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LANDSLIDE CASE STUDY: LUMNEZ, SWITZERLAND

OVERVIEW

The Lumnez valley, located in the Canton of Grisons, Switzerland (Figure 1a), is one of the most active landslide zones in the built-up area of the Swiss territory. The valley has a landslide-affected flank, which is characterised by an active deep-seated roto-translational sliding process. The landslide covers an area of 32 km^2 and affects a population of over 2000 people across 8 villages .

Figure 1a: The study area.

[DEFORMATION ANALYSIS]

A Persistent Scatterer Interferometry (PSI) analysis was performed over the landslide using 68 ascending Synthetic Aperture Radar (SAR) scenes from ERS and Envisat sensors spanning from 1992 to 2005. Within the landslide area 1,256 PSI points were identified which show a higher density in correspondence to the villages. Figure 1b shows the results of the analysis, providing the estimated mean velocity of displacement along the satellite line of sight (LOS). The negative velocities correspond to points moving away from the sensor, approximately from west to east for this study. Positive velocity values, which would correspond to upslope movements, are not present. Stable areas at the marginal parts of the slope are visible, the central part of the slope is characterised by moderate displacements, while towards the south there is a zone of high displacement.

The estimated velocities represent relative deformations with respect to a reference point located outside the sliding area. Considering that the movements of the slope are approximately slope-parallel, the LOS mean displacement velocity can be corrected to get slope-parallel velocity by multiplying by a conversion factor of approximately 2.

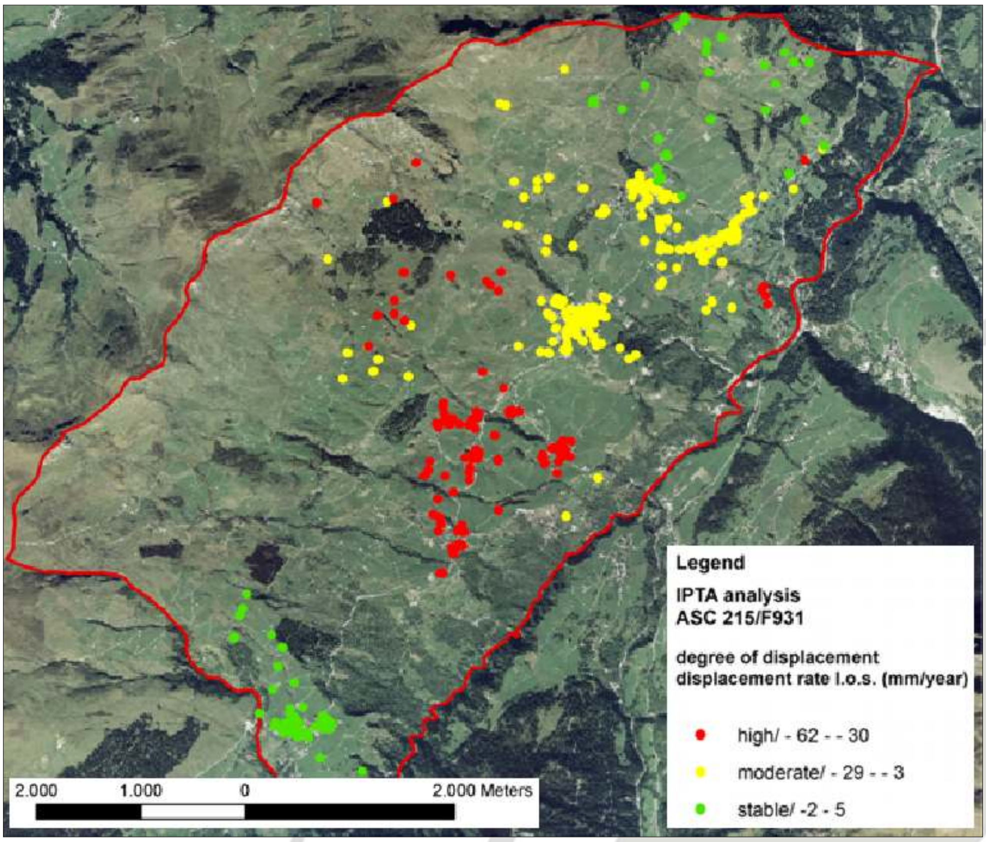

Figure 1b: Results of the PSI analysis, where the mean velocities of the displacements are grouped in three classes: stable, moderate and high deformation areas.

