

Disastrous landslides under changing forcing factors triggered end 2019 in West Kenya

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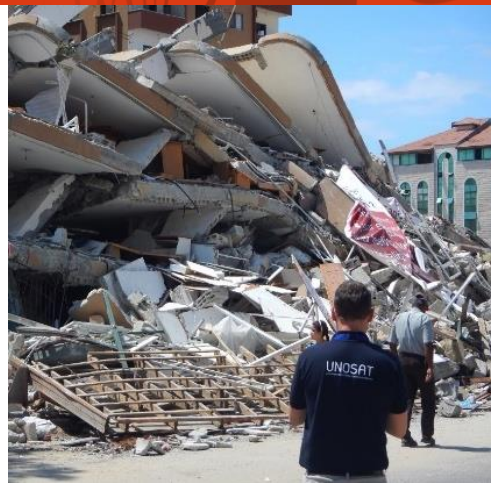
 Ecole et Observatoire
des Sciences de la Terre



 General
Assembly 2020

Outline


- Natural hazards in Kenya
- Humanitarian Rapid Mapping Service
 - International Response
 - Case of West Pokot in December 2019
- Satellite Imagery Analysis
 - International Charter (UNOSAT)
 - Geohazard Exploitation Platform (GEP/ALADIM)
- Discussion and Conclusion

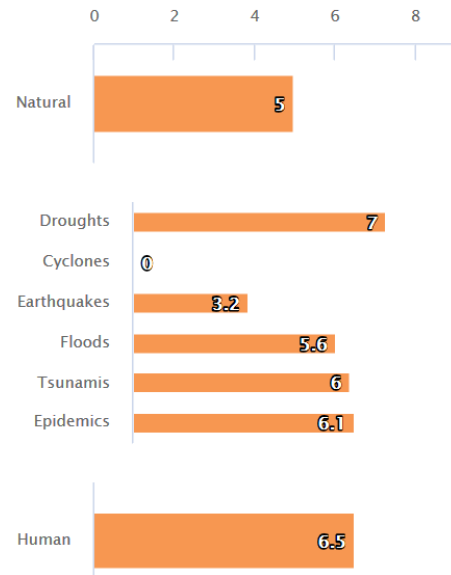
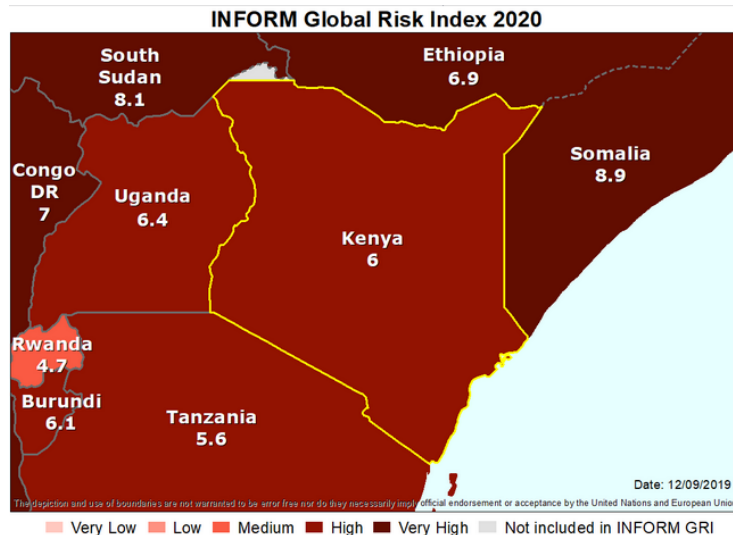


Natural hazards in Kenya

- **INFORM (Index for Risk Management):**
 - useful tool for risk assessment developed by the UN Inter-Agency Standing Committee Task Team for Preparedness and Resilience and the EC
 - assesses risk at country and sub-country level based on indicators to measure hazards and exposure, vulnerability & coping capacities

	Value	Rank	Trend
INFORM Risk	6	25	—
Hazard & Exposure	5.8	32	—
Vulnerability	5.9	29	—
Lack of Coping Capacity	6.2	43	▲

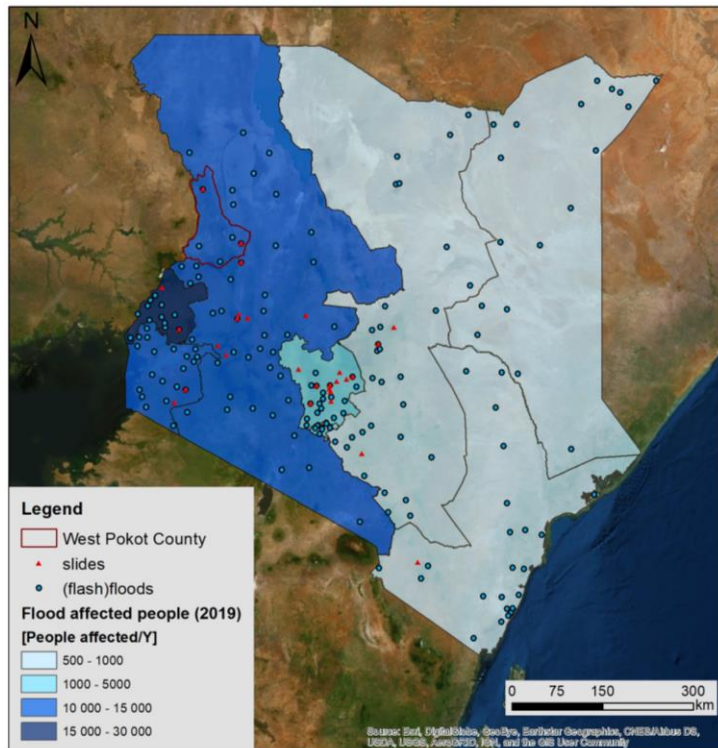
Kenya	
Region: Eastern Africa	
Income Group: Low income	
Hazard & Exposure	



Natural hazards in Kenya

■ Heavy rains, flash floods, mudslides and landslides

- Undated: 39 land/mud slides and 566 (flash)floods from the national disaster inventory (shown on map)
 - Non-geolocated: 756 floods and 51 landslides (2002 and 2016) from the DesInventar catalogue
 - Time limited: 44 land/mud slides (2007 and 2013) from the NASA Landslide geodatabase
- Incomplete natural hazards inventories in Kenya
- Western region at risk



Hydro- geohazards in Kenya with flood affected people layer from <http://riskprofilesundrr.org>

DAILY NATION

NEWS

BUSINESS

COUNTIES

SPORTS

BLOGS & OPINION

Death toll in West Pokot landslides rises to 52

MONDAY NOVEMBER 25 2019



NEWS / AFRICA

Heavy rains cause flash floods in western Kenya

Police officers reportedly trapped in floods as West Pokot county is hit again by a potentially deadly landslide.

19 Apr 2020

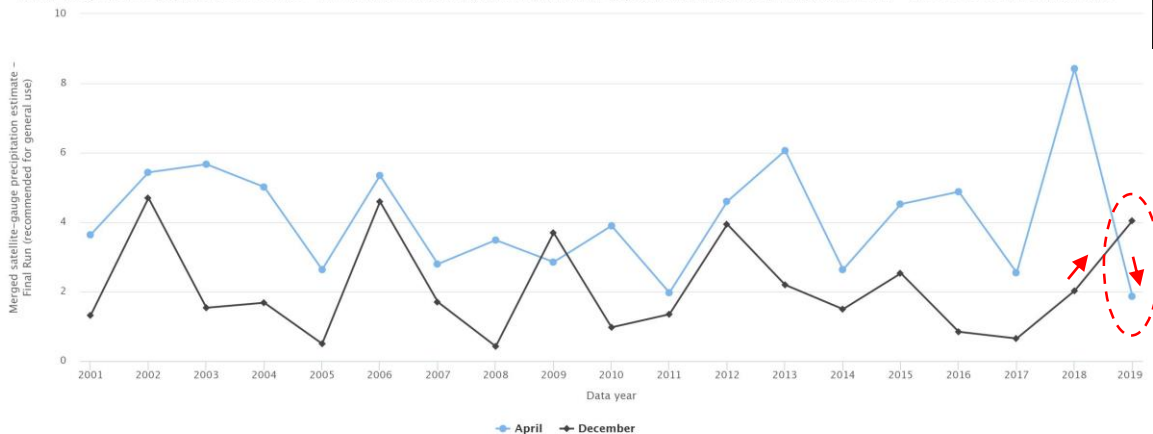


Kenyan climate and forcing meteorological factors

- Short (Nov-Dec) and long (April-May) wet seasons
- In April 2018: extremely wet season with > 8 mm/day over Kenya
- In April 2019: unusual low rain while in December 2019 downpour with mean rainfall > 4 mm/day over Kenya

Interannual Time Series

Average Merged satellite-gauge precipitation estimate - Final Run (recommended for general use) monthly 0.1 deg. [GPM GPM_3IMERGM v06] mm/day for 2001-Apr - 2019-05-01 00:00:00Z, Shape Kenya

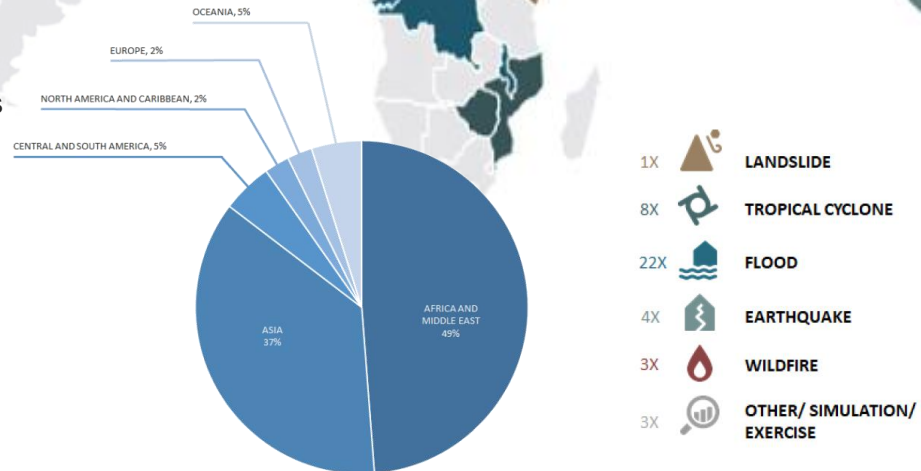


- Positive Indian Ocean Dipole or "El Niño" effect :
colder than normal in the Pacific Ocean and warmer than normal along the Horn of Africa with storm clouds becoming heavier and lasting longer ([BBC communication](#))

UNOSAT Operational Satellite Imagery Analysis & Mapping Support to Humanitarian Emergencies & Post Disaster Recovery

Humanitarian Rapid Mapping Service

- Provides satellite image analysis during humanitarian emergencies, both natural disasters and conflict-situations
- 24/7 operational service
- Team of experienced analysts ensure timely delivery of satellite imagery derived maps, reports and data
- 2019: 41 activations following major disaster events



SATELLITE ANALYSIS AND APPLIED RESEARCH - UNOSAT

Delivering applied research solutions through technology and data.



