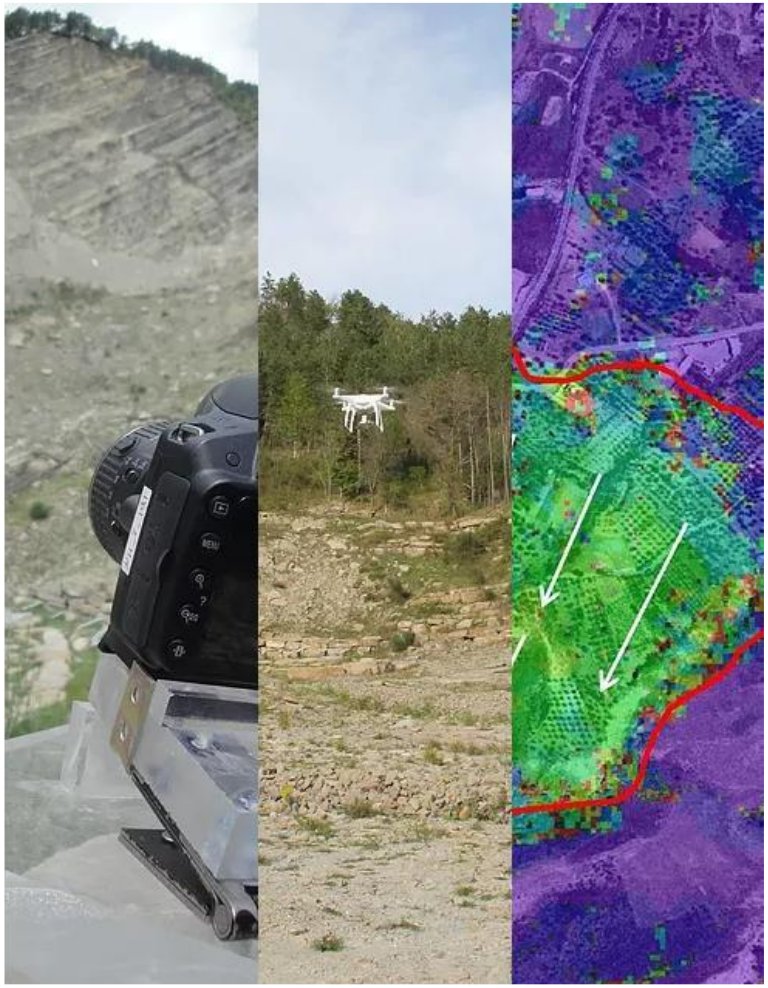
PHOTOMONITORING

Planned to avoid

- Costly and complex sensors
- Difficult data interpretation
- Accidental changes in sensor position

Possible input data

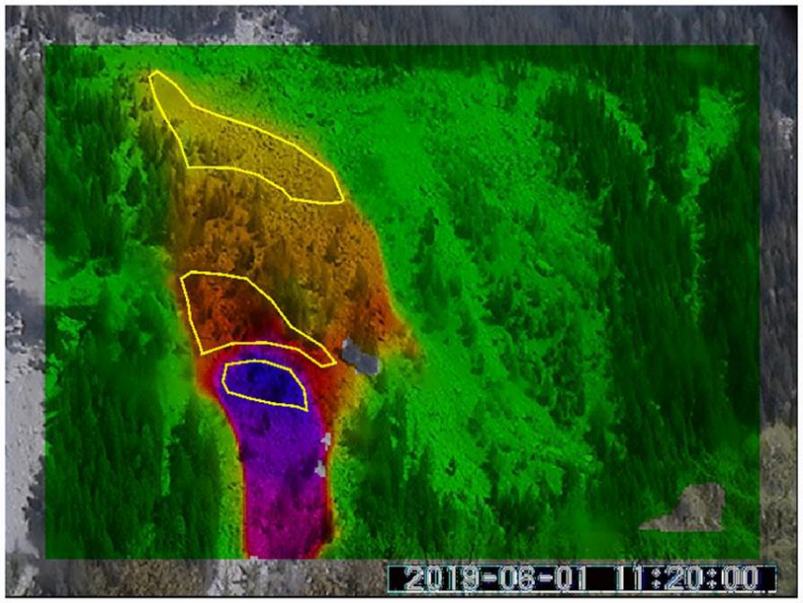
- Ground-based camera
- Drones
- Airborne campaign
- Satellite
- Smartphone



PHOTOMONITORING

Applications

- Landslide displacement monitoring
- Structural monitoring (e.g. bridges, roads)
- Construction sites monitoring
- Flood Mapping
- Monitoring the rock scarp activity



