Community advice to young hydrologists

Scott T. Allen and Wouter R. Berghuijs
ETH Zurich (allensc@ethz.ch wouter.berghuijs@usys.ethz.ch)
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Early career hydrologists can benefit from the advice of others who are more advanced in their careers. We have solicited short answers from established hydrologists to (one or more of) the following questions:

Q1. What book or paper has been most influential to your career and why?
Q2. If I could only work on one problem in hydrology it would be […], because […]
Q3. What is your golden tip for current early career scientists?
Q4. What (avoidable) mistakes did you make early in your career?
Q5. How can young scientists improve their writing or presentations?

We thank all hydrologists that have been so generous to share their knowledge, and took the effort to respond. The advice here reflects a diversity of philosophies that have led to wide variety of careers. All responses are listed below (in alphabetical order). Enjoy reading!

We welcome more advice! You never know who it will help or inspire. Submissions can be added in the comments section on the website's version of this article, available at www.younghs.com

Q1. What book or paper has been most influential to your career and why?

Q1. Groundwater by Freeze and Cherry – this textbook, now out of print, was a critical reference as I began my graduate training in hydrogeology and I still refer to it today. ***Jean Bahr (University of Wisconsin)***

Q1. I can think of no single one. However, papers that were a combination of field observations and clever analyses leading to new insights always are intriguing. Papers which I find of little value are those that propose a new modeling approach with little to no field verification, or which use existing models to reach some conclusion. For example, we seem to be seeing a proliferation of papers using complex models to highlight some "new" effect of climate change on the hydrologic cycle, with no grounding in hindcasts. (See this, also) The musings of Keith Beven always have been insightful, including his Advice to a Young Hydrologist. ***Jerad Bales (CUAHSI)***

Q1. I can't identify single "most influential" books or papers – I learned early to read as widely as possible, and not just within narrow/specific research problems of direct interest. I have been inspired by a range of articles – including books on philosophy, history of physics, etc. – which broadened my approach and ways of looking at a given problem. Indeed, some of my most influential work developed from studying methods and approaches in statistical physics and physical chemistry. ***Brian Berkowitz (Weizmann Institute of Science)***

Q1. The most important influence was a person – Mike Kirkby and particularly the undergraduate course on quantitative hydrology he taught at the University of Bristol when I was taking my degree there (later, I would do a post-doc with him at Leeds that resulted in the development of Topmodel). That gave me a lot of reading to do – but it was probably not the hydrological reading that had most influence, but rather the papers on theoretical geomorphology starting with Horton BGSA 1945, then picked up by Kirkby, Frank Ahnert and others in the late 1960s. I struggled to understand them (at the time I wanted to be a geomorphologist but I have never quite finished getting the water part right) but they left me the idea that it was possible to theorise about environmental processes and systems in approximate but useful ways.

During my PhD the most influential paper was undoubtedly Freeze and Harlan JH 1968, and the papers about the field site I was applying my model to by Darrell Weyman (HSB 1970, IAHS 1973). If I had talked to him a little more (he was doing his PhD at Bristol while I was an undergraduate) or read those papers more carefully, then I might have been more realistic in my PhD modelling.

The most important book at that time was Zienkowicz, Finite Element Modelling (that was the technique I was trying to master). Hillslope Hydrology edited by Kirkby was also important but came later. ***Keith Beven (Lancaster University)***

Q1. Paper: Scale of Fluctuation of rainfall models by I. Rodriquez-Iturbe. It formed the basis for my MSc research that I did during 11 months in Davis California (As a Dutch Student from Wageningen). It was extremely difficult stuff, but I kept on it and it understanding gave me the stamina to really dig into a subject. It was the basis for my first paper entitled "Analytically derived runoff models based on rainfall point processes" in WRR. To obtain better background I also read in depth the influential. Book: Random Functions and Hydrology by R. Bras and I. Rodriquez-Iturbe". ***Marc Bierkens (Utrecht University)***

Q1. Dooge' 1986 Looking for hydrologic laws in WRR. This paper gives a broad perspective on science, including scales. ***Günter Blöschl (TU Vienna)***

Q1. Konrad and Booth (2005), Hydrologic changes in urban streams and their ecological significance, American Fisheries Society Symposium, 47:157-177. This paper is a bit outside my area of expertise, but I think the linkage they make between physically measurable streamflow changes and stream ecology represents a fundamental shift in thinking from engineering hydrology to more of an eco-hydrology perspective. They illustrated that we need to go beyond analyzing just changes in peak flow or low flows (or fixed percentiles), to look at more derived metrics that better capture hydrologic regime change. ***Laura Bowling (Purdue University)***

Q1. That is a very hard question. As a Geography undergraduate student, I had to write a particular essay on the "all models are wrong" theme and this involved critiquing two papers which completely changed my worldview about models and modelling: Konikow and Bredehoeft's 1992 'Ground-water models cannot be validated' Advances in Water Resources 15(1):75-83. and Beven's 1989 'Changing ideas in hydrology - the case of physically-based models' Journal of Hydrology.