LATEST MAPS

UNOSAT's latest maps for current events are listed here. Older maps and data can be found in the Map Library.

LATEST MAPS

FIJI, GLIDE NUMBER: TC20200408FJI

- Preliminary satellite-derived damage assessment, Central Division, Republic of Fiji - 27 Apr 2020 - 10:52
- Preliminary agriculture damage assessment, Kadavu Island, Fiji - 24 Apr 2020 - 11:58
- Buildings Damage Assessment of Fiji Museum In Suva City Center, Republic of Fiji - 21 Apr 2020 - 11:43
- Buildings Damage Assessment & Related Density In Kadavu Province, Eastern Division, Republic of Fiji - 17 Apr 2020 - 15:00
- Preliminary satellite-derived damage assessment In Central and Western Divisions, Republic of Fiji - 17 Apr 2020 - 14:56

VANUATU, GLIDE NUMBER: TC20200403VUT

- Preliminary cultural heritage satellite-derived damage assessment report, Republic of Vanuatu - 27 Apr 2020 - 10:46
- Damage Assessment In Paama Island, Malampa Province, Vanuatu - 24 Apr 2020 - 15:24
- Preliminary agriculture damage assessment, Pentecost Island, Vanuatu - 24 Apr 2020 - 11:54
- Preliminary satellite-derived damage assessment Pentecost Island, Penama province, Vanuatu - 17 Apr 2020 - 14:10

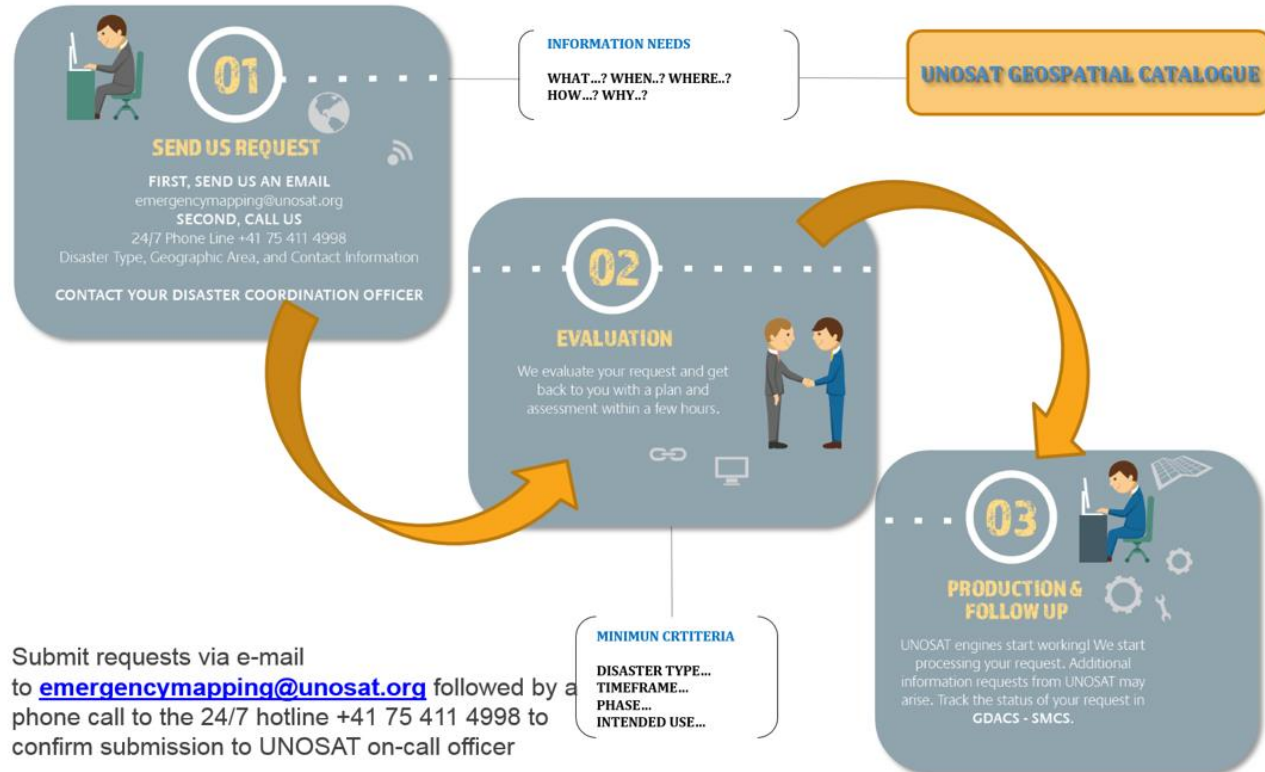
TONGA, GLIDE NUMBER: TC20200409TON

- UNOSAT Live Map: Tropical Cyclone Harold, Tonga - 16 Apr 2020 - 18:00

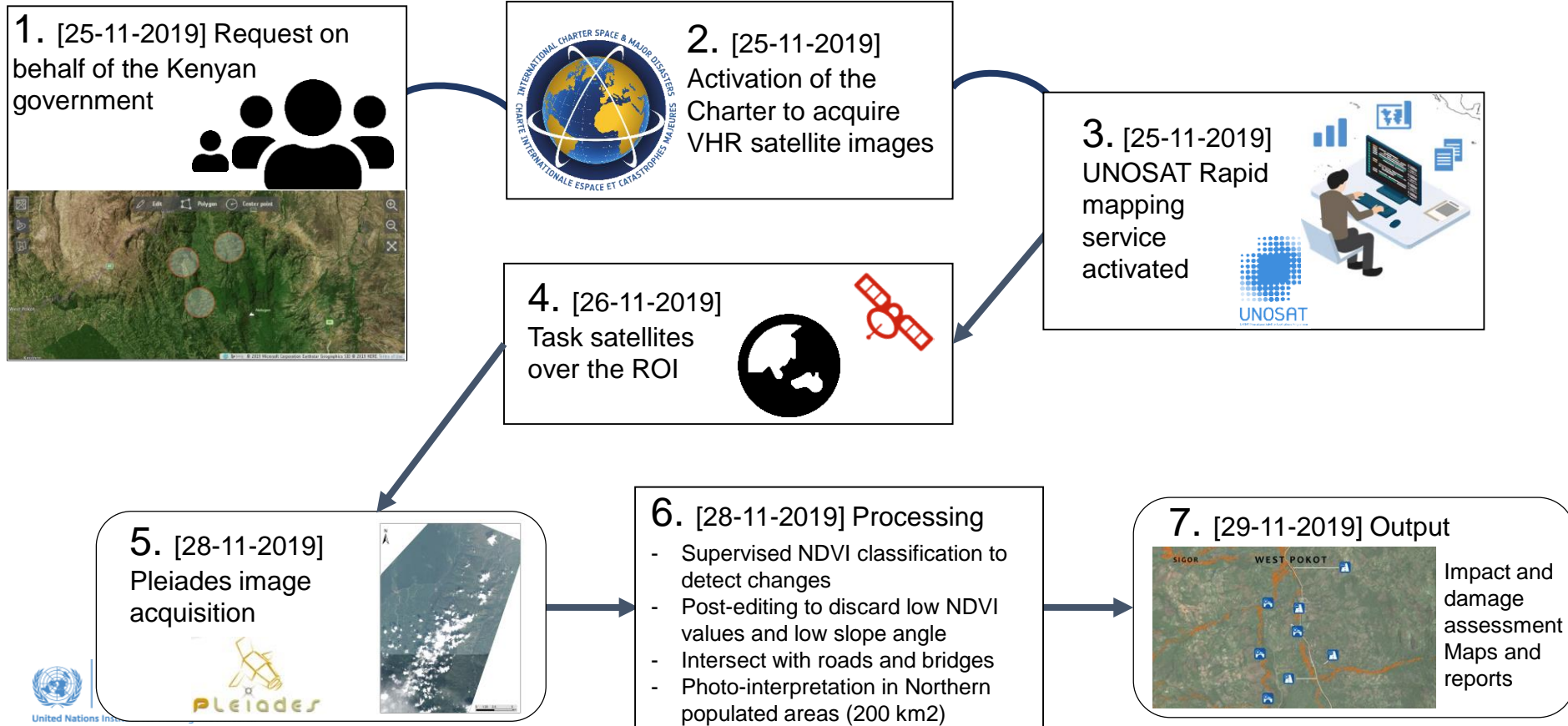
Satellite Imagery
Analysis
- UNOSAT Products-

UNOSAT Operational Satellite Imagery Analysis & Mapping Support to Humanitarian Emergencies & Post Disaster Recovery

Rapid Mapping Satellite Imagery Workflow

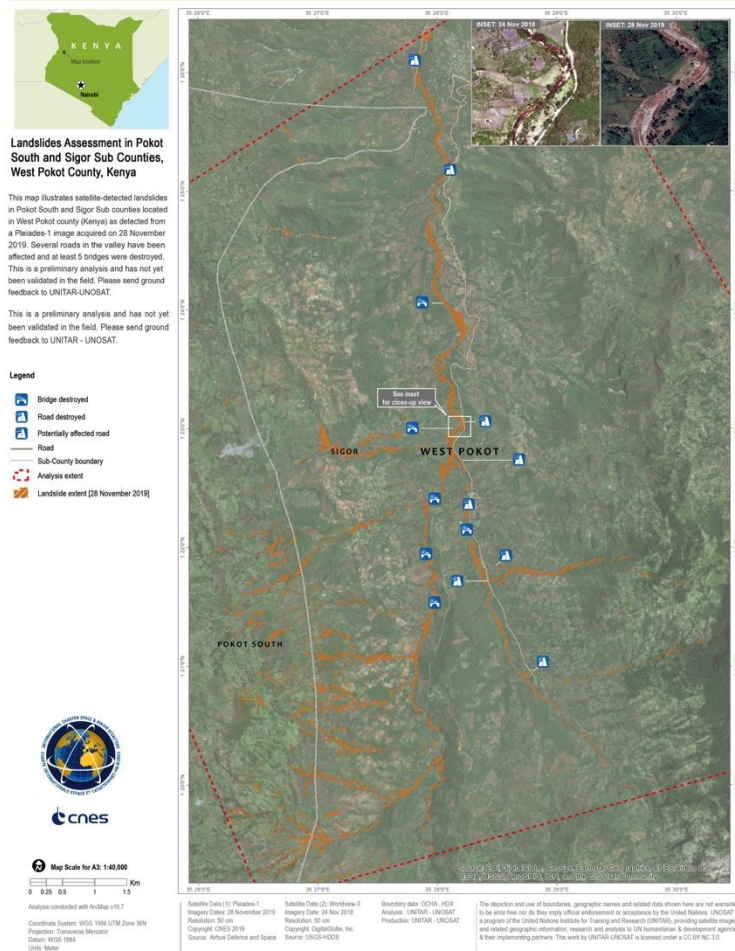


UNOSAT: tasks and processing flowchart after International Charter activation in Dec 2019, Kenya






