

Seismic analysis of bedload discharge at Tagliamento River during flood events

The study is field-based rather than laboratory-based and is methodologically well designed. It is not limited to power spectral density (PSD) analysis, but also attempts to interpret the physical processes occurring during floods. A particularly valuable aspect is the use of an existing seismic network originally intended for earthquake monitoring, which demonstrates the potential of low-cost environmental monitoring. The analysis of time lags between the seismic signal and the rise in water level is also valuable and may have predictive significance, although it requires further verification. The comparison between a classical flood and a flash flood, as well as the hysteresis analysis, also deserves attention, as it is consistent with previous studies and strengthens the credibility of the observations. At the same time, the main conclusions are based almost entirely on a single major event, Storm Ciarán, while the flash-flood analysis serves only as a comparative case, which limits the generalizability of the results.

The main weakness of the study remains the lack of clear separation between the different sources of the seismic signal. The authors assume that low frequencies reflect fluvial processes, whereas high frequencies are mainly associated with wind. However, the results shown in Figure 7 indicate a high correlation between wind speed and the seismic signal ($\rho \approx 0.7\text{--}0.8$) across nearly the entire analyzed frequency range of 1–40 Hz. This undermines the unambiguous attribution of low-frequency signals exclusively to fluvial processes. It is also questionable to treat Spearman's rank correlation as evidence of a physical mechanism. Correlation indicates only covariation, not a causal relationship; therefore, some of the interpretations extend beyond what can be directly supported by the results.

Further concerns relate to the interpretation of the physical processes. The explanation of the characteristic V-shaped signature remains speculative, because the authors propose two possible hypotheses—source migration or changes in the grain size of the transported material—without performing analyses that would allow these hypotheses to be distinguished. Similarly, the interpretation in terms of Rayleigh waves is not supported by phase analysis, FK analysis, beamforming, wavefield analysis, or dispersion analysis. The polarization analysis also appears insufficient, as it is limited to the estimation of back azimuth and degree of polarization (DOP), without considering ellipticity, rectilinearity, planarity, or wave-type identification.

The interpretation of hysteresis and time lags also remains ambiguous. The authors associate hysteresis primarily with bedload transport, whereas it could equally result from flood-wave propagation, catchment storage, nonlinear hydraulic response, or other processes. Likewise, the time lags between the seismic signal and water level may be related to the geometry of the monitoring network, the location of the gauging stations, flood-wave propagation, or the method used to calculate PSD, rather than solely to the earlier detection of fluvial processes.

The interpretation of the flash-flood results also raises concerns. The authors suggest that the absence of a detectable seismic signal indicates the absence of bedload transport, which constitutes an example of the logical fallacy that absence of evidence is not evidence of absence. Equally plausible explanations include a signal amplitude that was too low, masking by other noise sources, the presence of the signal outside the analyzed frequency band, or the event being too short to allow unambiguous detection.

Another important limitation is the lack of independent field data on bedload transport. The authors do not have granulometric measurements, direct sediment-transport measurements such as Helley–Smith sampling, camera observations, ADCP measurements, LiDAR data, or analyses of channel-bed morphological changes. As a result, all

conclusions concerning bedload transport are indirect. In addition, although the authors refer to the models of Tsai and Gimbert, they do not use them for a quantitative interpretation of their own results, nor do they attempt to model flow, process energy, or expected PSD values. The analysis therefore remains primarily empirical.

The choice of the analyzed frequency range, 1–40 Hz, also raises some concerns. The authors themselves note that rainfall-generated signals often occur above 50 Hz, yet they restrict the analysis to 40 Hz, which may hinder effective source separation. Conversely, excluding frequencies below 1 Hz may result in the loss of information related to processes operating over longer timescales.

Finally, the statistical analysis appears insufficient. Apart from Spearman’s rank correlation coefficient, the study does not present uncertainty analysis, confidence intervals, bootstrap procedures, sensitivity analysis, or tests of result stability.

Despite these limitations, the study should be regarded highly because of its originality, interdisciplinary character, and clear practical value. Particularly valuable is the use of an existing seismic network to monitor natural fluvial processes and the demonstration that flood-related signals can be detected even at considerable distances from the river channel. The work provides interesting field-based results and offers a valuable starting point for further research on seismic flood monitoring.

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