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World Centre of Excellence (WCoE) 2017-2020
Progress Report Form 2019

1 January 2018 to 31 December 2018

1. **Short Title of WCoE**: Advanced Technologies for LandSlides (ATLaS)

2. **Name of Institution (Name of leader and email)**

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3. **List of core members**

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4. **Progress report of activities up to 31 December 2018 (up to 30 lines)**

The research activities, in the framework of the proposed WPs, are described below

WP1: Ground-based SAR interferometry for landslide monitoring and early warning.
In continuity with the previous activities, the Ground-based SAR interferometry was further exploited by DST-UNIFI for monitoring the deformational activities in space and time of unstable slopes threatening natural and anthropic assets and consequently for developing efficient operational strategies from first interventions to the application of more structured management systems.
During the last year the use of these instruments supported the emergencies that occurred with the triggering of Arquata del Tronto (Marche region) and Marano sul Reno (Emilia Romagna region) landslides. In both sites a real time monitoring activity was promptly organized for the purpose of managing the potential evolution of the ongoing collapse. Then the combination of deformation measured by the radar technology and rainfall intensity measured by the rain gauges was used to define criticality levels (warning thresholds) and the related operational phases (alert system). In the Arquata del Tronto case the GB-InSAR data interpretation were calibrated and specifically used also to evaluate the residual risk conditions in support of the traffic safety of an important provincial road at the foot of the collapsing slope (i.e., managing the supervised opening during specific time slots), as well as for the integration of the municipal emergency plan and the safety plan of the temporary construction site working for securing the slope.

WP2: EO (Earth Observation) data and technology to detect, map, monitor and forecast ground deformations.
The research activity of this year was aimed at using multi-sensor data (radar and multispectral), remotely

sensed by satellite, for the identification, mapping, monitoring and analysis of risk scenarios related to localized mass movements. Specifically, the activities concerned: 1) the control and support actions to emergencies situations in areas affected by geo-hydrological problems and active slopes instabilities, through multi-temporal interferometric satellite processing. The Moncenisio reservoir (France) and the urban area of Civitacampomarano (Molise region, Italy) were covered by this activity; 2) analysis of ground deformation velocity maps obtained by the processing of archive satellite radar data (2013-2018 COSMO-SkyMed) on the Moncenisio area. This operation was aimed at evaluating the slope instability phenomena (deep and superficial) that have affected, since historical times, both the shoulders of the earth dam (especially the one on the hydrographic left) and the natural slopes along the norther border of the Moncenisio reservoir; 3) deformations monitoring and statistical analysis of the displacement time series for the identification of anomalous deformation trends. This analysis was focused in Civitacampomarano town, in order to identify any anomalous velocity changes after the seismic sequence that affected the Molise Region in August 2018; 4) enhancement of the Sat.SAR system with inclusion of multispectral and hyperspectral optical data (Sentinel-2 images).

WP3: Coupling of short-term weather forecasting with geotechnical modeling for shallow landslide prediction.
The activity of this year has focused on study of soil properties variability as input data of physically based prediction models. A statistical study was performed to identify the main lithological units and the main land cover classes most frequently associated to shallow landslides and debris flows in Italy. Focusing on just 6 lithologies or 5 land cover classes, it is possible to account for almost 80% of the shallow landslides occurred in Italy. This result is important to optimize and prioritize the efforts in collecting soil properties and to obtain reliable reference values to be applied in the largest possible set of case studies with little amount of new calibration measures. A geodatabase was built to collect, homogenize and organize relevant information on soil properties coming from different sources. The objective is to allow the expansion of the dataset with the results of new and old tests, using a standard that allows an effective use in HIRESSS with reduced pre-processing efforts. HIRESSS code was modified to speed up calculations (thus increasing the lead time of forecasts). Failure probability maps are now produced at hourly time steps and at daily aggregations and it is possible to use a raster of bare rock areas as an additional input layer, to filter-off from the calculations the area where soil is absent and shallow landslides cannot occur. Moreover, the effect of root reinforcement in the modelling was improved by considering the 4th level of classification of the Corine Land Cover map. All these new features were tested in the Valle d'Aosta case study, obtaining satisfactory results, since a reduction of false alarms with respect to previous tests was observed.

5. Plan of future activities (up to 30 lines)

The planned future activities in the framework of **WP1** will concentrate on the definition of automatic methods and operational protocols for the technical and scientific support in the procedures for managing an early warning system (EWS) both in the overcoming of the emergency early stage and in the management of possible contingent situations (e.g., management of the safety of construction sites, support for targeted and planned interventions such as blocks removal, opening of roads to traffic and so on). The synergistic use of rapid mobile units for localized investigations based on terrestrial, marine and airborne sensors will support, as a sensor network where feasible, the fielded radar instrument according to specific site needs.

For year 2019 the activity proposed in the framework of **WP2** will rely on the full implementation of Sentinel-1 radar images as operative tools for ground motion monitoring at regional scale. Thanks to the experience gained in the last year, Sentinel-1-derived deformation data are now ready to be used for active hydrogeological phenomena mapping and motion changes early detection in different environmental contexts. In particular, these interferometric products will be tested in hilly and mountainous areas where climatic and topographic effects can limit the obtainable results.

The activity of the **WP3** in the next year will focus on the expansion of the geodatabase of soil properties with new measures and inclusion of the results of past tests contained in the archives of the Earth Science Department of the University of Florence. The WP will then focus on the applications to existing and new test sites of the HIRESSS model and will particularly concentrate on different approaches to spatially aggregate the probabilistic results for early warning and for model validation.

6. Publication (in Landslides, proceedings, meeting reports, or WEB)

Carlà T.; Intrieri E.; Di Traglia F.; Nolesini T.; Gigli G.; Casagli N. (2018). Reply to discussion on “Guidelines on the use of inverse velocity method as a tool for setting alarm thresholds and forecasting landslides and structure collapses” by F. Bozzano, P. Mazzanti, and S. Moretto, LANDSLIDES, 15(7), 1443, 1444

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Frodella W.; Ciampalini A.; Bardi F.; Salvatici T.; Di Traglia F.; Basile G.; Casagli N. (2018). A method for assessing and managing landslide residual hazard in urban areas, LANDSLIDES, 15(2), 183, 197

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Zhou C.; Yin K.; Cao Y.; Intrieri E.; Ahmed B; Catani F. (2018). Displacement prediction of step-like landslide by applying a novel kernel extreme learning machine method, LANDSLIDES, 1, 15

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