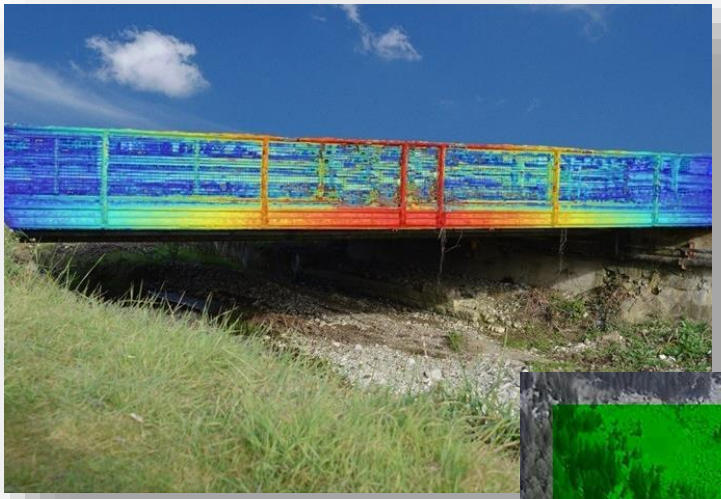
Purposes

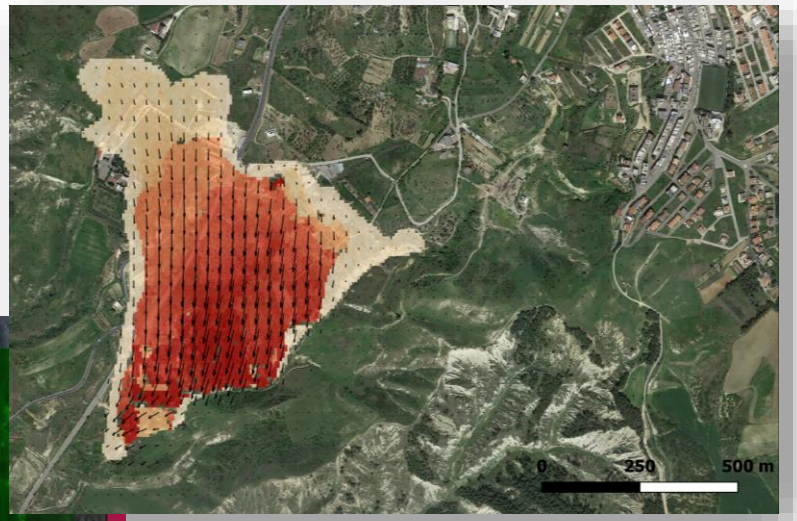
- To characterize,

understand,

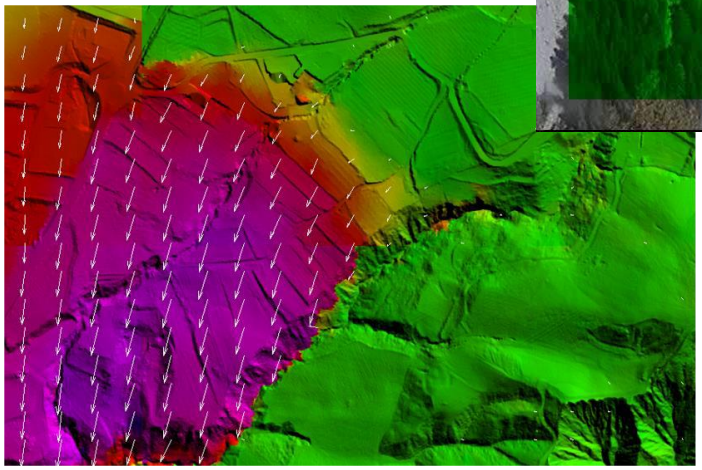
and control

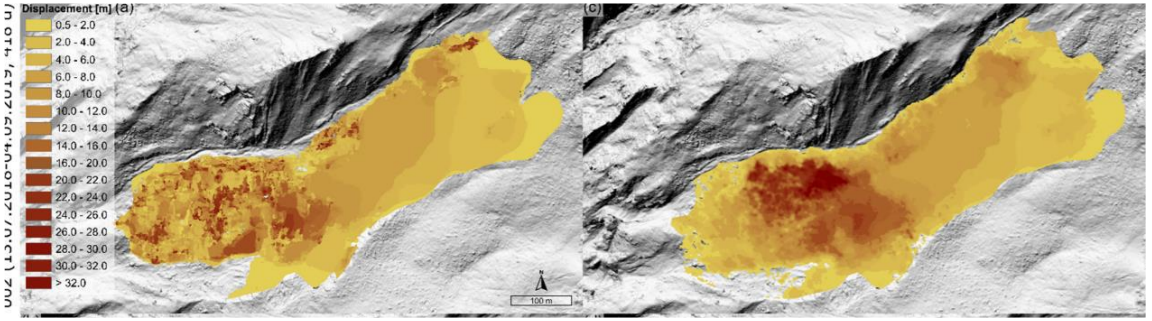
the evolution over time




0
250
500 m

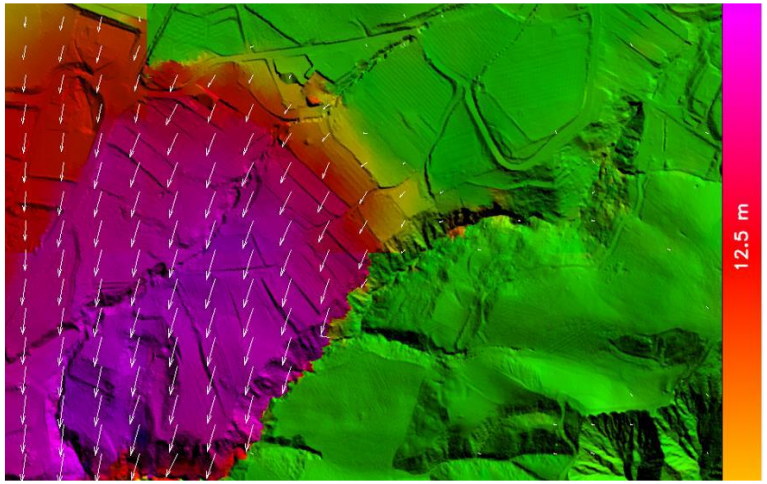

55.0 px
Date: 2019/06/01, 11:20:00

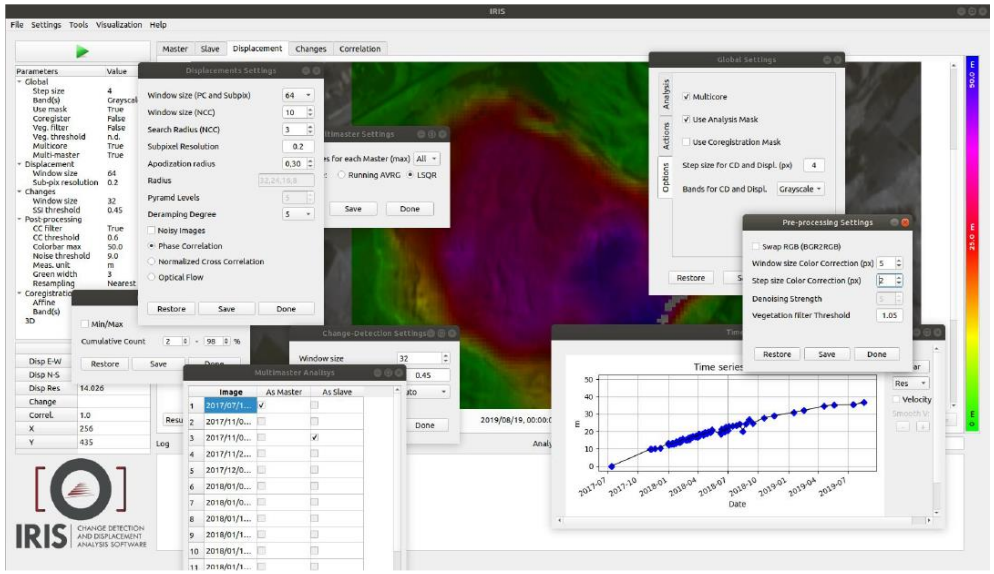


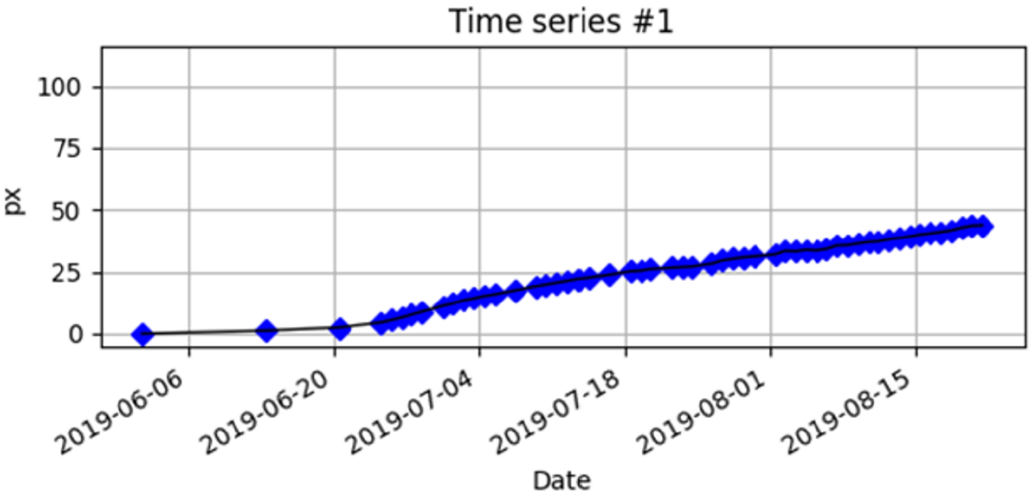

Displacement [m] (a)
0.5 - 2.0
2.0 - 4.0
4.0 - 6.0
6.0 - 8.0
8.0 - 10.0
10.0 - 12.0
12.0 - 14.0
14.0 - 16.0
16.0 - 20.0
20.0 - 22.0
22.0 - 24.0
24.0 - 26.0
26.0 - 28.0
28.0 - 30.0
30.0 - 32.0
> 32.0
100 m
(c)

DISPLACEMENT DETECTION

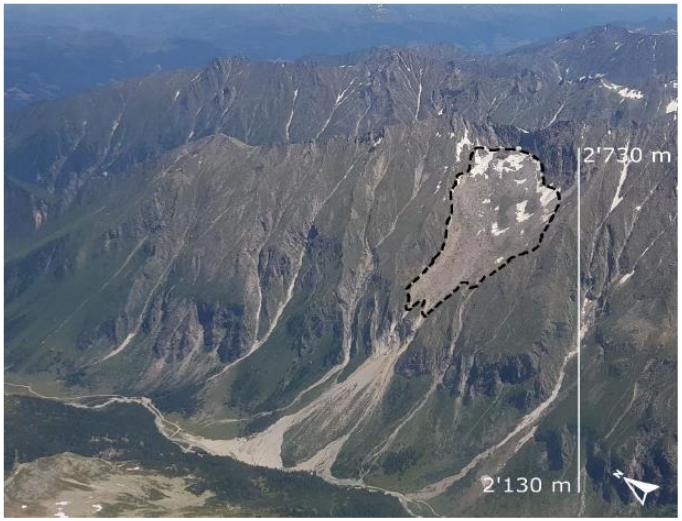
If I analyze more than two images (multimaster analysis) I can extract a time series of the displacement of an area or a point.



