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Hydro-morphological changes and sediment supply investigation: a case study in an Alpine-type river catchment (Marche, Italy)

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Hazards may arise not only from inundation and the direct effects of the flowing water but also from the physical impacts of sediment movement, erosion, deposition, and the resulting destruction. Major geomorphological changes in channels occur during flood events, and one of the important questions is how big floods impact sediment flux and landscape changes overall. For this reason, it is important to study the effects of extreme floods on fluvial dynamics. The key concept is the sediment connectivity within a river catchment that can be used to explain the continuity of sediment transfer from a source to a sink and the movement of sediment between different zones of a catchment. This work aims to analyse the complex interactions of the elements that play an important role in the morpho-fluvial system, bearing in mind a series of cascading processes that can be triggered during an extreme rainfall event. A study was conducted on the small catchment area of the Tenetra creek, which is located in a mountainous area of the Marche region and whose physical conditions of geomorphological evolution are similar to an Alpine environment. This area was affected by a flood event in September 2022, triggered by an intense rainfall of about 419 mm in 12 hours, that caused an intense mobilisation of the material towards the valley floor and the main watercourse. The rainfall event also activated several highly mobile landslides, most represented by debris flows, that sometimes reached the river network, contributing to the increase in the river solid transport. The sediment transport analysis in the study area was structured with an integrated methodology based on different techniques developed individually by various authors for different environmental contexts. Focusing on the origin of the material to be able to define the availability as well as the productivity of the sediment, and secondly quantifying the material for a better understanding of the changes in the hydro-morphological. The slopes were analysed using Cavalli's connectivity index, which, using free, stand-alone GIS-based software, assesses the potential connection between the slopes and the land elements chosen as the target for analysis, in our case the main hydrographic network. Applying Geomorphic Change Detection (GCD) software, it was possible to quantify the difference between two high-resolution (1x1 m LIDAR-derived) Digital Terrain Models used to estimate the volume involved and to study river morphological dynamics through lateral and vertical variations. Iber Software, a two-dimensional numerical tool designed for simulating free surface flow in rivers, was employed to investigate erosion and deposition processes in Tenetra Creek. Iber solves the full depth-averaged shallow water equations to compute water depth and velocity. The sediment transport module within Iber is used to model bedload

transport, applying the Meyer-Peter and Müller equation. The results explore the role of sediment availability and supply in a catchment basin through the study of connectivity, seeking to understand the relationships established between different types of processes. Through scenarios with different supplies, we set up to understand the impact of morphodynamic change during an extreme event.