Mapping Activities

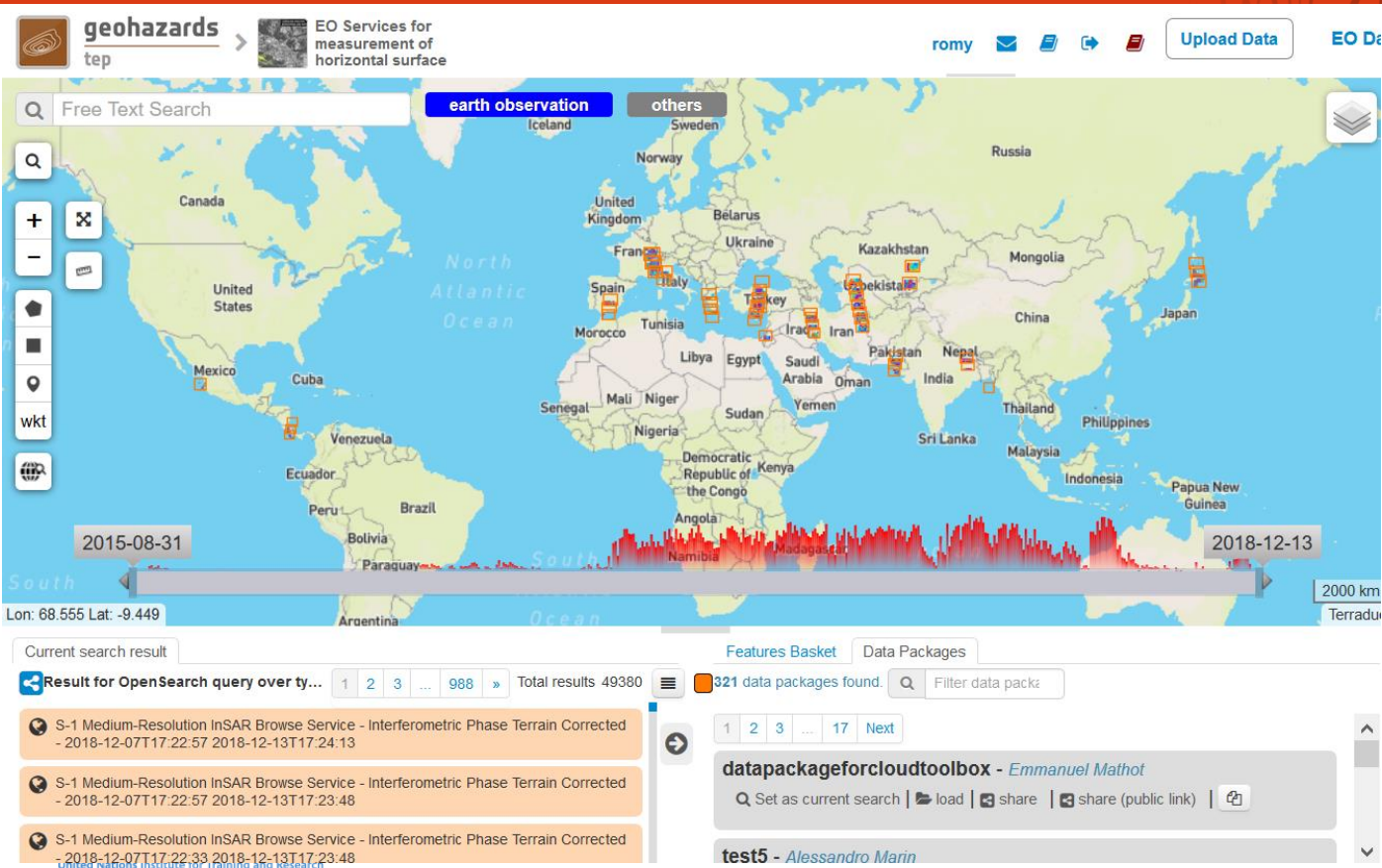
- Floods
- **Landslides**
- Earthquakes
- Cyclones
- Refugee and Internally Displaced Persons Mapping
- Cultural Heritage Sites
- Conflict Damage Assessment
- Etc.



Damaged elements

- 6  Bridge destroyed
- 5  Road destroyed
- 3  Potentially affected road

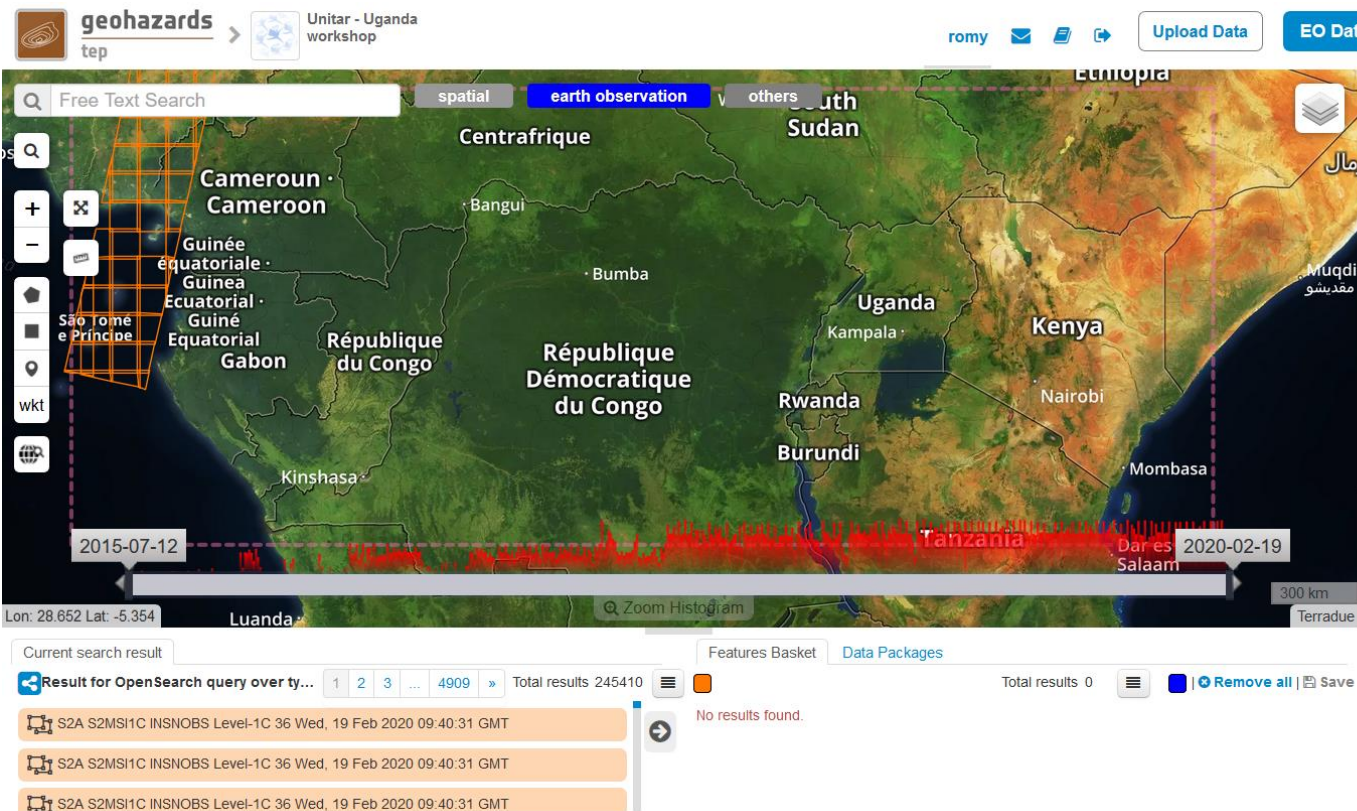




Satellite Imagery Analysis

ALADIM Service on the Geohazards Exploitation Platform

Geohazards Exploitation Platform | GEP



Processing Services

Services Jobs

Filter services

SNAP InSAR

SNAP Sentinel-1 IW SLC I...

COIN

COIN - Coherence and In...

MPIC-Opt

MPIC-Opt: Multiple pairi...

DIAPASON Sentinel-1

DIAPASON InSAR Sente...

ALADIM-S2

ALADIM-S2: Automatic LA...

SNAC

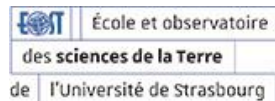
SNAC - SNAP S1 GRD A...

ALADIM-S2/VHR: a service for Landslide Detection on GEP

ALADIM: Automatic Landslide Detection and Inventory Mapping from multispectral images



Service
developped by



This service is developed by CNRS-EOST (Strasbourg, France). It allows to detect and map new landslides triggered by large forcing events (earthquake, heavy rains) from the analysis of pre- and post-event imagery, and is based on change detection methods. It allows the processing of High Resolution multispectral data (ALADIM-S2; Sentinel-2 SAFE files) and Very-High Resolution multispectral data (ALADIM-VHR; typically Pléiades and Spot 6/7). The set of pre- and post-image should be accurately co-registered in order to use the service. A training dataset of manually mapped landslides (by digitalization), the extent of the training areas, and the extent of the region of interest (ROI) should be provided as inputs (shape file-format) by the user. The outputs consist in a database of landslide polygons than can be assimilated to an Earth-Observation derived landslide inventory. ALADIM builds on the change detection methodology partially described in ^[1] and ^[2].



Input specifications

Beside the service parameters an archive folder containing the training set, the training areas (and aoi) in shapefile format is needed. See the tutorial (tutorial) to create these inputs.