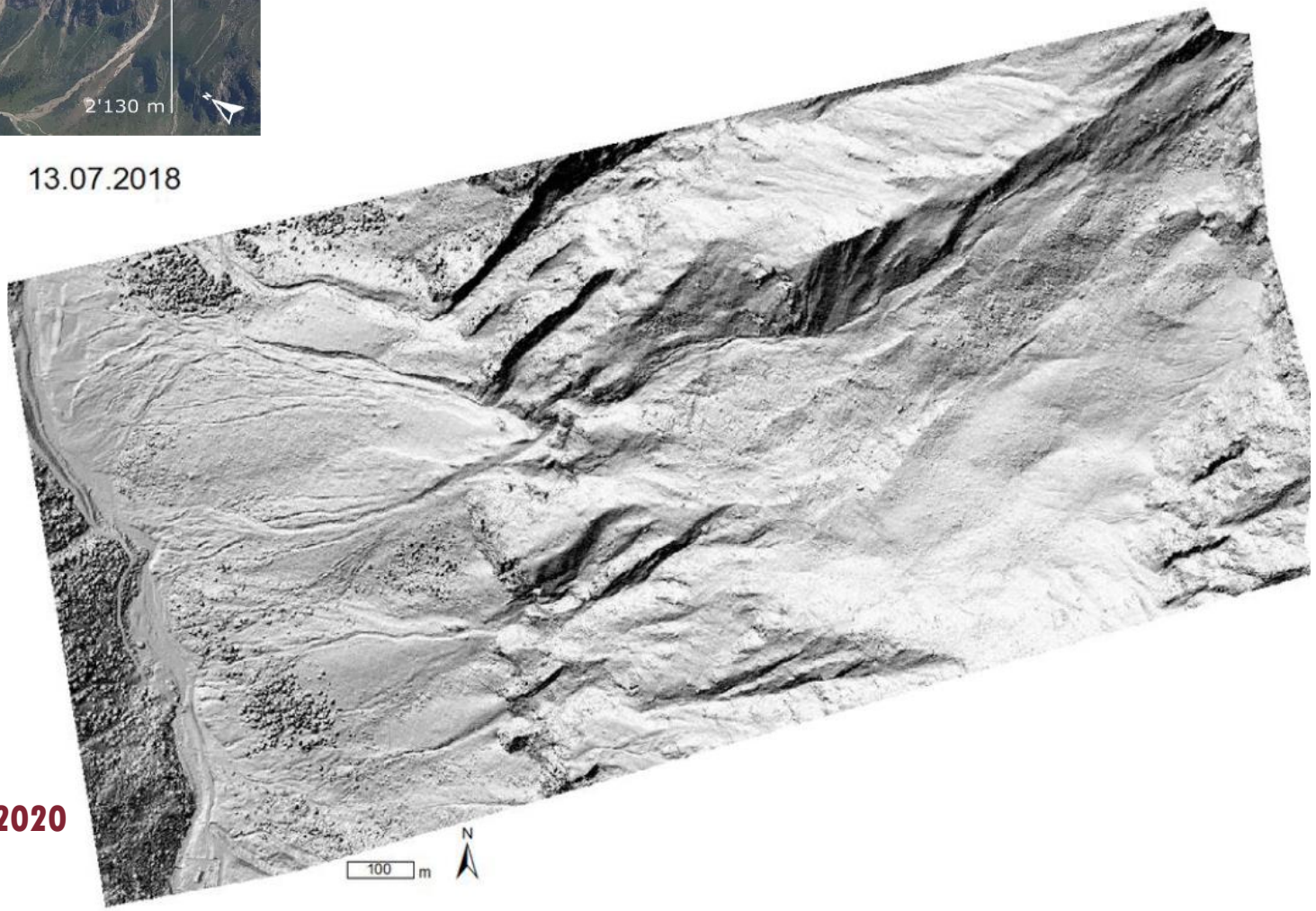




DRONE-BASED APPLICATIONS

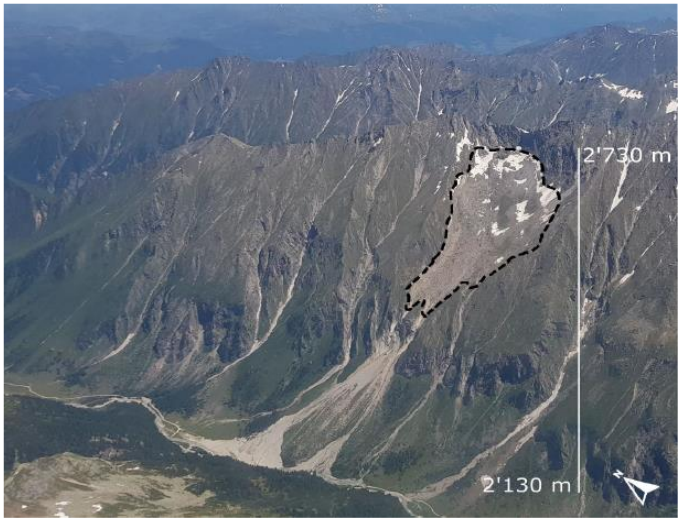


SATTELKAR, AUSTRIA



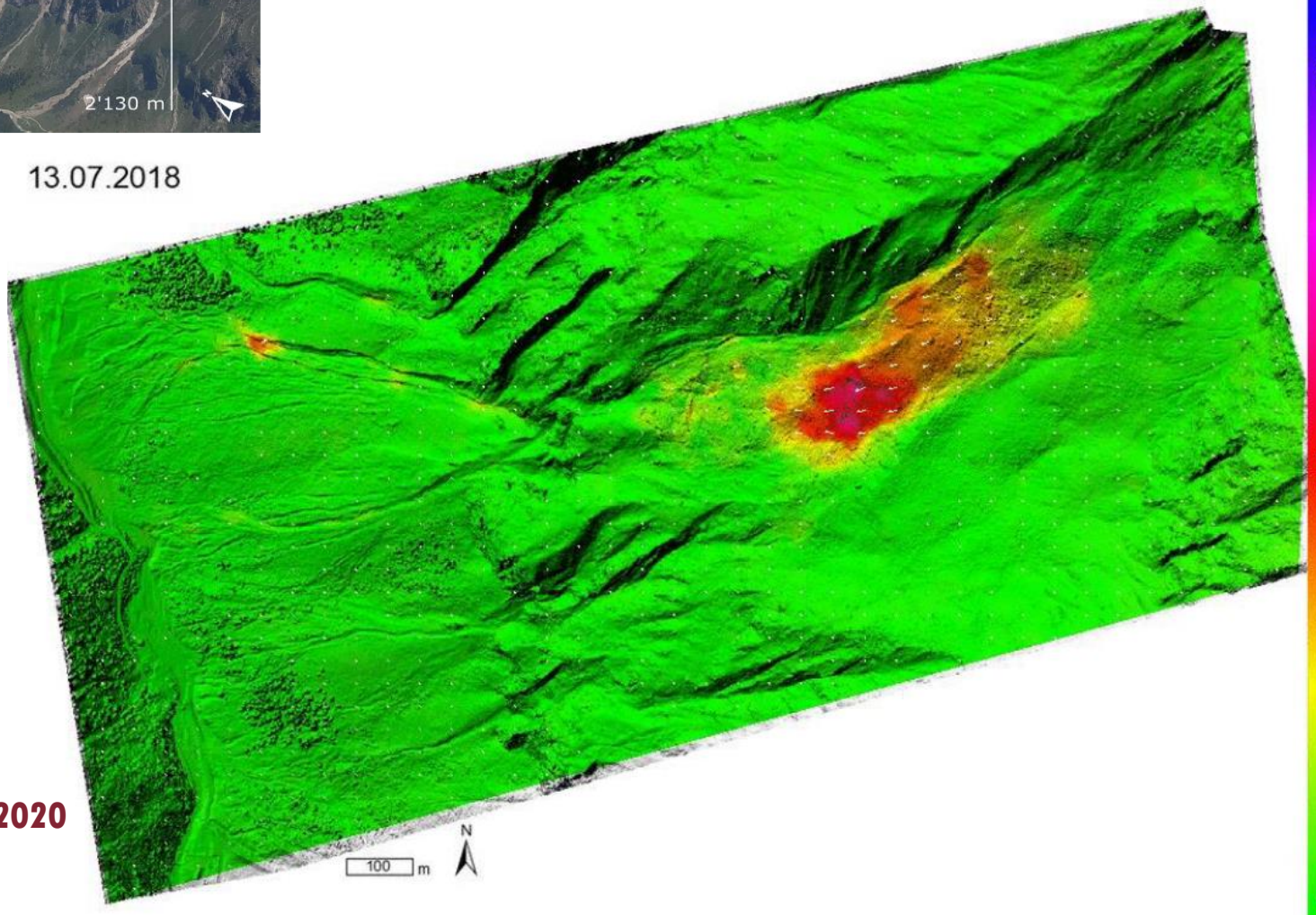
UAS ORTHOIMAGES
Resolution: 0.16 m
13/07/2018 – 11/09/2020