But in the last year I would say it has been Lab Girl by Hope Jahren (2016) who is a gifted and talented scientist and writer and has the knack of intertwining the natural world with tales of remaining brave in your career. I wish I'd had the opportunity to read it earlier in my career. ***Hannah Cloke (University of Reading)***

Q1. Ecological and General Systems – H.T. Odum. This book explores general systems theory in the context of ecosystem behaviors. It is holistic, comprehensive, and full of important insights about the structure and dynamics of systems. ***Matthew Cohen (University of Florida)***

Q1. It is a novel by Milan Kundera: "Slowness". My natural tendency is to rush up, be as fast as possible, quickly fix things... Yet, speed often leads to miserable outcomes. Many lines of Kundera's book are still in my mind, and they work as a continuous reminder for me that only slowness allows thoughtful consideration, serious reflection, and appreciation of reality. Realizing this has strongly influenced my academic career as it made me focus on the quality (and not the quantity) of my work. ***Giuliano Di Baldassarre (Uppsala University)***

Q1. Several hydrogeology-related texts were very helpful for me. These include some of Mary Hill's papers, John Doherty's PEST manual (as much for the philosophy as the instruction), some of Jasper Vrugt's early papers, and work by both Wolfgang Novak and Steve Gorelick on measurement design. The real recommendation would be to find authors that you enjoy and read as much of their work as possible - in this category, I would add Shlomo Neuman, Randy Hunt, Hoshin Gupta, Dani Or, Keith Beven and Graham Fogg. I am sure that I am forgetting more than I have listed. I think it is equally important to read broadly. Rather than provide a list, I'll encourage you to look at my recent paper in Ground Water (Sept 2016) for some suggestions! ***Ty Ferre (The University of Arizona)***

Q1. Book: Groundwater Hydrology by David Keith Todd, 1st edition, 1959. As a 3rd-year undergraduate in hydrology at University of New Hampshire in 1973, this book (and course by Francis Hall) kindled my interest in groundwater and completely changed my career path, which previously was essentially an aimless sleepwalk through my major in mathematics.

Paper/report: Kaiser, W. R., Johnston, J. E., and Bach, W. N.. 1978, Sand-body geometry and the occurrence of lignite in the Eocene of Texas: The University of Texas at Austin, Bureau of Economic Geology Geological Circular 78-4, 19 p. This paper demonstrated in stunning detail how modern borehole geophysical data together with understanding of the geologic genesis of sedimentary deposits could be used to create unprecedented subsurface maps of aquifer/aquitard system heterogeneity and structure. This led me down the long path of better integrating groundwater hydrology and geologic depositional systems. ***Graham Fogg (UC Davis)***

Q1. My interests have been in predictive hydrometeorology. The following were influential books at the start of my carrier in the late 70s and early 80s: Dynamic Hydrology by Eagleson; Atmospheric Science, An Introductory Survey by Wallace and Hobbs; Applied Optimal Estimation by Gelb (ed). These represented the fields of hydrology, meteorology, and estimation theory with applications to prediction, and were the necessary pillars to build predictive hydrometeorology. ***Konstantine Georgakakos (Hydrologic Research Center in San Diego)***

Q1. Haitjema and Mitchell-Bruker (2005) which taught me to think of groundwater as a process that interacts with topography, climate and geology in complex but predictable ways. ***Tom Gleeson (University of Victoria)***

Q1. The paper that has been most influential to my career is most certainly "Johnston, P. R., and D. H. Pilgrim (1976), Parameter optimization for watershed models, Water Resources Research, 12(3), 477–486.

I read this paper during my graduate work in the early 1980's and was intrigued by their report that "A true optimum set of (parameter) values was not found in over 2 years of full-time work concentrated on one watershed, although many apparent optimum sets were readily obtained."

On the one hand this paper clearly identified an important problem that needed to be addressed. On the other (as I often remark during talks on the subject), I think it was remarkable as an example of a paper reporting the apparent "failure" of the researchers to achieve their goals … how often do we see people reporting their failures in the literature these days :-). More of this kind of work - reporting a scientific study and accurately reporting both successes and failures … but especially failures … is critically important to the progress of science, so that people can both contribute to solutions and also avoid unsuccessful forays down paths already tried.

In any case, the paper clearly pointed me towards an important problem that led to me adopting a path of research over the past decades, which led to the development of the SCE and SCEM optimization algorithms (and indeed a whole field of optimization developments), studies into impacts of model structural deficiencies, multi criteria methods for parameter estimation, the diagnostic model identification approach, and more recently the Information Theoretic approach. ***Hoshin Gupta (The University of Arizona)***

Q1. The 1990 paper by Michael Celia et al on the numerical solution of Richards equation, recommended to me by Philip Binning at the beginning of my Honours Project at Newcastle Uni. This paper made a big impression on me because it provided a very clear exposition of how to solve a challenging modelling problem - and played a bigly role in getting me interested in research. ***Dmitri Kavetski (University of Adelaide)***

Q1. The Ecological Studies Series, published by Springer, was the most influential in my career because several books published in the Series (e.g., Forest Hydrology and Ecology at Coweeta edited by Swank and Crossley and Analysis of Biogeochemical Cycling Processes in Walker Branch Watershed edited by Johnson and Van Hook) sparked my interest in forest hydrology and biogeochemistry. In tandem with the superb mentorship of Prof. Stanley Herwitz (Clark University), I decided to embark upon a career as a forest hydrologist as a sophomore in college. I never looked back. ***Delphis Levia (University of Delaware)***

Q1. The papers of the series "Plants in water-controlled ecosystems" (2001, Advances in Water Resources 24), by Laio, Porporato, Ridolfi, and Rodriguez-Iturbe have been among the first and most influential I have read. Their clean, analytical approach to the complex interactions among vegetation, soil, and climate remains deeply inspiring. As an example of inter-disciplinary work (actually outside hydrology), I would like to mention the book by Sterner and Elser (2002) "Ecological stoichiometry. The biology of elements from molecules to the biosphere" (Princeton University Press) – a great example of how integrating knowledge from various sources around a common theme can yield deeper understanding and perhaps even lay the foundation of a new discipline. ***Stefano Manzoni (Stockholm University)***