Output specifications

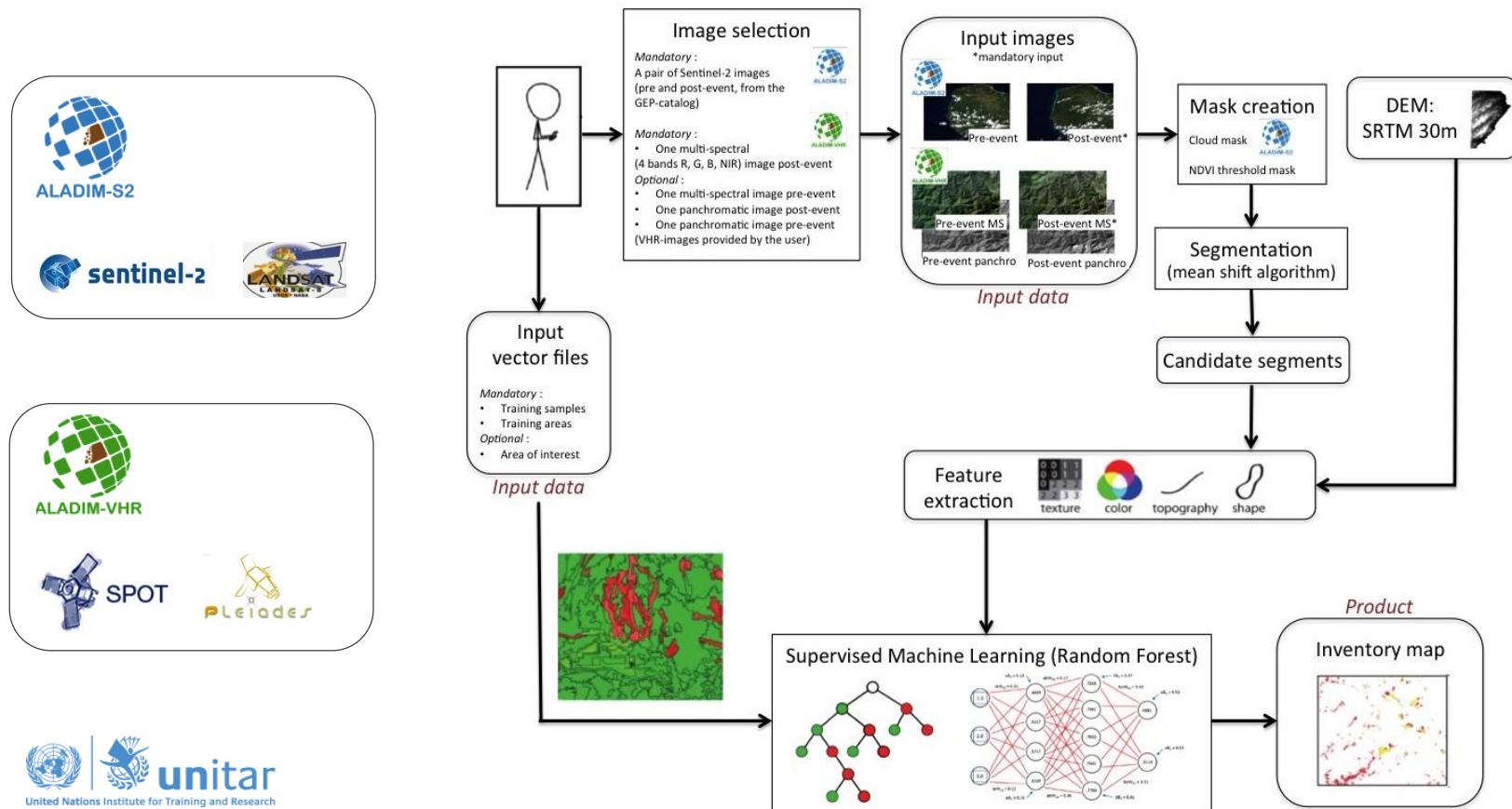
- A shapefile (*.shp files) containing the landslides detected at an F2 optimal threshold.
- An image (geotiff file format) containing all landslides detected at an F2 optimal threshold.
- Two documents (*.pdf files) presenting the cross-validation quality control (precision-recall curves and accuracies of the parameters).

A machine learning based service for Sentinel-2 and VHR images

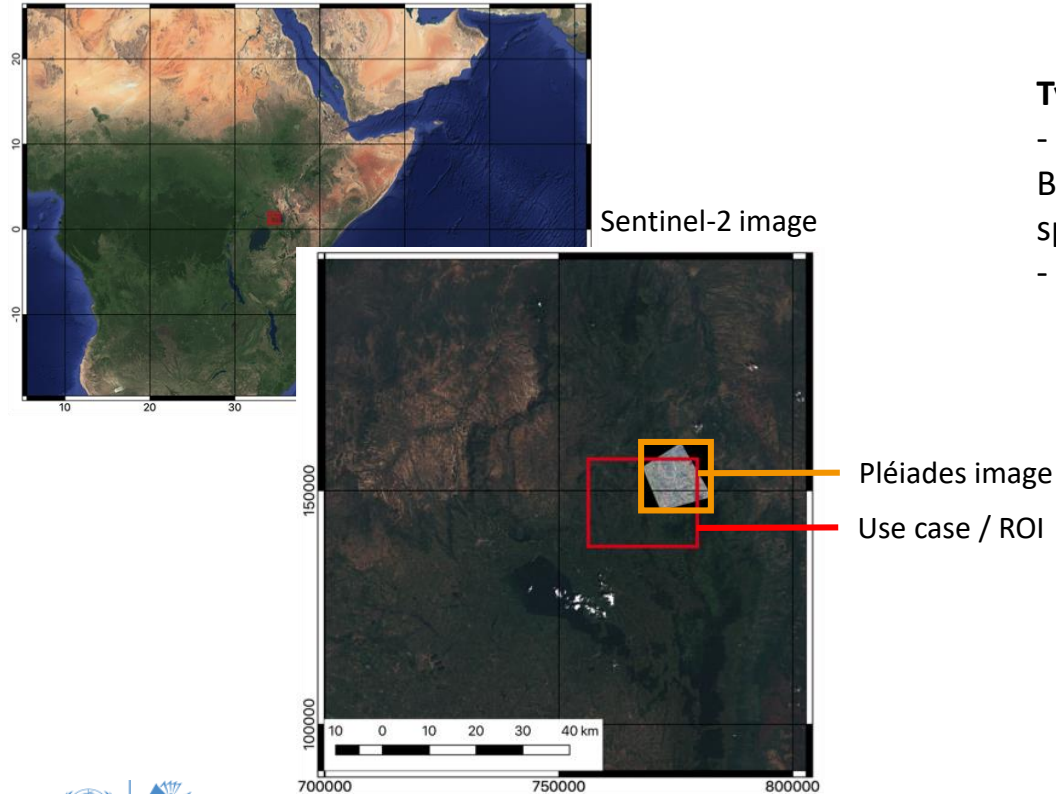
Parameters

Name	Value
ALADIM_POST_O	https://recast.terraviva.com/t2api/search/depreza/results?uid=B5AC3194BDCC3AD95591F0850CBB8231109B5C6
RTHO_MS	uid=B5AC3194BDCC3AD95591F0850CBB8231109B5C6
ALADIM_IMAGE_	0
NODATA	
ALADIM_SEG_SC	400
ALE	
ALADIM_SEG_CO	0.9
LOR_WEIGHT	
ALADIM_SEG_SH	0.1
APE_WEIGHT	
ALADIM_SEG_MI	3
N_SIZE	
ALADIM_POSITIV	0.5
E_THRESHOLD	
ALADIM_SHAPES	https://recast.terraviva.com/t2api/search/depreza/results?uid=4AFA3DA2147F67FC3F13034E916F661DAB3B4EE0

ALADIM-S2/VHR: processing flowchart

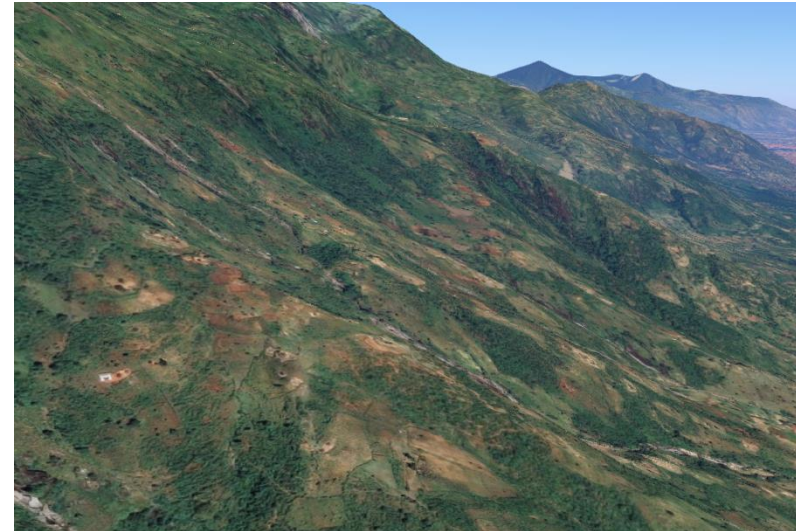


Study case and image coverage: S2 vs. Pléiades



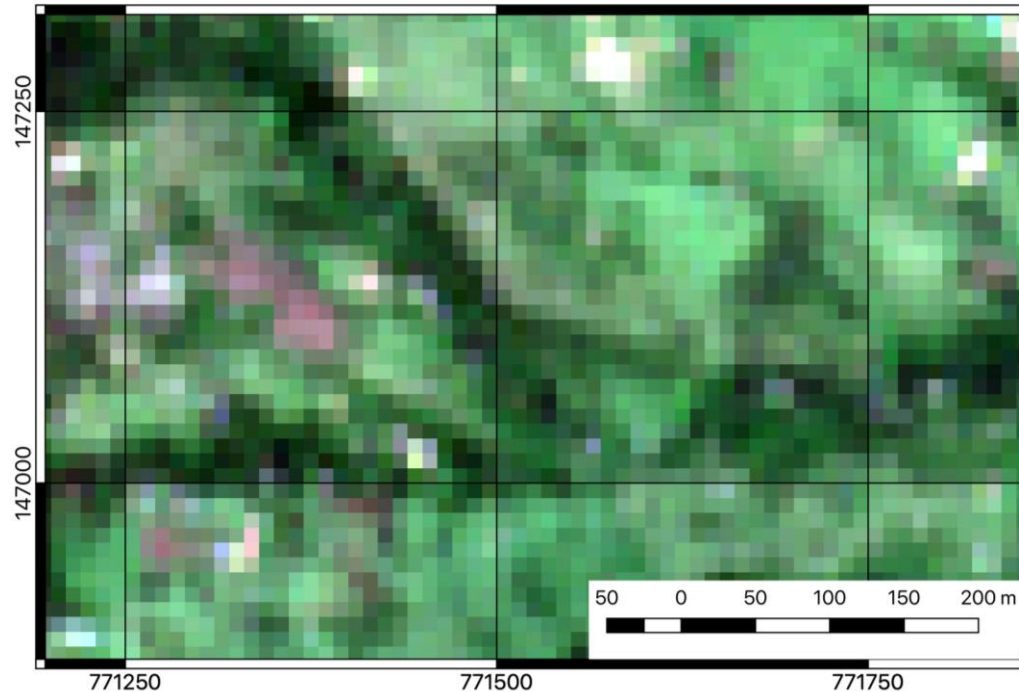
Typical landscape in West Pokot (Kenya)

