# Assessment of flash flood impacts in a mountain basin: an integrated approach for the management of channel control works

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## INTRODUCTION

In steep alpine catchments barriers like torrent control structures are fundamental to control water, sediment and wood fluxes, especially during extreme events (Comiti, 2012). Particularly, flash flood events can rapidly affect the ordinary conditions of mountain streams due to intense and short precipitation within a limited areal extent, producing high peak discharge and causing abrupt hydrogeomorphic responses (Gaume *et al.*, 2009). Therefore, the assessment of the physical and functional condition of channel control systems is of major importance for the maintenance of the existing structures and the design of new ones (Mazzorana *et al.*, 2014). In addition, the analysis of sediment morphology dynamics is crucial to recognize the effectiveness of torrent control works (Piton and Recking, 2017).

## OBJECTIVES

In this work, the aims are to assess the effectiveness of the torrent control structures and to quantify their impact on sediment continuity in the Vegliato mountain basin (Italy), affected by a flash flood event occurred on the 30th July 2021. A specific objective is to develop a novel parameter to measure how the structures either promote or disrupt sediment (dis)continuity within the sediment cascade.

## STUDY AREA

The Vegliato catchment, located within the municipality of Gemona del Friuli (UD), NE Italy (Fig. 1A), spans an area of 4.4 km² with an average slope of 35°. The channel network extends for approximately 9 km and several control works are present (Fig. 1B). The majority of the catchment is forested but a consistent portion of the study area is covered by bare rock and loose sediment, while grasslands and open meadows constitute only a minor portion of the overall land cover (Fig. 1C).

