



## An integrated geomorphological approach based on Stream-Length Gradient Index to detect deep-seated landslides

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The Stream-Length Gradient Index (SL Index) is a proxy of the stream-power per unit length ( $\Omega$ ), as it shows the variation of stream-power along river reaches. Values of SL Index, as well as their normalized values (SL/k Index), are very sensitive to changes of slope along streams. Thus, the anomalies of this parameter have been frequently used to evaluate recent tectonic activity and/or lithological contrasts along the river profile. Moreover, recent researches highlighted the useful of both indexes, SL and SL/k, to evaluate the spatial pattern of processes domains in headwater river basins with complex longitudinal profiles.

In this work, preliminary results of the application of SL and SL/k indexes to detect deep-seated landslide occurrence and activity are presented. In particular, it has been analyzed the spatial correlation between extreme values of this two indexes and active mass movements. This analysis has been developed in three study areas, belonging to the Mediterranean region, characterized by different extent, as well as litho-structural and geomorphological settings. Landslide information used herein derives from well-known existing data (i.e. available geomorphological maps, landslides inventory maps, interferometric data, etc.). Deep-seated landslides are the mass movement typology we mainly refer to, even if we also took into account wide and complex landslides (i.e. earth flows and earth slides).

The first study area matches the prevalently calcareous flanks of the Mt. Pietralata-Mt. Paganuccio Ridge, where active deep-seated mass movements occur. This area covers a 200 km<sup>2</sup> mountainous sector belonging to the mid Metauro River basin, within the Adriatic side of the northern Marche Apennines (Central Italy). The second study has an extent of 1.800 km<sup>2</sup> and comprises the Savio, Rubicone, and Lamone Rivers, in the Romagna Apennines (Northern Italy). Here, the slopes characterized by marly, arenitic and marly-limestone rocks belonging to the Marnoso-Arenacea Formation and, partially the Val Marecchia Sheet, are widely affected by active mass movements of different typologies, thickness, width, and spatial density. The third area extends for 47 km<sup>2</sup> in the mountain sector of the Upper Tena Valley in the Central Spanish Pyrenees. This area is mainly occupied by the outcrop of Devonian shales where several deep-seated landslides have been developed. These mass movements are complex and involve roto-translation with flow. They were triggered by the glacial retreat and, nowadays, the whole bodies present a relict slow movement.

In each study area, starting from high-resolution DTMs, it has computed SL Index and SL/k Index maps through specific tools in GIS environment. Comparing these maps with landslides data is highlighted that: (1) Along the carbonatic flanks of the northern Marche ridge, a good linkage between extreme values of indexes and the occurrence of active deep-seated landslides is generally recognizable. (2) In the Romagna Apennines extreme values of parameter seems to be connected to the presence of slopes entirely affected by mass movements of various typology and size. Actually, these mass movements can be superimposed on deep-seated landslides not reported on the examined landslide data. (3) Many SL and SL/k anomalies observed in Upper Tena Valley are caused by lithologic changes related to Hercinic faults. However, there is also a good correspondence between high values of the indexes and recognized active mass movements. In order to verify this hypothesis ad hoc detailed geomorphological field surveys have to be carried out in these areas.