Date: December 4, 2019

From: John R. Gray (U.S. Geological Survey Scientist Emeritus; Principal, GraySedimentology.com), Peer Reviewer

To: Guillaume Nord, Yoann Michielin, Romain Biron, Michel Esteves, Guilhem Freche, Thomas Geay, Alexandre Hauet, Cédric Legoût, and Bernard Mercier, Authors

Through: Natascha Töpfer, Copernicus Publications Editorial Support

Subject: Peer Review of EGU Manuscript gi-2019-33, "An autonomous and low-power instrument platform for monitoring water and solid discharges in mesoscale rivers" (Geoscientific Instrumentation, Methods and Data Systems, European Geophysical Union)

Thanks for the opportunity to review this manuscript on a subject Near and Dear to My Professional Heart. As the National Sedimentologist in the U.S. Geological Survey's (USGS) Office of Surface Water (1996-2014), my primary objective was to abet and augment the development of surrogate technologies for monitoring fluvial sediment and sorbed-constituent fluxes. In the 1990s, my then-USGS colleague Randy Parker suggested formulation of a "Sediment-Superga(u)ge Network" that would combine collection of hydrological data at a number of river sites, each using traditional and surrogate monitoring methods. A "Sediment Monitoring Instrumentation and Analysis Research Program (SMIARP)" among several U.S. Federal Agencies that encapsulated the Supergage concept ensued (Gray and Glysson, 2003; Gray, 2005). The RIPLE concept is a most-welcome and promising extension to the "Supergage" concept.

I have completed the on-line evaluation of the manuscript. As is my professional habit of 40+ years, I provide "Notable Observations and Considerations" before sharing my detailed review comments per page/line numbers. These are followed by my "references cited," which are provided solely for your information with neither an explicit nor implicit "requirement" for your use or even review.

Aside…the review format greatly facilitated my review. Kudos to the editor et al.

Do not hesitate to follow up directly with me with respect to my review comments at GraySedimentology@gmail.com.

Without further ado…

NOTABLE OBSERVATIONS AND CONSIDERATIONS

1. First and foremost, it is evident that this the RIPLE project was thoughtfully conceived and carefully developed. The authors are commended for their obvious in-depth knowledge of sedimentology, inventiveness, writing, and exposition skills.
2. The figures, particularly the photographs, are top-notch. The project sites are neat, and the beauty of the surrounding area(s) is stunning. I suggest all authors decline compensation for this effort due to the stunning work environment and ability to have so much fun on-the-job. Seriously?
3. One important concept of the Sediment Monitoring Instrument and Analysis Program (SMIARP, see later) is the key requirement for ground-truth data to be obtained concurrently with surrogate data. If this theme appears in the paper, I've missed it. The importance of ground-truth data can't be overstated for current calibration purposes, and for historical-to-present-to-future comparisons of datasets obtained using different technologies. There are examples of major 'breaks' in sediment transport in the USA that were subsequently determined to spurious artifacts of the data-collection process (instruments and/or methods).
4. I was pleased to see uncertainty estimates included with most of the parameters being measured.
5. Turbidity monitoring may be useful, but eventually one should consider including (an admittedly expensive but quite useful) subaqueous laser device for SSC AND particle-size distributions determined volumetrically. See the LISST-100X (or newer version) by Sequoia Scientific Inc., Bellevue, Washington, USA. I am not a fan of turbidity as a suspended-sediment concentration (SSC) surrogate even if I am a co-author of the 2009 USGS "turbidity guidelines."
6. For SSC values exceeding ~20 g/L, and particularly for hyperconcentrated streamflows, consider the ~simple and ~inexpensive densimetric technicque (Brown and others, 2015).
7. For bedload monitoring, it would be appropriate to state that passive hydroacoustics are relevant "only to gravel-bedload transport," if it can't be proven otherwise (wasn't so a decade ago…see Gray and others, 2010).,
8. Much of the "spec"-type information was tedious. Table 2 captures the "power balance," but I wonder if information on uncertainties, etc. might be included in yet another table?

DETAILS, DETAILS

1-10: Suggest that the acronym "RIPLE" instead be spelled out and followed by (RIPLE) in the abstract.

1-13: Terms such as "mesoscale" (somewhat defined on page 16-2 as having depths <5m), "fine" and "coarse" sediment (some consider the division at 0.062 mm, some at 2 mm), etc. would benefit from (more-or-less) precise definition.

1-16: Hydrophones…no mention of the bed type in which this technology is applicable. Unless times have changed, use of hydrophones (and geophones) is largely limited to gravel-bed rivers. If so, it would be appropriate to delimit the use of the hydrophones in the text.

1-18: I am a Big Fan of "robustness," even if some accuracy is lost. However, regarding accuracy, most of the RIPLE sub-technologies are qualified by uncertainty values. This is a practical and tractable approach, with which I concur.

2-15: A good reference on "persistent turbidity" is available in USGS SIR 2007-5178, "Major Turbidity Events in the North Santiam River Basin, Oregon, Water Years 1999–2004" (https://pubs.usgs.gov/sir/2007/5178/index.html).

