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Remote sensing: a tool for landslide investigations at a basin scale

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Traditional methods used for mapping slope instabilities can benefit from the use of remote sensing systems which allow rapid and easily updatable acquisitions of data over wide areas, reducing the field work and the costs. Although several attempts in employing remote sensing techniques for this purposes have been carried out in the last years, especially in the optical region of the electromagnetic spectrum, the use of such data for a systematic and generalized use has rarely been successful. The recent advances in the optical satellites capabilities (e.g. high spatial resolution, stereoscopic capabilities), the development of new robust techniques based on the interferometric analysis of radar images, such as the Permanent Scatterers (PS) and the possibility of integrating these data within a Geographical Information System (GIS) have dramatically increased the potential of remote sensing for landslides investigations.

As part of the SLAM project (Service for Landslide Monitoring) of the European Space Agency (ESA), a methodological approach has been developed to integrate interferometric information coming from the Permanent Scatterers analysis with the interpretation of optical images. The method relies on the possibility of giving a spatial meaning to the point-like quantitative ground deformation measurements provided by the PS technique, through the interpretation of remotely sensed imagery (both from satellite and airborne platforms), topographic maps and ancillary data.

The Arno river basin (Central Italy), with a spatial extension of about 9000 km2, has been chosen as test basin for the presence of a high number of mass movements (up today about 300 areas at high landslide risk and more than 27,000 individual

landslides have been mapped from the institutional authorities) and for its significance with respect to the Italian Apennine territory.

EO-data have been employed at a basin scale as a support of landslide inventory mapping and of hazard mapping. The methodology proposed and applied for landslide mapping relies on the possible integration of ground deformation measurements on a sparse grid of points provided by the PS analysis within a pre-existing landslide inventory map produced with traditional geomorphologic tools. Such an approach has allowed a better definition of boundaries of already detected mass movements or of their state of activity and the detection of unknown unstable areas.

On the other hand EO-data have been also employed for the creation of a landslide hazard map. Remote sensing data have been used in two different ways. For a portion of the basin the inventory map, produced as previously described, has been used for evaluating the weight of each one of the landslide-factors (e.g. lithology, terrain slope, terrain curvature, contributing area, etc.) through a neural network analysis (ANN). In another portion of the basin the PS have been employed for validating the spatial and temporal prediction of landslide occurrence provided by the hazard map produced by means of a neural network analysis based on a pre-existing landslide inventory map.