**Reviewer's comment on egusphere-2022-1494**

**General comment**

This study focuses on the assessment of coarse sediment volumes in mountain catchments, which is an important issue for the control of sediment-related hazards and risks. The developmjent of statistical models that relate sediment volumes to catchment characteristics is not novel, but this work shows some valuable features, namely the frequency analysis of time series of sediment volume data, the inclusion of sediment connectivity among the predictive factors, and a careful evaluation of model performances. The analysis is based on a very good dataset and is performed using up-to-date statistical techniques.

I am reporting below some comments hoping that they could be useful in the paper's revision.

**Table 1.**

The equations (b) and (c) of Rickenmmann (1997) define envelope curves (EC).

The equations involving catchment area, slope and the geological index, proposed by D'Agostino et al. (1996) and D'Agostino and Marchi (2001) could be removed because they have a similar structure to the equation by Marchi and D'Agostino (2004), which is based on a larger dataset.

The authors could consider the equations proposed by Marchi et al. (2019) that link debris-flow volume ($V_{DF}$) to catchment area ($A_B$) for various quantiles. These equations, which are based on a sample of 809 debris-flow volumes in the Eastern Italian Alps (https://doi.pangaea.de/10.1594/PANGAEA.896595), are not intended as predictive tools, while they aim at defining the scaling relationships between these variables. We observe, however, that the equation for the 99 percentile ($V_{DF} = 77000 \pm 7000 \cdot A_B^{(1.01 \pm 0.06)}$) is similar to the empirical envelope line (fitted by eye) proposed for the same region by D'Agostino and Marchi (2001).

**Type of flow process**

The records of sediment transport events include information on the type of flow process, i.e. debris flow of flood (line 84). It is likely - and some details about that would be welcome - that some catchments were affected by only one type of sediment transport process, whereas other catchments experienced both floods with intense bedload and debris flows. It seems to me that the information on the type of sediment transport has not been fully exploited, and events with different transport mechanisms have been processed together to derive the equations for predicting sediment volumes. Developing separate equations for floods and debris flows could have permitted to gain significant insights into the capability of different processes in delivering sediment in the catchments of the studied region. I understand, however, that the smaller sample size for separate processes could have been detrimental to the robustness of the analysis.

The issue of the type of sediment transport processes also arises in section 2.3.3 with the application of two approaches based on catchment topography to the recognition of the dominant sediment transport. Little is said about the agreement between the transport process predicted according to Wilford et al. (2004) and the transport process documented from debris basin dredging and RTM archives (section 2.1).

I presume that the three classes of sediment transport processes considered in Figure 5 are based on the application of the approach by Wilford et al. (2004) (i.e., not on archive data): this could be clearly stated in the caption. I suggest describing the three classes in Figure 5 using a legend within the figure instead of the caption.

## Sediment contributing areas

Does the recognition of "bare soil" permits discriminating bare soil from bare (outcropping) rocks? Both bare soil and bare rocks, if connected to the channel network, supply sediment for debris flows and fluvial transport. However, the erosion rate is usually much higher on bare soil/debris than on outcropping rock.

Regarding the use of channel area as a proxy of sediment source area (lines 165-166, 207), it could be of some interest to remember that the area of main stream channel was found to be significantly correlated to the sedimentation of reservoirs in one of the earliest studies that applied multiple regression to sediment yield estimation (Anderson, 1949).

## Roughness in sediment connectivity

The rather coarse DTM resolution could hamper the computation of the topographic roughness as an index of impedance to sediment transfer across the landscape. The optimal DTM resolution in the computation of the topographic roughness depends on the spatial scale of the geomorphic processes investigated. This issue is discussed in Crema et al. (2020) and a conversation on GitHub: https://github.com/HydrogeomorphologyTools/Connectivity-Index-ArcGIS-toolbox/issues/4

However, in the wide frame of this study, which computes the index of connectivity IC to derive an independent variable lumped at the catchment scale, this detail on the computation of the topographic roughness can be considered less critical than for studies aimed at representing sediment connectivity in a distributed way.

## Discussion

The authors frankly acknowledge the limits in the accuracy of the developed equations, which "capture a relevant first approximation but cannot be very precise" (line 290). The suitability of statistical equations for sediment volumes prediction has received different opinions in the literature. In the case of debris flows, Rickenmann (1999) found that some predictive equations "may overestimate the actual debris-flow volume by up to a factor of 100" and recommended "to make a geomorphologic assessment of the sediment potential rather than using these equations". This statement could sound too drastic, especially if the equations are based, like in this study, on careful data collection and thorough statistical analysis. However, in my opinion, the geomorphological assessment of mobilizable debris remains the core of any estimation of sediment volumes in torrent catchments, while the statistical equations relating sediment volumes to catchment parameters provide at most a useful comparison with the geomorphological estimates. I don't know if the authors agree with my point of view: I am proposing it as a hint for extending the discussion on the application of the predictive models developed in this study, including the integration with other methods, now briefly mentioned in lines 370-371.

## References

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