

The ah ha moment of measurement: Introduction to the special section on Hydrologic Measurement Methods

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Received 10 March 2009; accepted 16 April 2009; published 23 June 2009.

Citation: Selker, J., and T. P. A. Ferre (2009), The ah ha moment of measurement: Introduction to the special section on Hydrologic Measurement Methods, *Water Resour. Res.*, 45, W00D00, doi:10.1029/2009WR007966.

[1] Water is essential to life; therefore, when humanity asks how much fresh water there is, the answer better be right. Answering this question correctly is one of the primary goals of hydrologic science. We do this through development of hydrologic theory, advancing hydrologic analysis, and improving hydrologic measurements. Theory constructs the framework of our investigations and analysis extracts information from our measurements, but after the dust settles, our understanding must be based on observations. The value of our measurements depends on the intrinsic capabilities and limitations of our sensors and on making the best decisions of what to measure (where, and when, and how) to challenge our theories and improve our understanding. As a result, the adequacy of observations must be assessed in the context of the question to be addressed.

[2] The need for informative hydrologic measurements has never been greater. Humanity is in the midst of a radical global hydrologic experiment. It is critical that we quantify and understand the trajectory of change in the distribution of water in response to a changing climate. Of direct and practical interest to all people is: will the patterns of water availability in the future be significantly different than those that we have come to depend upon? Meeting this need requires accurate and complete measurements of the current conditions to provide a baseline against which changes will be assessed. In addition, we will have to continually improve our measurements, analyses, and theories to quantify, understand, and adapt to our changing world.

[3] We believe that this special section of *Water Resources Research* on Hydrologic Measurement Methods marks a turning point in appreciation of the essential and unfinished business of learning how to get the right data upon which our understanding of hydrology rests. At first look, some of the questions that our science is asking may seem straightforward, but as is shown in this collection of almost 50 papers, getting the answers requires insight, ingenuity, and persistence. Readers of this special section will find approaches to determining answers to the following questions. How much of a rainfall evaporates [Heitman *et al.*, 2008]? How much hits the ground [Friesen *et al.*, 2008] and infiltrates [Kamai *et al.*, 2008]? What is the flow in a river [Le Coz *et al.*, 2008; Muste *et al.*, 2008; Nihei and Kimizu, 2008]? How much

sediment is the river water carrying [Gray and Gartner, 2009]? How much snow is on the ground and what is its condition [Fassnacht *et al.*, 2009; Lundquist and Lott, 2008]? How much water is stored in the subsurface [Gehman *et al.*, 2009]? These findings are joined by discussions of new technologies (e.g., lasers, ultrasonics, microradio networks, and fiber optics) to “see” water and to sense its movement [Robinson *et al.*, 2009; Scheuermann *et al.*, 2009; Trubilowicz *et al.*, 2009; Tyler *et al.*, 2009]. Other authors [e.g., Abdu *et al.*, 2008; Bradford *et al.*, 2009; Crook *et al.*, 2008] discuss the necessary bridge between measurement and analysis (e.g., tomographic analysis, exhaustive data checking, and assimilation of models in data analysis) to ensure that as much information as possible is extracted from the data.

[4] What becomes obvious when reading this collection of papers is that while technology has transformed our ability to obtain and interpret quantitative observations, the full potential of our technologies are only realized when hydrologists combine dedicated attention, dogged resolve, and deep appreciation of the desired capabilities and inherent limitations of sensors to their investigations. Equally obvious is the joy that drives most scientists, including hydrologists: the rare gift of being present at the ah ha moment, when new measurements challenge old beliefs and spark discovery.

[5] With this special section, *Water Resources Research* concretely reaffirms its recognition of the primacy of hydrologic measurement. Into the future, *Water Resources Research* will continue to provide authors with a venue for their discoveries of how to better quantify our precious common resource. As editors of this collection, we find great satisfaction in seeing the volume and quality of work dedicated to the advancement of hydrologic understanding through measurement. We thank all the contributors, reviewers, and the journal’s remarkable staff for their tireless efforts that made this collection possible.

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