



## Executive Summary

# SLAM Service for Landslide Monitoring

*The SLAM project, funded by ESA (European Space Agency) as part of the DUP program (Data User Programme), concerns the implementation of landslide event mapping and monitoring services. The services are tailored according to the requirements defined by national and local organizations that are involved in slope instabilities assessment and hydro-geological risk mitigation in Italy and Switzerland.*

## Objectives

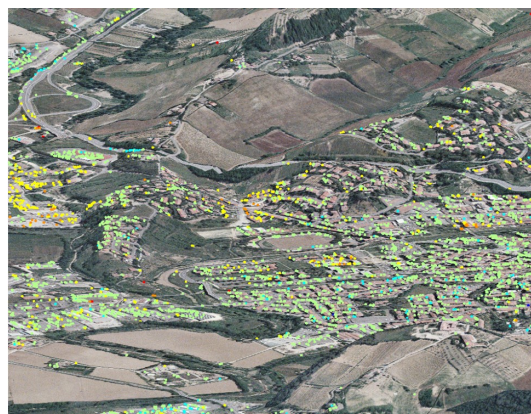
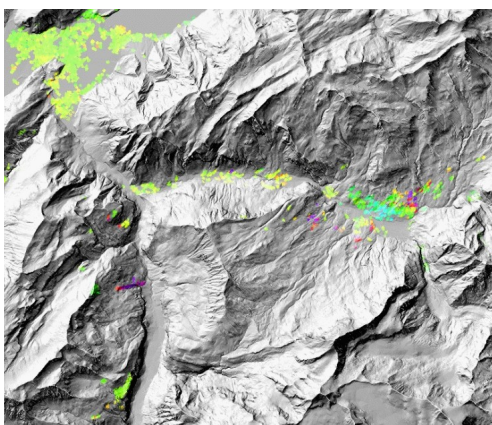
The main objective is to develop and qualify a complete service meant to supply products, which are derived from the integration of the satellite data with information acquired in situ, and that can facilitate operational activities of those Institutions that are in charge of hydro-

geologic risk management. In particular, SLAM is designed to realise three types of products:

- 1. Landslide Motion Survey;**
- 2. Landslide Displacement Monitoring;**
- 3. Landslide Susceptibility Mapping.**

## Landslide Motion Survey

The *Landslide Motion Survey* identifies the areas affected by landslides for the whole hydrographic basin, or for a significant portion of it. This large scale product could be a useful support for the geological risk service agencies in their activities related to the update of landslide inventories and the planning of structural intervention.



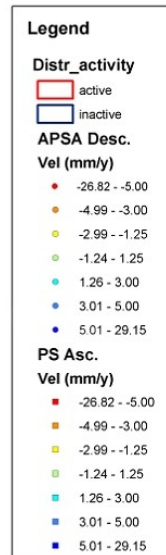
In Italy, the service is developed for the whole extent of Arno river basin (about 9,000 km<sup>2</sup>) and over an area of about 900 km<sup>2</sup> in Campania region. Meanwhile in Switzerland, the service covers the geographic areas of eastern Valais and Berne Cantons and Tre Valli region in Ticino Canton.

## Landslide Displacement Monitoring

This product allows the monitoring of the areas of interest on a reduced scale basis. The objective is to accurately quantify the deformation velocity of unstable areas through the displacement rate measurement of some points located within identified landslides.

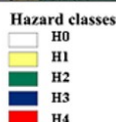
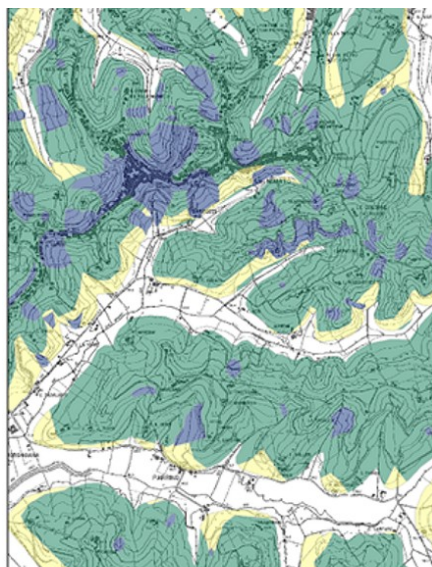
The outputs could be used to monitor the areas characterized with high hydro-geological risk, and to test the effectiveness of structural interventions.

In Italy the Landslide Displacement Monitoring is implemented for Arno River Basin in the test sites of Pelago, Poggibonsi, Chianciano and Capannori municipalities and in the following four landslides sites in Campania region: San Marco dei Ca-



voti, Pesco Sannita, Reino and Campolattaro. For Switzerland, the product is provided for some landslide test sites in Berne, Valais, Fribourg and Ticino Cantons.

## Landslide Susceptibility Mapping



The Landslide Susceptibility Mapping classifies the area of interest with respect to different classes of landslide risk. The product is realized through the integration of the information concerning the millimetric ground displacements, resulting from the two products above, with the thematic maps of land use, slope, geomorphology, and more. The Landslide Susceptibility Mapping could support geological hazard mapping and could be considered as an important tool for land use planning and environmental impact assessment. In Italy this product is realized only on Arno basin, while in Switzerland, the area around Grindelwald in Berne Canton has proved to be the most suitable test site.



## The Team

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*The realization of SLAM project, entirely funded by ESA, is carried out by an international Consortium led by Planetek Italia (I) and formed by other five partners: Tele-Rilevamento Europa (I), Gamma Remote Sensing (CH), Spacebel (B), Geotest (CH) and Florence University, Earth Science Department (I).*

SLAM involves three end users organizations working at national level in Switzerland and in Italy: the Federal Office for Water and Geology (FOWG), the Italian Ministry of Environment and the Italian National Research Council Group for Hydro-geological Disaster prevention (GNDCI).

