

Monitoring and Detection of Landslides from optical Images time-Series

MuDslIdeS

Executive Summary

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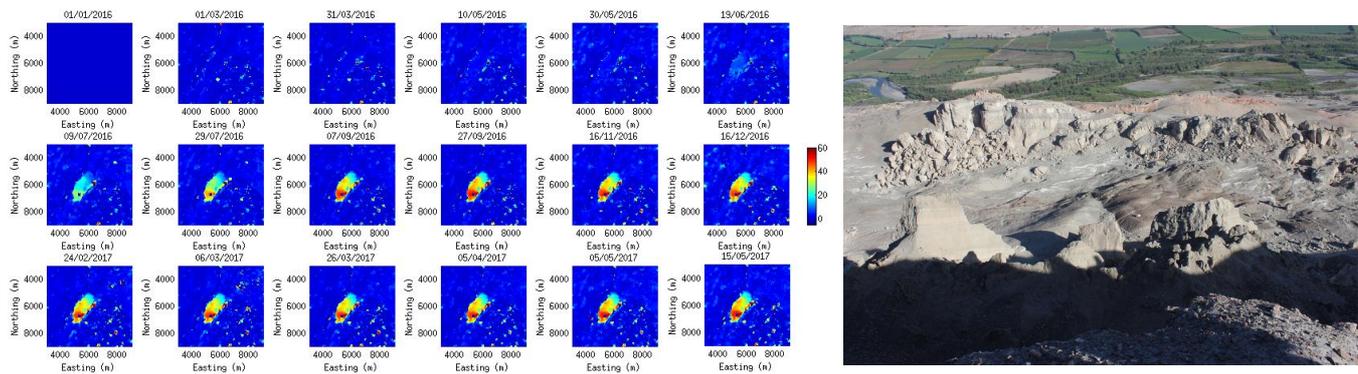
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1. Picture:



Time-series of displacement fields, retrieved with Sentinel2 images, over a major landslide in Peru

2. Motivation:

Slow-moving landslides are of particular threat in many areas around the world, with large impacts on infrastructures and populations. In this project, we aim at developing the tools to detect them and monitor their activity with time, using optical sensors.

3. Methodology:

A method dedicated to the landslide monitoring from repeat optical satellite images (TIO) is developed based on the inversion of a redundant system of multi-temporal displacement fields. We validate the time-series of displacement by comparison of the Sentinel-2 and GPS data, installed on 3 landslides in Peru. This shows uncertainties of between 40 cm and 2 m for all the measurements. TIO is integrated on the GEP platform.

The detection of landslides is then achieved by optimization of the time-series of displacement fields, under specific constraints. This original method, applied on old SPOT1-5/Pléiades images over the Colca valley in Peru, re-sampled at 10 m to simulate the Sentinel-2 datasets, shows its ability to detect large previously known landslides and detect smaller unknown ones.

Training of peruvian colleagues to the different methods developed were finally undertaken in the framework of this project.

4. Results:

- Development and Validation of 2 methods to monitor and detect slow-moving landslides from time-series of optical data
- The good revisit time of Sentinel-2 data is of main interest for monitoring transient motion of landslides.
- 3 landslides in Peru were equipped with permanent GPS monitoring, to validate the satellite measurements.
- This project led to a reinforcement of the partnership between France and Peru, thanks to the training of two peruvian students and the GPS equipments installed.

5. Publications:

Papers in journals with scientific committees

- Lacroix P., G. Bièvre; E. Pathier; U. Kniess; D. Jongmans, *Use of Sentinel-2 images for the detection of precursory motions before landslide ruptures*, Remote Sensing of Environment, Submitted
- Bontemps, N. P. Lacroix, M.-P. Doin, *Inversion of deformation fields time-series from optical images, and application to the long term kinematics of slow-moving landslides in Peru*, Remote Sensing of Environment, Submitted
- Pham M.-Q., P. Lacroix, M.-P. Doin, *Sparsity optimization method for Slow-moving Landslides detection in satellite image time series*, IEEE Trans. Geosc. & Rem. Sens., submitted
- Lacroix P., E. Taïpe, G. Araujo, J. Hollingsworth, *Slow-moving landslide kinematics in an extremely arid environment*, Journal of Geophysical Research, In preparation
- Lacroix P., H. Perfettini, E. Taïpe, G. Araujo, *Rockfalls driven slow-moving landslides*, Earth and Planetary Science Letters, In preparation

Student training reports

- Loaiza Y., *Estudio del deslizamiento de Písaq – Cusco, Perú utilizando imágenes satelitales ópticas.*, UGA, May 2017, 17p.
- Huarez C., *Estudio del deslizamiento Sigüas mediante la correlación de imágenes ópticas Landsat8 y Pléiades*, UGA, May 2017, 29p.

Abstract in conferences

- Bontemps N., P. Lacroix, and M.-P. Doin, *Inversion of deformation fields time-series from optical images, application to the long term kinematics of slow-moving landslides*, EGU, Vienna, Poster session, April 2017.
- Bontemps N., P. Lacroix, and M.-P. Doin, *Inversion of deformation fields time-series from optical images, application to the long term kinematics of slow-moving landslides*, MDIS Workshop, Clermont-Ferrand, October 2017.
- Bontemps N., P. Lacroix, and M.-P. Doin, *Inversion de séries temporelles de champs de déformations à partir d'images satellites optiques, et application à la cinématique long terme de glissements de terrain lents au Pérou*, JAG 2017, Besançon, Oct 2017
- Lacroix P., G. Bièvre, D. Jongmans et E. Pathier, *Détection des précurseurs de déplacement à la réactivation du glissement de terrain de l'Harmalière, Trièves, France, par imagerie satellite Sentinel-2*, JAG 2017, Besançon, Oct 2017
- Pham M.-Q., P. Lacroix, M.-P. Doin, *An optimization method for slow-moving landslides detection in satellite image time series*, MDIS Workshop, Oct. 2017
- Volat M., P. Lacroix, N. Bontemps, M.-P. Doin, *Introducing "TIO": Optical imagery time series analysis on the Geohazards Exploitation Platform*, MDIS Workshop, Oct. 2017

Outreach

<http://deslizamientos.pe/>

Palmer J., *Creeping earth could hold secret to deadly landslides*, Nature, 548-7668

6. Highlights:

We detect precursory motions before landslide ruptures. We also show that landslide motion in arid valleys of Peru are characterized by irregular pattern of displacement with time, driven by major rockfalls. Those two main results show the high value of the good revisit time of Sentinel2 for landslide studies. Our ongoing research will therefore focus on the detection of these transient signals from space.