DRONE-BASED APPLICATIONS



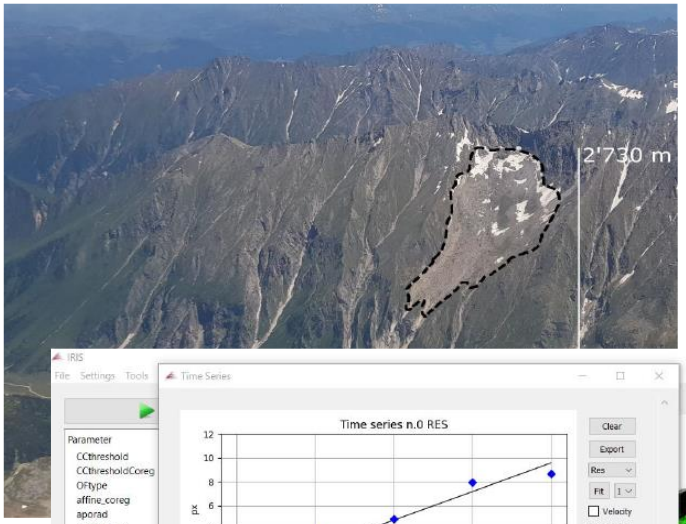
SATTELKAR, AUSTRIA

13.07.2018



UAS ORTHOIMAGES
Resolution: 0.16 m
13/07/2018 – 11/09/2020

DRONE-BASED APPLICATIONS



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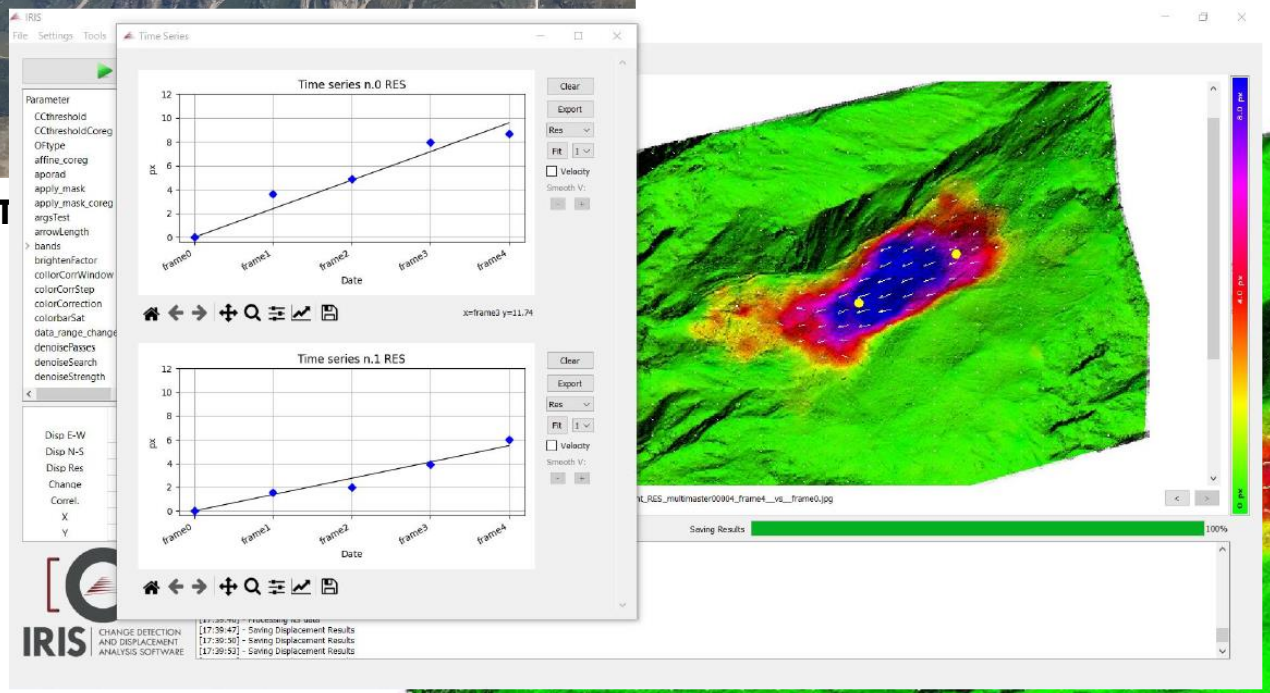


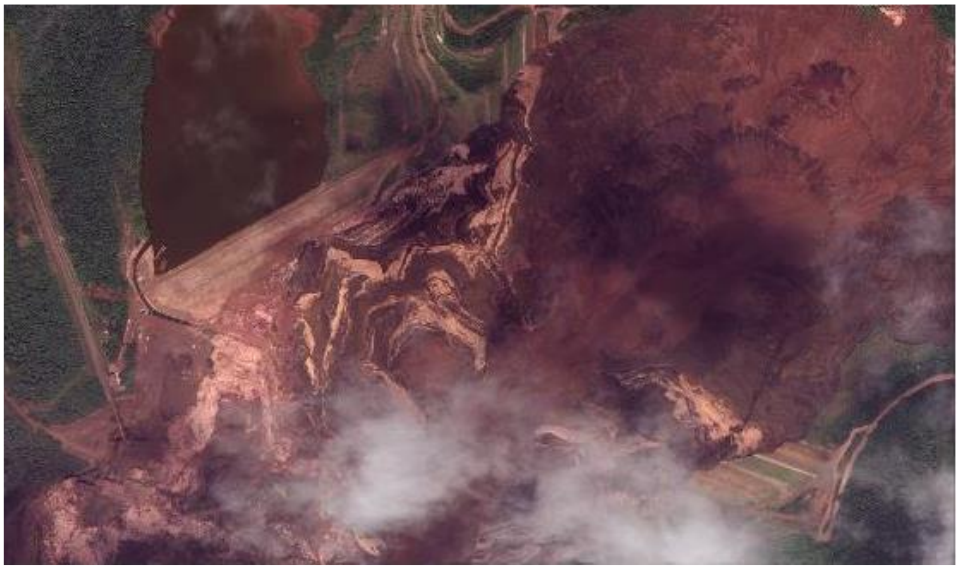
UAS ORTHOIMAGES
Resolution: 0.16 m
13/07/2018 – 11/09/2020

GROUND-BASED APPLICATIONS

BRUMADINHO (BRASIL)
TAILING DAM COLLAPSE
DISPLACEMENT ANALYSIS

SURVEILLANCE CAMERA
DISPLACEMENT MAP
25/01/2019

GROUND-BASED APPLICATIONS



BRUMADINHO (BRASIL)
TAILING DAM COLLAPSE
DISPLACEMENT ANALYSIS

SURVEILLANCE CAMERA
DISPLACEMENT MAP
25/01/2019

SATELLITE-BASED APPLICATIONS

AREQUIPA LANDSLIDE DISPLACEMENT ANALYSIS (PERU)