Q1. The Hewlett and Hibbert 1967 conference paper "Factors affecting the response of small watersheds to precipitation…" is perhaps the best paper ever written in hydrology. For a full homage, please see. The paper is field-based, theory focused and a blend of bottom-up and top-down research, before that was even 'a thing'. It inspired me in my graduate research in the 1980s; I continued to read it and ponder it in my first years as a professor, as I strived to follow in Hewlett's footsteps. He was my mentor even though he retired before I could ever meet him. ***Jeff McDonnell (U Saskatchewan)***

Q1. In general, the books that have been most influential to me refer to sister disciplines. The reason is that I found illuminating to study methods and models used in statistics and economics for the purpose of applying them to hydrology for the first time. Thus, the most influential book to me has been "Statistics for long-memory processes", by Jan Beran. The very reason is that I found there a detailed explanation of models that were useful to get to target with my Ph.D. thesis. ***Alberto Montanari (University of Bologna)***

Q1. Chamberlin TC. 1890. The method of multiple working hypotheses. Science 15: 92-96 (reprinted in Science 148: 754–759 [1965]). I read this paper as part of a second-year course in Archaeology, which I took as an elective in my undergraduate program. Although the writing style is somewhat archaic, this article introduced me to the value of hypothesis-based thinking in science and the need to avoid favoring a pet hypothesis or model. It is instructive also to read the many follow-up essays to gain a broader perspective on hypothesis-based research and, more broadly, the "scientific method." ***Dan Moore (University of British Columbia)***

Q1. I think I was more influenced by my peers, colleagues, mentors, supervisors and friends as I learn better through discussions and challenges. One of the more memorable papers is one of Manning (Manning, R. (1891). "On the flow of water in open channels and pipes," Transactions ofthe Institution of Civil engineers of Ireland.) and it's associated history. In this paper, he actually suggested a far more 'complex' formulation than the formula which is today widely known as the Manning equation - history has it that it was never adopted widely as well as many subsequent more more sophisticated formulations. Science doesn't work linear and we are sometimes less rational or objective (if the latter is actually possible) than we believe. ***Florian Pappenberger (ECMWF)***

Q1. "Show me a person who has read a thousand books and I'll show you my best friend; show me a person who has read but one and I will show you my worst enemy." I have been influenced by many and I can't say one is *the* most influential or important alone. At the moment, I am reflecting on (McCuen RH. 1989. Hydrologic Analysis and Design. Prentice Hall: Englewood Cliffs.) As far as being a hydrology textbook it is not particular special, but it is written extremely clearly with a lot of good step-by-step workflows. Most importantly, the book integrates throughout its whole development the concept of analysis versus synthesis, and this has been central to how I approach my research. We do both analysis and synthesis. ***Gregory Pasternack (UC Davis)***

Q1. This is very difficult to say. I must admit that my academic work started from engineering practice and I only started reading the international literature very late in my career. But a book that has been very influential to me was the book by Fischer et al. (1979) "Mixing in inland and coastal waters". Fischer soon died in an accident after this book was published. The book introduced me to the fundamentals of mixing processes in estuaries, on which I had done substantial field research and had developed my own practical engineering method, which I still use, but which lacked a fundamental theoretical basis. I am still working on finding this fundamental basis, and Fischer's book put me on that track. ***Hubert Savenije (TU Delft)***

Q1. It would be tough to answer what's been the most influential to my career as a whole, but I could answer what was the most influential to my early career, and that was Menke's Geophysical Data Analysis: Discrete Inverse Theory. I labored through that book for years during my PhD. My copy has dog-eared pages and writing throughout as I tried to figure out inversion methods. Finally getting my head around the mathematics of inversion really opened up some doors for me early on. Davis' Tools For Teaching also really helped me think about how to be as effective a teacher as I could be. ***Kamini Singha (Colorado School of Mines)***

Q1. Books are hardly ever influential once you are actually 'in' research. Early on, look for the best review articles in your field. They will 'set the scene' for you. ***Keith Smettem (The University of Western Australia)***

Q1. "Opportunities in the hydrologic sciences", National Academy Press, USA (via this link you can still download a pdf of this book). This landmark book which defined hydrology as a science appeared right at the start of my PhD. It provided a nice framework for my own research and that of my fellow PhD students in those days. ***Remko Uijlenhoet (Wageningen University)***

Q1. It is difficult to select one single work from the literature that has been influential over my entire career in groundwater flow and transport modeling. But, there is one book that I used as a grad student that I still refer to today. It is "Conduction of Heat in Solids" by Carslaw and Jaeger. The book is a treatise on analytical solutions to diffusion equations. The lesson for me is that knowledge from other disciplines (in this case thermal engineering) can be applied to problems in hydrology. Another lesson is that we can learn a lot and gain important insights through wise approximations that have analytical solutions. ***Al Valocchi (University of Illinois at Urbana-Champaign)***

Q1. Abramowitz & Stegun: Math is something you look up, not something you try to memorize. ***Nick van de Giesen (TU Delft)***

Q1. In hydrology, some of the most influential books for me have been Handbook of Hydrology (edited by David Maidment) and Principles of Environmental Physics (Monteith & Unsworth). These two books are so rich in physics, empirical equations, recipes, and references. Of course, the times have changed and nowadays you can google almost anything, but some of the chapters in these books are so well written that I still regularly use them. They also have the benefit that they summarise areas of research where things haven't actually changed too much since the 80ies - the physics we use haven't become that much more sophisticated, and sometimes in fact less so; whereas the field measurements on which a lot of the empirical rules and equations are based generally also haven't been added much to since.

