RIEGL LASER MEASUREMENT SYSTEMS

Landslide Monitoring
Visualization and Quantification of Material Movement

Project Key-Facts:

***RIEGL* instrument**	LMS Z-620
Object of interest	Landsliding area within Miozza basin, Eastern Italian Alps
Client's order	High resolution DEM for mass-calculation
Project management	Riegl LMS together with Dr. Paolo Tarolli and Dr. Alberto Guarnieri, Interdepartmental Research Center in Cartography, Photogrammetry, Remote Sensing and G.I.S. (C.I.R.GEO), University of Padova, Italy

Process Key-Facts:

Time needed for data acquisition	2 hours
Time needed for post processing	2 hours
Acquisition workflow	high resolution scan (VxH 80°x70°, resolution 0.03°), registration of scandata was realized by best fit alignment with LiDAR data of 2003 (before reactivation of largest landslide)
Acquisition platform	standard surveying tripod

Scanner at work:

The Miozza basin, located in Carnia, a tectonically active alpine region of north-eastern Italy covers an area of 10.7 km^2. Elevation ranges from 471 to 2075 m a.s.l.. The slope angle has an average value of 33° with a maximum value of 77° . The area has a typical North Eastern Alpine climate with short dry periods and a mean annual precipitation of about 2200 mm. Vegetation covers 94% of the area and consists of forest stands (74%), shrubs (10%) and mountain grassland (10%); the remaining 6% of the area is landslide scars and deposits without vegetation.

The Miozza basin was chosen as a study area because a lot of landslide scars are present and mapped in the field, in addition to detailed topographic, land use and geomorphologic information from various sources (including airborne LiDAR), and availability of several modelling applications (Tarolli and Tarboton, 2006; Tarolli and Dalla Fontana, 2008). Within the study area landslides have been mapped and the area of landslide scars amounts to 0.5 km^2, i.e. about 4.7% of the total catchment area. The average slope of the landslide scar area is 39°. Most of these areas, in particular the largest single landslide area, are located at the head of the basin and occur in complexes that result from the aggregation of many shallow landslides (Fig. 1, 2). The occurrence of landslides in complexes is not the result of a specific event, but a combined effect of different events including extreme short rainfalls, low intensity long duration rainfalls, snow melt, and also tectonic activity.

In 2004 the largest single landsliding area was interested by slope failures that generated then several debris flows along the main channel. In November 2003 the whole area was covered by aerial LiDAR data[1]. This data is showing the situation of the slope before the reactivation of largest landslide. Terrestrial Laser Scanning, cheaper in data-acquisition, was not a practicable approach, because of the long distance from possible scan position towards the area of interest. The Riegl-Z620 is the first available scanner on the market offering a max. range up to 2000m in combination with high accuracy and high speed data acquisition. The measurement campaign was realized in spring 2008 after the snow-melting period. Fig.1 shows the high resolution DEM of 25cm x 25cm textured by images captured by the mounted calibrated camera.

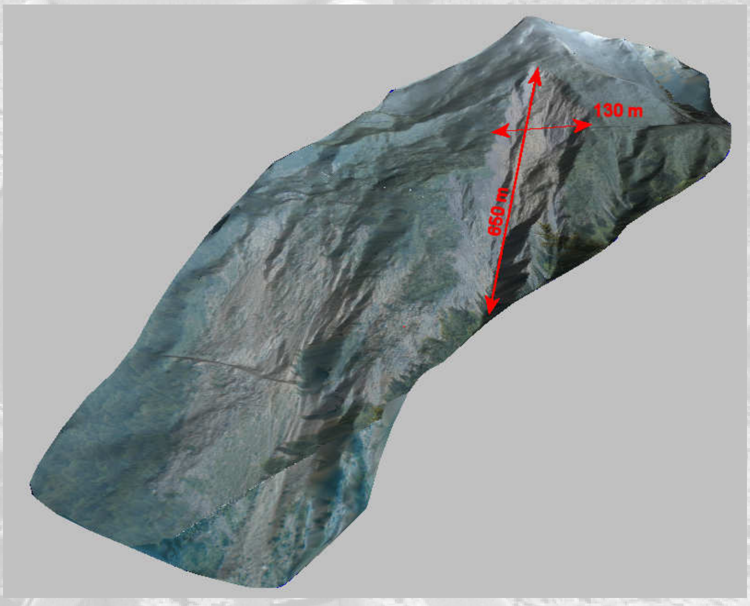

Fig. 1

The landslide is covering an area of around 650m in vertical direction and 130m in horizontal direction. The max. object-distance from the scanner was around 1.2km. Vegetation was filtered out by semi-automatic filtering-procedures within RiSCANPRO, the companion software to *RIEGL* 3D Terrestrial Scanners.

