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InSAR techniques for supporting landslide investigations:

a regional and a local case studies from ESA-Terrafirma project

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Terrafirma is an initiative funded by ESA (European Space Agency) in the framework of GMES (Global Monitoring for Environment and Security). The project aims at providing pan-European services based on the latest technology to measure terrain motion from satellite InSAR data relating to subsidence, landslides, crustal deformation and volcanic deformation and informing specialists, planners and community about the new approach to the assessments of risks from ground movements across Europe and beyond.

The technology at the base of the project uses the data collected by European radar satellites, namely ERS1, ERS2 and Envisat processed through SAR interferometry (InSAR). by using state-of-the-art InSAR processing techniques, such as the Persistent Scatterers approach, thanks to the available archive of repeated satellite data, measurements of ground displacements with a millimetre scale accuracy can uniquely be provided back in time for the last 15 years coupled and integrated with conventional geomorphologic tools.

The most involved users are represented by National Civil Protection Agencies and public authorities in charge of landslide risk management at national or local level.

The present work is focused on the description of the results obtained in the Stage 2 of the service for landslide mapping at regional scale in the Canton Graubünden (Switzerland) and landslide monitoring at local scale for the Gorgoglione landslide (Italy).

The analysis, concerning the Canton Graubuenden (Switzerland), for supporting landslide investigation has been carried out through a combined approach based on the use of multi-interferometric analysis and photo-interpretation.

Canton Graubuenden is located in the Swiss Alps between the Gotthard Cristalline Massive and Austrian-Italian Border. This densely populated region is a landslide prone area. There are also many installations for touristic purposes in the unstable slopes, sometimes they are located in the Permafrost areas. Between St. Moritz, Chur and Disentis many other landslides are still active and there are high annually costs for mitigation and countermeasures. The damage concern inhabited areas, industrial zones and many roads in lateral valleys.

For the Canton a complete landslide inventory is not available, but several of the large landslides are known and the geological documents and field surveys have allowed an integration of InSAR technique for hazard assessment.

The analysed area has an extension of about 3800 km^2. Radar datasets used are SAR images acquired by ERS1 and ERS2 satellite (spanning the temporal interval from 1992 to 2002) acquired both in ascending and descending geometry and SAR images from ENVISAT satellite (spanning the temporal interval from 2002 to 2006) acquired both in ascending and descending geometry processed through the Interferometric Point Target Analysis (IPTA) technique developed by Gamma Remote sensing. IPTA analyses allowed to investigate and confirm most of the large known landslide and allowed to identify several new landslides.

The local case study is related to Gorgoglione landslide. Gorgoglione is a small village located in Southern Italy (Basilicata region), affected by an ancient landslide, reactivated during the Irpinia earthquake (1980), as testified by its classification as area at moderate - to - very high risk (class R4) reported in the PAI (Hydrogeological Asset Plan of the Basin Authority). Following an acceleration of the ground movements observed between late 2003 and the summer 2004, which induced the evacuation and the demolition of several buildings, field surveys, carried out by experts from GNDCI (National Group for Geo-hydrological Disaster Prevention of the Italian funded by the CPA), highlighted the presence of a general slope instability in the portion of the village located below Piazza Zanardelli. After the 2003-2004 acceleration in situ instrumentations has been installed by the Gorgoglione municipality, but the causes of the slope movements are still under investigation. The village has been proposed by the Italian Civil Protection Department for a Landslide Monitoring product for Terrafirma service. The result of InSAR analyses performed on historical ERS1/2 data and current ENVISAT data through the Permanet Scatterers technique developed by POLIMI, in advanced mode, highlight the presence of ground displacement perfectly

correspondent to the portion where damage were registered and also confirm the acceleration occurred in the 2003-2004, the analyses had allowed to spatially extend the information for the geological interpretation regarding the area affected by the slope instability and allowed to make comparison with in situ data instruments.

Both the results confirm the capabilities of multi-interferometric InSAR data, integrated and coupled with conventional techniques and in-situ data, to support landslides investigation at regional and local scale.