Seismic constraints on reach-scale spatial and temporal variations in bedload transport

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Measurement of spatially and temporally heterogeneous bedload transport in rivers remains a basic challenge for studies of landscape evolution and watershed management. A 700-m reach of the Trinity River, a large gravel-bed river, was instrumented with an array of 76 seismographs during a dam-controlled flood event and two episodes of controlled gravel augmentation to investigate the potential for out-of-stream seismic monitoring. Low frequency seismic amplitudes, 3–12 Hz, varied smoothly in concert with water discharge. Higher frequency, 20–100 Hz, seismic amplitudes were greatest following gravel injections and then decayed for up to 7–10 hours. Transient increases in seismic amplitude following each gravel injection indicate that augmentations temporarily increased bedload transport along the whole reach. Neither the duration nor the downstream extent of enhanced transport would have been constrained without the seismic array. Comparison of the spatial distribution of high frequency amplitudes with time-lapse bathymetry identifies higher amplitudes along the upstream segment of the reach where migrating bedforms were observed compared to downstream where bed morphology was nearly constant. Net accumulation of gravel occurred in both segments of the reach, but accumulation was ~4 times greater in the upstream segment and approximately equal to the total bedload transport inferred from physical sampling. These results are consistent with a downstream decrease in bedload flux as a cause of the along-stream variations in high frequency amplitudes, though changes in the mechanics of bedload transport may also contribute. Our results demonstrate potential to expand studies of reach-scale variations in bedload transport and responses to controlled or natural supply perturbations with seismic monitoring. Ongoing research on seismic recordings of a subsequent flood with two equal discharge maxima rather than a plateau at peak discharge are being used to evaluate the change in transport efficiency and help optimize strategies for coarse sediment transport management to enhance salmon habitat with scarce reservoir water.