ABRAHAM AND MCELORY, COE AND USGS, Proposal:

1)

We seek support in the development of an application of multibeam sonar technology as a surrogate for direct measurements of bed load and bed material load in large sandy rivers. Because of their depth, velocity, and/or turbulence, deployment of physical samplers is nearly precluded in large rivers, and as a result of the difficulty and cost, bed load is very rarely measured in them. As an alternative to physical sampling, Abraham and others (in review, JHE) and McElroy and Mohrig (JGR-ES, 2009) have proposed methods to determine bed load fluxes and bed material fluxes, respectively, from repeat topographic surveys. While each of these methods has been supported by laboratory data, simultaneous vetting with appropriate field data will provide the necessary scientific and technical background to use the topographic evolution of sandy beds to calculate both bed load and bed material load sediment fluxes in general. This objective is parallel to FISP's goals of developing practical field applications of emerging sediment-sensing technologies. Because bed material is immediately related to riverine physical habitats, structural stability, coastal land-building, and reservoir filling, we suspect that this work will have immediate relevance to the engineering, scientific, and management efforts of FISP's partner agencies as well as many others.

2)

The purpose of our proposed work is to perform some initial tests on the ability of a new method to compute total bed material load in large sand bed rivers. We suggest that this can be accomplished using ***only*** sequential bathymetric profiles obtained in repeat-bathymetric-surveys. This would be a significant development and advance in sediment transport studies that would have far reaching implications. If shown to be viable, many research questions could be addressed regarding the proportions of suspended bed material load transport and the bed material load which moves in the bed forms. The method could possibly be more accurate because only one data set is necessary, where as with present methods, two data sets are necessary (suspended transport data and bed-from transport data). Using traditional methods, the two data sets are also acquired using two separate data collection techniques, which can introduce bias and/or overlap. The new method will require only one data set, and is non-intrusive. Possibly the most important result of the new method would be that the need for collecting suspended bed material load samples would no longer exist. This would of course require some transition time and rigorous verification tests. For the present work, we would use the following methodology.

1. Compute the bed material load transport in the translating bed forms (BML_b) by using the ISSDOTv2 method.
2. Compute the total bed material load (BML_t) using equations 18 and 20 in McElroy and Mohrig.
3. Subtract BML_b from BML_t. The difference should represent the computed bed material load in suspension (BML_{sc}).
4. BML_{sc} can then be compared to the measured suspended bed material load (BML_{sm}). It is important in this case to make sure that the wash load is removed from the suspended sediment samples. This would require that the particle size distributions for the bed and the suspended sediment samples are known.

The researchers have much experience in sedimentation work and have published several relevant papers and/or dissertations on the proposed methods. Abraham has already developed a methodology for computing bedload transport in large sand bed rivers, where in the past, it has not been possible to do so. The method requires sequential bathymetric profiles and is non-intrusive. This will be used in step one. McElroy has developed a methodology for measuring a deformation (vertical) flux and translational (horizontal) flux of bed material using sequential bathymetric profiles. This will be used in step two.

Besides the experience mentioned above, the researchers have access to Mississippi River measurements taken in the spring and summer of 2010 which will provide all the bathymetric profiles, suspended sediment, and grain size distribution data required to test the new methodology. These data will be used in all steps, and though already collected, will require much additional processing.

3)

Abraham and others have demonstrated with flume data that integrated surface differences of bottom topography are faithful recorders of bed load fluxes when sediment suspension is negligibly small. In the field where this condition rarely holds true, it is hypothesized that bed load fluxes are still accurately captured by integrated surface differences. Although this method clearly does not capture all of the transport of bed material. McElroy and Mohrig have shown how the combined translation and deformation of trains of bed forms creates an estimate of bed material flux. The difference between the bed load flux and the bed material flux is accounted for by the portion of the bed material that is transported in suspension. We propose to utilize an existing dataset with simultaneously collected bed topography, bed sediment samples, and suspended sediment samples to demonstrate how these three parts of sediment transport are related to each other and are also reflected by the evolution of bed topography. Because the suspended and bed sediment samples were collected together, the suspended sediment concentrations can be broken down by size fractions represented on the bed, and therefore the suspended bed material flux can be calculated. In this way the method of Abraham and others to calculate bed load can be related to the method of McElroy and Mohrig through the suspended portions of the bed material load.

4) The project will be completed in one year's time from the time of acceptance and receipt of funds.

The first quarter (year) will be used to acquire the data and perform any necessary processing.

The second quarter will be used to perform the computations as described in item 2.

The third quarter will be used to analyze the outcomes and perform any feedback computations.

The fourth quarter will be used to summarize and finalize the results and write a technical and /or journal paper describing the outcome. An appropriate conference will be selected in which the work can be presented.

Costs:

The salary of McElroy will be leveraged and not cost the project any $'s.

The salary of Abraham will be $19.2 K for an estimated work time of 4 weeks. An additional work time of 3 weeks will be leveraged through the project for which the data were already collected.

There will be no direct costs associated with the data collection.

For travel and per diem, $6.6 K is requested. This is for one trip for McElroy to be at ERDC when necessary for discussions and data evaluations, and for one trip for McElroy to present a paper at an appropriate venue.

For reporting and publication, and miscellaneous technical expenses $5.0 K is requested.

Total Requested funding: $30.8 K