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Improving methods for the hydroacoustic monitoring of suspended sand concentration and grain size: Application to the Isère River at Grenoble Campus
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The knowledge of the suspended sand concentrations and grain sizes in rivers remains a challenge for river management as these quantities are difficult to measure due to their high spatio-temporal variability. A typical example is the engineered Isère River in France with its high suspended sand concentration over a gravel bed system leading to potential costly troubles for navigation and hydropower generation, depending on reservoir management operations. The aim of this PhD work is to improve and evaluate methods for the hydroacoustic monitoring of suspended sand concentration and grain size applicable to the Isère River. Therefore, measurements with 400 and 1000 kHz Horizontal Acoustic Doppler Current Profilers (HADCPs) were performed in the Isère River at the Grenoble Campus hydrosedimentary station during 27 months. The concentration and grain size of suspended sediments were determined by 31 suspended sediment measurements using the point sampling method. The Sand Discharge Computation method developed by Dramais (2020) was made operational through an open-access toolbox and supplemented with an original uncertainty estimation method. The application of different tools for measuring sand suspension allowed to improve some methodologies and to discuss the limits of some instruments such as an unexplained flux bias using the Delft bottle. Moreover, the masking of sand particles in laser diffraction grain size measurements of silt/sand mixtures was demonstrated and quantified, and further avoided by separating the fine sediments from the sand prior to analysis. Existing single and dual- frequency hydroacoustic methods introduced by Topping and Wright (2016) were applied and adapted, and provided good estimates of the suspended sand concentration at high temporal resolution, while the hydroacoustic estimations of the grain size do not provide any added value to prior knowledge. The outputs of the hydroacoustic methods are consistent with those of well calibrated empirical rating curves for long-term sand fluxes, but the acoustic methods provide more accurate estimates at the event-scale.