Outside hydrology, some books that have made me think differently about the field and my research include

Emergence: The Connected Lives of Ants, Brains, Cities, and Software (Johnson) - one of the first popular science books I read that made me think different (about ecohydrology)

The Sceptical Environmentalist (Lomborg) - I didn't accept his reasoning but it was seductive and it forces you to really pick apart the logical and rethorical flaws he uses.

Thinking, fast and slow (Kahneman) - which really made me realise the questionable quality of my analytical rigour and decisions in general (also those of anyone else, though!). ***Albert van Dijk (Australian National University)***

Q1. Physical Hydrology by Dingman and Elements of Physical Hydrology are both great textbooks. Why: just lots of "basics" well explained, emphasizing the need to understand PROCESSES. ***Doerthe Tetzlaff (University of Aberdeen)***

Q1. House at Pooh Corner, specifically, Chapter VI. In which Pooh invents a new game and Eeyore joins in. The first paragraph is an awesome description of a classic watershed and affirms my theory that hydrology is truly everywhere… even on Mars. Indeed, the search for "life" has largely been a search for "water." ***Todd Walter (Cornell University)***

Q1. Comparative hydrology, edited by Malin Falkenmark and Tom Chapman (1989). This book is one of the first to examine global hydrology phenomena. It asserts that a comprehensive and systematic description of hydrological processes is (i) possible (ii) not too complicated. Until then I'd thought the task was impossible, so I found the approach inspirational for my research. ***Ross Woods (University of Bristol)***

Q2. If I could only work on one problem in hydrology it would be […], because […]

Q2. I do not think it wise to focus on only one problem. Even with a specific area of interest, work in parallel on various related problems – if one project does not bear fruit, you will have others that do. And, some projects require years of effort – exploring experiments or theory/modeling – until the "right" approach and a convincing (re)solution are found. ***Brian Berkowitz (Weizmann Institute of Science)***

Q2. Encouraging the community to get better measurements of river flows, sufficiently accurate to be able to assess (continuously) the incremental discharge at multiple points downstream. No current method does this with sufficient accuracy – except perhaps continuous input dilution gauging but that has its own permission problems. This would allow much greater understanding of the relationship between catchment characteristics and river flow and would probably reveal that geology is more important than currently considered (e.g. the studies in Walker Branch). This would actually be going back to the nested gauging network I had in Crimple Beck while doing my post-doc – but doing it better with new measurement technology. [… and then there is still the rather fundamental problem of how to deal with epistemic input uncertainties of course] ***Keith Beven (Lancaster University)***

Q2. The hydro-economics and socio-hydrology of scarce and nonrenewable water resources, because it holds the key to understand the mechanism behind unsustainable water use and solutions to sustainability. ***Marc Bierkens (Utrecht University)***

Q2. I do not wish to work on only one problem, but we still have not resolved the scale issues, and it would be worth doing this. ***Günter Blöschl (TU Vienna)***

Q2. Earlier flood warnings (what I work on now!), because there are so many people living at risk of flooding with inadequate warning systems in place. We still have more questions than answers in understanding the predictability of floods and I believe we can do so much better. ***Hannah Cloke (University of Reading)***

Q2. Understanding and predicting landscape hydrologic connectivity and how this influences habitat connectivity. This issue is both intellectually challenging, and relevant to open sociopolitical questions about water management and regulatory jurisdiction. ***Matthew Cohen (University of Florida)***

Q2. If I could only work on one problem in hydrology it would be would be on how the hydrologic cycle evolved in early Earth when continents first appeared, probably in the Archean, because little is known and because no one else is working on it. ***Ying Fan Reinfelder (Rutgers University)***

Q2. How to predict the VALUE of added data before it is collected. This lies at the nexus of how we investigate systems, how we use our analyses, and how we justify our major costs and efforts. ***Ty Ferre (The University of Arizona)***

Q2. Monitoring and modeling long term changes in basin-scale groundwater quality, including role of modest to heavy groundwater development on hydrologic basin closure and salinity accumulation. Because: (1) This is a daunting, largely unrecognized threat to the sustainability of world water resources and (2) Properly modeling regional scale solute transport remains a grand scientific challenge. ***Graham Fogg (UC Davis)***

Q2. Developing cellular automata designs and theories for dynamic hydrometeorological processes and their predictive uncertainty on field scales ***Konstantine Georgakakos (Hydrologic Research Center in San Diego)***

Q2. Sustainable global groundwater use because this is the most pressing (and fascinating, interdisciplinary) problem a hydrogeologist can work on. ***Tom Gleeson (University of Victoria)***

Q2. If I could only work on one problem in hydrology it would be the problem of how to successfully convert various kinds of information (in data, in ideas and beliefs, in concepts and theories, in discrepancies between model simulations/predictions and data, etc.) into properly constructed dynamical systems models that can be used for both a) understanding/learning about the world, and b) making predictions and decisions necessary to society. Of course, this is a more fundamental problem than just hydrology … it applies to the sciences in general. The problem of going from Data & Ideas —> Information —> Models, and in particular models that are designed to be isomorphic to reality and therefore able to provide insight (as opposed to purely mathematical relationship/ predictive models) is, to me, the most interesting problem of all because it deals with the need to understand how "learning" happens, both at the individual level, and at the communal level of society and science. I am fortunate that, because this problem is so general and so fundamental, I have been actually able to work on various aspects of this problem for my entire career. I believe the key to this problem is to bring Information Theory to bear (as I and several colleagues are currently doing). ***Hoshin Gupta (The University of Arizona)***