Global-registration of the DEM was realized by GPS-measurements (GPS-antenna mounted on Z620) and best-fit-alignment using areas of overlap with the existing LiDAR-data. This automatic alignment-procedure is calculated by Multi-Station-Adjustment Plugin of RiSCANPRO

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[1] Airborne LIDAR raw data were elaborated by University of Udine (http://geomatica.uniud.it/) and collected within the Interreg IIIA Italia-Slovenia project: “Ricomposizione della cartografia catastale e integrazione della cartografia regionale numerica per i sistemi informativi territoriali degli enti locali mediante sperimentazione di nuove tecniche di rilevamento”.

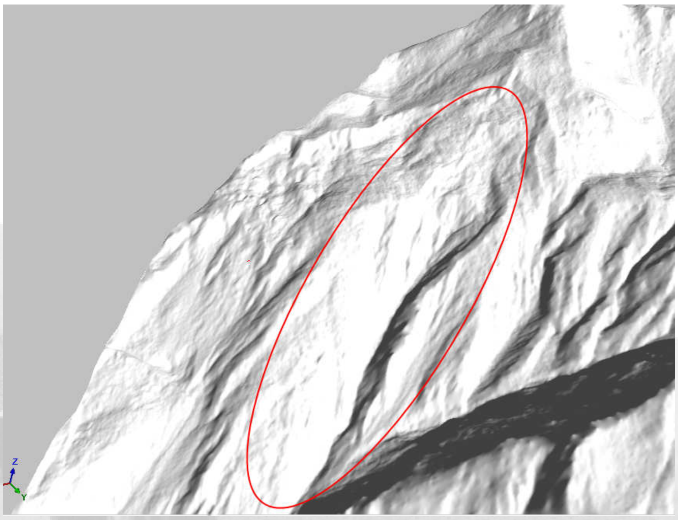

Fig. 2

Fig. 2 shows the shaded DEM of 1m x 1m calculated by the aerial LiDAR-data of 2003. The red box is indicating the area of the later landslide.

Once the two data-sets are aligned to each other, the mass-balance can be calculated. The Cut- and Fill-Volume is illustrated in Fig. 3 on the DEM calculated from the terrestrial laser-scan-campaign in 2008. The massive material loss in the upper part (221.090m³) is visualized on the left side, while the right side indicates a partly deposition (63.136m³) of landslide-material in the lower areas. The difference of the two volumes give an estimation of landslide-material, which was deposited in lower areas not considered by the DEM. A comparable result was obtained in a previous study conducted in the same area by the comparison of different airborne LiDAR-derived DEMs (Massari et al., 2007) before and after landsliding activity.

