RAIN AND SMALL EARTHQUAKES MAINTAIN A SLOW-MOVING LANDSLIDE IN A PERSISTENT CRITICAL STATE

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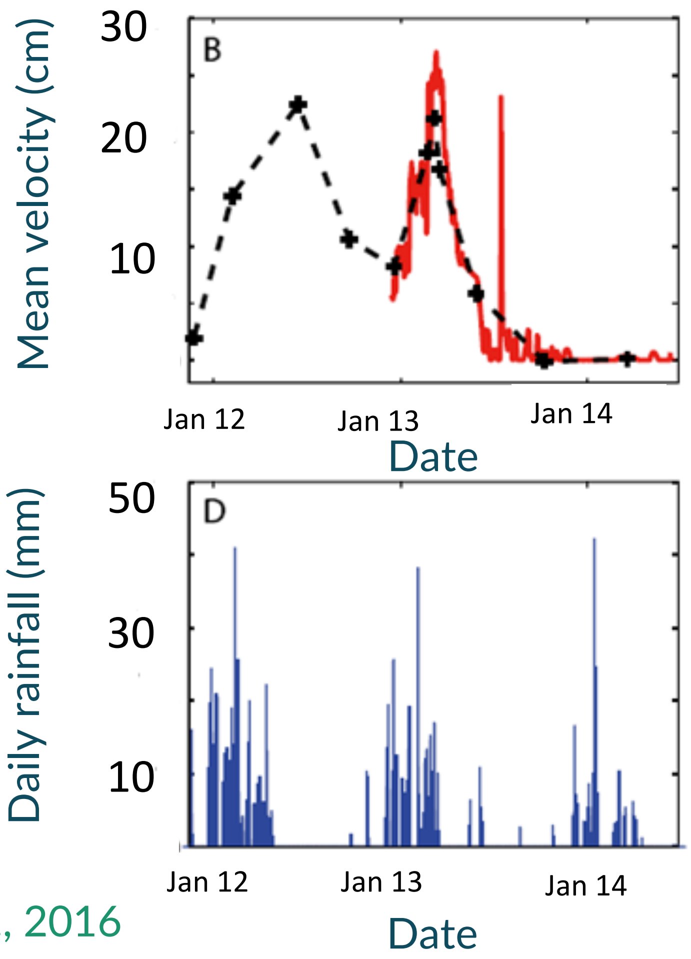
LANDSLIDE FORCINGS