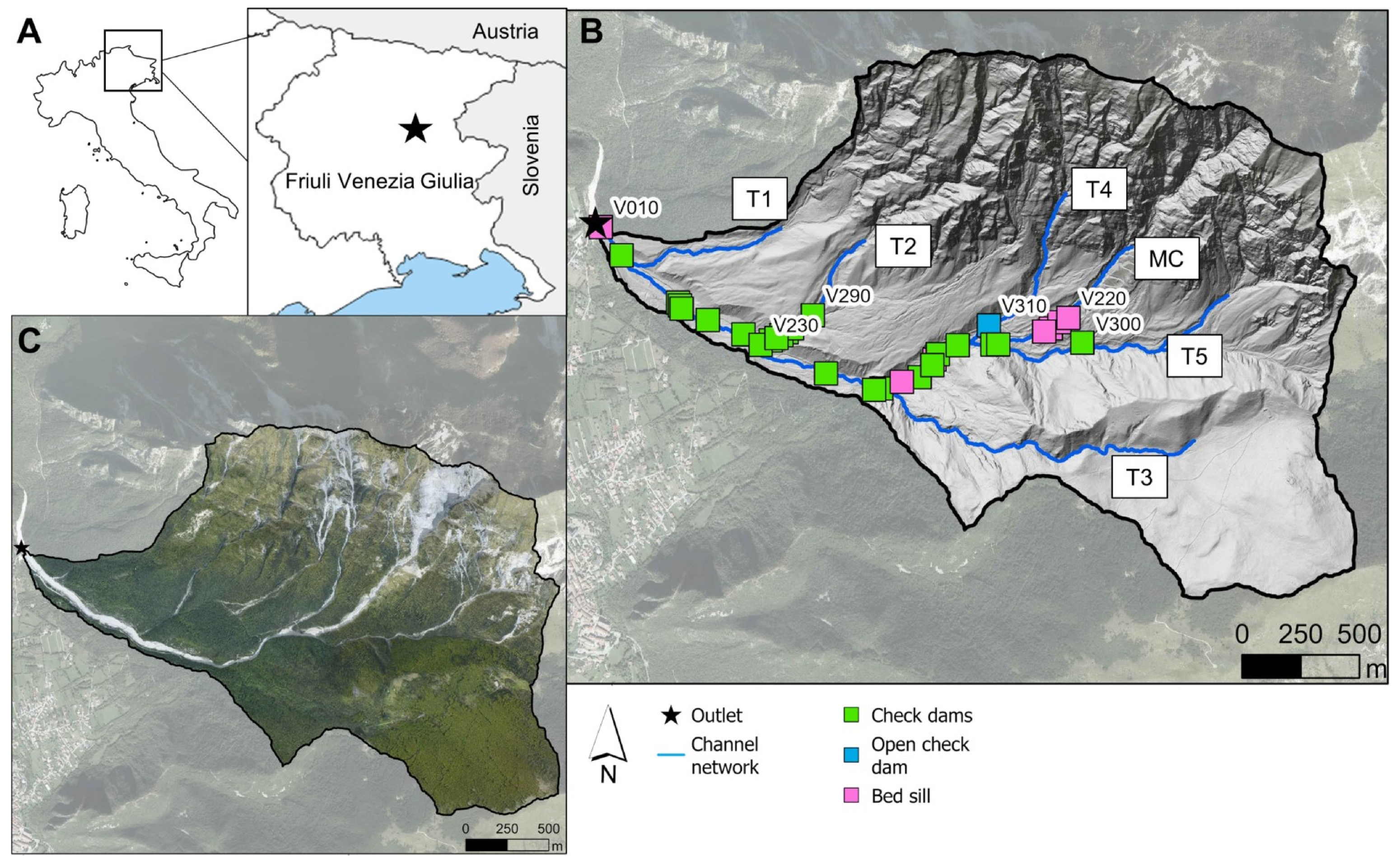


Fig. 1. Location of the study catchment (A) in the Friuli Venezia Giulia Region (Italy). The Vegliato (B) is characterized by several torrent control structures positioned along the main channel (MC) and tributaries (T1-5). The active channel and sediment sources are visible even though the forest covers most of the catchment (C).

## MATERIALS AND METHODS

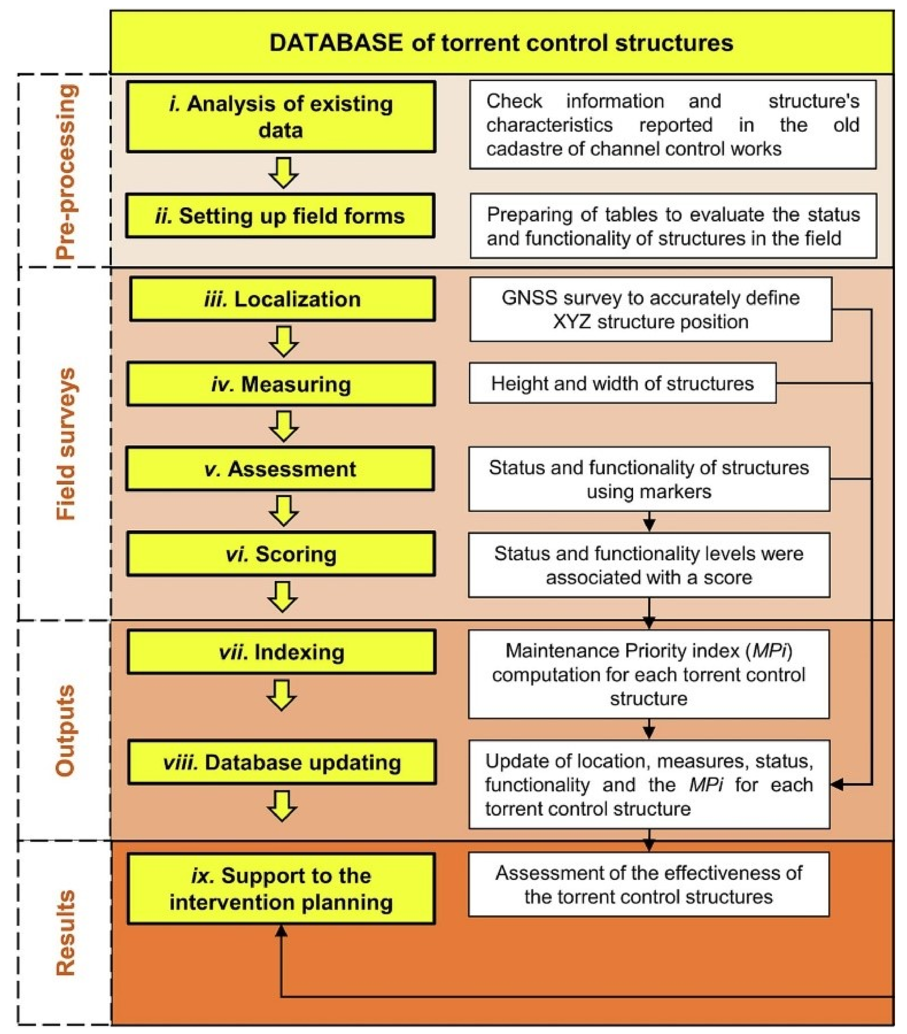



Fig. 2. General workflow of the analysis of the inventory of torrent control structures .

