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Evaluating bedload transport with RFID and accelerometer tracers, airborne LiDAR, and HEC-GeoRAS modeling: field experiments in Reynolds Creek, Idaho

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Relationships between bedload transport, channel geometry, and bed topography in upland channels are not well understood due in part to a lack of quantitative field data. With this motivation, we are performing field experiments related to (i) bedload travel distances within and between transport events, (ii) style of bedload motion during transport events, and (iii) channel characteristics of depositional areas. To address these objectives, we deployed 1500 gravel and cobble Radio Frequency Identification (RFID) and 73 accelerometer tracers, installed three stationary RFID antennas, utilized airborne LiDAR, and conducted stream surveys in Reynolds Creek, Idaho. This gauged coarse alluvial stream is located at the USDA-Agricultural Research Service Reynolds Creek Experimental Watershed within the Owyhee Mountains. Flood discharges generally consist of occasional flashy winter rain-on-snow flows spanning less than a day, large spring snowmelt events lasting several weeks, and no high summer discharges during our experiments. Through repeat surveys of tracer clast positions with mobile RFID antennas, to date we have quantified travel distances of 800 RFID particles. Spring 2011 discharge transported RFID tracers nearly seven kilometers while the shorter Spring 2012 flow only displaced particles up to approximately three kilometers. During Winter 2011 rain-on-snow events, tracers moved a maximum of 200 meters. Stationary cross-stream RFID antennas constrain periods of bedload motion and rest. In Spring 2012, antennas recorded significant RFID tracer motion initiating just when discharge began to rise due to snowmelt, travel times between antennas decreasing as flow increased, and RFID particles no longer passing almost immediately after the hydrograph peaked. Accelerometer tracers deployed in Spring 2012 expanded bedload motion records, confirming minimal motion after peak spring flow. Accelerometer clasts also revealed that cobbles deposited in relatively close vicinities can have similar and different modes of transport- some traveled consistently over weeks as discharge increased while others of similar sizes traveled in short bursts to arrive at the same stream location. At tracer deposition locations, we extracted local channel characteristics from airborne LiDAR and field surveys. Finally, we modeled shear stress with HEC-GeoRAS, airborne LiDAR, and discharge to identify locations with significant shear stress changes and compared these areas to where RFID particles preferentially deposited. The combination of field methods, statistical analysis, and flow modeling provide additional insight into bedload transport mechanisms.

Keywords: coarse bedload transport, stream monitoring, mountain channels, flow modeling, RFID tracers, and accelerometer tracers