[VALIDATION]

The PSI results were compared with those from topographic surveys made by Ecole Polytechnique Federale de Lausanne (EPFL) in the period 1887-1992 (Figure 2a). Despite the very short temporal overlap between the PSI and topographic data, the agreement between the two data sets is evident. In particular, they show the same spatial pattern of displacements. Note that the topographic velocity values refer to the whole period 1887-1992: this explains part of the discrepancy in terms of magnitude of velocities. Besides the above comparison, observations carried out in the field showed the effects of the landslide deformation on infrastructures and geomorphologic features.

[INTERPRETATION]

Following the Swiss landslide classification based on the mass movement velocity, the PSI points were re-classified into three groups: sub-stabilized (slope-parallel velocity < 2 cm/yr), slow (2 - 10 cm/yr) and active (> 10 cm/yr). Such a classification was then employed to estimate the level of landslide intensity of each of the villages affected by the slope movements, which is used for landslide hazard assessment purposes. The PSI points were used to derive an improved geomorphologic zonation of the area (Figure 2b). In fact, besides the information derived from the DEM and aerial images, the PSI results allowed the separation of sectors of the slope characterized by homogenous morphologic features and state of activity.

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[CONCLUSIONS]

The analysis of the Lumnez landslide provided interesting data related to its activity and the spatial distribution of ground displacements. The validation of the PSI results against topographic data showed a strong agreement between the two data sets. Furthermore, the PSI results are in agreement with the in-situ observed effects of the landslide deformation on infrastructures and geomorphologic features. The deformation velocities estimated by PSI were used to estimate the level of slide intensity of the villages included in the landslides, a key input for landslide hazard assessment. Finally, the PSI velocities were used to derive an improved geomorphologic zonation of the area at hand. From this case study, considering the high costs related to landslide activity and the difficulties in the detection of the active, slow, and dormant landslides, one may state that the use of PSI can positively impact the current hazard mitigation activities of local authorities.

