Spectral variations of underwater river sounds

Passive acoustic monitoring of the self-generated noise of particle impacts has been shown to be correlated to bedload flux and bedload size. However, few studies have concentrated on the role of acoustic wave propagation in a river. For the first time, the river environment is modeled as a Pekeris waveguide, where a wave number integration technique is used to predict the transformation of sounds through their propagation paths. Focusing on the distance of a hydrophone from the channel bed and cutting off the low frequencies produced by impacts between gravel particles, we demonstrate that acoustic propagation modifies the spectral content of bedload-generated sound. Acoustic signals analyzed with the proposed model are interpreted by comparison to Helley- Smith bedload data obtained during flood conditions on the large gravel-bedded Arc-en-Maurienne River, France. This study shows that careful attention to acoustic propagation effects is required when estimating bedload grain size distribution with hydrophones in rivers, especially for rivers with slopes higher than 1%. Bedload monitoring with a hydrophone is particularly appropriate for large gravel-bed rivers - especially so during large floods, when in situ sampling is difficult or impractical and the impact of acoustic propagation is weaker relative to the self-generated noise of bedload impacts.

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