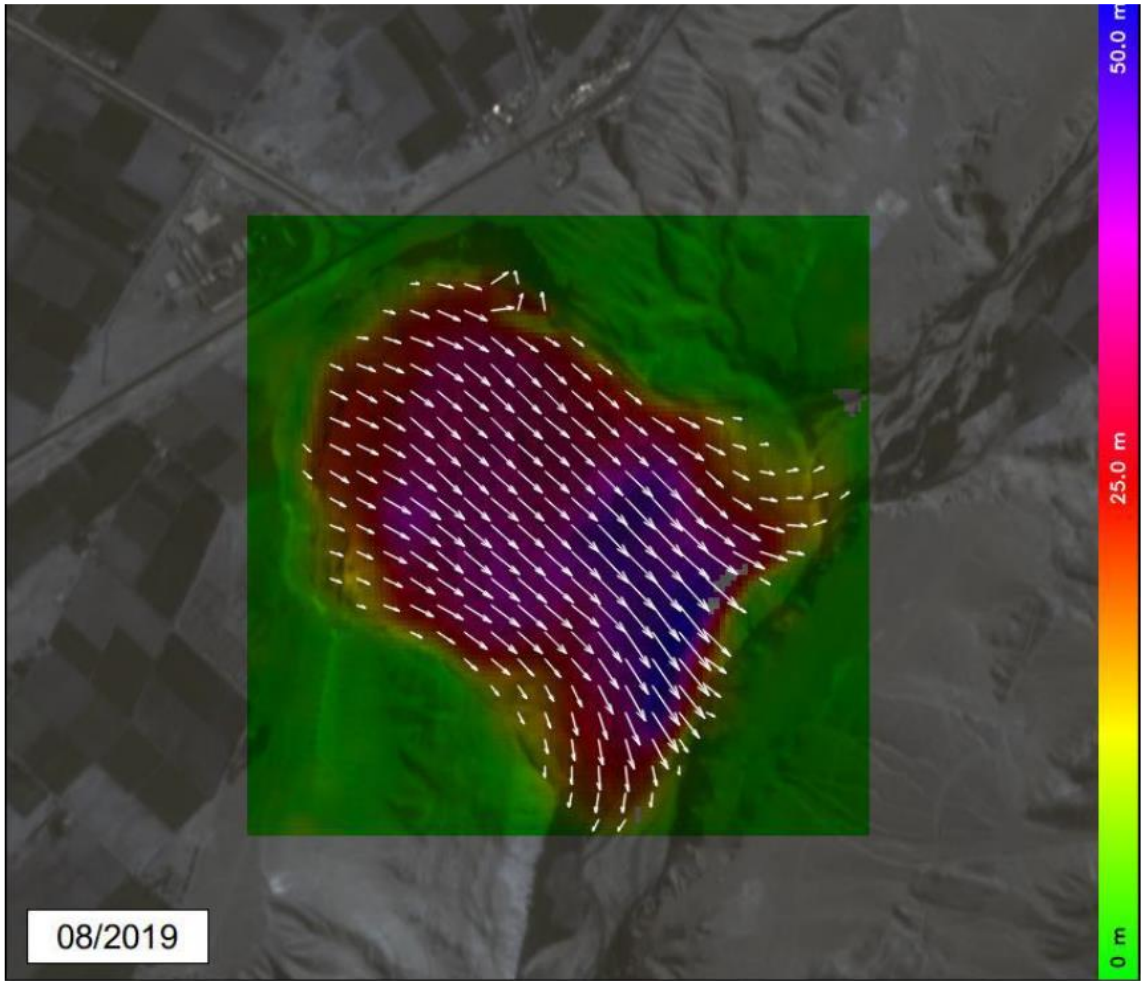
PLANETSCOPE OPTICAL SATELLITE IMAGES

High Resolution: 3x3 meters DISPLACEMENT MAP

11/2017 – 08/2019

SATELLITE-BASED APPLICATIONS

AREQUIPA LANDSLIDE DISPLACEMENT ANALYSIS (PERU)



