Hydrological and sedimentological responses of an Alpine river to the 2022 summer drought

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Abstract

In fluvial systems, mountain river basins control the water and sediment fluxes delivered downstream, influencing the physical processes and configuration of lowland rivers (Picco et al., 2014). Mountain basins feature an interplay between geological, topographic, climatic, and ecological factors that results in complex relationships between flow and sediment transport conditions (Rainato et al., 2020). This complexity is further exacerbated by the ongoing climate change that is strongly impacting the rainfall regime, increasing the frequency of drought periods as well as extreme events (Peleg et al., 2020). Such conditions are making it challenging to ecologically preserve mountain basins and manage sustainably the river corridors. In light of this, this work aims at analyzing the response of an Alpine river to the drought conditions that occurred in 2022. Specifically, the relationships between rainfall, water discharge, and sediment transport were investigated in the Cordevole River, which is one of the main tributaries of the Piave River (NE of Italy). The Cordevole River was analyzed in the proximity of Saviner village, where it closes a basin of ~ 109 km^2.

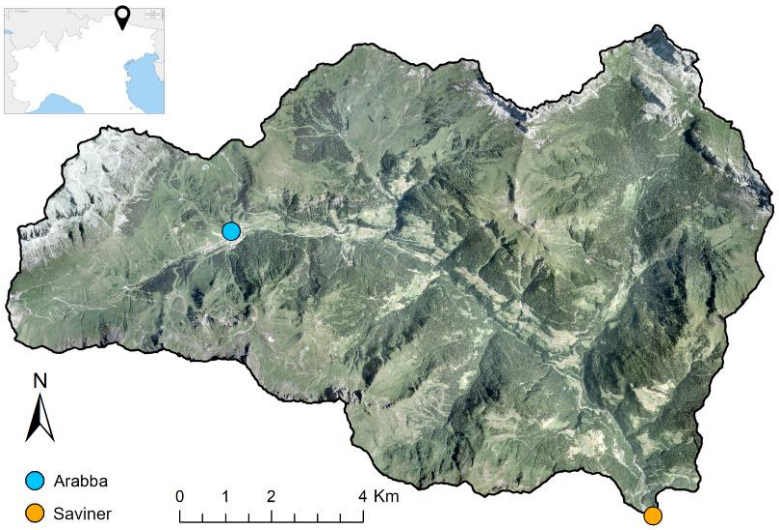

Figure 1. The Cordevole River basin. Blue and orange circles identify Arabba (meteorological station) and Saviner (ultrasonic level sensor, multiparameter sonde, and tracers), respectively.

In the basin, air temperature and rainfall were measured hourly by a meteorological station located in Arabba, while water discharge (Q) was recorded every 30-min by an ultrasonic water level sensor installed in Saviner (Figure 1). Both devices are managed by ARPA Veneto. In the same site of the ultrasonic water level sensor, a multiparameter water quality sonde (OTT Hydrolab MS5) was installed to measure the suspended sediment (turbidity *Tu*, in NTU) every 30-min. Also, 95 coarse sediment tracers (i.e., clasts equipped with Passive Integrated Transponders) were seeded in the study site to analyze the dynamic of bedload transport. Particularly, sonde and tracers were used to monitor

the sediment fluxes between 25 August and 1 December 2022. In the Cordevole River basin, the mean temperature and the total rainfall amount recorded in 2022 were 6.36 °C and 873 mm, respectively, which were 27.7% higher and 24.7% lower than the relative 1994-2021 average values. During the study period, the abovementioned conditions resulted in limited water fluxes, with only one event with Q > median Q being recorded in 2012-2021 (2.33 m^3 s^{-1}). In fact, the event of 8 September featured a peak of Q (Q_{Peak}) = 3.66 m^3 s^{-1} with a peak of Tu (Tu_{Peak}) equal to 737 NTU. Interestingly, a ~ 4 times greater Tu_{Peak} (2732 NTU) occurred on the 31 August event (Q_{Peak} = 2.45 m^3 s^{-1}), suggesting that Tu could be driven more by rainfall than by Q. In fact, the 31 August event featured a rainfall amount in the antecedent 24h (R_{24}) = 21.8 mm, while on 8 September this value was 13.8 mm. Such tendency was observed also in the other events recorded. Finally, it is worth noting that the analyzed flow conditions induced no effects on bedload tracers.

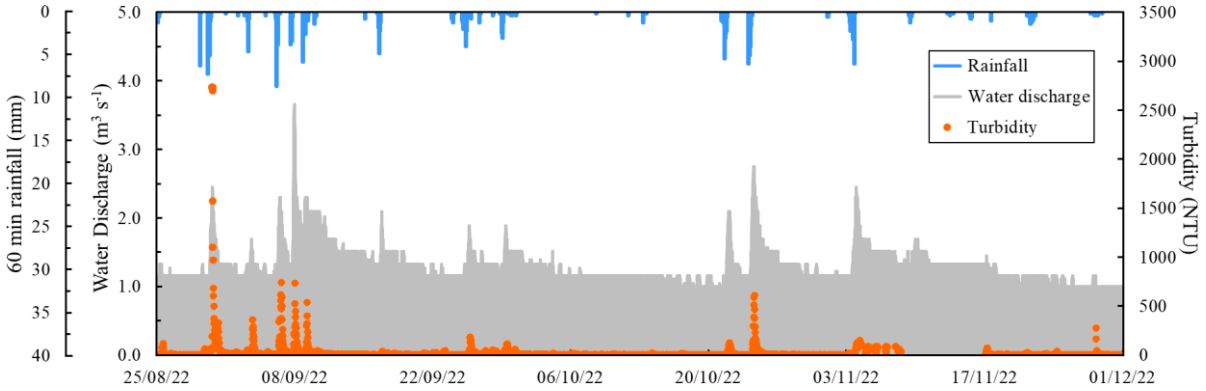

Figure 2. Rainfall (60-min), water discharge (30-min), and turbidity (30-min) measured during the study period.

Keywords: Alpine basin, climate change, suspended sediment load, sediment transport.

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