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Development of Model for Acoustic Noise Generated from Bedload in Rivers

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Quantifying bedload transport is important for many applications such as river management and hydraulic structures protection. Bedload flux measurements can be achieved using physical sampler methods. However, these methods are expensive, time-consuming, and difficult to operate during high discharge events. Besides, these methods do not permit to capture the spatial and temporal variability of bedload transport flux. Recently, alternative measuring technologies have been developed to continuously monitor bedload flux and grain size distribution using passive or active sensors. Among them, the hydrophone was used to monitor bedload transport by recording the sounds generated by bedload particles colliding on the river bed (referred as self-generated noise SGN). The acoustic power of SGN was correlated with bedload flux in field experiments. To better understand these experimental results and to estimate measurement uncertainties, we developed a theoretical model to simulate the SGN. The model computes an estimation of the power spectral density (PSD)by considering the contribution of all signals generated by impacts between bedload particles and the riverbed, and accounting for the attenuation of the acoustic signal between the source and the hydrophone position due to river propagation effects,. In this model, we

The energy of acoustic noise generated from the collision between two particles is mainly dependent on the transported particles' diameter and the impact velocity. We tested different empirical formulas for the estimation of the number of impact (impact rate) and the impact velocity depending on particle size and hydraulic conditions. To characterize the acoustic power losses as a function of distance and frequency, we used an attenuation function which was experimentally calibrated for different French rivers.

We tested the model on a field dataset comprising acoustic and bedload flux measurements. The results indicate that the PSD model allows estimating acoustic power (in between a range of one order of magnitude) for most of the rivers considered. The model sensitivity was evaluated. In particular, we observed that it is very sensitive to the empirical formulas used to determine the impact rate and impact speed. In addition, special attention should be kept in mind on the assumption of the grain size distribution of riverbed which can generate large variability in some rivers particularly in rivers with a significant sand fraction.