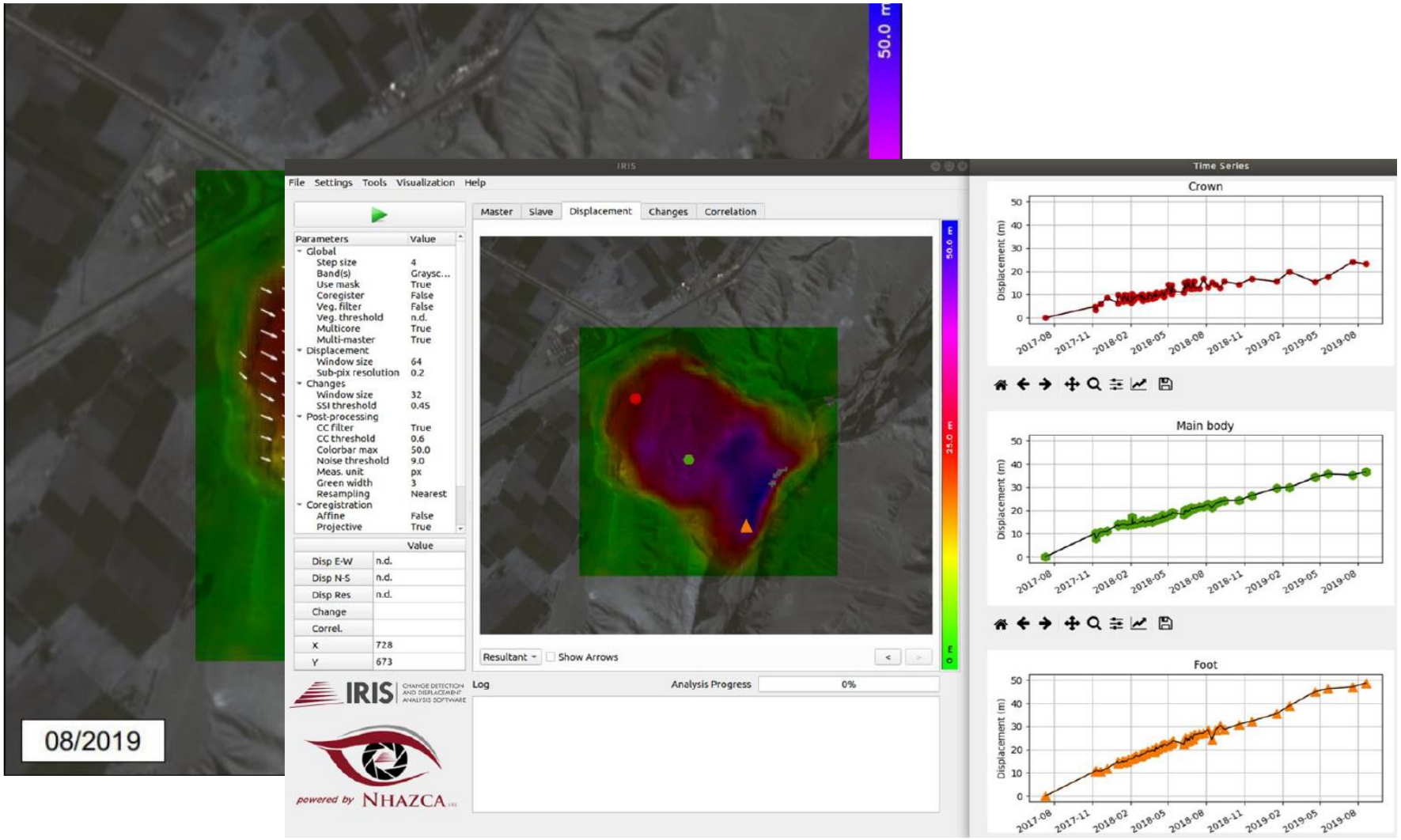
PLANETSCOPE OPTICAL SATELLITE IMAGES

High Resolution: 3x3 meters DISPLACEMENT MAP

11/2017 – 08/2019

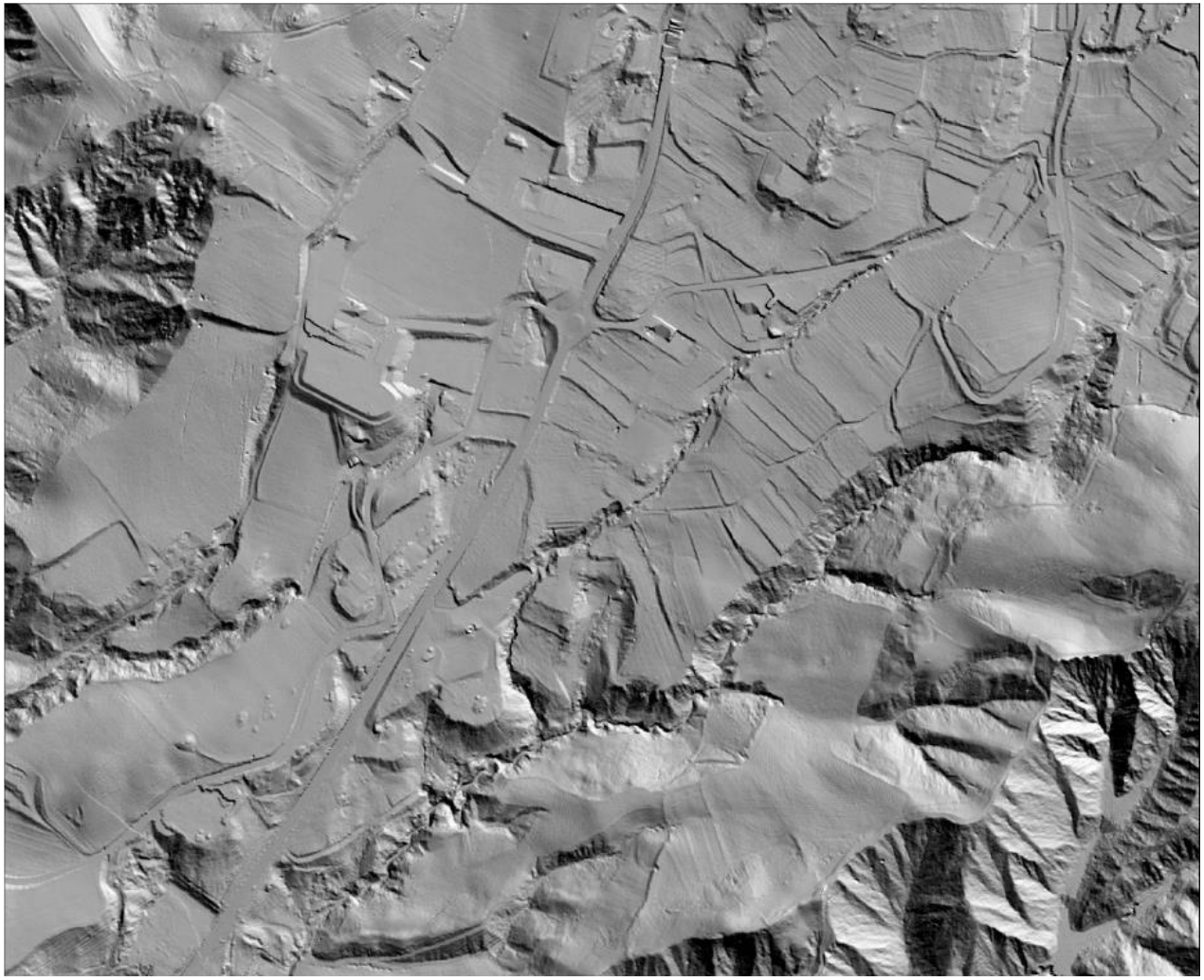
SATELLITE-BASED APPLICATIONS

AREQUIPA LANDSLIDE DISPLACEMENT ANALYSIS (PERU)



AIRBORNE-BASED APPLICATIONS

MONTESCAGLIOSO LANDSLIDE DISPLACEMENT ANALYSIS (ITALY)



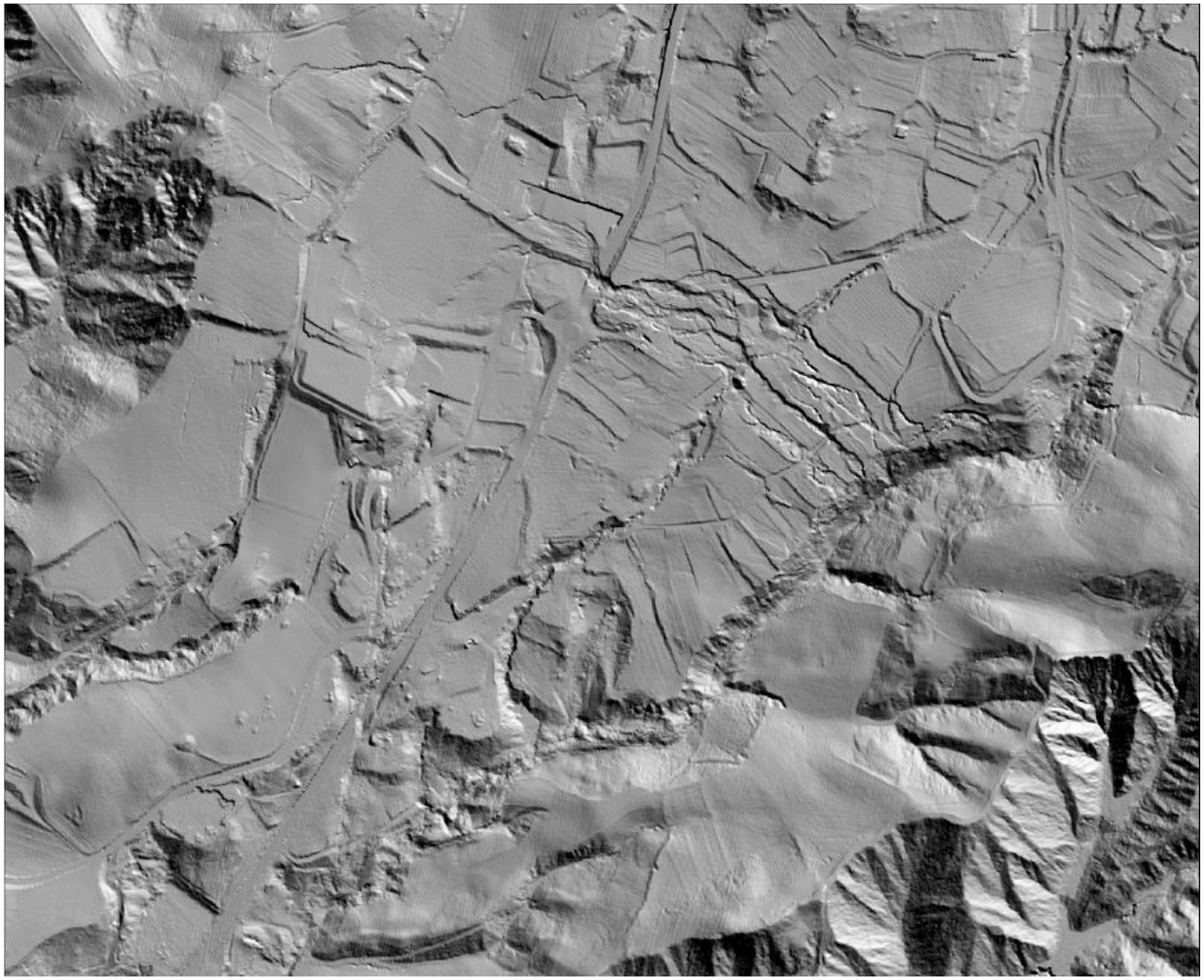
AIRBORNE LIDAR DTM

Resolution:

1x1 meter

AIRBORNE-BASED APPLICATIONS

MONTESCAGLIOSO LANDSLIDE DISPLACEMENT ANALYSIS (ITALY)



