Storm Period Fine Sediment Transport in Logsdon River, Turnhole Spring Basin, Mammoth Cave, Kentucky

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Abstract

Flow rate, water quality, and suspended sediment concentrations were measured in Logsdon River, a karst conduit within the Turnhole Spring Basin. Logdson River drains approximately 25 square kilometers. Turnhole Spring drains approximately 240 square kilometers and discharges into the Green River within Mammoth Cave National Park. River stage and flow velocity were monitored continuously with an upward-looking acoustic doppler current profiler. Turbidity, water temperature, pH, and specific conductivity were recorded continuously with a multi-parameter water quality sonde. A laser-diffraction suspended sediment sensor (LISST 25x, Sequoia Scientific, Inc.) provided measurements of suspended solids concentration and grain size. Storm period water samples were collected with an automatic water sampler triggered on a turbidity threshold. Suspended solids concentrations were estimated based on LISST concentration estimates and on empirical correlations between turbidity and laboratory analysis of measured sediment concentrations.

Analyses of several flow events reveal that peaks in turbidity and suspended solids concentration display a complex relationship to variations in flow hydraulics. There is often a peak in turbidity and suspended sediment concentration that corresponds to peak stage and flow rate, flowed by a secondary turbidity peak on the falling limb. Decreases in specific conductivity correlate with increases in turbidity and suspended solids concentration, supporting the interpretation that the peaks in suspended solids concentration correspond to the arrival of surface water at the monitoring site. The magnitude of the initial peak in sediment concentration scales with peak flow rate, whereas the magnitude of the secondary turbidity peak is weakly correlated with flow rate. The concentration of sand sizes (greater than 63 micron), tends to track flow rates closely, suggesting that the transport of these coarser fractions is dependent on local hydraulics and local supplies of sand in the conduit system. These patterns suggest that the initial sediment peak represents hydraulically controlled mobilization of sediment stored within the conduit system in response to proximal inputs from surface water sink points and rapid transmission of increases in hydraulic head through phreatic portions of the karst aquifer. The secondary suspended solids peak appears to represent inputs of finer suspended solids from distal surface inputs to the karst aquifer. This pattern of suspended solids concentration relative to discharge variation contrasts with typical surface water catchment responses in which suspended solids concentration peaks precede peak flow rates. These differences are likely important for understanding spatial and temporal patterns of contaminant transport in karst conduit systems.