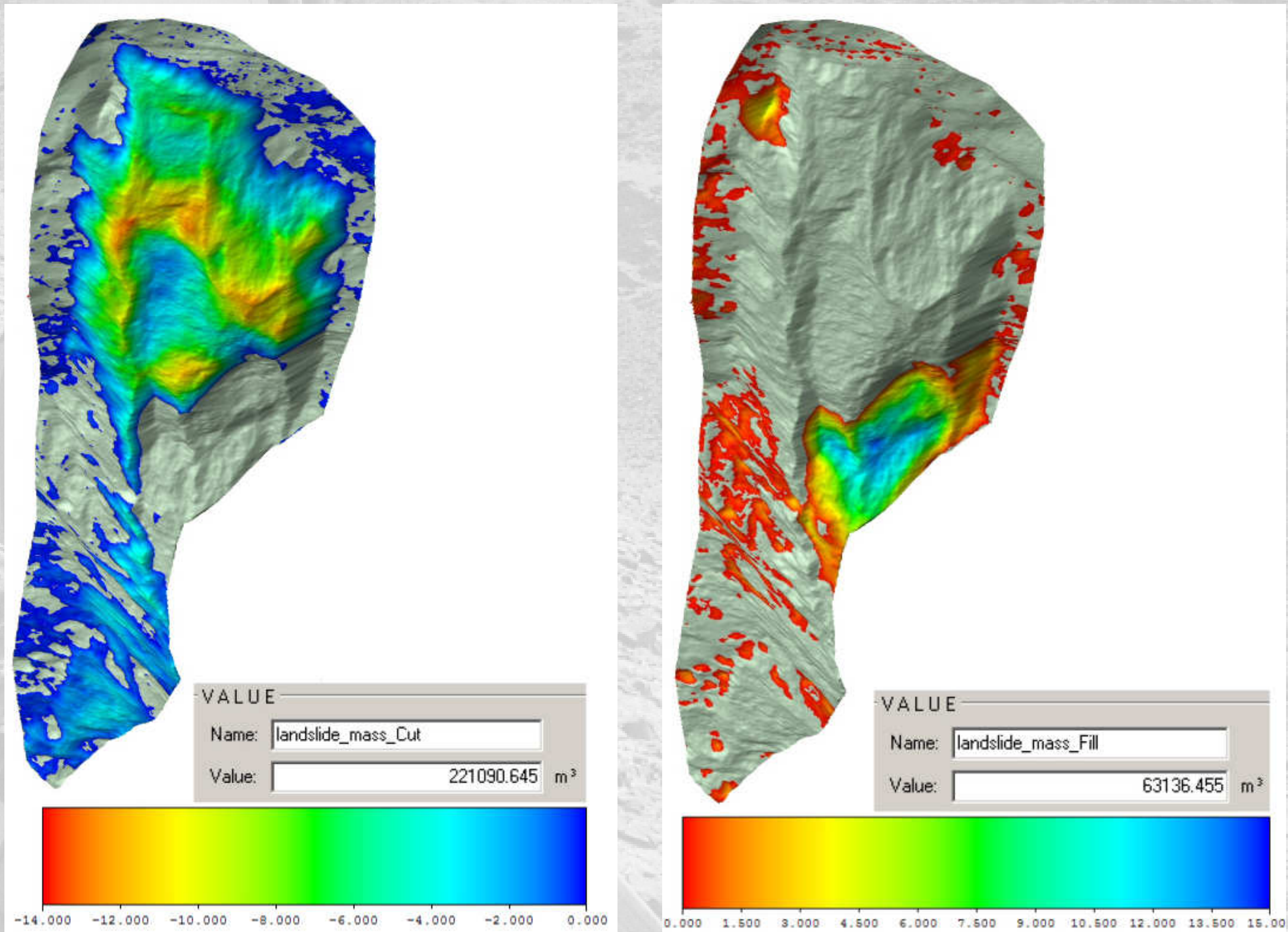

Fig. 3

The findings obtained by these applications reported a first analysis, done in order to show the potential of this new instrument, the great benefit to compare TLS and airborne LiDAR DEM, and an example of field application. Further research is needed (1) to investigate more about the comparison between airborne LiDAR data and terrestrial laser scanner application, (2) quantify the landslide movement by seasonally field TLS surveys, (3) evaluate the potential of very high resolution TLS-derived DEM for landslide modelling applications.

References:

Massari, G., Paganini, P., Potleca, M., Torresin, M.T., (2007). Controllo dei Dissesti su Un Bacino Montano Tramite Analisi Multitemporale, *Decima Conferenza Italiana Utenti Esri*, 18-19 Aprile, Roma.

Tarolli, P., and Dalla Fontana, G., (2008). High resolution LiDAR-derived DTMs: some applications for the analysis of the headwater basins' morphology, *International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 36 (5/C55), 297-306, ISSN: 1682-1777.

Tarolli, P., and Tarboton, D.G., (2006). A New Method for Determination of Most Likely Landslide Initiation Points and the Evaluation of Digital Terrain Model Scale in Terrain Stability Mapping, *Hydrol. Earth Syst. Sci.*, 10, 663-677, ISSN: 1027-5606, www.hydrol-earth-syst-sci.net/10/663/2006/.

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