Q2. Tough question - depending how narrowly you define "one problem". I'd say catchment-scale attracts my attention because it requires a combination of conceptual reasoning (we cannot represent everything we'd like) and technical skills (otherwise things just don't work well). But I am sure there are other problems out there that meet these criteria! ***Dmitri Kavetski (University of Adelaide)***

Q2. If I could only work on one problem in hydrology it would be to foster better dialogue among and within various sub disciplines of hydrology, because better communication among specialists in and within various sub disciplines of hydrology are needed to better position the discipline in the academy as well as to solve some of the most pressing issues facing society. ***Delphis Levia (University of Delaware)***

Q2. I am fascinated by how life is affected by and affects hydrological (and more in general biogeochemical) processes. How does this feedback manifest itself across spatial and temporal scales? My impression is that this question is still at least in part open and highly relevant for linking process understanding at small scales to large scale modelling of water and element cycles. ***Stefano Manzoni (Stockholm University)***

·Q2 I think that we should work on problems that are important. Problems that likely hydrologists will be still be working on in 50 or 100+ years from now. We have worked on the water balance problem for since the 1670s. But, we have not dealt with the other half of the equation: the age of the water balance components. Developing an age-based theory of the water cycle is an importance problem and one that permeates all corners of our field (see). Such a theory will unlock solutions to many of today's environmental problems linked to contaminant transport, landuse impacts and climate change expression in our hydrological systems. ***Jeff McDonnell (University of Saskatchewan)***

Q2. I would focus on the use of modern information and technologies to identify critical areas for flash flood risk, because too many people are still dying for our incapability to locate flood prone areas in advance. ***Alberto Montanari (University of Bologna)***

Q2. River restoration. The world is in a state of ecological collapse. No one person can solve the whole scope of the problem, but if each person applies their capabilities to their piece of the puzzle, then we can work as a worldly community to change. I am not the same person I was even 1 year ago, and so the world can change as a society too, if it decides to and if each person puts their head down and does their part. My part is river restoration. ***Gregory Pasternack (UC Davis)***

Q2. Never - I will quit the day on which I want to work on only one problem (and love meteorology at least as much as hydrology). I like interdisciplinarity, complexity and confusion :) ***Florian Pappenberger (ECMWF)***

Q2. If I could only work on one problem in hydrology it would be understanding relationships between instream-processes and landscape scale processes around streams influence hydrology and aquatic chemistry. ***Mary Santelmann (Oregon State University)***

Q2. If I could only work on one problem in hydrology it would be "prediction in ungauged basins", because "although we have made great advances during the PUB decade, there is still a lot to be discovered, both in understanding hydrological processes at the catchment scale and on proper applications in practice". ***Hubert Savenije (TU Delft)***

Q2: I would work on the problem on how to revolutionize the science-publication system since we cannot continue to publish and review papers and hydrology is particularly suffering from this. ***Bettina Schaefli (University Lausanne)***

Q2. There are so many interesting questions to be asked, and at so many scales--I'd be sad if I could only work on one problem! Right now, I'm really interested in connections between evapotranspiration and groundwater at small scales. It's been a ton of fun to struggle through the tree physiology literature. But who knows what I'll find most interesting a year from now! ***Kamini Singha (Colorado School of Mines)***

Q2. it would be to further understand hydrological processes and ecohydrological linkages in our complex landscapes, because there are still many unknowns. Nature is complex – and understanding how it works is fascinating. ***Doerthe Tetzlaff (University of Aberdeen)***

Q2. If I could only work on one problem in hydrology it would be the development of a sensor / instrument / methodology to monitor both precipitation and evaporation at the catchment scale, because (1) I like to work at the border between the disciplines of hydrology, meteorology and sensor / algorithm development and (2) I feel understanding the two-way interaction between the land surface and the atmosphere remains an outstanding research topic in hydrology. ***Remko Uijlenhoet (Wageningen University)***

Q2. If I could only work on one problem in hydrology it would be addressing the "curse of locality", because we tend to turn away from the simple and undeniable fact that every square meter is different. ***Nick van de Giesen (TU Delft)***

Q2. If I could only work on one problem in hydrology it would be scaling, because the spatial/temporal scales relevant to solving practical societal problems rarely matches the scales where our theories are valid and where we have data. ***Al Valocchi (University of Illinois at Urbana-Champaign)***

Q2. Ha! I have never tried working on one problem only, but it sounds pretty dull to me... ***Albert van Dijk (Australian National University)***

Q2. I'm not sure this question makes sense to most hydrologists. The thing I most enjoy about hydrology is that it intersects so many other disciplines such that the "problems" or questions continue to unfold like a 1:1 scale map of everything and allow me to engage with an increasingly diverse suite of people from molecular biologists to social scientists to policy makers to climate scientists to astrophysicists to historians to farmers to…. In short, hydrology is not about one problem unless that problem is defined very broadly. ***Todd Walter (Cornell University)***

Q2. If I could only work on one problem in hydrology it would be hydrological prediction in ungauged basins, because it is both intellectually rich and extremely useful. ***Ross Woods (University of Bristol)***

Q3. What is your golden tip for current early career scientists?

