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PREFACE

HP Volume to honor Keith Beven

1 | INTRODUCTION

This volume of HP honors the career of Keith Beven. Keith is the world's most cited hydrologist with unparalleled sustained contributions perhaps matched only by Robert Horton. Many of us in catchment hydrology instruct new graduate students and post docs to prepare for a research career in catchment hydrology by reading Keith's papers. Like Horton, Keith Beven's research has been path-breaking and led the way for a generation of other catchment hydrologists to follow.

Keith is known for many areas of study, but a few stand out as distinctive. What is striking in viewing these is Keith's ability to toggle back and forth between field work and modeling and laboratory study and fundamental theory development.

2 | THE LEGACY OF KEITH BEVEN

2.1 | TOPMODEL

The TOPMODEL concept (developed with Mike Kirkby) ushered in a new approach to catchment modeling—one driven by terrain information and process-based assumptions of how water is routed to the stream in the surface and subsurface. TOPMODEL was a quantum leap forward in hydrology. Originally rejected by the *Journal of Hydrology*, this paper is now the most cited ever in the Hydrological Sciences Journal at over 5,000 citations. Nothing since has equaled the beautiful simplicity of that work that continues to drive work in large basins, for water quality studies, to drive landscape evolution processes, and as part of first attempts to explicitly include groundwater in climate models. TOPMODEL, along with the work on hydrological similarity theory (with colleagues like Eric Wood and Siva Sivapalan), led a path towards upscaling hillslope and headwater hydrology to global circulation models.

2.2 | Hillslope hydrology

Keith Beven's work in process studies in hillslope hydrology followed his PhD work focused on finite element modeling. The macropore review paper with Peter Germann in Water Resources Research in 1982 is one of his most cited paper in this area of study (well over 2,000 citations at last count). Although over 30 years since its publication, the paper is still frequently cited in contemporary papers concerned with runoff generation, chemistry (especially water quality), land restoration, and landsliding. Keith has published dozens of other preferential flow papers—ones based on field work, careful lab study, and kinematic wave theoretical reasoning for preferred flow behavior. Like many of the other themes that Keith has pursued in the field, these continue to this day. His edited special issue of *Hydrological Processes* on *Preferential flow and Residence Time Distributions* from summer 2010 shows continued leadership in this area and uncanny knack of being able to put his finger on the problems of the day—namely in the introduction to that special issue, the problem of epistemic and aleatory errors—areas not yet explored in residence time model analysis.

2.3 | Uncertainty analysis

Keith Beven has done more to ensure that estimation of uncertainty is an integral part of environmental modeling than any other single scientist. The concepts that he has introduced, such as equifinality, uniqueness of place, dotty plots, and many others, have become household names within the hydrological modeling community. His GLUE paper in 1992 (with Andrew Binley), his most cited HP paper with over 3000 citations, provided a radically different approach to thinking about model calibration and the impact of equifinality. Through his passionate embrace of uncertainty and his uncompromising stance demanding that it be considered in all modeling work that is published in the literature, Keith has turned himself into the "collective conscience" of the community, putting other modelers on notice for not accounting for uncertainty in our model calibrations and prediction. Keith's explicit analysis of uncertainty has proven to be the *sine qua non* for the study of fundamental problems in catchment hydrology.

2.4 | Teaching

Keith Beven's career has been one that has sought to tackle the most fundamental of problems and issues confronting our field. Keith has been a student of hydrological history. He compiled the first IAHS Benchmark Papers in Hydrology volume on streamflow generation processes and set the standard for the many volumes to follow. In that work, he showed remarkable sense of the evolution of the discipline, reverence for the main contributors to the science and guidance for the would-be student to find her or his path through the literature. Keith has also been a student of Robert Horton. Keith's AGU Langbein Lecture in 2004 was titled "Robert Horton and the application of distributed hydrological models." He, more than any other hydrologist to date, has honored the Horton legacy and highlighted the many unknown contributions contained in the Horton archives. His two

2004 papers in Hydrological Processes chronicled Horton's perceptual model of infiltration and Horton's take on abrupt groundwater rises.

Keith retired from Lancaster University in 2015 after 30 years service (although he continues with an emeritus position). He was one of the first Lancaster academics to be awarded the position as Distinguished Professor. During his time at Lancaster, he has helped shape hydrology and catchment science research in the University and stimulated countless students and researchers with his philosophical, yet analytically rigorous, approach to teaching. Beyond Lancaster, Keith has contributed to ongoing post-graduate shortcourses around the world, most notably his Uppsala **Uncertainty in Environmental Modelling course** and the **Aberdeen Catchment Science Summer School—collectively, these courses have reached over 500 students.**

More than 60 of Keith's over 300 journal papers are solo authored. Many of these solo-authored papers are in turn HP*Today* Invited Commentary on the state of the science; how we as hydrologists should approach our discipline. Buttle (2015) notes that these commentaries have had an enormous impact on the field—generating discussion, commentaries of their own, and sparking new graduate student ideas and thesis chapters. Indeed many a group meeting in hydrology labs around the world have centered around controversial commentary themes that Keith chose to tackle. Keith is also one of a very few hydrologists who use hydrology to communicate to the wider environmental sciences audience. His hugely successful *Rainfall–Runoff Modelling: The Primer* was published in Chinese in 2006 and is the benchmark in the field. His book, *Environmental Modelling: An Uncertain Future*?, published in 2009 by Routledge, is an example of how Keith has communicated to a wide audience—one well beyond the confines of hydrology.

3 | THIS VOLUME

This volume includes three invited Commentaries, which outline in detail Keith's impact on hillslope and catchment hydrology. Jan Seibert and Ilja van Meerveld assess the future of hydrologic modeling to quantify the effects of change (land use, climate, etc.) and more specifically change detection and prediction in a world of uncertainties. Markus Weiler evaluates the evolution of research on the identification and quantification of the effect of macropores and preferential flow on hillslope and catchment hydrology since the introduction of the concept by Keith Beven and Peter Germann in 1982 (Beven and Germann, 1982). Keith Loague and Brian Ebel trace the impact of Keith Beven's research on finite-element modeling of physics-based hillslope hydrology, followed by a Commentary, written by Keith himself, in which he provides advice for the career of a young hydrologist—thoughtful as always. Finally, there are 14 manuscripts organized into two themes, which align with Keith's research themes: (a) hydrological processes understanding and representation and (b) uncertainty and model structure.

4 | CONCLUSIONS

During much of Keith's career, he has often been somewhat at odds with mainstream hydrological research. Many of his citations have therefore come from papers by others trying to explain why he has been wrong, or overly subjective, or undermining the science. His role as playing the devil's advocate in trying to persuade others to be more circumspect in modeling these difficult systems has been hugely valuable for the field. These papers and authors involved with this volume all recognize and appreciate Keith's role in this regard. We hope that this will be a lasting testament to the career and contributions of Keith Beven to the field of hydrology and advancement of our understanding of hydrological processes. But we know full well that retirement may not stop Keith from continuing his pioneering work, and we all look forward to many more years of leadership from one of hydrology's greats.

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