$$\textit{Maintenance Priority Index } (MPi) = 1 - \left[ Score_{status} \times \left[ \frac{Score_{status} + Score_{functionality}}{2} \right] \right]$$

$$\textit{Sediment Continuity Ratio } (SCR) = \left[ \frac{D_i - E_i}{E_i + \sum_{j=1}^{i-1} (E_j - D_j)} \right] \times 100$$

j: upward component
i: downward component

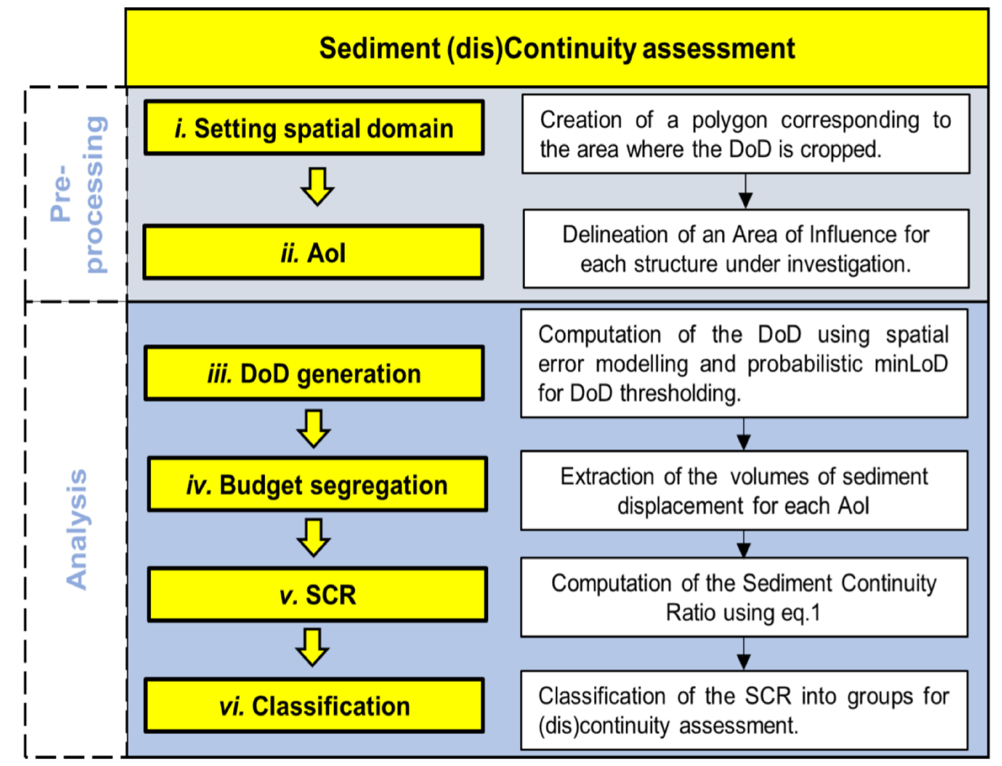



Fig. 3. General workflow of the (dis)continuity assessment carried out in this study.

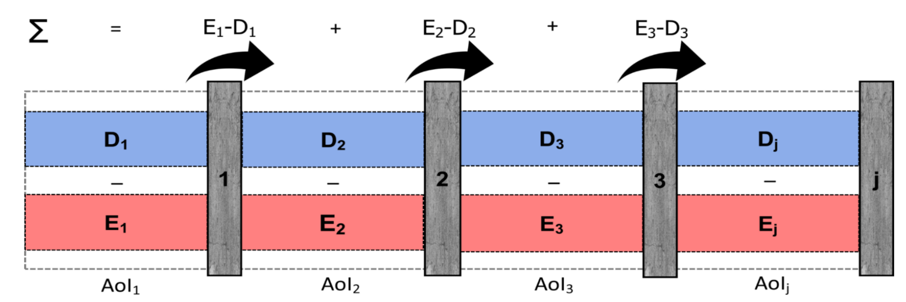


Fig. 4. Schematic representation of the SCR. For each AoI, the volume of sediment eroded (E), deposited (D) and the difference between the two is involved. The cumulative net fraction of sediment passed over the upstream structures is also considered.

