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High-density landslides in NW Italy: from documentation and study to land management.

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The study area is located on the inner margin of the Western Alps, about 30 Km NW of Turin, in the drainage basin of the Malone creek, a tributary of the Po river.
The particular position and morphology of this area, directly surrounding the Po plain and with a sudden increase in height from the plain to the mountain range (up to 1500 m in a few Km), means that the local climate is prone to heavy rainfalls.
In summer, the area is subjected to short rainstorms almost on a daily basis, whilst during spring and fall this zone of the inner Western Asps can experience heavy precipitations, lasting some days.
During the November 1994 flood event, the area experienced three days of almost continuous rainfalls.
According to the available data, a total precipitation of more than 500 mm was recorded, in front of an average November month rainfall of more or less 140 mm. The highest daily rainfall was of 280 mm, while the greatest hourly rainfall was slightly more than 30 mm.
The flood event triggered a number of landslides: in the following months, the investigation and survey of the drainage basin, covering an area of some 40 Km2, led to an inventory of at least 150 slides (some of the smallest landslides could not be detected, owing to the dense vegetation cover or to improvised recovery works performed by inhabitants).
In front of an average density of more than 3 slides each Km2, some south-east facing hillsides, placed in the lower zone of the catchments basin, on the leading edge of atmospheric disturbances coming from the Po plain, scored a density of 10 slide/Km2.
Most of the landslides were in the form of debris slides, with masses of soil and regolith sliding over a deeply weathered bedrock, consisting of micaschists and fine grained gneisses.
In some cases, the fluidized mass evolved in form of a debris flow, moving downhill or in the lesser tributary streams of the Malone creek.
Many of the landslides affected hillside roads, and a few buildings were destroyed or severely damaged, but no life losses were experienced, because most of the affected buildings were holiday or weekend retreats, used mainly in summer.
Some landslides were subjected to a detailed analysis, showing that the most common instability processes can be explained with a loss of shear strength due to a sudden increase in pore water pressure in the soil-regolith cover, leading to a reduction in effective stresses that triggered the instability.
By means of a back-analysis, the failure threshold has been identified in a temporary water table level overtopping more or less half the thickness of the soil-regolith cover.
The survey of the drainage basin has showed that the occurrence of debris slides is related to hillslopes with the presence of a thin soil and regolith cover, overlying a deeply weathered metamorphic bedrock, together with a high acclivity and sparse vegetation (mostly due to a previous, abandoned agricultural use of the area); the presence, directly uphill of the back scarp, of a more flatter zone, is a common feature of areas subjected to slides.
The survey has led to a land-management classification of the studied area: owing to the lack of further funding for a more detailed hazard mapping, and the overcoming of very restrictive national and regional rules, most of the hillslopes in the catchments basin have been prevented, if showing some feature typical of slide-prone areas, from future settlements.