RIVER

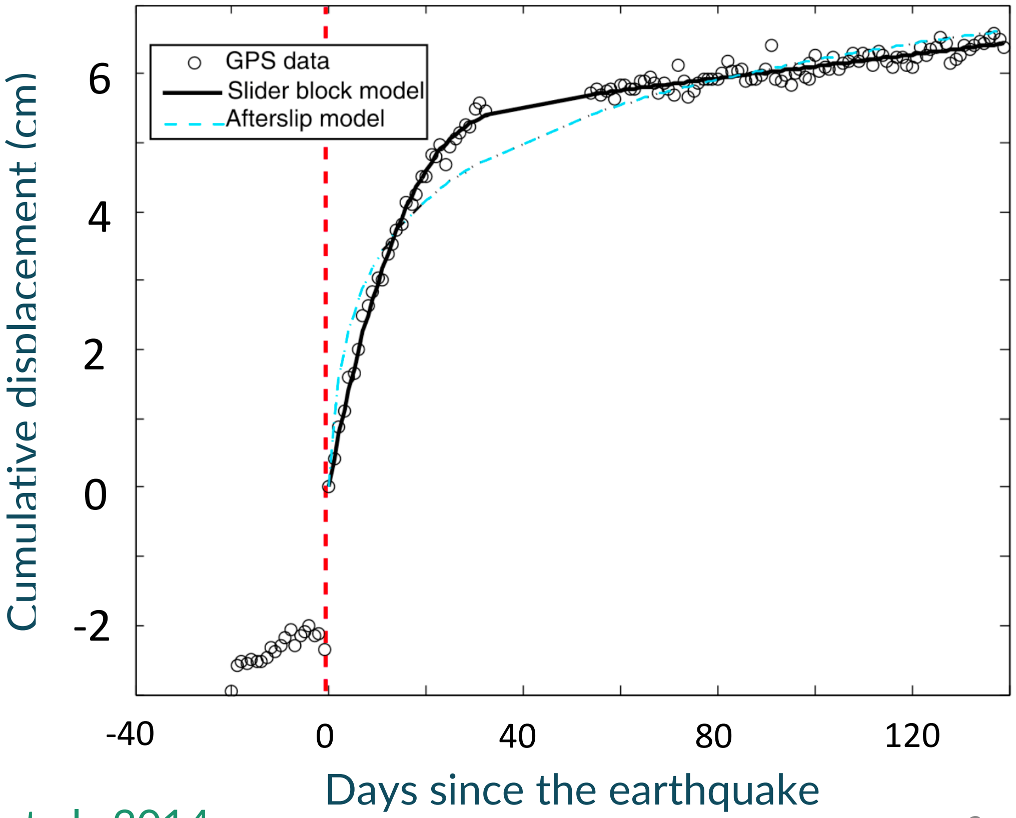
RAINFALL

HUMAN ACTIVITY

EARTHQUAKES



Zerathe et al., 2016



Lacroix et al., 2014

PROBLEMATIC

PROBLEM

Lack of quantitative data to explain the coupling effect of precipitation and earthquakes

What are the mechanisms at the origin of the long term combined effect between precipitations and earthquakes in seismic regions?

