Time-Series Sediment Acoustics and LISST-ABS Testing

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Abstract

Acoustics and other surrogates can be used to accurately and cost-effectively provide time-series estimates of suspended-sediment concentration and load, which is essential for creating informed solutions to many sediment-related environmental, engineering, and agricultural concerns. Interagency efforts in recent years have advanced the testing, methods development, operational guidelines, and training on sediment acoustics. This extended abstract provides an update on horizontal profiling methodologies and introduces the testing of the LISST-ABS (Acoustic Backscatter Sensor).

Introduction

Fluvial suspended-sediment characteristics relate functionally to acoustic parameters. Some of the earliest U.S. Geological Survey (USGS) research at sediment acoustic sites was done by Wall and others (2006), Topping and others (2006, 2015), Wright and others (2010), Landers and others (2012), and Wood and Teasdale (2013). The USGS has partnered with interagency groups to test instrumentation and develop operational methodologies for using acoustics to estimate suspended-sediment concentration. The primary collaborative groups involved are the Federal Interagency Sedimentation Project (FISP) and the Sediment Acoustic Leadership Team (SALT). The currently active FISP agencies are the Bureau of Reclamation, U.S. Army Corps of Engineers (USACE), U.S. Department of Agriculture-Agricultural Research Service, U.S. Forest Service,

and USGS. The SALT members include Reclamation, USACE, and USGS. The FISP was created in 1939 to research and standardize fluvial sediment science methods and instruments. Information on the current and recent FISP research can be found on the FISP website (FISP, 2019). The multi-agency SALT was established in 2012 and develops technical guidance and training for using acoustic metrics to monitor aquatic sediment (SALT, 2019).

This extended abstract gives an update on horizontal profiling methodologies and point sampling instrumentation. Profiling instrumentation includes Acoustic Doppler Velocity Meters (ADVMs) of various frequency ranges; point instrumentation includes the LIST-ABS (Acoustic Backscatter Sensor) (Sequoia Scientific, 2019).

Horizontal-Profiling Sediment Acoustics

Fluvial suspended-sediment characteristics can be derived from backscatter data collected using fixed-mounted, horizontally-looking acoustic Doppler velocity meters (ADVMs). The goal is to "index" acoustic readings in the volume measured by the ADVM to the overall mean channel sediment concentration. The sediment acoustic index method applied can be used to accurately and cost-effectively provide time-series estimates of suspended-sediment concentration (SSC) and suspended-sediment load (SSL), which allows for informed solutions to sediment-related environmental, engineering, and agricultural concerns.

A web-based course is available to teach hydrographers the fundamentals of the sediment acoustic index method using a single frequency ADVM and how to establish a sediment acoustic index station. The web-based course provides introductory material and is a prerequisite to the full, week-long USGS course H-17-037 Acoustic Index Method for Estimating Fluvial Suspended Sediment. The material presented summarizes and augments information in the USGS

Techniques and Methods 3C-5 report “Sediment Acoustic Index Method for Computing Continuous Suspended-Sediment Concentrations” (Landers and others, 2016). The Surrogate Analysis and Index Developer (SAID) tool is a stand-alone tool to assist in processing the acoustic parameters using data from the single frequency ADVM using methods outlined in the USGS Techniques and Methods 3C-5 report. The tool uses acoustic parameters as predictor variables in the creation of ordinary least squares (OLS) regression models to predict SSC. The regression models can be used to provide time-series estimates of SSC. Sediment acoustic index methodology has been applied to multiple sites across the country; additional information about the sites, methods, and training can be found at the SALT (2019) website. Topping and Wright (2016) describes additional methods to obtain sediment-size and sediment-concentration data using multiple frequencies of ADVMs. These methods and functionality are being incorporated into an updated version of SAID.

LISST-ABS Testing

The LISST-ABS (Acoustic Backscatter Sensor) is considered a point-sediment acoustic instrument (Sequoia Scientific, 2019). The LISST-ABS operates at 8,000 kilohertz (kHz) and measures 5.5 centimeters (cm) in front of the sensor. The point measurement capability makes it suitable for use in similar field installations as a turbidity meter. However, the LISST-ABS can measure changes in concentration of coarse-grained material (Sequoia Scientific, 2019), unlike turbidity meters. The manufacture specified range of suspended-sediment concentration for the LISST-ABS is 1 mg/L to 30,000 mg/L (7-micron dust particle size) or less than 20,000 mg/L (200-micron sand particle size) (Sequoia Scientific, 2019). The LISST-ABS was independently tested in a laboratory setting for concentrations ranging from 100 mg/L to 3000 mg/L and particle sizes ranging from 1 to 149 microns (Snazelle, 2017). Field testing of the LISST-ABS by multiple agencies is being compiled by members of the FISP and SALT. Field and laboratory

testing is planned to include the LISST-AOBS (LISST-Acoustic Optic Backscatter Sensor) by Sequoia Scientific (2019), which combines the LISST-ABS and turbidity, allowing for a more ideal response across a wide range of grain sizes. Multiple reports and papers are planned for the compiled results.

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