

Proposal Title: LISST-SL2 Field Testing

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Location and Study Location (if different): Western Washington rivers

Introduction: The LISST-SL2 is an instream particle size analyzer that uses laser-diffraction to measure volumetric concentration and particle-size distribution of suspended sediment. The -SL2 is a redesigned version of the original -SL device manufactured by Sequoia Scientific Inc. The new design incorporates increased sampling frequency (1-Hz) and an expanded range of particle size detection (1-500 microns), allows easier on-site calibration checks and improved software for real-time data visualization. Currently, only a small number of -SL2 units have been produced and distributed, and the manufacturer has agreed to loan a demonstration unit to WAWSC. Field testing of this new version is consistent with the FISP mission of sponsoring research on emerging tools and technologies for measurement and analysis of sediment properties. There are no studies to date which have documented robust field tests of the redesigned -SL2.

Background: A previous FISP supported study (Czuba et al., 2015) documented the capabilities of the original LISST-SL and identified an operational shortcoming of the laser-diffraction method for determining mass SSC. Converting from volumetric SSC to mass SSC requires an understanding of the effective density (SSC_m/SSC_v), and in the previous study which evaluated results from multiple rivers, the effective density varied by site and flow conditions and, on average, was found to be unrealistically low for most sites. In accounting for this, it was suggested that the current laser-diffraction method only accounts for rounded or angular particles with particle axes approximately equal and that elongated (e.g., feldspar) or flaky (e.g., mica) particles present in suspension can create a strong bias in SSC without such an effect on PSD. Indeed, particle size distributions measured by the -SL were generally found in good agreement with physical samples and, because effective density can be determined on a site-by-site basis with some number of physical samples, the -SL remains a valuable instrument for suspended-sediment studies examining SSC and PSD gradient profiles.

Purpose and Scope: The purpose of this study is to conduct field testing of the redesigned LISST-SL2 in a variety of western Washington rivers to determine if PSD results are consistent with physical samples, to examine effective densities at different sites for converting volumetric SSC to mass SSC, and to evaluate the improvements in sensor design and operation. Data collected in this study will be shared in collaboration with Dr. Jon Czuba (Asst. Prof. at Virginia Tech and principal investigator for the previous -SL evaluation study funded by FISP) who will independently collect similar -SL2 data sets using methods consistent with this effort.

Technical Requirements: We propose to conduct -SL2 field testing at 4 rivers in western Washington at the location of USGS gages. At each site, concurrent -SL2 and physical sampling would occur at a single vertical in the cross section and at 5 depths in the water column (below surface, 0.2, 0.4, 0.6, 0.8) at each vertical (enough to capture potential variation in the vertical), for 10-20 mins at each depth. The -

SL2 timeseries data at each depth will be long enough to capture repetition in the variation of the turbulence/concentration. Concurrent with -SL2 data collection, a total of three physical point samples will be collected at each depth in close proximity with the -SL2. Of the three physical samples, two will be analyzed for SSC and percentage of fines (A&B), the third sample will be analyzed for PSD. The total number of samples collected at each site will be about 15. With a timeseries of concentration by grain size, one could evaluate the higher-order aspects of characteristics of that timeseries that would provide insight into the stochastic nature of suspended sediment transport in rivers. This would include examining the variance, intermittency of large concentration events in the water column, that would not be quantified by the average Rouse profile. All samples would be analyzed at the USGS Cascade Volcano Observatory Sed Lab (FISP to fund lab costs).

Deliverables: We will provide results of LISST-SL2 sampling in a USGS Science Base data release.

Timeline: This is a 12-month project. Data collection will occur opportunistically during months 1-6. Data analysis will occur in months 7-8, and data reporting will occur in months 9-12.

Budget: We are seeking total funds for the amount of \$15,000. Of this amount, \$5,000 will be used to pay for SSC and full particle size analysis of suspended-sediment samples, and \$10,000 will be used to pay for labor costs for collecting samples and reporting results. Sequoia Scientific Inc. has agreed to loan WAWSC the -SL2 demo unit free of charge for operational testing and validation with physical samples.

Unique Qualifications: We have previous experience with the LISST-SL and experience with documenting and troubleshooting issues that might arise. We have an experienced team and equipment for collecting physical samples using P-61 point sampler. Data will be shared in collaboration with Dr. Jon Czuba at Virginia Tech who is conducting similar and independent field testing of the -SL2.

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