Can we quantify them?

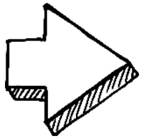
GENERAL APPROACH

OBJECT OF INTEREST

Maca Landslide, Photo: Edu Taipe

Slow-moving landslides:

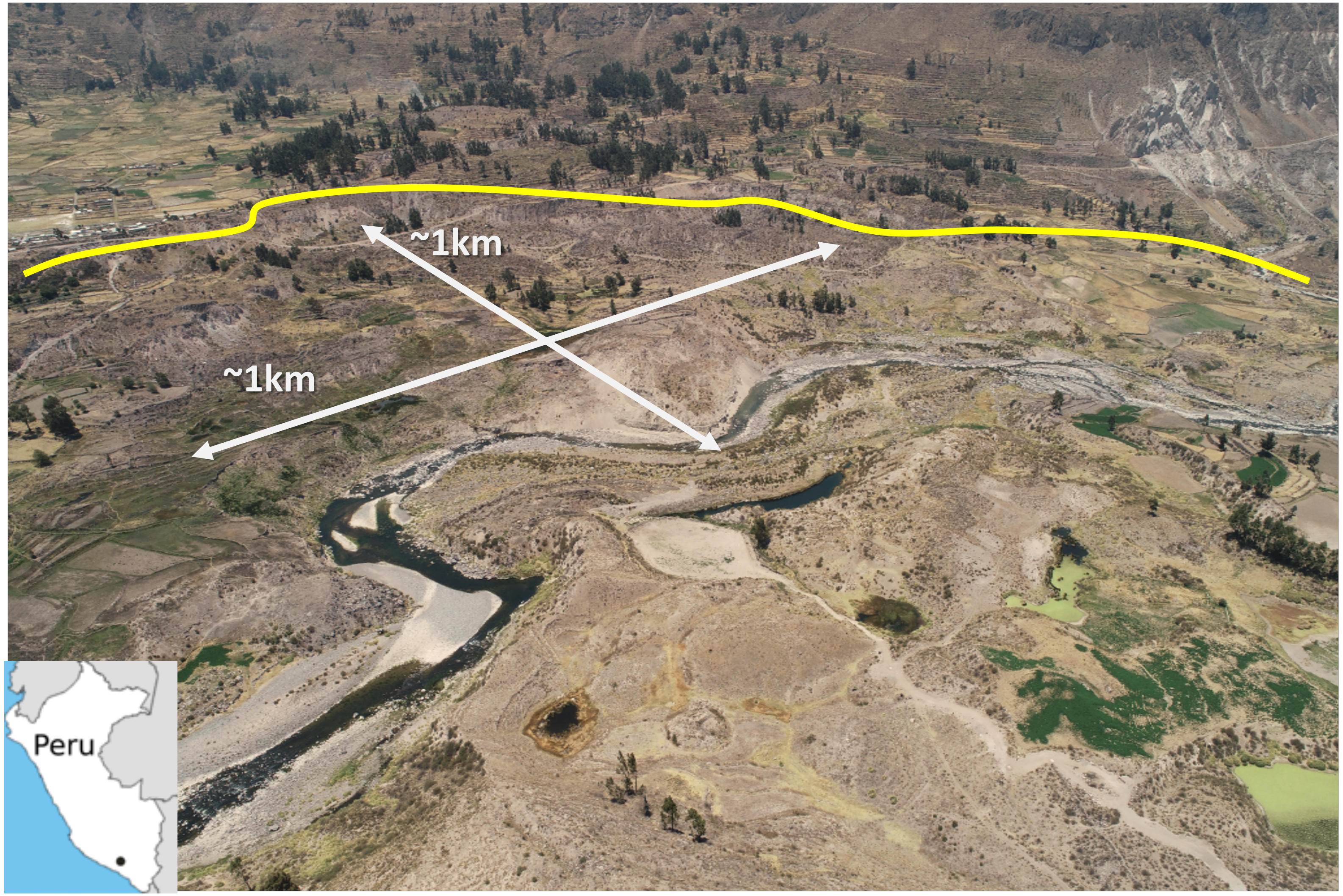
- Undergo acceleration and deceleration phases;
- We can monitor different physical parameters with time
- Allowing to better understand the mechanisms impacting their kinematic with time