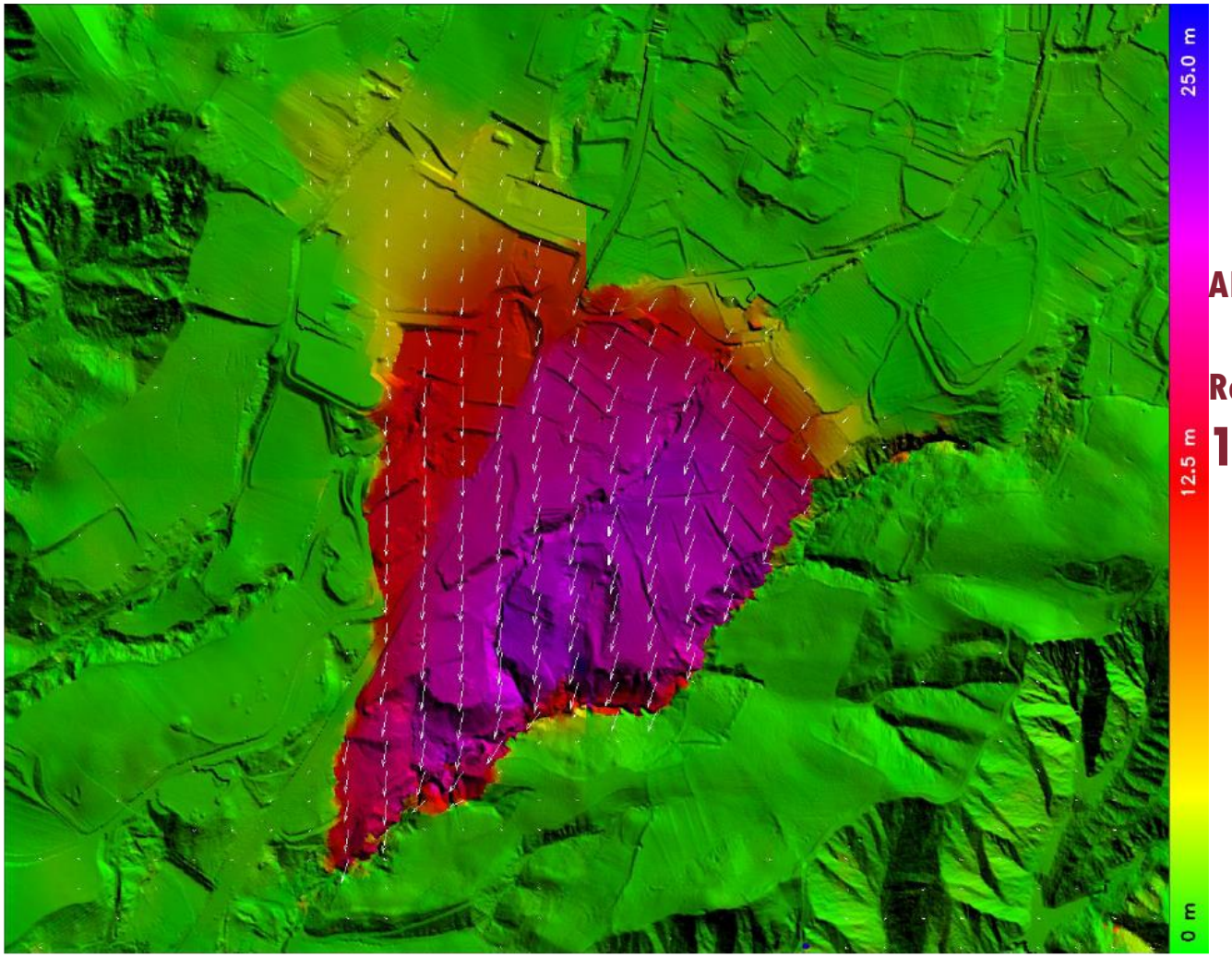
AIRBORNE LIDAR DTM

Resolution:

1x1 meter

AIRBORNE-BASED APPLICATIONS

MONTESCAGLIOSO LANDSLIDE DISPLACEMENT ANALYSIS (ITALY)

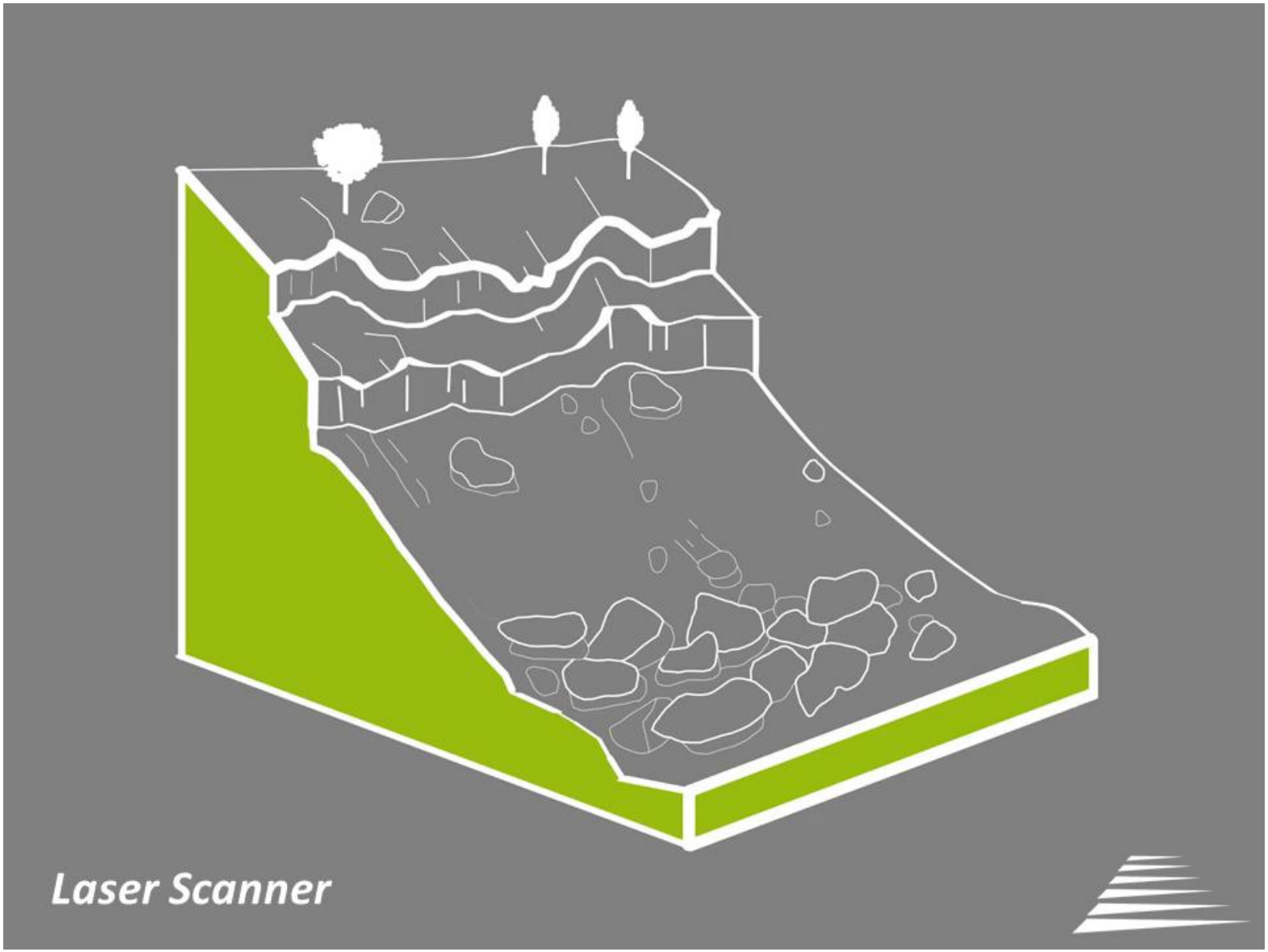


AIRBORNE LIDAR DTM

Resolution:

