Geophysical Research Abstracts
Vol. 17, EGU2015-11502, 2015
EGU General Assembly 2015

3D Numerical Optimization Modelling of Ivancich landslides (Assisi, Italy) via integration of remote sensing and in situ observations.

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The new challenge that the research in slopes instabilities phenomena is going to tackle is the effective integration and joint exploitation of remote sensing measurements with in situ data and observations to study and understand the sub-surface interactions, the triggering causes, and, in general, the long term behaviour of the investigated landslide phenomenon. In this context, a very promising approach is represented by Finite Element (FE) techniques, which allow us to consider the intrinsic complexity of the mass movement phenomena and to effectively benefit from multi source observations and data.
In this context, we perform a three dimensional (3D) numerical model of the Ivancich (Assisi, Central Italy) instability phenomenon. In particular, we apply an inverse FE method based on a Genetic Algorithm optimization procedure, benefitting from advanced DInSAR measurements, retrieved through the full resolution Small Baseline Subset (SBAS) technique, and an inclinometric array distribution. To this purpose we consider the SAR images acquired from descending orbit by the COSMO-SkyMed (CSK) X-band radar constellation, from December 2009 to February 2012. Moreover the optimization input dataset is completed by an array of eleven inclinometer measurements, from 1999 to 2006, distributed along the unstable mass.
The landslide body is formed of debris material sliding on a arenaceous marl substratum, with a thin shear band detected using borehole and inclinometric data, at depth ranging from 20 to 60 m. Specifically, we consider the active role of this shear band in the control of the landslide evolution process. A large field monitoring dataset of the landslide process, including at-depth piezometric and geological borehole observations, were available. The integration of these datasets allows us to develop a 3D structural geological model of the considered slope.
To investigate the dynamic evolution of a landslide, various physical approaches can be considered according to the characteristics of the analyzed phenomenon. In present case, we focused on Newtonian approach by considering a creeping flow approximation, which are suitable to simulate the kinematical trend of the Ivancich landslide test site. This model is suitable to simulate soil material undergoing secondary creep (steady state creep), with the creep rate almost constant over time and depending on the current stress level of the soil.
The experimental results are very promising and clearly show that this numerical approach is able to simulate the spatial distribution and temporal evolution of the landslide kinematic, highlighting that the translational movement of such a landslide portion results to be the reason for the long-term instability. We conclude that the developed three dimensional physical model, built up by the integration of dataset derived from geological information and different measure platforms, represents an innovative and effective approach to improve the comprehension of the slow landslide processes.