Slow moving landslide are interesting to study the forcings impacting the dynamic of landslides in general

STUDY AREA

THE MACA LANDSLIDE



Maca Landslide, Photo: Edu Taipe

Landslide characteristics

(Zerathe et al. 2016)

- clay/silt compound slide with a rupture surface of uneven curvature

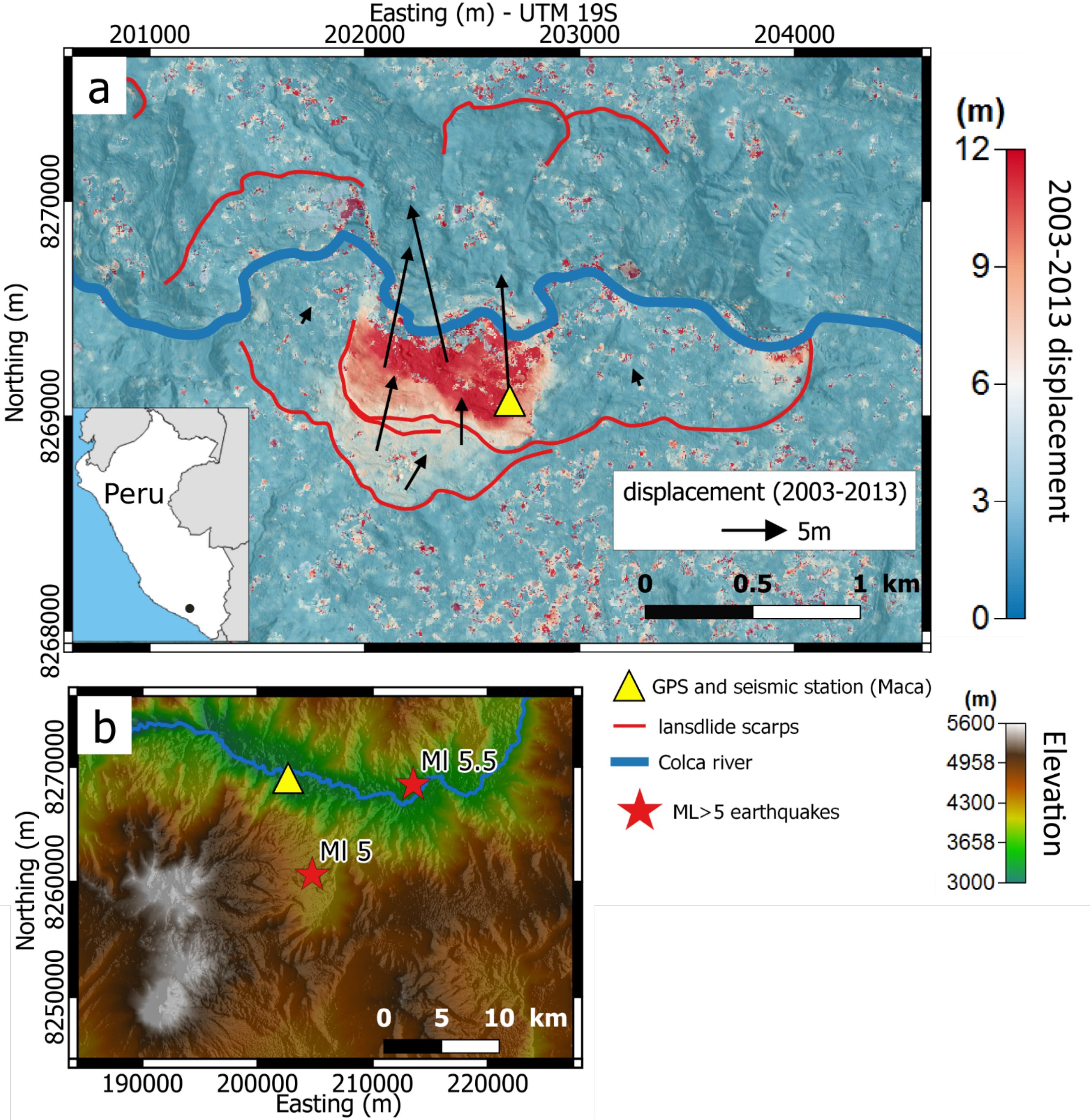
(Hungr et al 2014)