## RESULTS

### MPi

- 16% of the control works should be given the highest maintenance priority (MPi = 1)
- 45% of the structures are in need of intervention (0.63 ≤ MPi ≤ 0.88)
- 12% of the control works require re-planning operations (0.25 ≤ MPi ≤ 0.50)
- 25% of the structures are in the lowest range of priority for the interventions (MPi = 0)

### SCR

- Continuity is promoted (negative SCR) in the upper catchment, a downstream stretch of the primary channel and along T2
- multiple structures promote discontinuity (positive SCR) in the middle part of the main channel
- higher SCR depict structures in the downstream and wider part of the main channel.

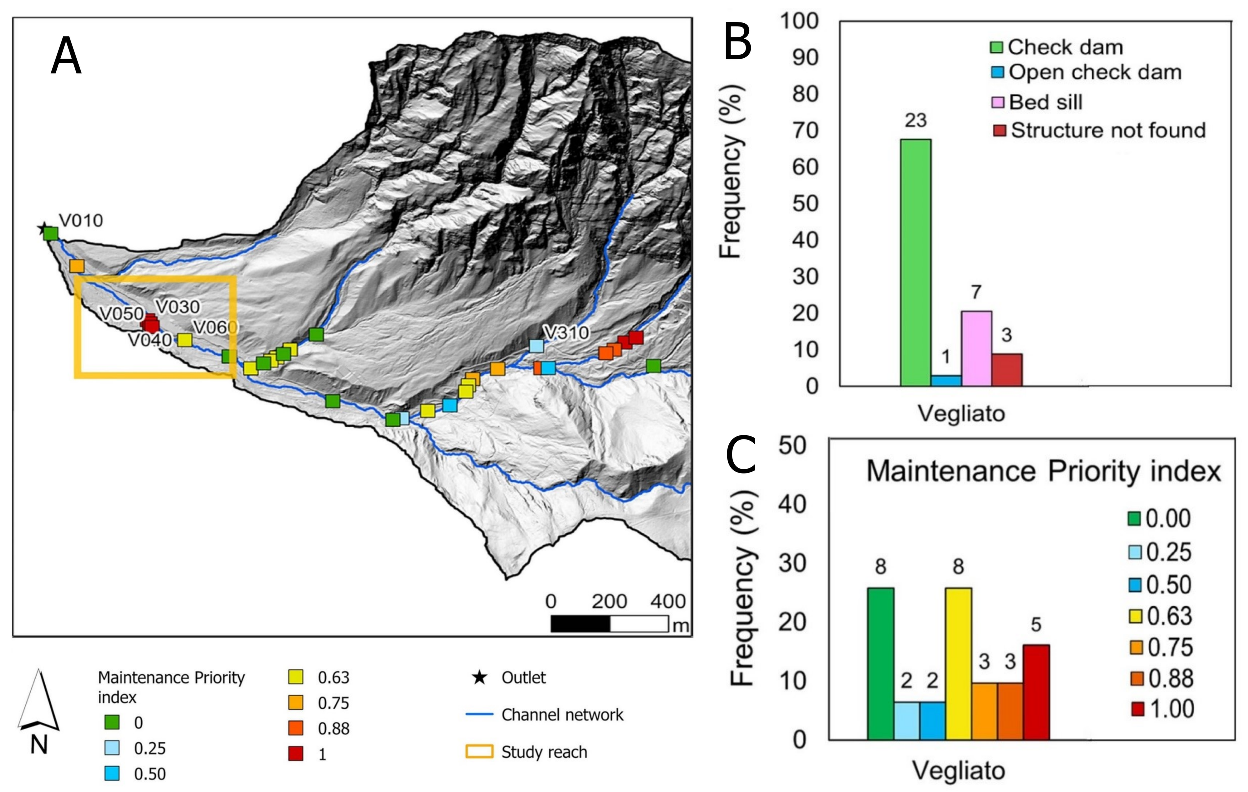


Fig. 5. MPi: (A) spatial arrangement of the torrent control structures with their relative MPi classification; (B) Relative frequency and number of the type of torrent control structures; (C) Relative frequency and number of the structures with a specific MPi value

