HIGH-RESOLUTION MEASUREMENTS OF SUSPENDED-SEDIMENT CONCENTRATION AND GRAIN SIZE IN THE COLORADO RIVER IN GRAND CANYON USING A MULTI-FREQUENCY ACOUSTIC SYSTEM


Abstract Computation of accurate sediment loads in rivers where the transport of suspended sediment is at least partially regulated by changes in the upstream sediment supply requires high-resolution measurements of suspended-sediment concentration that are collected independently of water-discharge data. To meet this objective, multi-frequency acoustic systems have been developed and tested at five locations on the Colorado River in Grand Canyon, Arizona, with different sediment-supply characteristics. These systems consist of arrays of either two or three single-frequency sideways-looking acoustic-Doppler profilers. Acoustic attenuation is used to measure suspended-silt and clay concentration, and the acoustic backscatter in each frequency is used to measure the concentration of suspended sand in a discrete grain-size range. The contribution of silt and clay to backscatter during periods of higher silt and clay concentration is removed through an iterative process. The median grain size of the suspended sand is then calculated by logarithmic interpolation between the acoustically computed concentrations in each grain-size range. Results from error analyses indicate that the random errors associated with the acoustic measurements of suspended-silt and clay concentration and suspended-sand concentration are comparable to those associated with conventional Equal-Discharge-Increment or Equal-Width-Increment measurements of suspended-silt and clay concentration and suspended-sand concentration made with depth-integrating samplers. Because many more measurements (that is, a measurement every 15 minutes) of suspended-sediment concentration and grain size are possible using the multi-frequency acoustic system than are possible using conventional sampling methods, this acoustic approach to measuring sediment loads is more accurate than using conventional sampling methods alone.