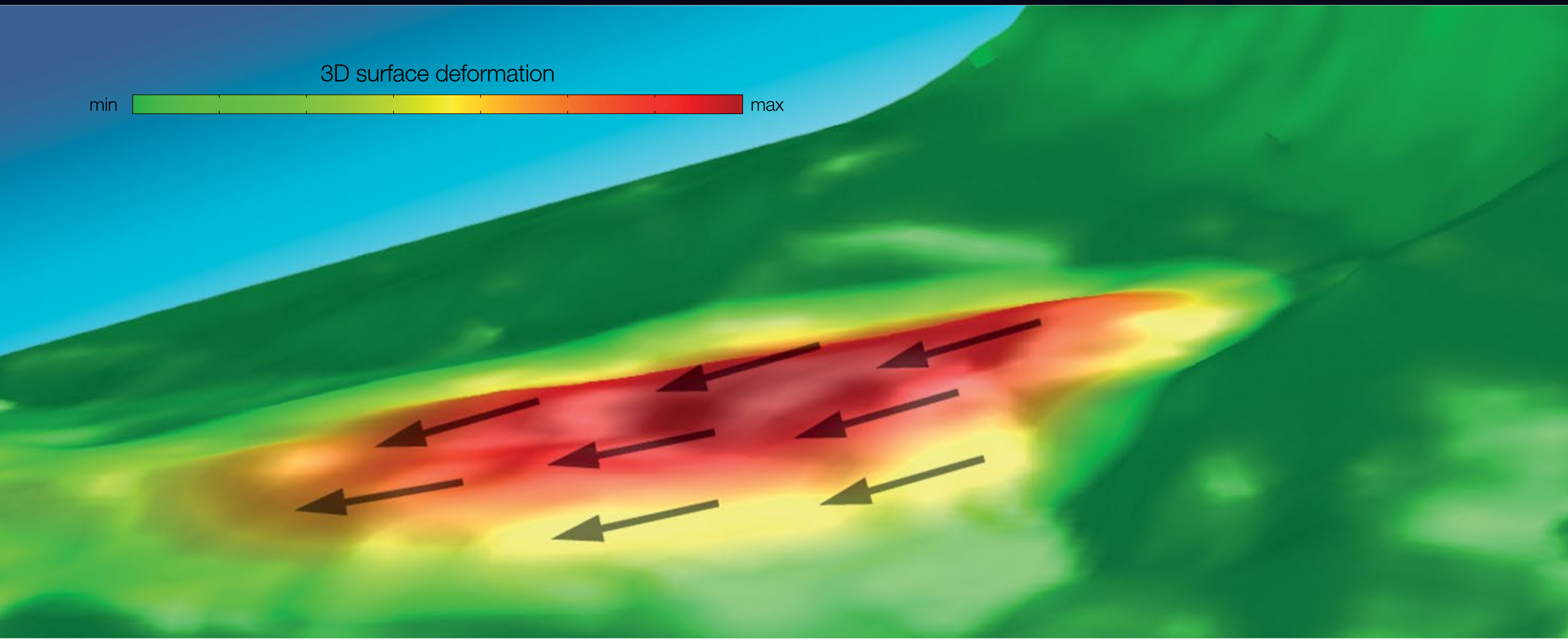
3DSDM

3D Surface Deformation Modelling

products



El Portalet (Huesca, Spain) 3D Finite Element model for an active landslide. Perspective view of a model predicting landslide velocity obtained from a 3D finite element analysis calibrated exploiting space-based Differential SAR Interferometry (DInSAR) products and ground-based inclinometer data.

WHAT

LAMPRE prepares 3D Surface Deformation Models (3DSDMs) exploiting advanced Finite Element Models (FEMs). A FEM is a numerical representation of the stress-strain behaviour of a slope, and can be used to predict the kinematical behaviour of slow moving landslides. To prepare 3DSDMs, LAMPRE combines advanced space-borne DInSAR products, *in-situ* monitoring data, and geological, geotechnical and groundwater information.

WHERE

The methods developed by LAMPRE allow preparing 3DSDMs for slow-moving landslides anywhere adequate time-series of surface and sub-surface displacements are available, together with topographic, geological, geotechnical and groundwater information. The methods are applicable to landslides of different sizes, and work best where continuous monitoring devices are available. 3DSDMs prepared by LAMPRE are well suited to predict the temporal evolution of slow-moving landslides in urban and sub-urban areas, and for landslides affecting infrastructures.

WHEN

LAMPRE can prepare 3DSDMs of slow-moving active landslides in a few weeks, provided that sufficient information of adequate quality is available.

WHO

Civil Protection authorities use 3DSDMs to anticipate the behaviour of slow-moving landslides for early warning and improved vulnerability and risk analyses.
Planning & development authorities use 3DSDMs to construct landslide scenarios for improved planning, and to investigate the efficacy of remedial and mitigation measurements.
Transportation authorities & utility managers use 3DSDMs to anticipate the impact of slow-moving landslides on transportation or utility networks.
Agricultural & forest agencies use 3DSDMs to assess the impact of slow-moving landslides on crops and forests.
Scientists use 3DSDMs to understand the kinematics of landslides in a changing climate.

SPECIFICATIONS

LAMPRE prepares 3DSDMs in a few to several weeks for single slopes or landslides. LAMPRE requires displacement time series of landslides and surface and sub-surface geological, geotechnical and groundwater information. LAMPRE delivers FEM 3DSDMs in the forms of plots, graphs and contour maps.