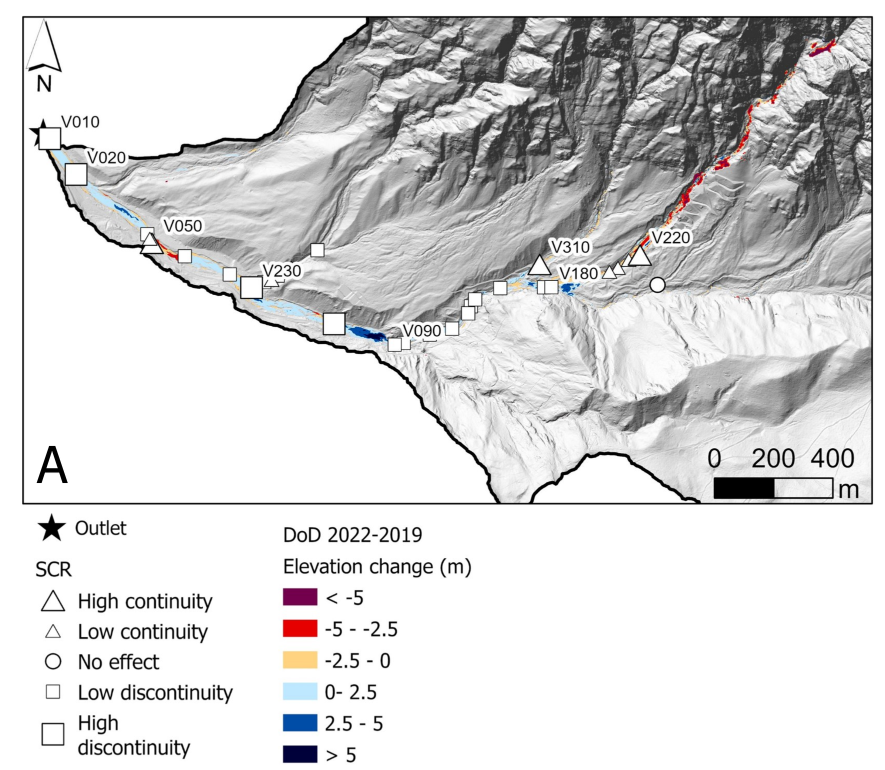
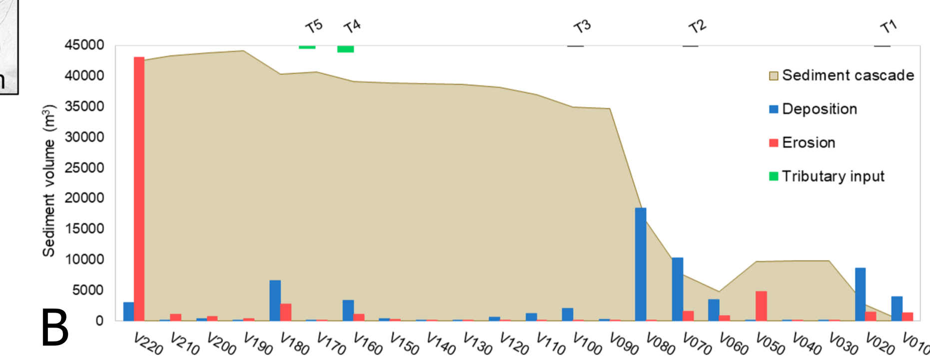


Fig. 6. SCR: (A) Map of the torrent control structures classified according to the computed SCR. Geomorphic changes are also visible thanks to the 2022-2019 DoD, with negative values indicating erosion and positive values deposition. (B) Summary chart of the sediment volumes displaced during the event along the channel network of the Vegliato.



## CONCLUSIONS AND FUTURE DEVELOPMENTS

- MPi proved to be a valuable tool to support a post-event evaluation of the effectiveness of interventions over time
- SCR was first conceived and then employed to assess how structures influenced sediment (dis)continuity
- This methodological workflow is a basis from which to draw up guidelines to be exported in catchments equipped with torrent control structures and provides up-to-date information to decision-makers for supporting sustainable and effective risk management decisions

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