THE POGGIO BALDI LANDSLIDE (HIGH BIDENTE VALLEY): EVENT AND POST-EVENT ANALYSIS AND GEOLOGICAL CHARACTERIZATION.

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INTRODUCTION

After a prolonged rain and snowfall period, on March 18th 2010 in the high Forlivese Apennine, a large landslide occurred (• $4*10^6$ m^3); it interested, in about 24h, three houses, the provincial and municipal roads, a large evergreen pine bush, occluding, at the end of its movement, the Bidente River and creating an obstruction lake.
Before the event there where no evidences of displacement of the main accumulation but the main headscarp was affected by periodical rockfall phenomena since the last activation in 1914.
This paper describe the event history and evolution, the geological and morphometric characterization and the monitoring survey, carried out by traditional direct methods for deep component (inclinometers, piezometers) and topographic methods (GPS and GB-InSAR).

Fig. 1 – Panoramic view of the landslide area on 2010 march 27th.

GEOLOGICAL SETTING AND LANDSLIDE EVOLUTION

The landslide area partly lies on an isocline slope and partly on transverse attitude strata-slope. The bedrock is constituted by flyschoid marls and sandstones of Marnoso-arenacea Formation (Corniolo Member, Langhian).
This gravity movement can be classified as complex, in which we recognize translational rock slides (on structural surface) with rock falls in the headscarp that evolve in translational and rotational debris and earth slides (Varnes 1978).
The main accumulation was correctly identified and mapped as dormant landslide in the Emilia Romagna Region Landslide Inventory Map (LIM), where it was hanged over by an active area, corresponding to the thick debris deposits outcropping discontinuously even till the top of headscarp, whose dimensions were extended about the same of today.
The geological observations highlight that the area has been repeatedly affected by landslides since thousands of years. Despite of this, only one total reactivation, in 1914, was recorded before the 2010 event. In that case, the reactivation phase involved the same triggering area of the 2010 event. During about one century, the wide and sub-vertical headscarp kept on releasing debris that at 2010 rose about 40m of thickness. Its overload combined with the intense and prolonged rainfalls and snow melt, in March 2010 triggered the reactivation of the landslide, characterized by the first movement on the upper part of the slope and progressively evolved far downward (by “undrained loading”), to dam the river and lean

against the opposite slope. Fig. 2 shows that the maximum depletion in the upper part was >50m of thickness whereas the maximum topography rise at the foot was >40 m.

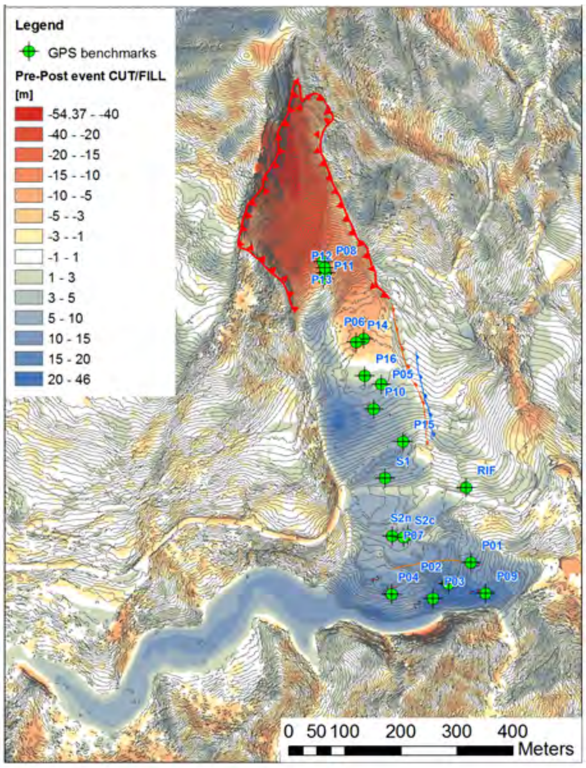

Fig. 2 – Cut/fill map derived by the pre-landslide CTR 1:5'000 and an high resolution post-event 1m LIDAR survey. It's also visible the landslide dam lake. Green dots shows the distribution of the GPS survey benchmarks.

GEOLOGICAL SURVEY

Geognostic survey has been realized through n° 3 boreholes (max depth: 43 m), 1200 m of seismic lines, micro-seismic passive methods (Tromino®), Down Hole, n° 3 samples and permeability tests in borehole. From this it's been possible to define the maximum depth of the landslide (41 m) and the asymmetric shape of the paleo-valley that the landslide accumulation fills.

During the period March 2010 – December 2011, the area was deeply and repeatedly field surveyed by the authors. Field work aimed to survey spring points, tectonic structures, deformation evidence, bedrock-colluvium boundaries and all the elements necessary to define kinematics and evolution of the landslide from the emergency phase to the present days.

MONITORING DATA

In the emergency phase, a quick topographic monitoring system has been realized. This showed the rapid decrease in velocity from the • 1 m/h until March 23th morning to the 5 m/day in the 23th afternoon, < 1m/day on march 24th, few cm/day on march 26th and negligible deformation from April.

GPS survey has been initially carried on to measure the landslide dam geometry and the dam lake filling; later it has been used in NRTK (VRS) acquisition mode to evaluate the residual landslide movements (fig. 2). The main accumulation and landslide foot have never shown displacements higher then the method resolution (few cm), whereas on the upper part of the accumulation, displacement of several mm/day kept on going at least until the end of 2010, following the continuation of rockfalls and debris contribution from the main scarp and the main rainfall events.

GB-InSAR survey has been realized on December 2010 to assess the main scarp evolution and, in particular, to identify possible movements of a portion of debris and very fractured rock, deformed but not involved on the parossistic event. The result of the survey (fig. 3) showed that residual displacement involved only shallow portion of debris.

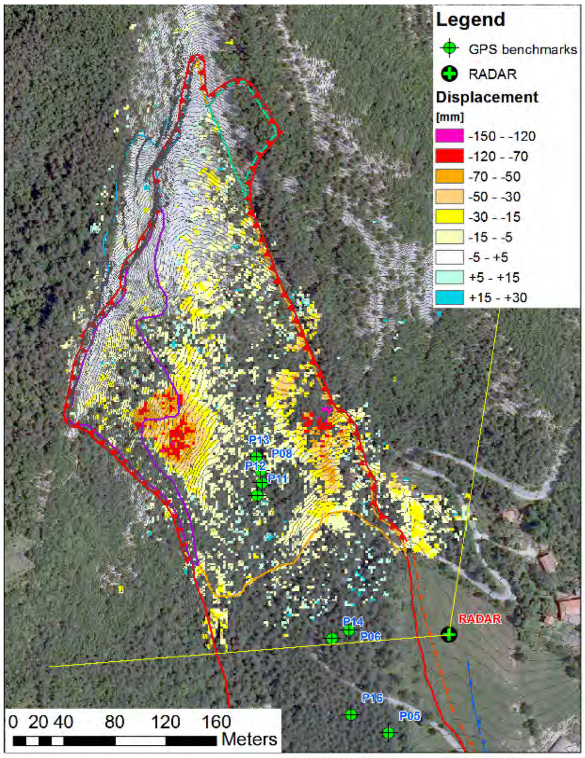

Fig. 3 - GB-InSAR displacement map.

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