THE CHALLENGES OF SAMPLING SUSPENDED SEDIMENT IN A MOBILE CHANNEL WITH HIGHLY DYNAMIC TRANSPORT

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Abstract: Establishing a new gage site for the measurement of turbidity and suspended sediment can be technically challenging, but most sites can be successfully measured after making minor adjustments to the procedures and instrumentation during the initial phase of data collection. Highly erosive watersheds, however, demand a higher level of technical skills and fortitude to achieve success. Cuneo Creek, a 10.8 km^2 tributary to Bull Creek, in Humboldt Redwoods State Park, near Weott California, is an example of a gravel-bed stream that produces large sediment loads in a watershed with steep topography and very erosive soils. High frequency sediment pulses from hillslope failures and floodplain erosion are often poorly related to water discharge. In addition, elevated sediment transport rates create unstable bed forms through the process of aggradation-degradation, making it nearly impossible to establish a stable stage-discharge relationship. Shallow flow depths and velocities of 3.7 m/s or more create turbulent conditions that complicate sensor deployment and sample collection.

A Turbidity Threshold Sampling (TTS) station was installed during February 2004, utilizing a cable-mounted sampling boom, a DTS-12 turbidity sensor, an ultrasonic stage sensor, and two automatic pumping samplers. The cable-mounted boom can be adjusted both vertically and horizontally to reposition the turbidity sensor and sampler intakes within the measurement cross-section, but this must be accomplished manually by field personnel. Changes to the streambed elevation during runoff events resulted in the loss of data when the boom became stranded on newly formed sediment bars. It is common for the streambed elevation to change by 1 m or more during a moderate runoff event. When stream velocities were above 2.5 m/s, the boom hydroplaned on the water surface, overcoming the gravitational force of the counter weight placing the sensor near the water surface. We replaced the cable-mounted boom with a depth-proportional boom mounted to a large boulder in the thalweg of the channel.

Turbidities exceeding the range of the sensor (approximately 2000 FNU) are common during larger events. The sampling logic in TTS program was modified to control two pumping samplers, providing additional sample bottles for fixed-time sampling when the turbidity exceeded the sensor's range. A subset of samples collected within the sensor's range, and all samples collected above the sensor's range, were measured in the laboratory with a Hach 2100AN turbidimeter. During extreme transport events, the highest measured laboratory turbidity was 7485 NTU, and the highest measured SSC (1.0 µ filter) was 9194 mg/l. Sand fractions (> 0.63 µ) were determined from a subset of all pumped samples (577). The average sand fraction was 1.7%, and maximum was 14% of the total SSC. Instantaneous discharge measurements at the gage site were well correlated (R^2=0.95) to the continuous discharge records at the USGS Bull Creek gage, 4.4 km downstream. A stage-discharge rating was not developed for Cuneo Creek, but an average lag time was calculated from the stage peaks and applied to the Bull Creek discharge data to produce estimated 10-minute discharge values for Cuneo Creek.