Q3. Take advantage of opportunities that present themselves to step outside of your comfort zone and broaden your perspectives by interacting with scientists from other specialties or sub-disciplines. ***Jean Bahr (University of Wisconsin)***

Q3. Try to work with someone who is as interested in advancing your career as she (he) is in advancing her (his) own**.** ***Jerad Bales (CUAHSI)***

Q3. Think carefully, with full knowledge of the relevant literature, to choose research problems. Do not just do "more of the same", or what is familiar and convenient – think out of the box to identify the truly important problems and means to address them. Learning new tools – whether experimental, theoretical or numerical – can be daunting and risky … but integrating your existing knowledge with new tools generally leads to more significant advances. ***Brian Berkowitz (Weizmann Institute of Science)***

Q3. In the beginning, stick to one subject that fascinates you and be really good at it. Later, try to place this expertise in a wider societal (even global) context and try to write a high-impact paper on it. Then, end with a review paper on this subject and then move on. ***Marc Bierkens (Utrecht University)***

Q3. Not sure there is one, but I have found 'perseverance' important, also 'listening'. ***Günter Blöschl (TU Vienna)***

Q3. Approach everything you do with an open mind. It's so easy to get attached to an elegant or exciting idea, but when you encounter data that challenge what you're thinking this often leads to the most important scientific advances. ***Gabriel Bowen (University of Utah)***

Q3. Remember that this is still just a job in the end. You can be an academic and have a family, even as a woman or a dual career couple. Yes, sometimes it means that you pass up some early lime light, or don't advance as fast as you otherwise think you could, but I whole heartedly believe that these 'sacrifices' you make for your family in the early years can come back to benefit your career in the long run, in multiple ways. ***Laura Bowling (Purdue University)***

Q3. Find a good mentor and don't be shy about asking them for advice. ***Hannah Cloke (University of Reading)***

Q3. Take every chance you get to share your work across audiences, and make sure you can explain why that work is important in 30 seconds or less. ***Matthew Cohen (University of Florida)***

Q3. Go travel and (slowly) enjoy the world. I truly believe that visiting different places and interacting with multiple cultures are key ingredients to build a solid career in academia. It helps not only build a network of fellows, but also open our mind facilitating out-of-the-box thinking. ***Giuliano Di Baldassarre (Uppsala University)***

Q3. Not sure if it is "golden", but I spend my morning reading, uninterrupted (email off, door locked, don't have a phone). So many books and papers are published each day, and it seems that there are more writers than readers. That cannot be good for civilization. To help tip the balance, I put myself on the readers' side. Besides, I learn by reading. Ideas form as I read. ***Ying Fan Reinfelder (Rutgers University)***

Q3. Early on (during your PhD), focus on something about which you can become the expert. Ideally, this should link to many possible areas of research. Then, expand to more findable areas in your post doc and early faculty career. ***Ty Ferre (The University of Arizona)***

Q3. Firstly, to succeed in the technical sciences you need to develop deep competency in appropriate subject matter. Even if you are really bright, this does not come without significant dedication to your education, including at times, deep immersion in your studies. Secondly, as research is the development of new knowledge, such discovery requires that students be allowed to develop their own unique brand of creativity. Although this creativity must blossom from within the person, I believe it is often stifled by habits developed by taking courses in our educational system in which the students are mainly told what to do. The creativity will never flow until the student sheds the habit of waiting to be told what to do and starts listening more to their own voice (and acting on it!) rather than those of others. This often requires a long, uncomfortable time in which the student's mentor mentors them not by telling them what to do, but by letting them wander in the wilderness long enough to let their true inner creativity begin to blossom. ***Graham Fogg (UC Davis)***

Q3. Find a research problem and search for solutions that open doors to a new field of research and application. ***Konstantine Georgakakos (Hydrologic Research Center in San Diego)***

Q3. Share (ideas, data, everything) early and often – generosity and openness bears many and rich rewards. ***Tom Gleeson (University of Victoria)***

Q3. My "golden tip" for current early career scientists would probably be "Find an important problem that needs solving, that seems to be difficult to solve, and then look for the hidden and overt assumptions that are currently being made that seem to be obstructing progress". These assumptions always exist, because people like to simplify problems when searching for solutions. In other words, the key to progress is often to look backwards into the past to see what "holy cows" (unsubstantiated beliefs and opinions) have become established and so are being assumed to be true when in fact they are poorly founded. ***Hoshin Gupta (The University of Arizona)***

Q3. Try finding a topic you enjoy working on, with generous and fun colleagues that share their knowledge and insight. And sometimes it is better to take things on board and learn, rather than having a constantly skeptical mindset - you need better understanding to criticize something than you need to apply it! ***Dmitri Kavetski (University of Adelaide)***

Q3. Use your platform as a researcher to nurture new talent and promote a diverse talent pool. Take care in recruiting, retaining, and mentoring an inclusive and supportive group of collaborators (in my case, undergraduates, graduate students, and postdocs). You end up surrounding yourself with a smart, supportive team, which makes all the difference. And, a supportive, inclusive, collaborative group is a productive group. ***Laura Lautz (Syracuse University)***

Q3. Know the literature. Let's not re-invent the wheel. Have an historic appreciation of the evolution of the discipline. This will lead to a more efficient advancement of knowledge in hydrologic science. Volumes in the Benchmark Series published by IAHS are a "must read" for all early career scientists. ***Delphis Levia (University of Delaware)***

