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Integrated analysis of sediment connectivity and geomorphic effects of Storm Ciaran in two mountain catchments in Tuscany (Italy).

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Extreme rainfall events over mountain catchments often trigger mass failures on hillslopes and sediment transport along the channel network. Understanding the connection between sediment sources and downstream transfer pathways is crucial in areas where settlements are impacted by hydro-geomorphic processes, to plan effective risk mitigation measures.

From November 2 to 5, 2023, northern Tuscany (Italy) experienced a severe flood due to storm Ciarán, causing landslides and flooding. This disaster led to eight deaths, displaced 300 people, and caused around €1.9 billion in damages.

This study focuses on two adjacent catchments, covering a total area of approximately 35 km^2, within the area affected by the storm event. To analyse sediment dynamics at the catchment scale, an integrated approach was devised, encompassing the analysis of high-resolution (0.5 m) satellite imagery combined with the field-based mapping of hillslope instabilities. After the instabilities census, the analysis was integrated with an Index of Connectivity map (created using SedInConnect 2.3 software) to characterize pre-event structural connectivity in both catchments. The integration of these datasets enables the determination of the type, extent, and characteristics of mass movements providing sediments to the channel network, as well as understanding the interaction between sediment transport in the main channel and its morphological modifications. This finding highlights that inventory maps developed soon after extreme events, combined with sediment connectivity data, can provide vital information for future land management and risk mitigation. These insights can help prioritize structural interventions in specific areas to reduce connectivity or disconnect inhabited areas from hydro-geomorphic systems, thereby preventing future damage.

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