1x1 meter

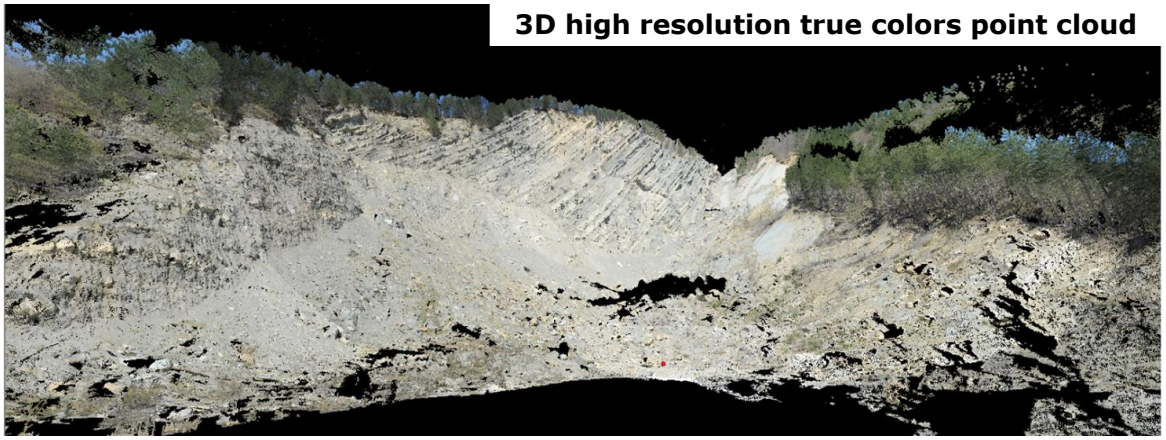
LASER SCANNER



LASER SCANNER

3D surveying and periodical monitoring

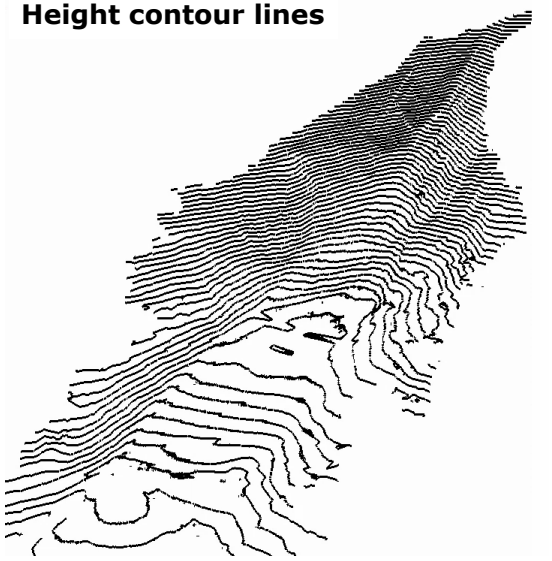
COLLECTED DATA



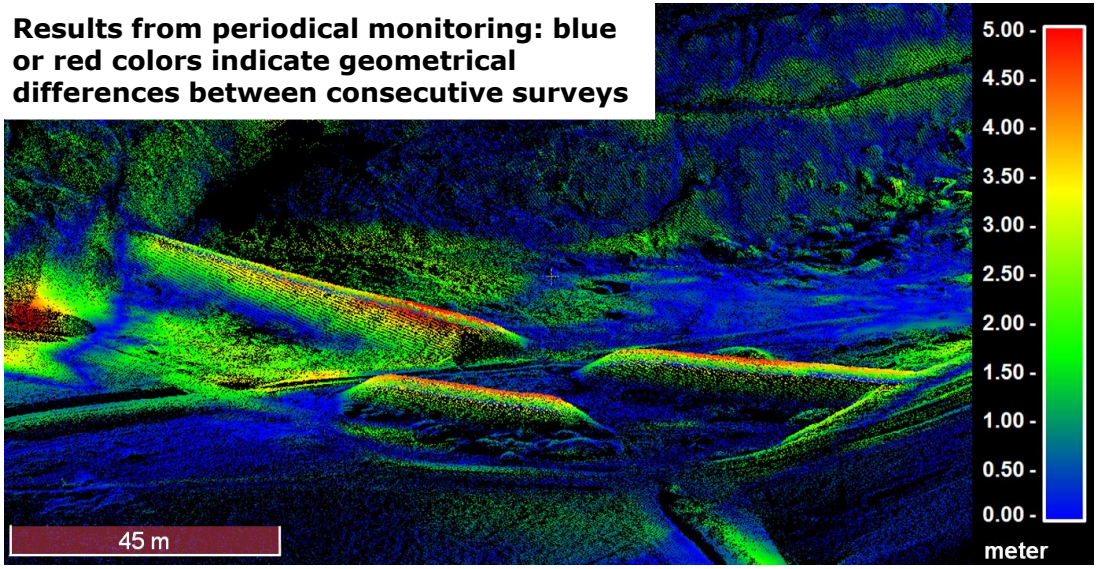
3D high resolution true colors point cloud

ACHIEVED RESULTS

Height contour lines

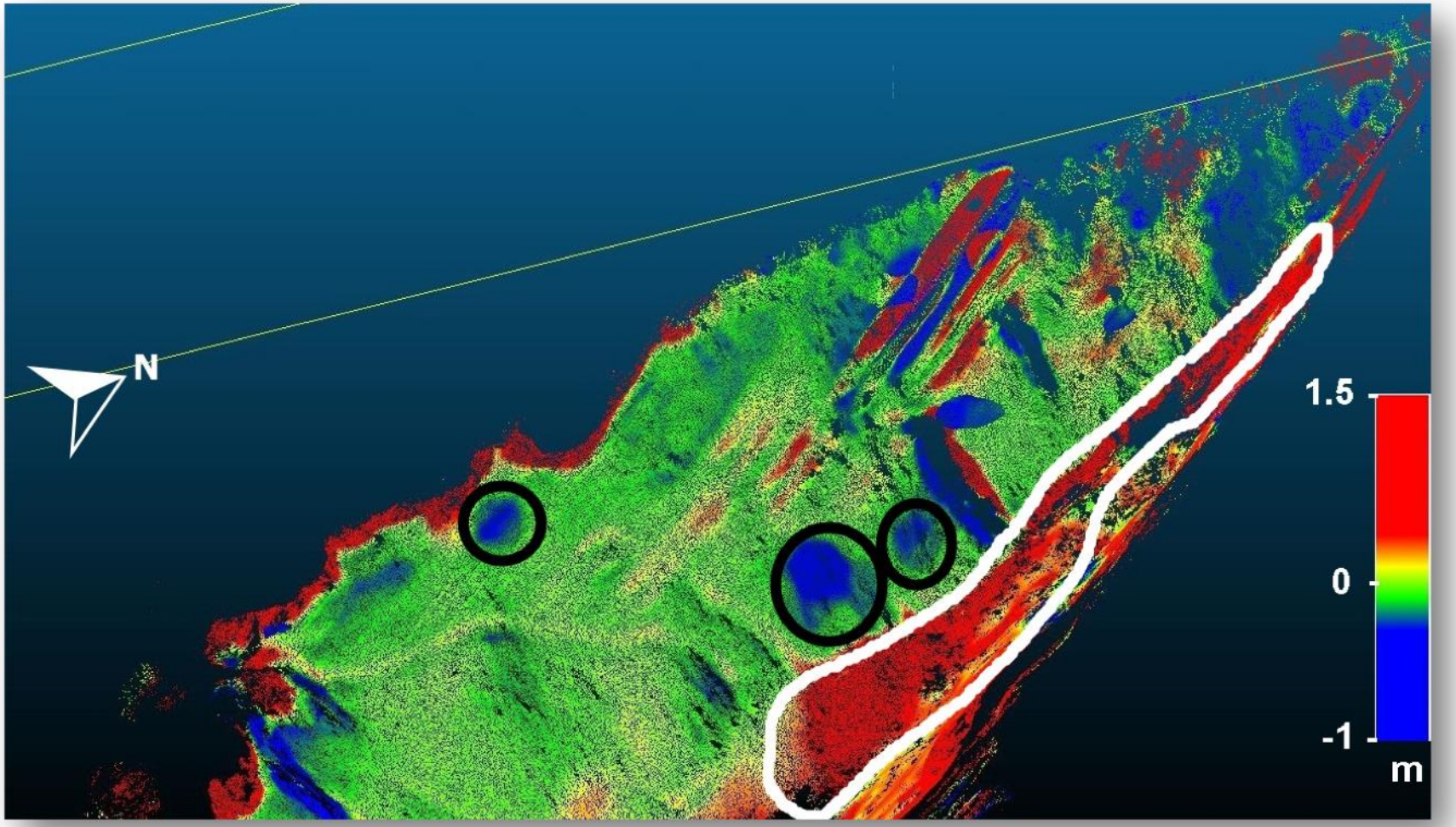


Results from periodical monitoring: blue or red colors indicate geometrical differences between consecutive surveys



LASER SCANNER

3D surveying and periodical monitoring



Comparison between 3D models acquired in different time (2015-2016)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