2-31: Fluxes are "estimated" or "computed," no? I.e., "Estimates of suspended-sediment flux are usually obtained…"

3-1: "…method to obtain …SSC measurement…is not currently available." Advances in hydroacoustic determinations of sediment fluxes have gained considerable traction in the USA. I can provide several references upon request.

3-4/5: I have measured many turbulent rivers and have often found substantial cross-sectional and vertical gradients in SSC. A not-best example of this can be found in figures 3 and 4 in Gray and O'Halloran (2015) (I can provide more dramatic horizontal gradients, and many examples of vertical gradients if pressed).

3-10/11: Can reference American Society for Testing and Materials, 2000, Standard test methods for determining sediment concentration in water samples: D 3977-97, vol. 11.02, Water (II) 395-400. I have a copy of this standard.

3-15: Concur.

3-19: No hyphen is needed after "hydraulically" given that it is an adverb and can only refer to "based." Picky, aren't I…?!

4-5: Might considering starting sentence with, "Knowledge…essential for…"

4-8: "hysteretic" might be favored (more descriptive) over "dynamic."

4-14: "substantial" might be favored over "significant." I try to limit the use of the latter to statistics.

4-20++: Believe more paragraph breaks would benefit the paper here and elsewhere. I'd be glad to suggest where to insert paragraph breaks upon request, but I'm confident the authors can attend to this on their own.

5-11: "…but little or none for monitoring…"?

5-20: Suggest express units either as l/s or as m^3/s.

5-23: Suggest "…commercially available equipment…" instead of "…company equipment…"

5-25/6: aDcps, if considered non-intrusive, arguably qualify as “existing to monitor SSC.”

5-30/1: Suggest, “All ‘recording’ instruments should be controlled…” but upon reflection a few days later, ignore this suggestion, given the impossibility of controlling non-recording equipment remotely…?!

6/1-4: See “Sediment Monitoring Instrument and Analysis Program (SMIARP)” entry under “notable comments.”

6/4: Table 1, very informative/good.

6/18 (also 12/27): I was a peer reviewer for the PASS sampler paper. Very useful device; I recommended its acceptance after several back-and-forths with the principal author (Nic a very good scientist). However, the PASS technology as originally published doesn’t provide information that would enable reliable flux estimates of suspended-sediment transport.

6/29: Appendix A is succinct and quite informative. I am impressed.

6/31: 10-minute data-measurement/recording interval: My experience indicates that this should be fine even if the rising phase of the hydrograph might be less than an hour in duration (?) for a “mesoscale river.”

6/31-2: Data are plural…as you indicate in 15/8... Elsewhere the verb is correctly plural. Picky reviewer?!

7/11: I smiled at power consumption “estimate” of 7,758 mA.h/day. Are four significant figures for an estimate appropriate, even if it is mathematically (excruciatingly) correct…? But overall the power-consumption considerations and calculations are Far More Involved than I every performed at any of my gauges. I just tried to “overpower” them…! Well done.

7/24: Excellent table 1 and figure 2. Your efforts on figures make what otherwise would be a “dry” paper easier and more enjoyable to review.

7/27: At first, I was unsure whether this was an aerial or subaqueous camera. Easily discerned, but might be useful to start sentence with “The aerial control camera…” Suite yourselves.

8/30: Index velocity range is given, but value(s) used not so. Would it not be desirable to define “them” empirically with, say, a manually deployed aDcp? USGS has guidelines on the index-velocity method.

9/1: Wholeheartedly concur.

9/2: As I’ve aged (regrettably, I have considerable experience in that process), I’ve shied away from gender-specific references whenever possible. Instead of “manpower” I refer to “human resources.” Yes, I know this is politically correct, but I’m the reviewer and that’s what I wrote…😊

9/6: Another foible, the USGS, for which I worked 37 years, mandates "relation" when used in scientific comparisons, and "relationship" to what I have with my wife, kids and grandson (born on October 26, 2019, I'm a rookie grandfather…). You of course aren't bound by USGS rules.

9/8: Reference is made to "…lack of brightness…" but I do not recall any reference to/caveats associated with "night monitoring." If this observation is correct and that some of the data could only be obtained half-the-time, it should be stated so. Perhaps in abstract and in body of text.

9/15: I found in the USGS "supergage" program that costs associated with human resources (!) required to operate and post-process surrogate data far outweighed capital costs of instruments. In fact, I called this my "Trojan Horse" project: I'd give instruments to eager-if-unsuspecting field folks who only later realized the extent of their commitment…! However, as time went on and the instruments were "figured out," such time commitments (and costs) diminished substantially.

10/15: Laser inclined upstream or downstream? And in a fixed position?

11/13: Radar, good.

11/14: Electrical conductivity versus Specific Conductivity: The latter is the "common" language, is indexed to a cm width of river water at 25 C (I recall).