- Difficult for EO automatic landslide detection
- Bare soils, agricultural fields and landslides have similar spectral behaviour
- Presence of previous landslides



Landslide detection: area 1 – S2 vs. Pléiades vs. reference

S2: 19/09/2019



Sentinel-2:

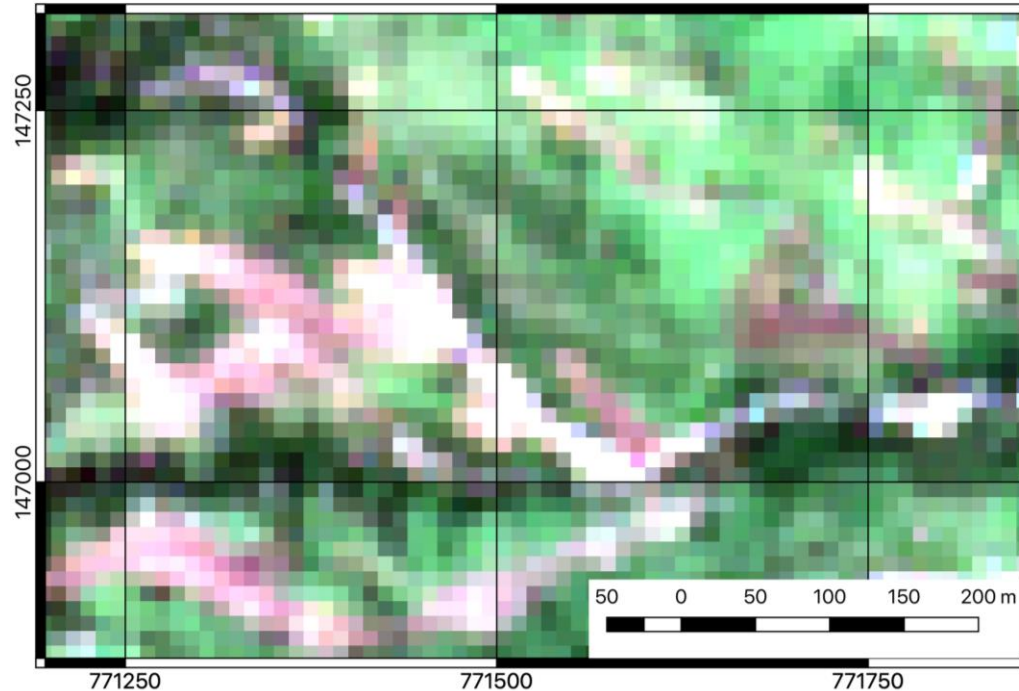
Pre-event: 19/09/2019

Post:event 28/11/2019

Pléiades: 28/11/2019

Landslide detection: area 1 – S2 vs. Pléiades vs. reference

S2: 28/11/2019



Sentinel-2:

Pre-event: 19/09/2019

Post:event 28/11/2019

Pléiades: 28/11/2019

Landslide detection: area 1 – S2 vs. Pléiades vs. reference

Pléiades: 28/11/2019

*(available by
International Charter
and CIEST)*



Sentinel-2:

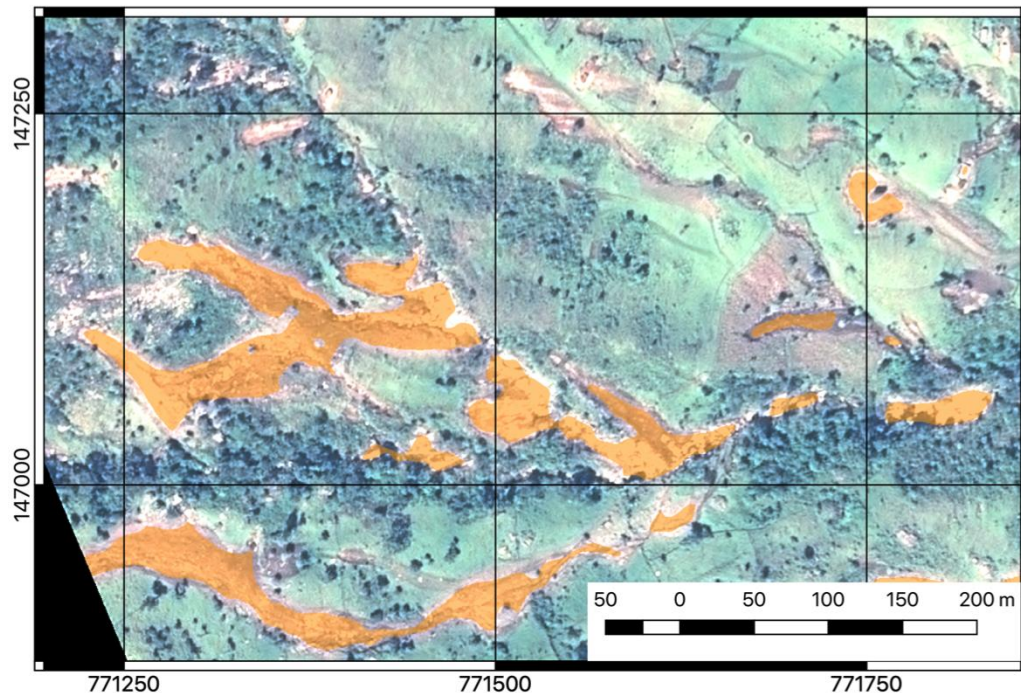
Pre-event: 19/09/2019

Post:event 28/11/2019

Pléiades: 28/11/2019

Landslide detection: area 1 – S2 vs. Pléiades vs. reference

Unitar:
reference mapping



Sentinel-2:

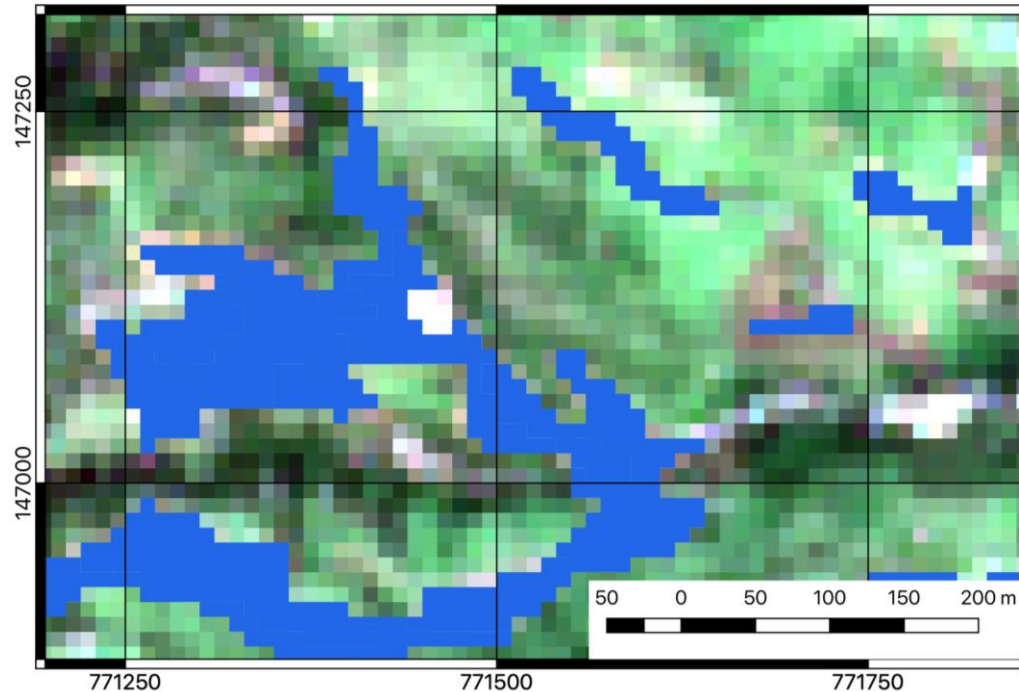
Pre-event: 19/09/2019

Post: event 28/11/2019

Pléiades: 28/11/2019

Landslide detection: area 1 – S2 vs. Pléiades vs. reference

S2: detection



Sentinel-2:

