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Landslide monitoring and characterization using multi-temporal helicopter-borne Lidar surveys: a successful application in the Northern Apennines

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A large number of landslide in the Northern Apennines have resumed activity in the last years causing relevant damage and civil protection intervention. Most of these landslides are large deep-seated earth slides evolving at velocities ranging from a few cm/year to m/day. Over a time span of months to a year, they cause relevant topographic and geomorphic changes, related to erosion, transport or accumulation processes. In one case, the so called Cà Lita landslide, located in the province of Reggio Emilia, the effects of the mass movement evolution between 2004 and 2005 have been analysed in great detail by using multi-temporal high resolution DEMs derived by airborne Lidar surveys. Due to the favourable ground coverage conditions, the two surveys conducted in April 2004 and in May 2005, have allowed a broad range spatial monitoring of the landslide movement rate to be obtained.

Surveys were conducted with an Optech ALTM 3100 scanner mounted on board of an I-FLAP Eurocopter AS 350 B1. The main component of ALTM system adopted is an infrared laser, which emits pulses at four different frequencies (33, 50, 70 and 100 kHz) and records up to four different return echoes. The infrared laser emits narrow optical pulses which a scanning mirror directs perpendicularly to the flight path of the helicopter where it is installed providing coverage to either side of the flight direction; the forward motion of the aircraft provides coverage in the direction of flight. ALTM is also composed of a GPS receiver and an inertial measurement unit (IMU); the roll, pitch and yaw (attitude) of the aircraft are measured by the inertial navigation system

unit at a frequency of 200 Hz. In the surveys of the Cà Lita landslide, flight height was about 1600 m above ground level, Flight trajectories were computed with a 0.035 rms maximum, using DGPS data integrated with the inertial one from the IMU. Orthophotos were also taken during the Lidar survey by a digital camera Rollei 6008 db45, 4080 x 5440 pixels to support laser data interpretation.

From the 2004 and 2005 surveys, a data density of about 2.9 points for square metre were obtained. Data were then processed and classified in order to obtain both the point cloud and the ground, that is the surface without buildings, vegetation etc. Laser points were then interpolated on a regular 0.5 m x 0.5 m grid, adopting linear interpolation and kriging algorithms. Differential analysis was carried out in GIS environment, together with geomorphic interpretation of shaded relief surfaces, from which compression and extension features and zones were identified, and landslide features classified.