Development of a Portable Passive-Acoustic Bedload Monitoring Surrogate for Non-Experts

Project Chief/Location:

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Proposed Start/End Date: July 2014 – June 2015

1-Year Funding: \$23,581

1. Relation to FISP Goals:

The work proposed here seeks to create a portable passive acoustic surrogate bed-load monitoring system to provide in-situ measurements in a fluvial environment. Current operational monitoring deployments such as the Trinity River Restoration Project (CA) could use an optimized portable device to quantify the total bed-load transport spanning many gravel sizes and gravel-laden beds. By optimizing the portability of the system, a wider variety of potential test sites become available.

The passive acoustic bed-load monitoring technology has several advantages over manual physical sampling techniques. Hazards such as darkness and storm event flooding pose difficulties for the direct, physical measuring of gravel-bed transport. Hydro-acoustic technologies measure continuous bed-load discharge for greater temporal and spatial resolution than manual sampling. It also provides access to survey regions of a particular watershed that may not be accessible for manual sampling. In complement to existing manual sampling techniques, the instrumented plate configuration allows for easy calibration with concurrent measurements performed by an experienced manual sampling crew. Following field site calibration, the physical grab sample measurements can be minimized, thereby, reducing total bed-load monitoring cost.

2. Scientific Merit and Relevance:

As part of a project funded by the Bureau of Reclamation, a hydrophone-based bedload monitoring surrogate was designed and tested by researchers at the University of Mississippi and the National Sedimentation Laboratory in Oxford, Mississippi. The system has been used at the Elwha River in Port Angeles, Washington as well as the Trinity River in Weaverville, California. The system currently consists of up to four hydrophones mounted inside of a piece of PVC pipe. The pipes are attached to mounting poles that have been driven into the river bed. The hydrophone cables are then strung across the river (out of the water to avoid potential damage) to their individual preamps. The preamps are connected to a National Instruments breakout box which is interfaced with a laptop computer.

The data from these three field trips show promising trends between various acoustic parameters and bedload transport. It is hoped that with more field deployments and data analysis, a reliable method of determining bedload transport can be attained. However, flume experiments conducted by the authors of this proposal as well as studies conducted by Moen[1] indicate that while the acoustic energy generated does trend positively with bedload transport, it is highly dependent on the particle size distribution. It is for this reason that field data from multiple sites is desired. By comparing the acoustic signals from multiple sites with varying particle distributions, it is hoped that a

more universal calibration can be made. The problem that arises is that the current deployment methods are fairly cumbersome, require care to be taken, and demand favorable river conditions. Thus realistically the system in its current state can only be deployed at a select number of locations and times.

The purpose of the proposed work is re-design the system with the goal of increasing versatility, compactness and durability. By improving the deployment techniques and mounting methods, the available deployment windows can be widened, thus improving the diversity of field data available.

3. Methodology:

This proposed work is largely design oriented, with the end goal being a product that is easily usable by non-experts so that a much larger range of field data can be taken. The main areas of focus to optimizing the system will be the address the overall bulk of the system as well as to reduce the extremely intricate and delicate nature of the equipment.

The bulky and cumbersome aspects of the current system allow for a variety of mistakes to be made in the field. In particular, for each channel being used there are four wiring connections that must be made and three settings on the preamplifiers that must be set to the correct value. While this is not particularly difficult, in the field it can prove to be problematic. These issues will likely be addressed by developing either an entirely new piece of electronic equipment that combines all of these connections, or by developing an enclosed sealable unit. By compacting the system, its overall usability will be drastically increased. In addition, it will eliminate many of the potential errors that arise on any given field deployment.

Finally, the current system has a few delicate components; namely the hydrophone cables. These are high-capacitive cables that are an integral part of the sensitivity of the element. They are thin and delicate and are thus very easy to pinch or snap. Therefore it is necessary that for any significant flow velocity, the cables be strung above the river as much as possible. This poses several logistical issues and even with precautions has a high probability of resulting in damaged equipment. Fixing this issue will be difficult due to the delicate nature of the cables, but is an achievable goal.

After the modifications have been designed and built, several experiments will be conducted in order to calibrate the new system. Properties of interest to be calibrated include frequency response and directionality.

4. Timeline:

Receive funding	0
Design Modifications	Months 1-2
Build Modifications	Months 2-9
Calibrate new system	Month 9
Analyze data, perform additional experiments if needed	Months 10-11
Complete reporting, publish, and/or present results	Months 11-12

Partners:

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References:

1. Moen, K.M., Bedload Measurement in Rivers Using Passive Acoustic Sensors, in U.S. Geological Survey Scientific Investigations Report2010.