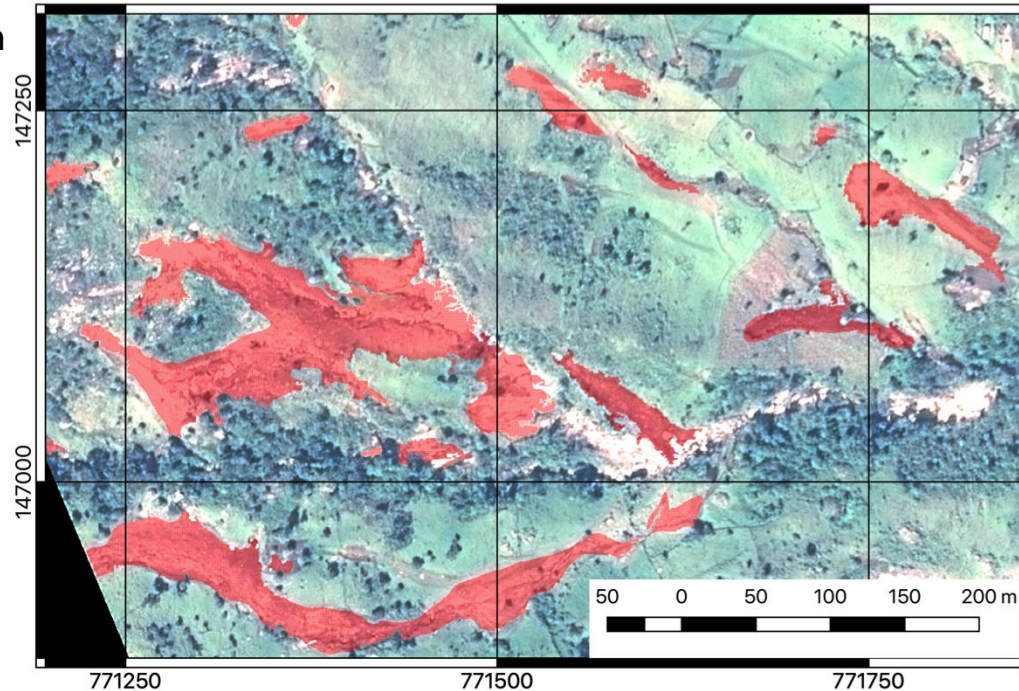
Pre-event: 19/09/2019

Post-event: 28/11/2019

Pléiades: 28/11/2019

Landslide detection: area 1 – S2 vs. Pléiades vs. reference

Pléiades: detection



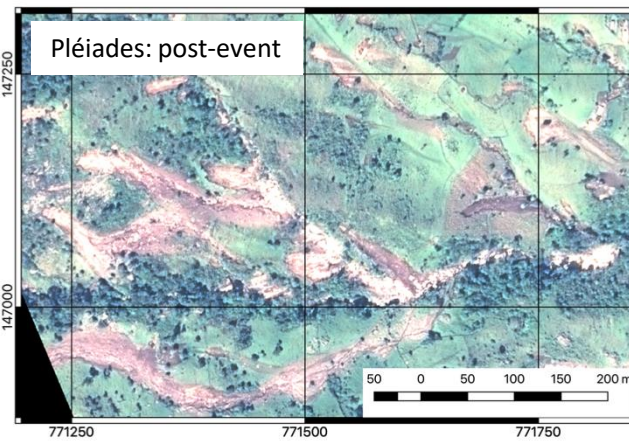
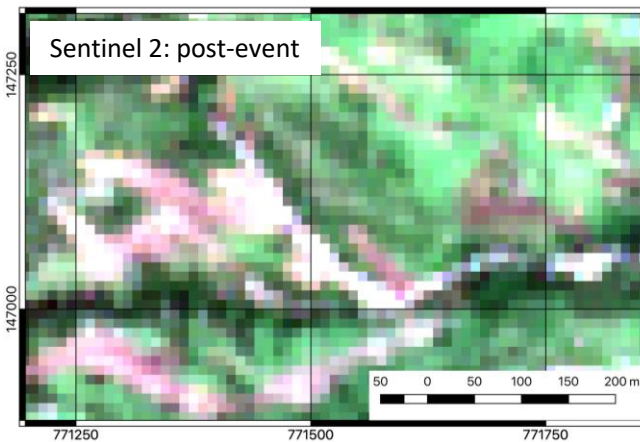
Sentinel-2:

Pre-event: 19/09/2019

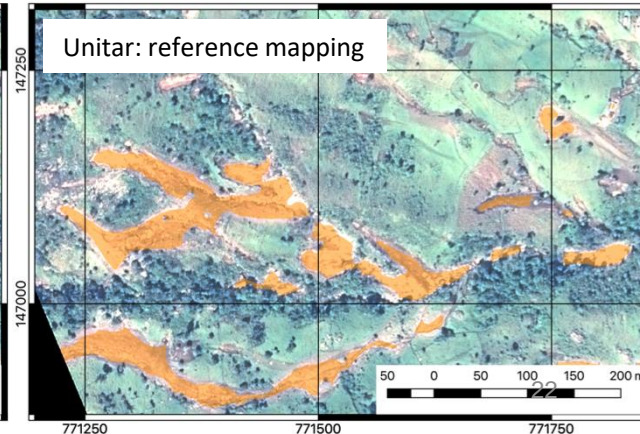
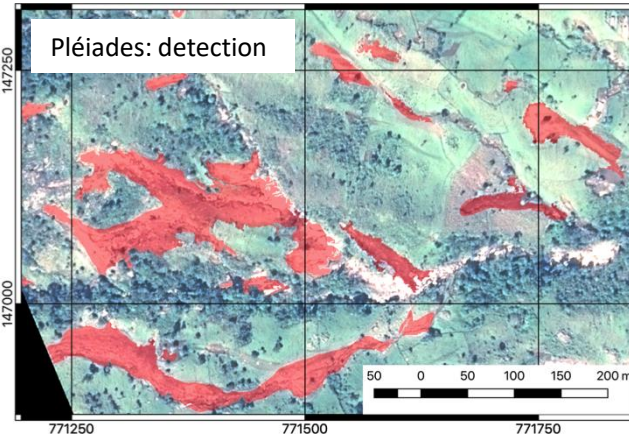
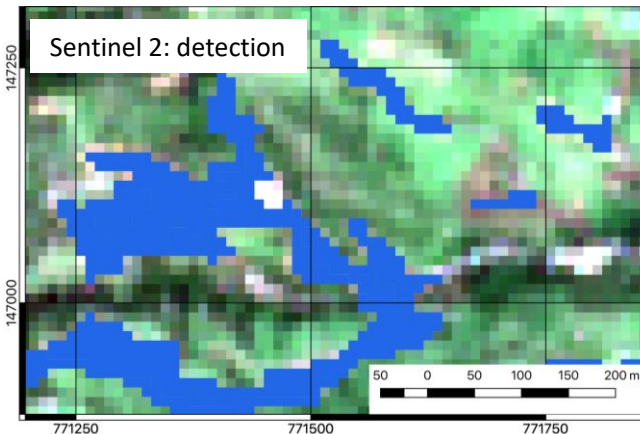
Post:event 28/11/2019

Pléiades: 28/11/2019

Landslide detection: area 1 – S2 vs. Pléiades vs. reference

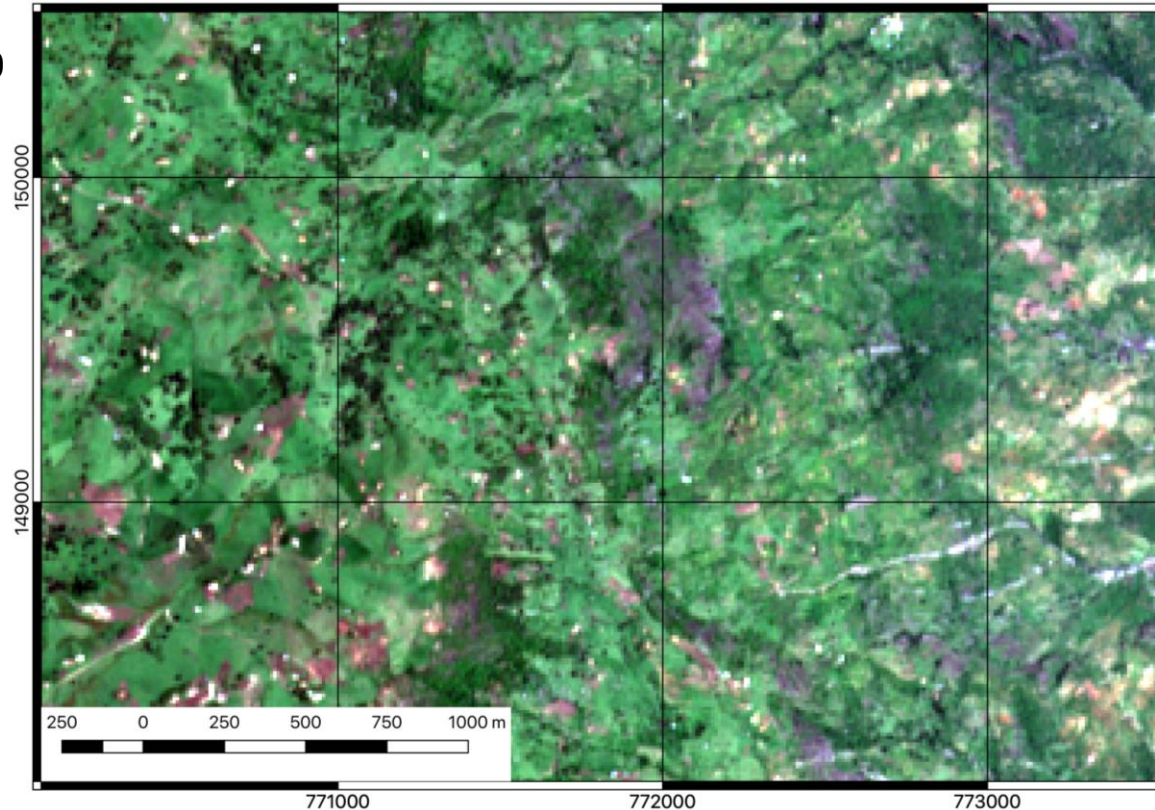


- Unitar reference mapping focuses on the largest landslides and most impacted areas
- ALADIM detects all the Unitar reference mapping, and also smaller landslides on the upper slopes



Landslide detection: area 2 – S2 vs. Pléiades vs. reference

S2: 19/09/2019



Sentinel-2:

