



## **Impacts of the November 2014 extreme rainfall event in Ticino, Switzerland**

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The 2-17th November, a meteorological block in the south of the Alps produced record rain precipitations in the North of Italy and in the canton of Ticino, Switzerland. During those fifteen days, the rain quantity was three to five times higher than the November average monthly rain. The Lugano meteorological station recorded a new precipitation record with 538 mm during this period.

During this event, the rainfall triggered many landslides and floods. Four people died in two different events 11 km apart. In the first case, a two-storey house, located in a large wooded area 10 km West of Lugano, was destroyed by a 1'000 m<sup>3</sup> landslide composed of mud, trees and rock masses which flew over 150 meters on November 5th 2014. The two occupants, a mother and her three years old daughter, were killed. The second event occurred in an urban area of the Lugano agglomeration where a wall, weakened by the heavy rainfalls, located 50 m away and above a three-storey apartment building broke, releasing 500 m<sup>3</sup> to 1'000 m<sup>3</sup> of muddy material. Besides two fatalities, one man was seriously injured, three persons were slightly injured and one person kept uninjured.

Concerning the transportation network, more than twenty roads and railways were blocked by landslides, floods and rockfalls. Some of them were closed over one month. The two secondary roads to Arogno and Rovio villages were blocked by landslides. The only asphalted access to those villages was a 45 km deviation of more than one hour travel time through Italy. Two hamlets a couple of kilometers away were isolated by a landslide. The only access was by boat from the lake. Two main roads and one railway along the Lake Maggiore and the Tresa River taken by Italian cross-border commuters who work in Switzerland were cut by floods and landslides generating economic and societal inconveniences.

The two main lakes of the canton of Ticino -lakes Maggiore and Lugano- reached their maximum flood level. In Locarno, the 3rd biggest city of the canton of Ticino with over 15'500 citizen, the shores along the Lake Maggiore were flooded until 300 meters inside the land. Dozens of basements and ground floor of buildings were flooded. Hillslopes were strongly affected by landslides, while floods occurred in valley bottoms.

The aim of this study is to document the natural events and their consequences in terms of transportation networks and societal inconveniences caused by this rainfall event. Damages and consequences of the events were documented during a field visit, obtained from the media and the official reports as well as by the aid of a drone in two areas.

We suspected that many impacted houses were located in areas where landslides could be expected. A first assessment based on geomorphological landscape analysis with an Airborne Lidar DEM show that some of these infrastructures seem to be built on alluvial / debris cones, suspected ancient landslides or steep slopes susceptible to be affected by (shallow) landslides, debris flows or rockfalls during extreme meteorological events. This raises the delicate question of urbanization in steep mountain slopes even if since a several tens of years nothing happened. More detailed studies about those hypotheses are necessary to understand the relationship between suspected old slope movements and the shallow landslides occurred during the November 2014 extreme rainfall event.

The transportation network in the canton of Ticino is vulnerable to extreme natural events because of a high number of artificially cut and fill slopes along the lanes. In some cases, a possibility to investigate could be to reduce the number of roads leading to a same place in order to concentrate enough financial, logistic and maintenance strengths on only one access well protected against natural hazards.