12/21: Time averaged data for QW parameters is a good idea. Maybe not so for some physical parameters. I can explain if needed.

12/30: Suggest use, "including…" instead of ending sentence with "…"

13/8: Use of strainer good idea (a lesson I learned the hard way).

13/21++: Two turbidimeters at low and high range, very wise. However, I'm not a fan of turbidity to infer SSC even if I co-authored the "Rasmussen et al. (2009)" paper which we refer to as the USGS "turbidity protocol for estimating SSC." See "notable comment" on (expensive) alternative.

13/25: See "notable comments" on densimetric technique for high/hyperconcentrated streamflow SSC determinations.

15/3: Instead of "allows," perhaps "enables?"

15/5+: Suspended solids vs SSC: I avoid the former unless the metric is Total Suspended Solids (TSS), which I studied 2 decades ago and declared fundamentally unreliable. See Gray et al. 2000 and other papers that "condemn" TSS data.

15/8: SCAF is a very neat innovation. Congratulations. It in itself (with calibrating data) worth a paper?

15/27: Echo-sounder is at-a-point…?

17++ I neither reviewed "data transfer" nor "visualization" closely, as I wouldn't have much to add given you're far ahead of me on these (and certainly other) topic(s).

22/7: "Sites" or "gauges" on two rivers?

23/11: My Ph.D. dissertation was on "calibration coefficients for 4 pressure-difference bedload samplers." I am keenly interested in using surrogate bedload data, but first things first (in USA, anyway) is to make sure we know trapping efficiencies of our ground-truth instruments. I found that some pressure-difference bedload samplers had substantially super-efficient trapping coefficients.

23/26: Dissolved Oxygen is (now) easily measured by luminescence technique, but of course its relevance is suspect-at-best in most non-tidal rivers.

24/6: Aquatic drone. Sounds neat, but how to use? I'm a rapt observer…

References Cited:

Brown, J.E., Gray, J.R., and Hornewer, N.J., 2015, In situ densimetric measurements as a surrogate for suspendedsediment concentrations in the Rio Puerco, New Mexico: Proceedings of the 3rd Joint Federal Interagency Conference (10th Federal Interagency Sedimentation Conference and 5th Federal Interagency Hydrologic Modeling Conference), April 19 – 23, 2015, Reno, Nevada, p. 1,261-1,272 (http://acwi.gov/sos/pubs/3rdJFIC/Contents/7BBrown.pdf and http://acwi.gov/sos/pubs/3rdJFIC/Proceedings.pdf).

Gray, J.R., and O'Halloran, Denis, 2015, Maximizing the reliability and cost- effectiveness of your suspendedsediment data: Proceedings of the 3rd Joint Federal Interagency Conference (10th Federal Interagency Sedimentation Conference and 5th Federal Interagency Hydrologic Modeling Conference), April 19 – 23, 2015, Reno, Nevada., p. 433-446 (http://acwi.gov/sos/pubs/3rdJFIC/Contents/3C-Gray.pdf and http://acwi.gov/sos/pubs/3rdJFIC/Proceedings.pdf).

Gray, J.R., (ed), 2005, Proceedings of the Federal Interagency Sediment Monitoring Instrument and Analysis Research Workshop, September 9-11, 2003, Flagstaff, Arizona: U.S. Geological Survey Circular 1276, 46 p. (http://water.usgs.gov/pubs/circ/2005/circ1276/).

Gray, J.R., and Glysson, G.D., 2005, Attributes for a sediment monitoring instrument and analysis research program, in, Proceedings of the Federal Interagency Sediment Monitoring Instrument and Analysis Workshop, September 9- 11, 2003, Flagstaff, Arizona, J.R. Gray, ed.: U.S. Geological Survey Circular 1276, 6 p. (http://water.usgs.gov/osw/techniques/sediment/sedsurrogate2003workshop/gray_glysson.pdf).

Gray, J.R., and Glysson, G.D., (eds), Proceedings of the Federal Interagency Workshop on Turbidity and Other Sediment Surrogates, April 30-May 2, 2002, Reno, Nevada, USA: U.S. Survey Circular 1250, 56 p. (https://pubs.usgs.gov/circ/2003/circ1250/).

Gray, J.R., Glysson, G.D., Turcios, L.M., and Schwarz, G.E., 2000, Comparability of suspended-sediment concentration and total suspended solids data: U.S. Geological Survey Water-Resources Investigations Report 00- 4191, 14 p. (http://water.usgs.gov/osw/pubs/WRIR00-4191.pdf).

Uncited References:

See GraySedimentology.com bio/bibliography for other papers of potential interest…the following in particular (if the link is broken, I can forward the paper).

Gray J.R., and Landers M.N., 2014, Measuring suspended sediment. In: Ahuja S. (ed.) Comprehensive Water Quality and Purification: United States of America, Elsevier, vol. 1, p. 157-204 (http://water.usgs.gov/osw/techniques/sediment/gray_landers_elsevier_chapter_12_10_17_2013.pdf).