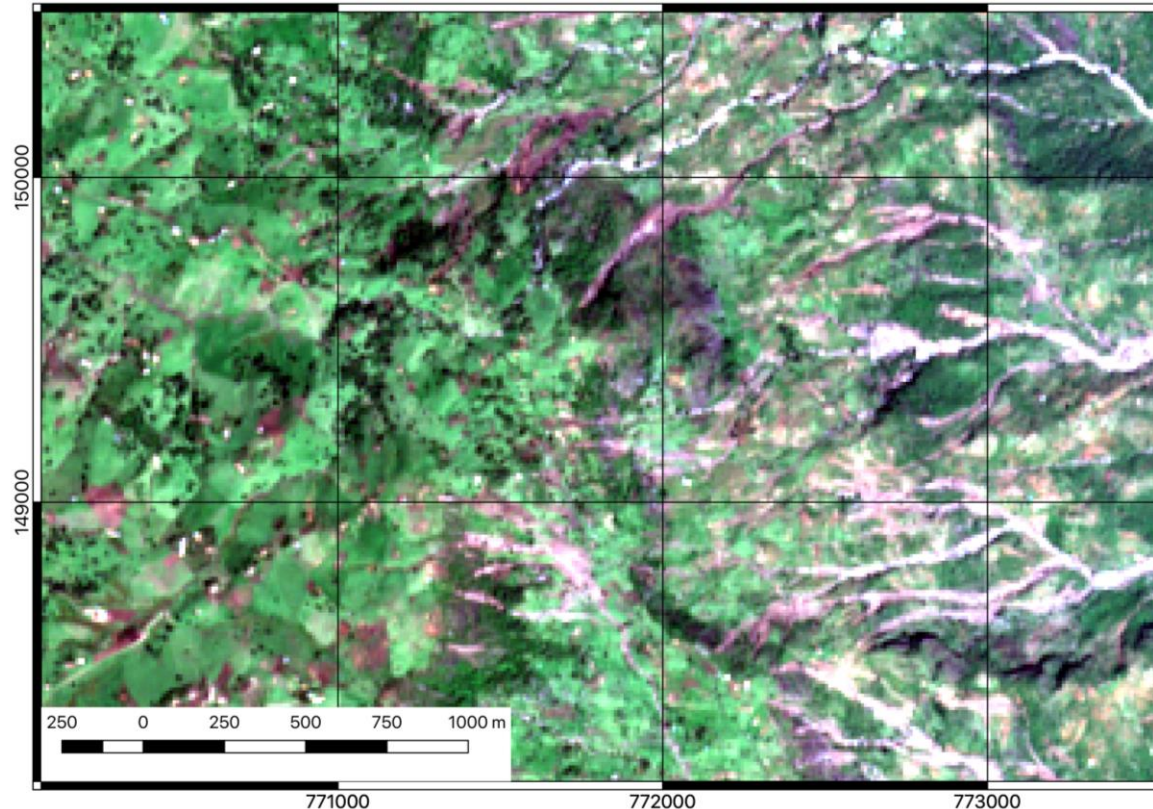
Pre-event: 19/09/2019

Post:event 28/11/2019

Pléiades: 28/11/2019

Landslide detection: area 2 – S2 vs. Pléiades vs. reference

S2: 28/11/2019



Sentinel-2:

Pre-event: 19/09/2019

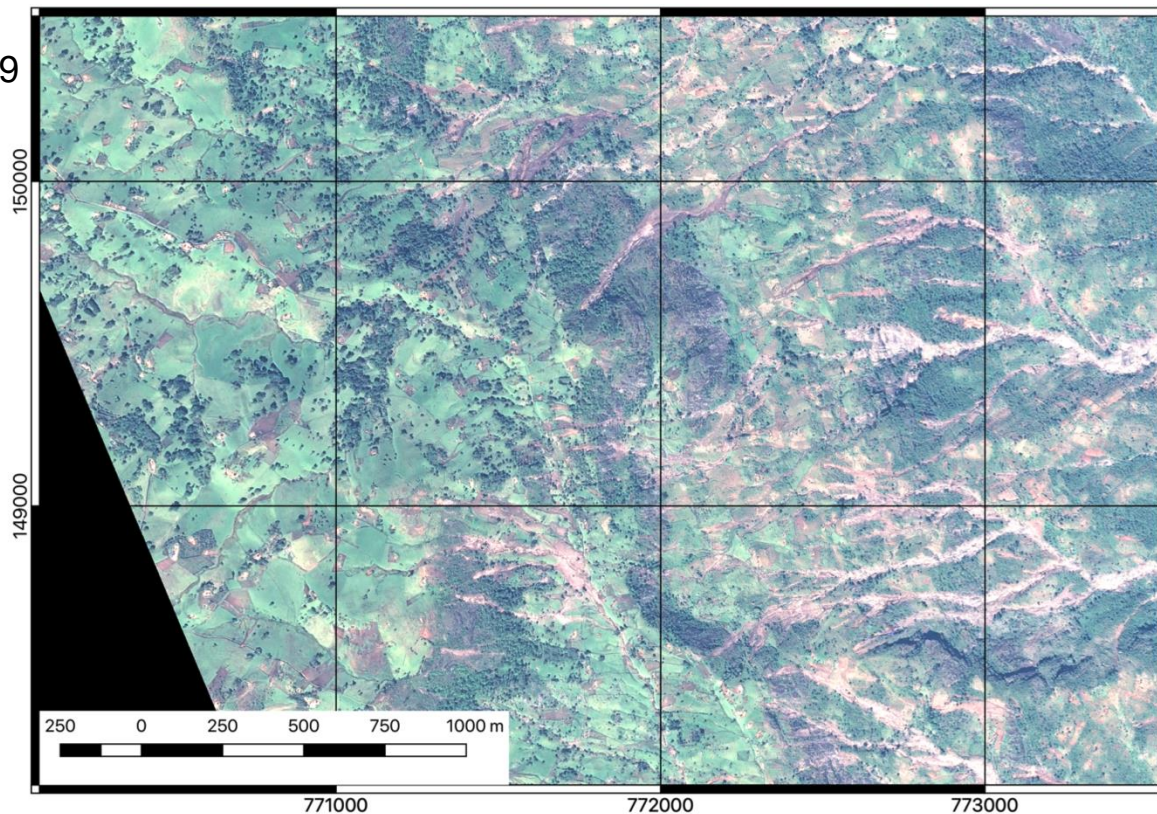
Post:event 28/11/2019

Pléiades: 28/11/2019

Landslide detection: area 2 – S2 vs. Pléiades vs. reference

Pléiades: 28/11/2019

*(available by
International Charter
and CIEST)*



Sentinel-2:

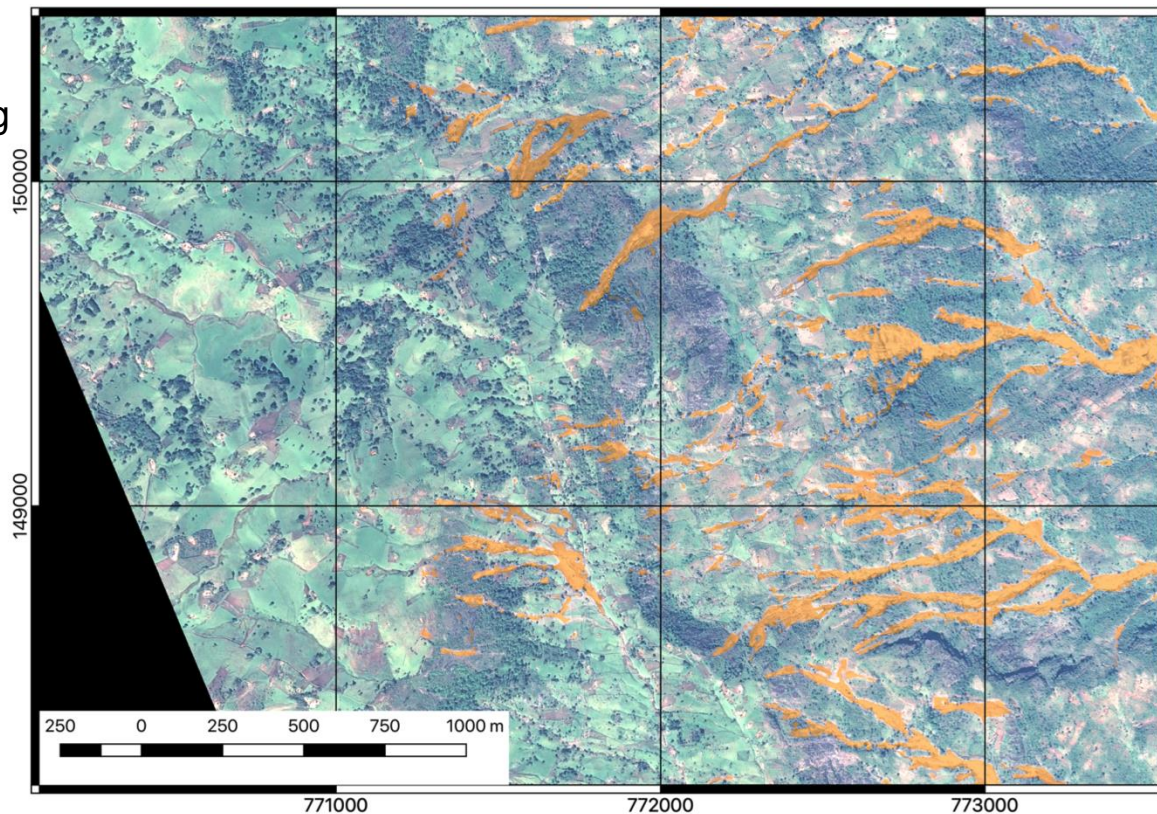
Pre-event: 19/09/2019

Post:event 28/11/2019

Pléiades: 28/11/2019

Landslide detection: area 2 – S2 vs. Pléiades vs. reference

Unitar:
reference mapping



Sentinel-2:

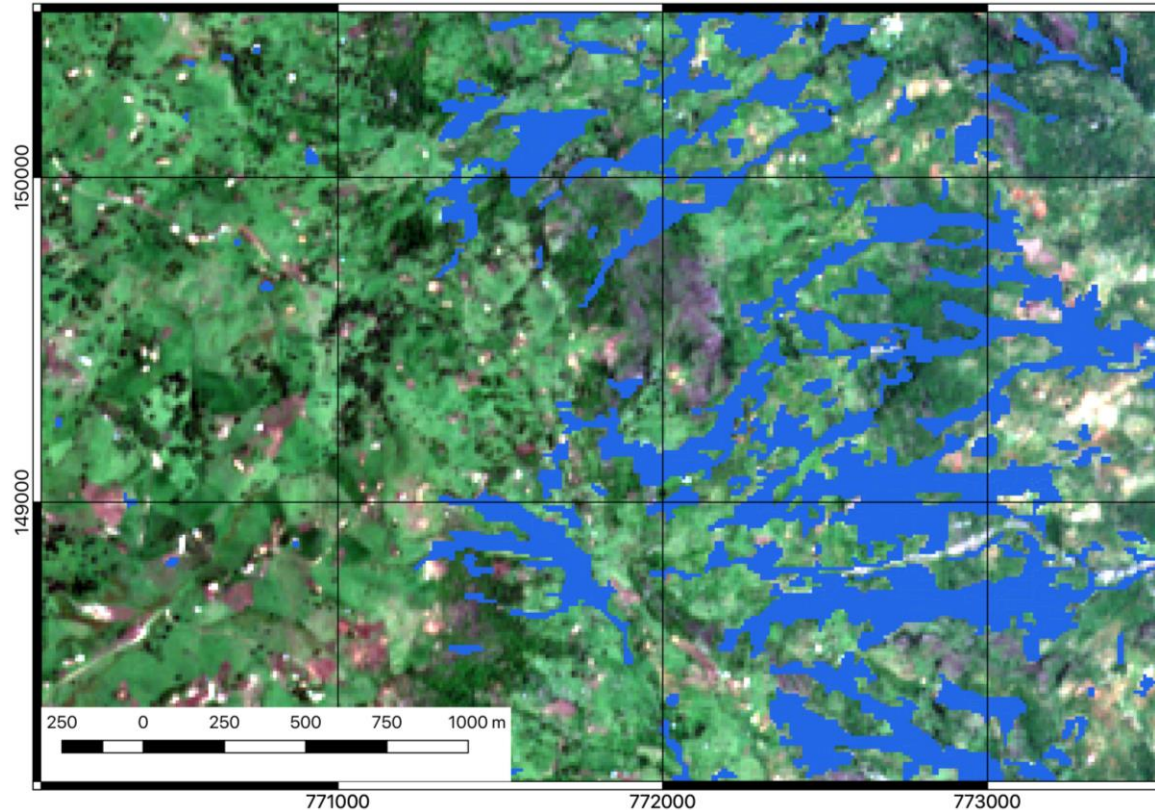
Pre-event: 19/09/2019

Post:event 28/11/2019

Pléiades: 28/11/2019

Landslide detection: area 2 – S2 vs. Pléiades vs. reference

S2: detection



Sentinel-2:

