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Acceleration of large active earthflows triggered by massive snow accumulation events: evidences from monitoring the Corvara landslide in early 2014 (Dolomites, Italy)

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In the Dolomites of Italy, snowfall during winter 2013/2014 was exceptionally abundant. Major snowfall events occurred from late December 2013 to mid-March 2014. Snow accumulation in Badia Valley peaked in early February: from 2 to 4 meters with a positive gradient respect to altimetry and accordingly to wind accumulation zones. Below 2000 m asl, due to the mild temperatures recorded before the onset of snowfall, the relatively dry snow cover was mostly deposited on top of unfrozen soils.

The Corvara landslide is a large active earthflow located close to Corvara in Badia, at an elevation from 2000 to 1600 m. It's displacement rate before, during and after the exceptional snowfall period was monitored at high temporal frequency. Surface displacement was measured bi-weekly by differential GPS in several benchmarks in the source, track and accumulation zone. Deep displacement was monitored semi-continuously by two in-place inclinometers at 48 m depth in the accumulation zone, across the main deep-seated sliding surface. Results show an acceleration of movements, both at surface and at depth, soon after the massive snow accumulation event of 31st January to 2nd February 2014, which suddenly increased snow thickness from 1 to more than 2 metres. Short time lags between the onset of the acceleration of movements in the source, the track and the accumulation zones were also recorded. The landslide then maintained a relatively constant velocity during the high snow cover period extended to earlyApril and underwent a progressive deceleration during the snowmelt period that lasted until mid-June.

The fact that the acceleration of the Corvara earthflow was triggered by a massive and rapid snow accumulation event, provides a quite different perspective from the generally adopted one that considers the destabilizing effect of snow only in relation to the increase of groundwater level during rapid snowmelt. A full explanation of the processes associated to the dynamics observed in Corvara is undoubtedly still an open issue. However, it can be tentatively speculated that in the some sectors of the source and track zone, where sliding surfaces are relatively shallow -around 15 m deep -, the weight of the copiously fallen snow induced a distributed undrained loading in the already fully saturated and confined landslide mass. Or, alternatively, that snow accumulation over the unfrozen soil induced groundwater levels above the ground. To explain how acceleration of movements occurred as deep as 48 m in the accumulation zone, it might be argued that the mass and/or the pore pressure transfer from the track to the accumulation zone - evidenced by the time lag of velocity peaks- can have played a role in indirectly transferring to the accumulation zone the acceleration induced by massive snowfall in the track zone. To provide more robust answers, further monitoring data collection and analysis is needed. Thus, while waiting for other massive snowfall events, three continuous GPS receivers and a water pressure transducer in the soil have been added to the monitoring network during 2014.