- 1 km over 1 km
- 60 million m^3

Landslide Forcings

- Homogeneous rainfall over all the site of study, and follows a seasonal cycle;
- Intense seismic activity;
- Colca river contributing to erosion;

MONITORING



Bontemps et al., Nat commun, 2020

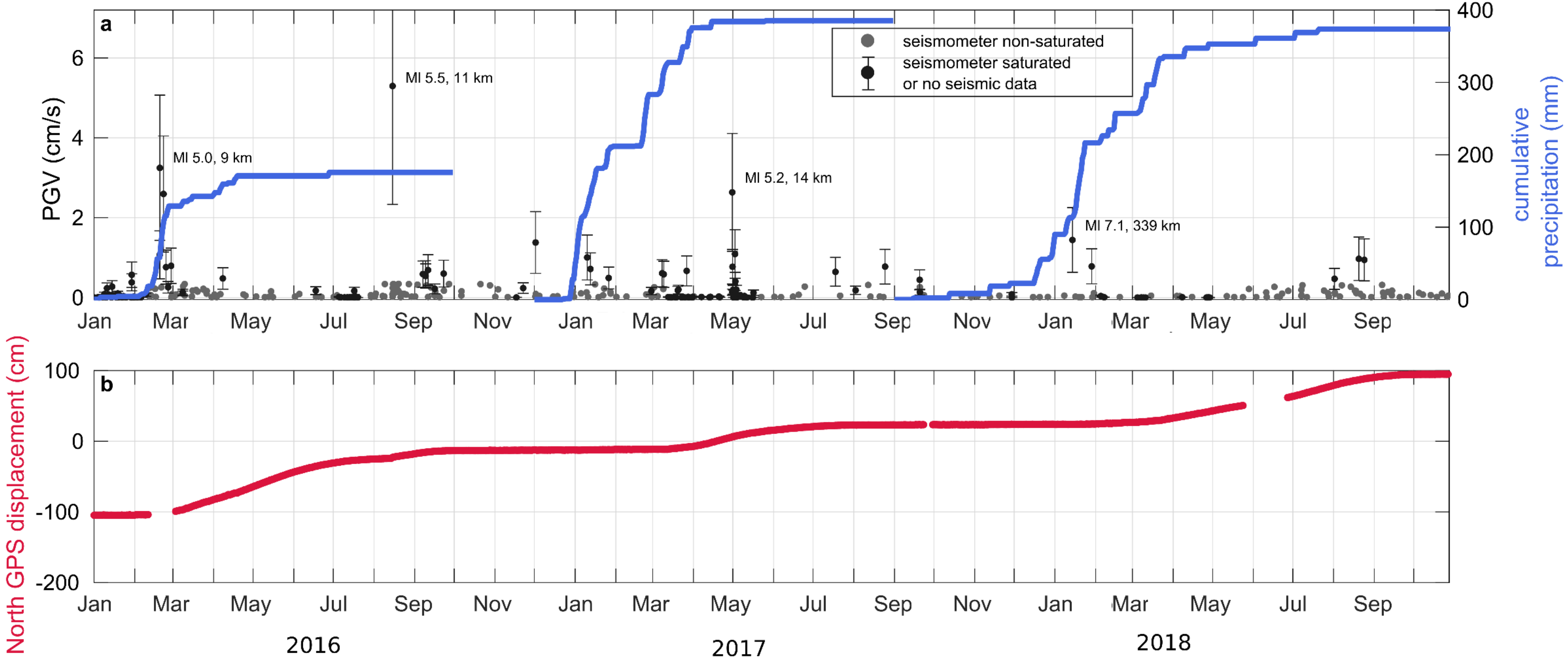
Photo E. Larose

Photo P. Lacroix

GPS and seismometer recording in continue since 2016

RESULTS

EGU General Assembly 2020



Bontemps et al., Nat commun, 2020

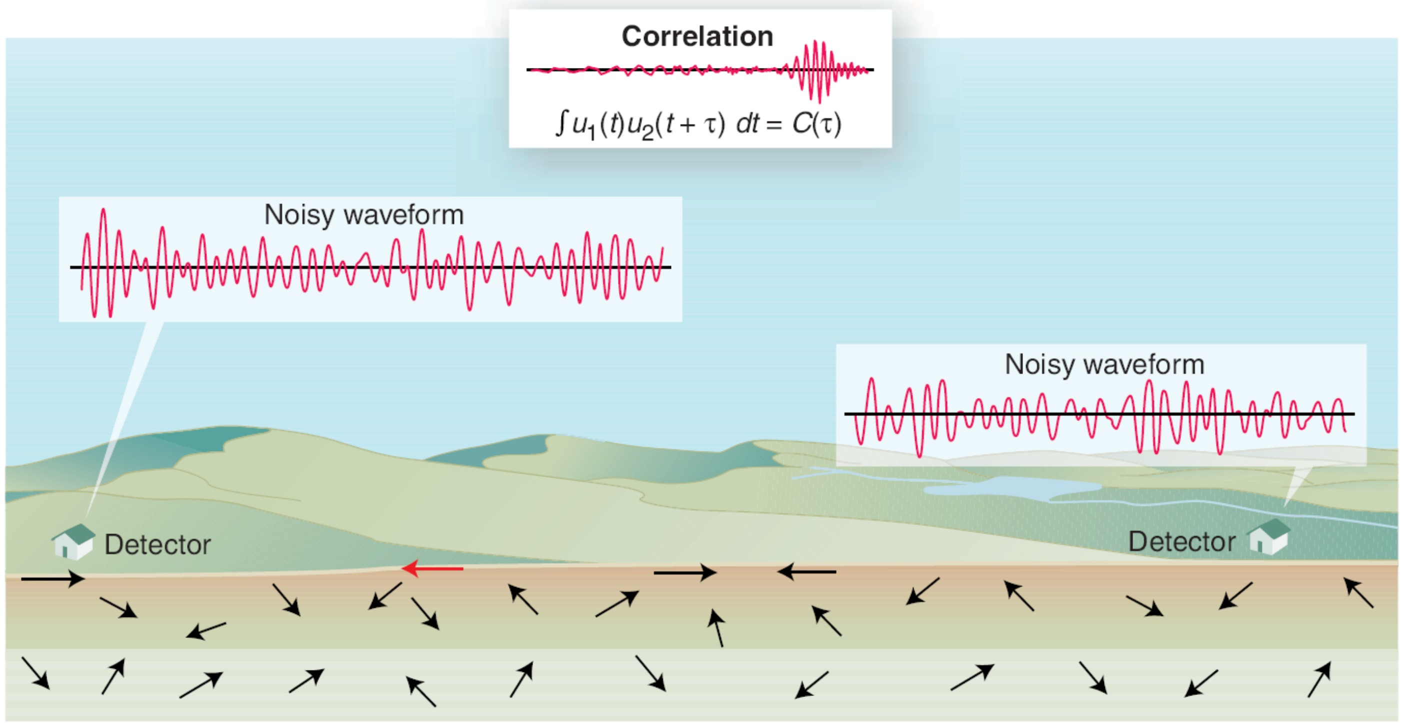
Twice more displacement during the rainy season 2016 than 2017 even though precipitations in 2017 were twice more important

