ATTRIBUTES FOR A SEDIMENT MONITORING INSTRUMENT AND ANALYSIS RESEARCH PROGRAM

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ABSTRACT

The number of daily fluvial-sediment data-collection stations operated by the U.S. Geological Survey has declined by almost two-thirds since 1980. This decline has occurred concomitant with a substantial increase in sediment-data needs, and increased availability of potentially useful sediment-surrogate monitoring technologies that lack Federal sanction. A Sediment Monitoring Instrument and Analysis Research Program is envisioned for the United States that would foster research, testing, and evaluations on instruments and methods for measuring, monitoring, and analyzing selected characteristics of fluvial sediments by cost-effective, safe, and quantifiably accurate means. The Federal Interagency Sedimentation Project represents a potential focal point for management of a Sediment Monitoring Instrument and Analysis Research Program.

INTRODUCTION

According to the U.S. Environmental Protection Agency (2002), siltation—also referred to as sedimentation—remains one of the most widespread pollutants affecting assessed rivers and streams. In additional to traditional uses of sediment data, such as for design and management of reservoirs and hydraulic structures, information is needed for contaminated sediment management, dam decommissioning and removal, environmental quality, stream restoration, geomorphic classification and assessments, physical-biotic interactions, the global carbon budget, and regulatory requirements of the 1972 Clean Water Act, including the U.S. Environmental Protection Agency's Total Maximum Daily Load Program (U.S. Environmental Protection Agency 2003). The need for reliable, cost-effective, spatially and temporally consistent data to quantify the clarity and sediment content of waters of the United States (U.S.) arguably has never been greater.

In spite of the need for more sediment data, there is evidence that the amount of nationally consistent daily sediment data being collected in the U.S. today is but a third of that collected in 1982. This is due in part to cost, accuracy, and safety issues (Gray 2002, Gray et al. 2002).

Although traditional methodologies that normally require collection and analysis of a physical water sample are well established, these methods are increasingly being forsaken in favor of less expensive, potentially safer, continuously recording in-situ or laboratory methods for monitoring water clarity and (or) for obtaining sediment-surrogate data. Turbidity and related bulk-optic measurements are the most common means for obtaining water-clarity data, and for inferring suspended-sediment concentrations. Other sediment surrogate techniques, including

those based on laser-optic, digital-optic, acoustic, and pressure-differential technologies, also are being deployed and (or) tested in field and laboratory settings for their applicability toward providing quantifiably reliable information on bedform and bed-material characteristics, and on concentrations, size-distributions and transport rates of suspended sediment and (or) bedload. However, there are no nationally accepted standards for collection, storage, or use of data derived from techniques other than those described by Edwards and Glysson (1999). Additionally, there is a perceived need for a better understanding and standardization of data produced by these technologies.

That perceived need was part of the impetus for holding the Federal Interagency Workshop on Turbidity and Other Sediment Surrogates, April 30-May 2, 2002 (U.S. Geological Survey 2002, Gray and Glysson 2003). The workshop breakout session that focused on suspended-sediment-surrogate technologies other than those based on bulk-optic properties of water proposed four recommendations to the workshop's sponsor, the Federal Interagency Subcommittee on Sedimentation (Glysson and Gray 1997). The recommendations are summarized as follows:

The fluvial-sediment data needs of the U.S. would be well served by:

(1) Forming a program to foster research, testing, and evaluation of instruments and methods for measuring, monitoring, and analyzing selected characteristics of fluvial sediments in cost-effective, safe, and quantifiably accurate means.
(2) Establishing and fostering group(s) of topical expert advisors, composed of private, Federal, State, and (or) academia, to advise the Subcommittee on Sedimentation.
(3) Enhancing communication among those producing or using sediment-surrogate instruments or data.
(4) Establishing and promulgating criteria for suspended-sediment data accuracy.

This paper addresses the first recommendation by proposing attributes of a Sediment Monitoring Instrument and Analysis Research Program (SMIARP). Activities under a SMIARP would include research on bedload, bed material, bedforms, and water clarity in addition to suspended sediment. Several of the suggested SMIARP attributes have already been considered by the Technical Committee of the Federal Interagency Subcommittee on Sedimentation for incorporation into the activities of the Federal Interagency Sedimentation Project (2003).

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A SMIARP would focus on instruments and methods for providing quantifiably reliable information on bed-material characteristics, and on concentrations, size distributions and transport rates of sediments in suspension and as bedload by the safest, most cost-effective, and quantifiably accurate means. In this section, a vision of a SMIARP is framed as if currently functional.

Goal: The goal of the SMIARP is to foster research, testing, and evaluations on instruments and methods for measuring, monitoring, analyzing (including computing, and estimating) selected characteristics of fluvial sediments in cost-effective, safe, and quantifiably accurate means. The methods and standards developed through the SMIARP must ultimately be acceptable to the Federal Interagency Subcommittee on Sedimentation. It is also desirable that these methods and standards ultimately be deemed acceptable by such standards-setting organizations such as ASTM International (2003) and the International Standards Organization (2003).