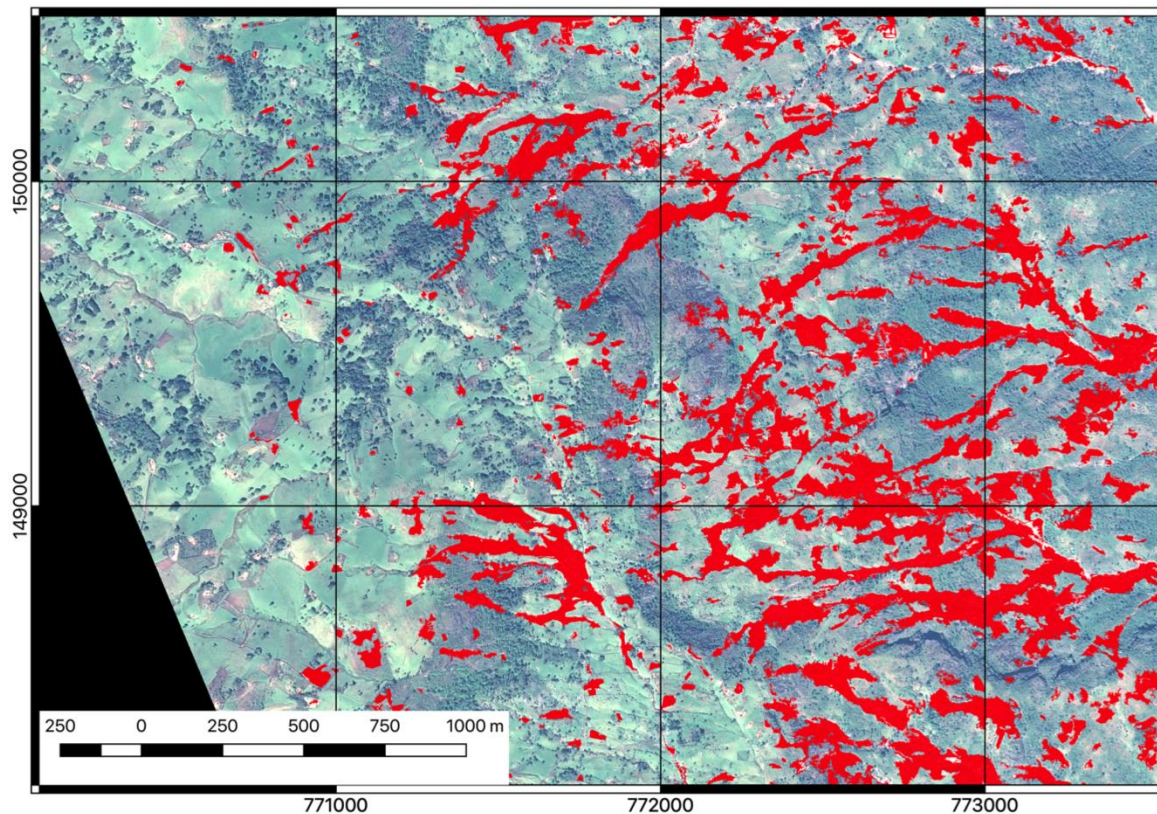
Pre-event: 19/09/2019

Post:event 28/11/2019

Pléiades: 28/11/2019

Landslide detection: area 2 – S2 vs. Pléiades vs. reference

Pléiades: detection



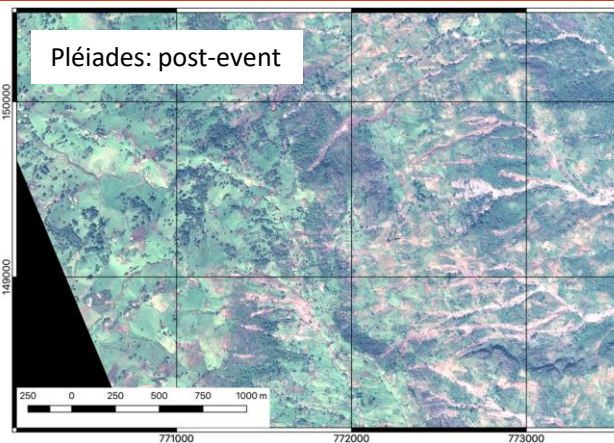
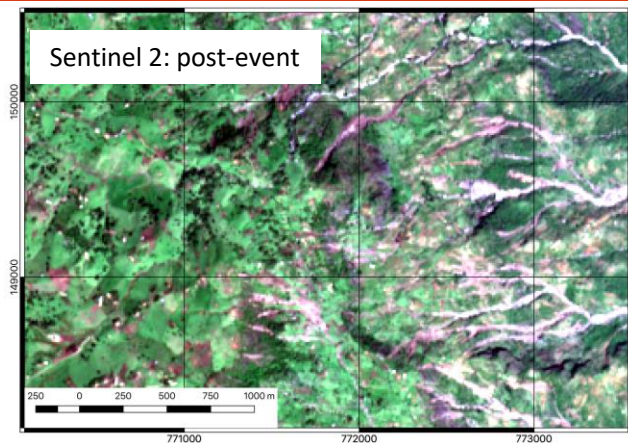
Sentinel-2:

Pre-event: 19/09/2019

Post:event 28/11/2019

Pléiades: 28/11/2019

Landslide detection: area 2 – S2 vs. Pléiades vs. reference

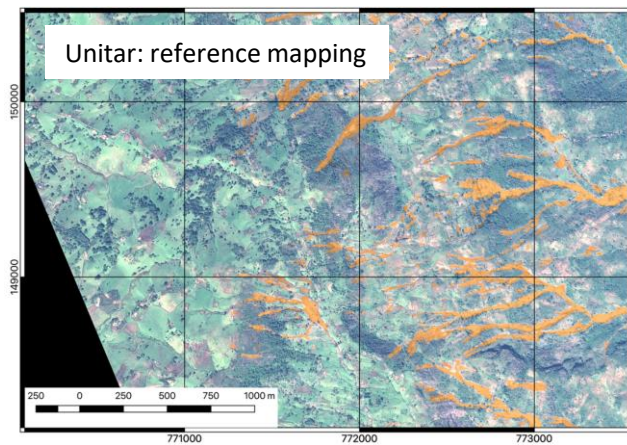
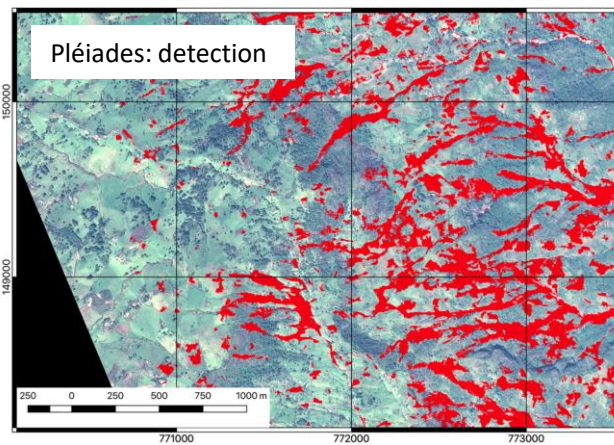
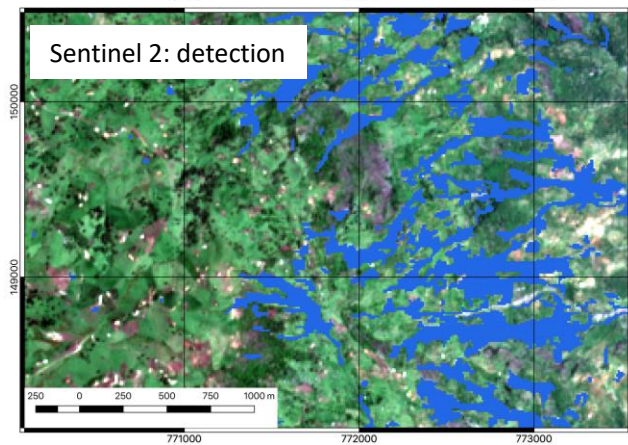


ALADIM detection

- Sentinel 2: landslide area: 18 km²
landslide number: 3622
- Pléiades : landslide area: 3.8 km²
landslide number: 2319

UNOSAT detection

- Pléiades : landslide area: 2.8 km²



Discussion and Conclusion

- **Recurrence of landslides affected by climate change in Kenya**
 - Swapping long and short term rainfall seasons
 - Areas less-prone to natural hazards newly affected (due to land use changes?)
 - It is important to document the hazard events after each meteorological events for landslide hazard management and disaster risk reduction to minimize fatalities
 - Earth Observation data and user-oriented mapping tools are necessary in various phases of disaster risk management (preparedness, emergency, recovery) such as for hazard mapping, impact and damage assessment
- **International Disaster Charter for Major Disaster and Rapid Mapping initiative (UNOSAT) :** impact and damages assessment maps within 1 day (3 to 5 days after the disaster happens according to satellite data availability) for emergency response purpose in populated areas
- **Landslide Detection Services:** ALADIM is currently being upgraded by the service provider CNRS/EOST (management of the training sets, other satellite sensor, mono-date vs. bi-date vs. time serie detection) for further flexibility. Landslide mapping ready after preparation of training datasets, processing and mapping of individual event over a larger area in about 1.5 days