Q3. Find a healthy balance between specialized work in your discipline and interdisciplinary research (easier said than done!). Everyone talks about interdisciplinarity, but departments may be reluctant to hire a person that does not fit a specific discipline, so extra efforts are necessary to prepare for interviews (emphasizing positive aspects of interdisciplinary work such as broader collaborations and more opportunities for funding than strictly disciplinary work). ***Stefano Manzoni (Stockholm University)***

Q3 Write a little every day (see). Learn when and where you are most productive and strive to maximize your productive time accordingly. Learn how to balance your focused hard work with enough play time to keep you sustainable and loving what you do. Most importantly, we kind and empathetic to others. Be unselfish in your research cooperation. ***Jeff McDonnell (University of Saskatchewan)***

Q3. Prepare a convincing reply to the question "What are you doing?". Several times in the future someone will ask details of your activity to you or your peers. Be ready to provide a clear answer to highlight the innovation you are focusing on and its implications for the benefit of society. I admire those people whose research trajectory and targets are very clear. ***Alberto Montanari (University of Bologna)***

Q3. Science today is a highly social enterprise and involves often-intense interactions with the community (e.g., peer review processes, asking/responding to questions in a conference, collaborative research projects), many of which can be personally challenging. My number one rule is always take the high road, even if someone attacks you or your work in an unprofessional or uninformed manner.

When you receive critical reviews of your manuscripts, especially if they seem harsh, remember that the vast majority of reviewers are well-intended, thoughtful and aim to be constructive. When I first began submitting manuscripts to journals, I would sometimes rail (in my thoughts) at the "stupidity" of reviewers who obviously did not "get" my work. Then I had an epiphany: reputable journals do their best to recruit the most qualified reviewers for each manuscript. If the reviewers did not understand my message, then it was my fault for not writing clearly enough – or, perhaps, my reasoning was indeed incorrect and I needed to re-think my arguments.

When you revise a manuscript, carefully consider each review comment and respond to it in a respectful manner. The reviewer has donated her valuable time to review your manuscript when she could have been doing something to advance her own productivity, and you should be grateful. Take each review comment as an opportunity to improve your manuscript. For example, if a review comment seems a bit "off base," it may reflect a lack of clarity in the manuscript that should be addressed.

When you review articles, recall the golden rule: try to provide for the authors the type of review that you would like to receive. Strive to be thorough, thoughtful, critical but fair, and constructive, even if (or, especially if) you are recommending rejection. ***Dan Moore (University of British Columbia)***

Q3. Have fun - being a scientist requires passion, dedicated and a lot of good friends who do the same thing as you :) ***Florian Pappenberger (ECMWF)***

Q3. Don't judge your progress by the peers at your institution; know that worldwide each institution has a few outstanding individuals reaching their full potential and those are the folks you will be competing with (and hopefully collaborating with) for your career. To achieve this, deploy your fear and anxiety if you must (whatever works!), but ideally find the willpower to do your work and write it up as journal articles through your energy from love and compassion. Think of a journal article as a love letter to the world of science. ***Gregory Pasternack (UC Davis)***

Q3. Seek out the best people to work with who will challenge the way you think but who are fun and interesting – people you would enjoy going to dinner with, and who can be counted on to work hard when the time comes to get the job done. ***Mary Santelmann (Oregon State University)***

Q3. Some people say that they should focus and single out a niche for themselves to concentrate on. I think this is not the right way. Try to be interested in many different aspects of sciences. Broaden your horizon and do many different things. You'll find that the breakthroughs are in approaching problems from different angles and from different scientific points of view. Having works with a wide variety of problems, in multi-disciplinary environments, will help you to do this and be more innovative. ***Hubert Savenije (TU Delft)***

Q3: The golden tip I received back in 2007 myself is: accept any invitation to collaborate, without always expecting an immediate return (e.g. provide some input to a proposal / a paper without asking first to be a co-author) since you can always learn something from any collaboration; being generous with your time is always a good investment into your future - people will remember you. ***Bettina Schaefli (University Lausanne)***

Q3. Think about what makes you happy. Science is probably a piece of that, but it isn't what makes the whole you. Make time for all those other things, and if you need to, schedule time for yourself to do them. Don't backburner what makes you you. ***Kamini Singha (Colorado School of Mines)***

Q3. Develop your 'skill set' and apply it where you can -don't get locked into one problem as funding fashions are fickle. ***Keith Smettem (The University of Western Australia)***

Q3. Find a topic which interests and fascinates you: it needs to keep you busy and interested for many years. Your scientific career does NOT end after your PhD –

there are many more years of discovery and learning to come. Don't just jump on "hot topics" if you are not interested. Science needs to be rewarding from its actual science / work (as there are not many other rewards for scientists) ;-). ***Doerthe Tetzlaff (University of Aberdeen)***

Q3. Try to submit your first paper at the end of the first year of your PhD and don't spend more than four years on obtaining your PhD degree. ***Remko Uijlenhoet (Wageningen University)***

Q3. Spend some energy working on problems you are passionate about, even if your funding requires you to work on less exciting problems. ***Al Valocchi (University of Illinois at Urbana-Champaign)***

Q3. Don't listen to late career scientists. ***Nick van de Giesen (TU Delft)***

Q3. Follow your curiosity where you can. It should be what drives you, even though there can be limits to your choice sometimes of course.