Scope: The technical scope of the SMIARP includes research on or related to instruments and methods for remote, in-situ, manual and (or) laboratory measurement of selected characteristics of suspended sediment and water clarity, bedload, bed material, and bedforms. The scope includes research on computational and estimating techniques; the most efficient linkage or usage of instruments, methods, and data-analysis techniques; and efficient storage and public retrieval of the types and amounts of sediment and ancillary data needed by the U.S.

Functions: The primary functions of the SMIARP are to recommend and (or) provide a formal structure and organization for collaboration; standard data-collection and test protocols; and standard acceptance criteria. The SMIARP also represents a forum or clearinghouse for effective communication among public and private entities; and, in some cases, a source of support for organized collaboration on fluvial-sediment research that has a high potential to result in operationally effective tools for providing the sediment data needed by the U.S.

Activities: The concept of the SMIARP is evolving and the full range of Program's potential endeavors are being considered. The following list represents appropriate activities that may be conducted under the auspices of the SMIARP (numbering the activities is for ease in reference and does not imply priority):

1. Develop and publish criteria describing the acceptable documentation, qualification, and reporting of data describing selected characteristics of suspended sediment, bedload, bed material, and bed topography in field and laboratory settings acceptable by standards-setting organizations.
2. Develop and publish quantifiably reliable procedure(s) for testing the precision and bias associated with data obtained by surrogate measurements.

3. Identify instruments, methods, and analytical techniques that show considerable promise for providing surrogate data for fluvial sediment in laboratory and field settings.
4. Test sediment-surrogate instruments in laboratory and (or) in field settings, with the primary goal to describe the capabilities and limits; bias and variance; and requisite ancillary data associated with the instruments.
5. Develop and (or) test analytical techniques for computing or estimating selected characteristics of fluvial sediment, including transport rates, size distributions, and their associated uncertainties.
6. Prepare and disseminate reports that summarize program findings and results.
7. Organize and hold joint briefings, workshops, national meetings, and (or) otherwise encourage effective communication with program collaborators, the Subcommittee on Sedimentation, its Technical Committee, and the Federal Interagency Sedimentation Project.
8. Fund projects, or assist in obtaining project funds to accomplish specific program objectives for which existing resources are inadequate.
9. Evaluate the effectiveness of the SMIARP and refine its mission and (or) functions to optimize its responsiveness to participants.

Leadership and Participation: One of the explicit reasons for holding the Federal Interagency Workshop on Turbidity and Other Sediment Surrogates—and one of its implicit outcomes—was recognition of the need for Federal leadership in setting standards and providing guidance for measurement of fluvial sediment and water clarity. The Federal Interagency Sedimentation Project (FISP) was created in 1939 to unify the research and development activities of Federal agencies involved in fluvial-sediment studies. Today, oversight for the FISP is provided by the Federal Interagency Subcommittee on Sedimentation, Technical Committee, which is comprised of the U.S. Environmental Protection Agency; U.S. Army Corps of Engineers; U.S. Department of Agriculture's Agricultural Research Service, and Forest Service; and the Department of the Interior's Bureau of Land Management, Bureau of Reclamation, and U.S. Geological Survey. FISP equipment and techniques are the standards used by most Federal, State, and local governments, and private organizations collecting sediment samples in the United States, and FISP-developed samplers have been used by the World Meteorological Organization as controls for comparison with suspended-sediment samplers developed in several foreign countries. Given its history (Skinner, 1989), interagency composition, and functions, the FISP represents a logical focal point for management of the SMIARP.

Proliferation of sediment-surrogate monitoring technologies (Wren and others 2000) primarily through private enterprise and universities, makes it likely that commercially produced devices will constitute the bulk of instruments that may eventually be applied for measuring fluvial sediments (Gray and Schmidt, 2001). Hence, it makes considerable sense for the private sector and universities to have the opportunity to participate in the SMIARP to provide and receive guidance. Additionally, participation of other countries—governments, international associations, or the private sector—should only serve to strengthen and enhance and perhaps help support the SMIARP.

SUMMARY

In response to expanding needs for fluvial-sediment data concomitant with declines in sediment-data acquisition, formation of a Sediment Monitoring Instrument and Analysis Research Program has been recommended. A SMIARP would foster research, testing, and evaluations on instruments and methods for measuring, monitoring, analyzing (including computing, and estimating) selected characteristics of fluvial sediments in cost-effective, safe, and quantifiably accurate means. If the Federal Interagency Subcommittee on Sedimentation accepts the recommendation from the Federal Interagency Workshop on Turbidity and Other Sediment Surrogates to form a SMIARP, delegation of SMIARP oversight to the FISP should be considered as a management option.

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