The Federal Office for Water and Geology (FOWG) belongs to the Administration of the Swiss Federal department for the Environment, Transport, Energy and Communication (DETEC). The FOWG is the confederation centre regarding water use, water management, hydrology, geology, and natural hazards of flooding, earthquakes, and distribution of earth masses. It is the Swiss national body that will coordinate the Canton final users involved during the product validation and the results dissemination of the SLAM products and services.

The Italian Ministry of Environment, in particular the Directorate for the territory Protection (*Direzione per la Difesa del Suolo*) is involved to draft guidelines and strategies for the territorial planning of Italy. In the project, the Italian Ministry of Environment plays the role of coordinator of the local administrations which take part to the operational phases and to the results dissemination.

The Italian National Research Council Group for Hydro-geological Disaster prevention (GNDCI) is a research network of the Italian National Research Council (CNR). It is the operating group of the Italian Civil Protection Department (*Dipartimento della Protezione Civile*, DPC) for issues related to hydro-geological disasters and coordinates the scientific activities in the fields of civil defence against flood, landslides, aquifer deterioration and coastal erosion. It is the Italian institu-

tion that will be involved during the refinement of the product requirements, the validation, the service assessment and the results spreading through international conferences, meetings and scientific papers.

This project will involve the following local institutions:

- ♦ Arno National Basin Authority, Italy
- ♦ Regione Campania, Assessorato all'Ambiente e alla Difesa del Suolo, Italy
- ♦ Canton of Berne, KAWA - Forest Office - Natural Hazard Division, Switzerland
- ♦ Canton of Valais, DTEE, Department of transport, equipment and environment - CREALP, Centre de Recherche sur l'Environnement Alpin, Switzerland
- ♦ Canton Fribourg, SeCA, Service des constructions et de l'aménagement – Section Geology and Natural Hazard, Switzerland
- ♦ Canton Ticino – Ufficio dei Pericoli Naturali degli Incendi e dei Progetti, Switzerland

The Basin Authority, Regione Campania and the Swiss Cantons have been involved in the technical discussion regarding the consolidation of the users requirements; they have also put at disposal of the Consortium the data needed for finalizing the products. In addition the personnel from these institutions are involved both in qualification of the products and providing support during the technical evaluation of different outputs.

## Operative Phases

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The project is organized in two phases. The Phase I began in May 2003 and addressed the following:

- ♦ **Service Consolidation**  
(May 2003 - July 2003)

During this phase the Consortium, in collaboration with the users, has carried out a further check of the user requirements to be utilized during the realization of the products and services. Moreover the test sites identification and the acquisition of available data have been finalized.

- ♦ **Service Prototyping**  
(July 2003 - February 2004)

The objective is the realization of a service prototype which includes the planning and the preliminary carrying out of the service for some test sites. The pre-qualification and product refinement have been realized at the end users through a comparison with ground truth data.

The Phase II is started at the middle of April 2004 and addresses the following:

- ♦ **Service Implementation**  
(April 2004 - November 2004)

It concerns the service implementation for all the test sites, on the basis of the user requirements consolidated during the previous phase; it continues on with the final service qualification and the service critical assessment by the end users.

- ♦ **Results spreading and promotion**  
(November 2004 - March 2005).

It includes a service sustainability study, in terms of costs and benefits analysis and a set of dissemination activities with workshops, symposiums and scientific papers. These activities are meant to promote the advantages of Earth Observation (EO) data utilization for an effective monitoring policy of land management. In fact, availability, continuity, coverage and accuracy could make the EO data a particularly valuable tool for the environmental planning.

## Methodology

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For the Italian test sites the technique of the Permanent Scatterers (PS technique) will be used. It has been developed and patented by the Politecnico di Milano (Italy) and improved by Tele-Rilevamento Europa. This methodology allows to estimate the measure and the displacement velocity on millimetric scale, of some points on the ground.

The methodology applied for the Swiss test sites will be the multi-interferometry SAR: Interferometric Point Target Analysis (IPTA), developed by Gamma Remote Sensing. This methodology allows to evaluate the motion rate of some points within the area of interest.

The analysis of the optical images with high spatial resolution (acquired by IKO-

NOS and SPOT5), is carried out by SPACEBEL and allows the automatic extraction of features related to landslide presence. The Geological Analysis is performed by UNIFI (Earth Science Dep.) and Planetek Italia for the Italian service cases and by GEOTEST for the Swiss service cases. This step foresees the integration of the data coming from the interferometric techniques with the ground based information.

The data integration in a GIS environment is realised by UNIFI and Planetek Italia, in aim to facilitate their use within the current monitoring practices.

The SLAM products have been defined according to the user requirements, and developed starting from the methodolo-

gies actually employed in the risk management; in this way they can be easily merged in the user database. For these reasons SLAM could be considered a service adaptable to the current landslide

management procedures compatible with the traditional methodologies actually adopted by the end-users.

## Expected Results

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All the users involved in the project will receive free of charge the outputs realized for their areas.

SLAM products are innovative instruments for the identification of the unstable areas on a large scale basis, easy to manage by the public administrations and to some extent by the civil protection authorities. In fact they are defined and developed according to the user requirements (e.g., scale, information contents, and updating frequency), as well as the requirements indicated in the Italian and Swiss legislation.

The integration of the data acquired by

traditional methodology and by Earth Observation into the user GIS environment, allow a comprehensive spatial analysis for areas subject to slow movements on regional and local scale. Furthermore SLAM will allow to enhance the database of the hydro-geological risk agencies building an historical data collection of the area of interest. This in turn could be useful for the future studies and for a more objective land management.

*For more information, visit the web site:*  
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