Key References
Tizzani et al. (2010) doi: 10.1029/2010JB007735
Calò et al. (2014) doi:10.1016/j.rse.2013.11.003
Lollino et al. (2014) doi: 10.1080/19648189.2014.985851

Copernicus Programme Taxonomy

	Land Monitoring	Emergency Management
Relevant for rush		
Relevant for non rush		

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under Grant Agreement nº 312384.

LAndslide Modelling and tools for vulnerability assessment Preparedness and REcovery management

LAMPRE

APPLICATIONS IN LAMPRE TEST SITES

LAMPRE has prepared 3DSDMs for the El Portalet (Huesca, Spain) and for the Ivancich (Assisi, Umbria, Italy) landslides. In both areas, the slow-moving, deep-seated active landslides affect structures and infrastructures, producing significant damage.

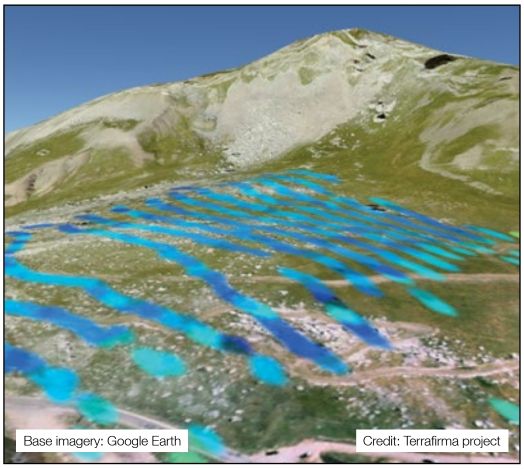


Fig. A - 3D view of the El Portalet active landslide. Blue colours show ground velocity obtained through DInSAR analysis.

Fig. B - Automated Inclinometer System (AIS) installed in the El Portalet active landslide.

To prepare the 3DSDMs, LAMPRE exploited Finite Element Modelling (FEM) to integrate *in-situ* monitoring data, surface and sub-surface geological, geotechnical and groundwater information, and surface deformation measurements obtained through advanced Differential SAR Interferometry (DInSAR).

The **El Portalet (Huesca, Spain)** active landslide extends for 0.35 km^2 with an estimated volume of about three million cubic meters. LAMPRE has measured the long-term movement of the landslide through space-borne DInSAR using ERS and ENVISAT SAR data acquired between 1992 and 2010 (Figure A). For the same landslide, continuous measurements of the surface and sub-surface displacements were obtained using GPS and inclinometer systems, including an Automated Inclinometer System (AIS, Figure B). LAMPRE determined the 3D kinematical evolution of the landslide using a 3D FEM constrained exploiting the available geological, geotechnical and groundwater information. A numerical procedure developed in COMSOL© Multiphysics software optimized the physical parameters needed to construct the FEM. The procedure determined the best-fitting kinematical behaviour of the landslide, compared to the available remote sensing and ground-based monitoring measurements (Figure C).

LAMPRE has developed a 3DSDM of the **Ivancich (Assisi, Italy)** active landslide (Figure D) using space-borne DInSAR measurements and geological, geotechnical and groundwater subsurface information. Inclinometer data were used to define the geometry of the sliding surface of the landslide. LAMPRE has obtained the best-fitting surface deformation field for the landslide through the minimization of the error between the numerical results and the measured landslide displacement rates (Figure D).

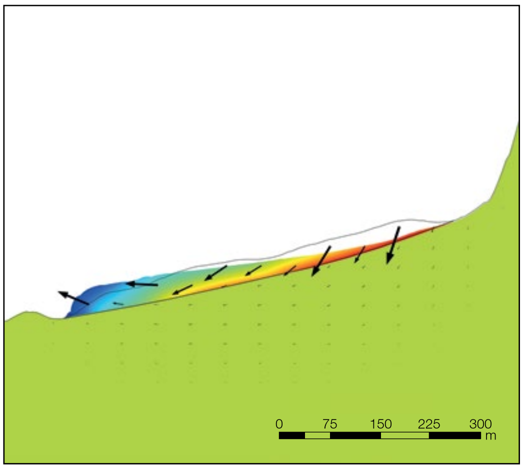


Fig. C - Cross section of the 3DSDM for the El Portalet active landslide obtained from a Finite Element model.

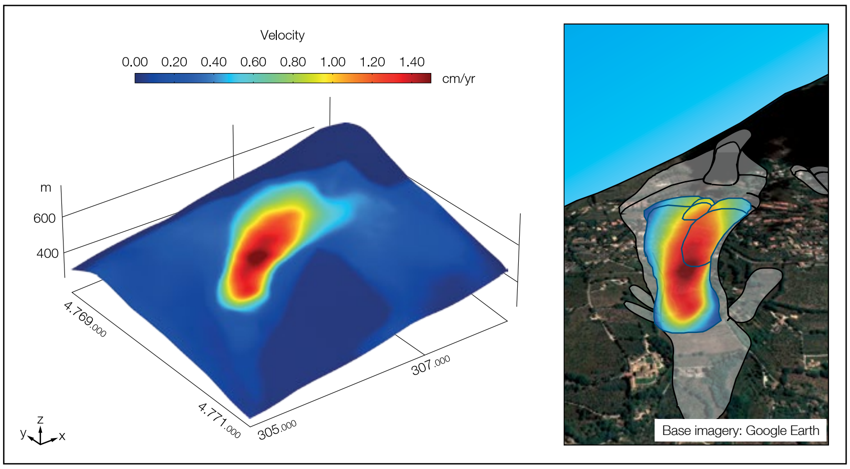


Fig. D - 3DSDM for the Ivancich (Assisi, Italy) active landslide (left) compared to a 3D view map showing landslides in the same area (right).

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