METHOD

AMBIENT NOISE CORRELATION



Shear waves $Vs = \sqrt{\frac{\mu}{\rho}}$

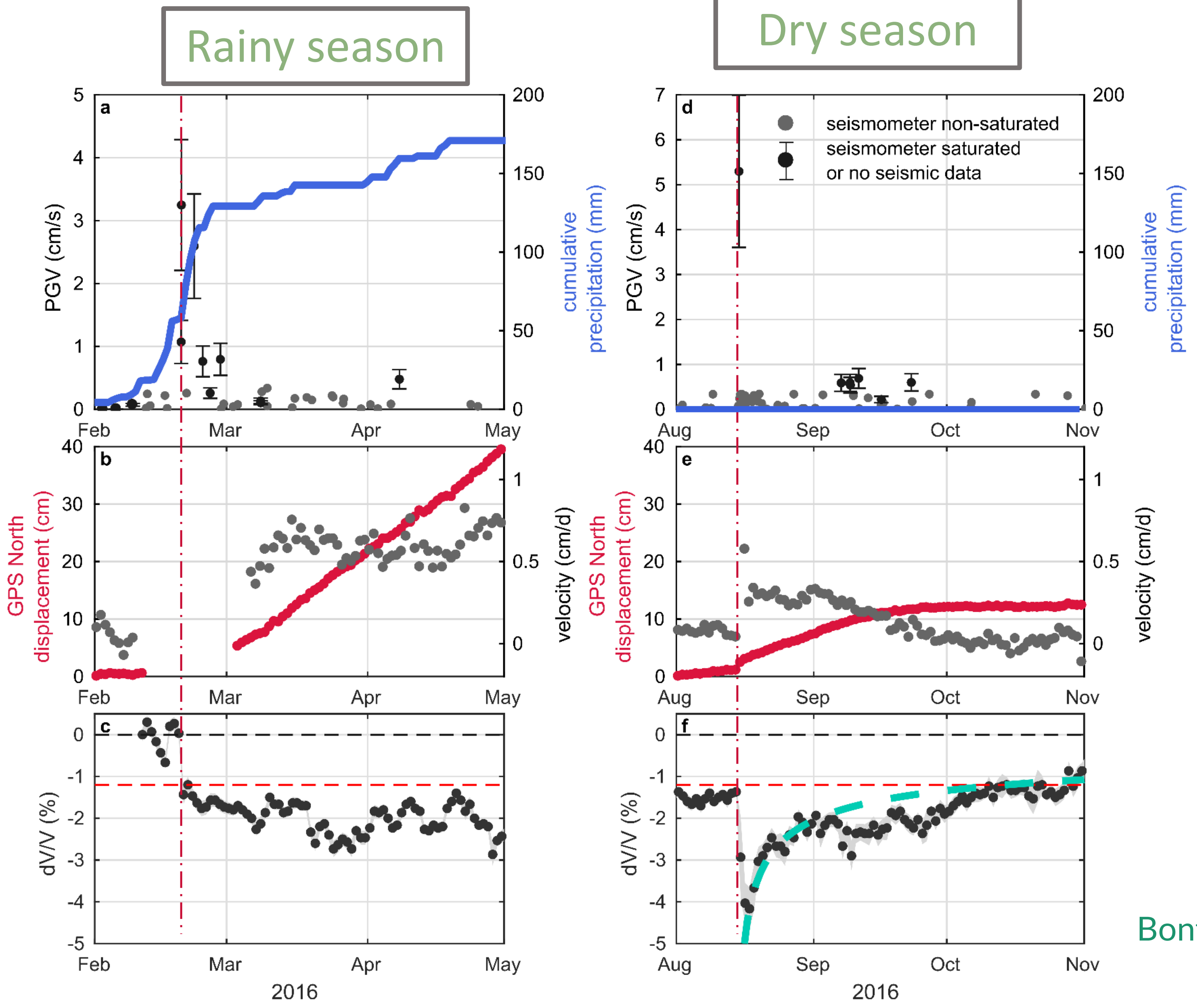


Weaver, Phys. Rev. Lett. 2001 & Science 2005

↘ Rigidity (μ)
↗ density(ρ)
} Vs ↘

For application on landslides see :
Mainsant et al., 2012
Larose et al., 2015

RESULTS

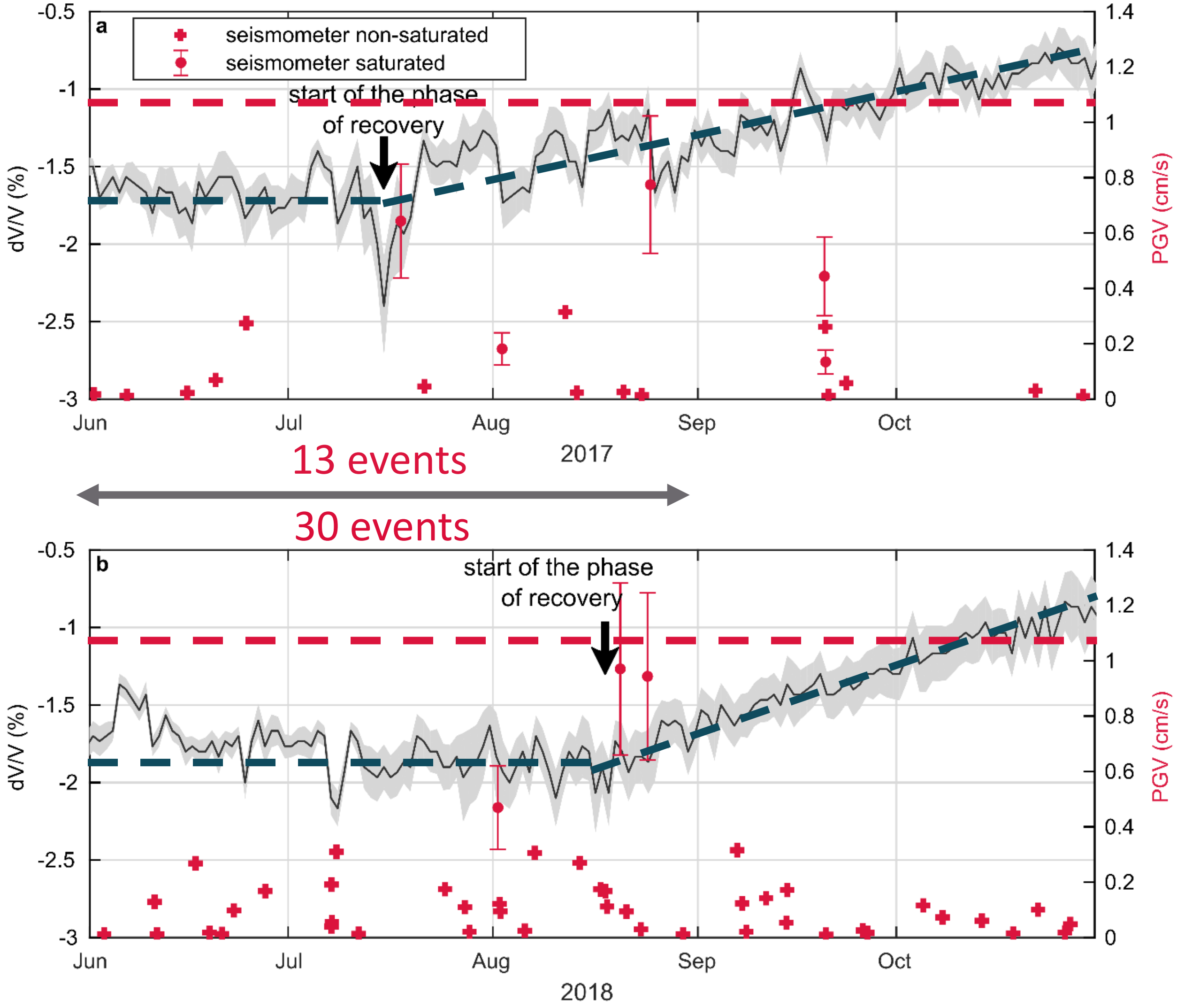


Damage of the soil is here the mechanism at the origin of the combined effect

Bontemps et al., Nat commun, 2020

RESULTS

EFFECT OF SMALL EARTHQUAKES



Bontemps et al., Nat commun, 2020

Recovery phase starts later in 2018 compared to 2017

difference in cumulative precipitations ?

delay in the rainy season ?

rate of low magnitude earthquakes

Small earthquakes combined with saturated soil can have an impact on the recovery of the rigidity of the soil

Observed in other study :
Durand et al., 2018 ; Wistuba., 2018

Existence of a **dv/v threshold** under which the landslide is in motion. **Important for the monitoring of this landslide**

CONCLUSIONS

- Observation of the combined effect of earthquakes and precipitation on the rigidity of the Maca landslide;
- Small events, when combined with a saturated soil can have a strong impact on the dynamic of the landslide;
- Existence of a dv/v threshold in Maca that could help with the risk management part of the landslide ?
- highlight the importance of the temporality between forcings on the dynamic of the slow-moving landslide of Maca.

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