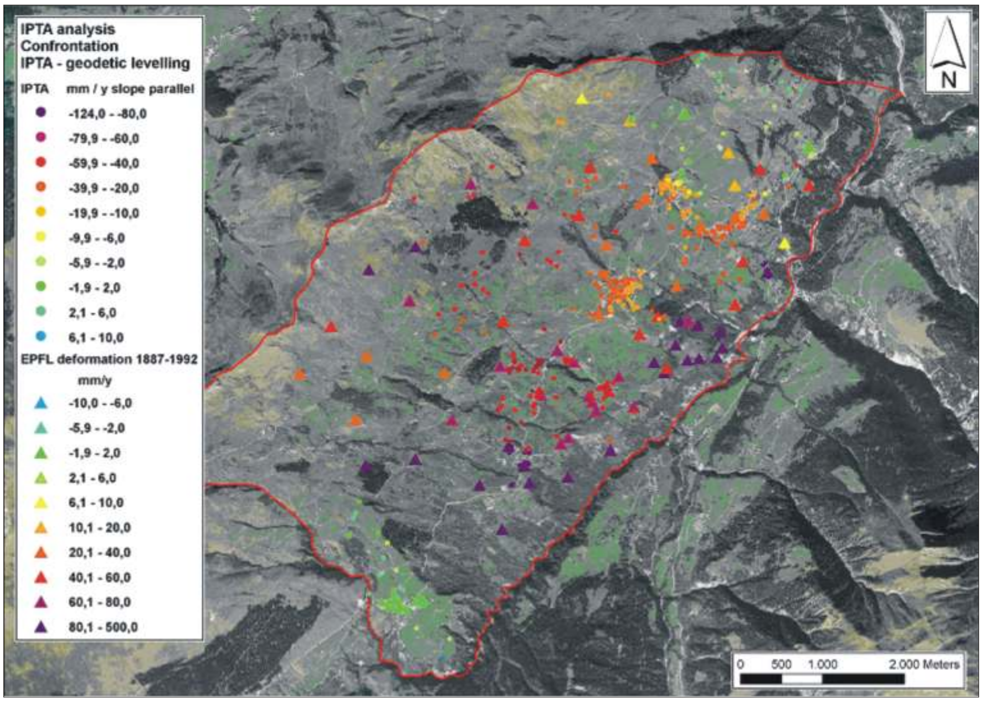

Figure 2a: Comparison of the PSI results with those coming from topographic surveys. The legends indicate slope-parallel deformation velocities, and the same colour scale is used for PSI and topographic results.

[ACKNOWLEDGEMENTS]

This report forms part of the work carried out for the ESA funded 'Terrafirma' project (ESRIN/Contract no. 17059/03/I-IW). The PSI processing was performed by Gamma Remote Sensing (Switzerland), while the analysis and interpretation was carried out by the Earth Sciences Department of the University of Firenze (Italy). The FOEN provided the DEM used in this study, while the topographic data used for the PSI validation were acquired by the EPFL. For further reading, see Raetzo et al., Monitoring of Lumnez landslide with ERS and Envisat data, Envisat Symposium, April 2007, Montreux.

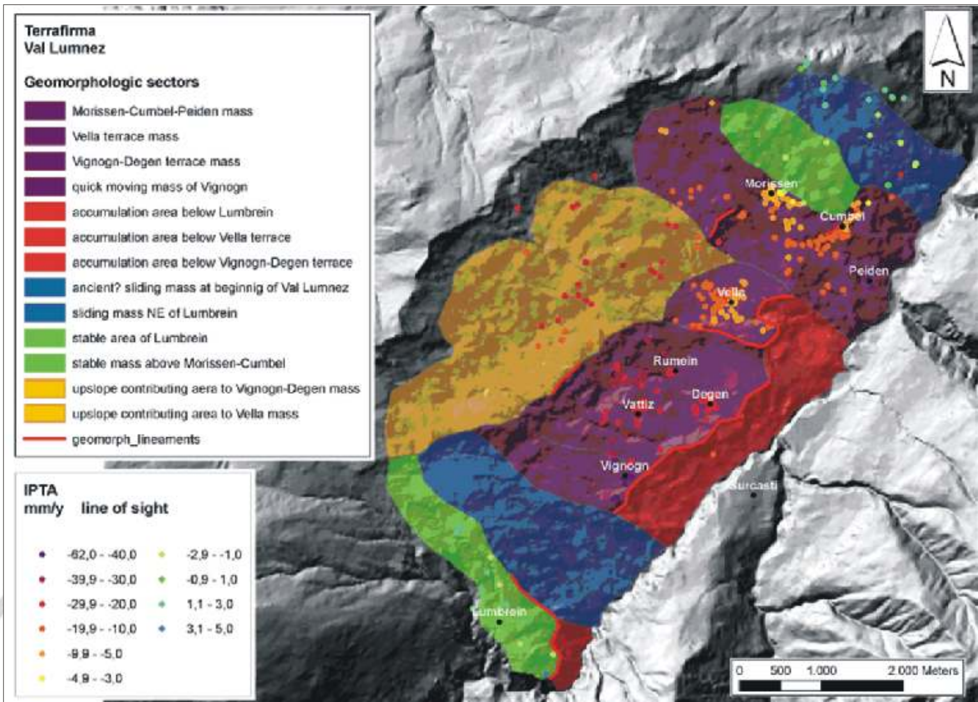

Figure 2b: Result of the geomorphologic zonation using the PSI estimates.

Terrafirma is one of a number of Service Element projects being run by the European Space Agency under the Global Monitoring for Environment and Security (GMES) initiative. Terrafirma is establishing a pan-European ground motion hazard information service in support of policies aimed at saving lives, improving safety and reducing economic loss. For more information on ESA initiatives on GMES, see http://earth.esa.int/gmes/ or email: info@terrafirma.eu.com. For further information www.terrafirma.eu.com.