Collaborate! In research, pleasure shared is pleasure doubled and you can learn so much more working with others than alone. Find people with similar interests but different skills and experience, not just around you, but elsewhere. Co-authored publications are just one example: they are good for everyone involved, and the quality of the publication is almost always improved as a result. Don't be afraid to approach experts you don't know, most of them don't bite!

Don't worry too much that you might chain yourself to a particular topic or field. You will always be able to take and create opportunities to change direction or broaden your interests.

Focus on the rigor and quality of your insights and they will have lasting value. Don't worry about getting that paper into Nature or Science, certainly not if that means hiding uncertainty in your conclusions or over interpreting your results. Time has a way of showing up poor quality research and it will likely not help your career.

Finally, don't forget to enjoy life! Doing a PhD in particular can perhaps feel like a sentence of solitary confinement, but it shouldn't be. Give yourself a break. ***Albert van Dijk (Australian National University)***

Q3. Follow your own dreams and ideas, and try to realize them through research and travel grants from the very beginning of your scientific career. ***Wolfgang Wagner (TU Vienna)***

Q3. Don't wait until you think you've gained the required credentials to engage in research and be part of the scientific dialog. There are some amazing scientists with little more than a high school level formal education. And there are some mediocre scientists with advanced degrees. ***Todd Walter (Cornell University)***

Q3. Thinking about this as a field scientist, I have four tips. First, visit as wide a diversity of field sites as you can. Although the underlying physics are the same everywhere, hydrologic processes are strongly influenced by site-specific details. Exposure to a wide variety of field sites early in your career is especially beneficial. Balanced against this, think about longer term projects once you attain a permanent position. I have found that the insights I have gained through continuing projects in one region over more than a decade are uniquely valuable – many of them likely only result from continued observations of a specific place. Also, take plenty of photos of hydrologic features when you travel – these will be useful for presentations and lectures.

Second, identify and accept your strengths and weaknesses. You may be able to address some of the weaknesses, but others you may have to simply accept and compensate for via developing collaborations with others who have relevant strengths.

Third, think about how to balance strategic versus curiosity-driven research projects. 'Strategic' refers to those projects that you expect to have a higher impact, whereas 'curiosity-driven' refers to issues that you'd really like to investigate but from which you may not expect as much attention by the scholarly community. I think pursuing things you're particularly interested in is important partly because these projects can turn out to have a higher impact and partly because it can help to keep you satisfied and fully engaged in research.

Finally, although you may focus on one particular research emphasis, try to remain open to new or alternate possibilities. Some of my most satisfying and productive research emphases have arisen unintentionally as a result of observations or insights gained while doing field work on other topics. ***Ellen Wohl (Colorado State University)***

Q3. Read around the edges of your current interests. There's a lot to be gained by bringing concepts and ideas from other disciplines into hydrology. ***Ross Woods (University of Bristol)***

Q4. What (avoidable) mistakes did you make early in your career?

Q4. I had not learned the skills needed to successfully negotiate for salary, start-up funds, etc. ***Jean Bahr (University of Wisconsin)***

Q4. Not publishing original work on digital elevation data analysis – originally developed to calculate the topographic index but clearly of much wider application. It was just such an obvious and simple thing to do, it did not seem important in itself at the time, just a sideline to the model applications. It would, however, have been a highly cited paper because at the time it would have been the first (in fact the work went back to an undergraduate project where I programmed some analysis of DEMs to calculate Horton Ratios and applied it to randomly generated topographies on both gridded and triangular DEMs) !! ***Keith Beven (Lancaster University)***

Q4. Some, to be discussed over a beer. You may also want to ask about the strokes of luck - these were more important for me. ***Günter Blöschl (TU Vienna)***

Q4. Not pushing students to get their papers submitted for publication before graduation. **Laura Bowling (Purdue University)**

Q4. I did not have a good enough backup of my PhD model simulations and a major disk failure meant that I lost a substantial portion of my work. BACK UP YOUR FILES! ***Hannah Cloke (University of Reading)***

Q4. Not insisting that all research efforts have a clear path to tangible outcomes. ***Matthew Cohen (University of Florida)***

Q3. My main regret is that I didn't do any Erasmus exchange when I was an undergraduate student. Also, I did not study any English until I got my PhD diploma. Luckily, Paul Bates hired me in Bristol as a postdoc despite my weak language skills**.** ***Giuliano Di Baldassarre (Uppsala University)***

Q4. Do not openly critique the work done by senior colleagues. Try to do better and publish it. ***Ying Fan Reinfelder (Rutgers University)***

Q4. I spent too much time focused on teaching. But, I would do the same again. ***Ty Ferre (The University of Arizona)***

Q4. I was not sufficiently aware that my insights are often unique and valuable. I under-valued my contributions compared to those of others and did not assert my opinions enough. A consequence of this was my not publishing some really cool, publishable things. ***Graham Fogg (UC Davis)***

Q4. I mistakenly thought that faculty positions were all about scholarship and teaching, and pursued an academic career. It was soon apparent to me that they involved very significant entrepreneurship, had rewards based on research funding (rather than research quality alone), and extensive requirements for university committee work. I then turned to pursue applied work that could be done well within that environment. I currently work in an independent research center, which allows me to pursue impactful work. ***Konstantine Georgakakos (Hydrologic Research Center in San Diego)***

Q4. In my view, mistakes are simply not avoidable. More importantly, they are actually the necessary fuel for science. Don't be afraid of making mistakes. Just be ready to learn from each one. I have probably made unaccountably many so-called mistakes over the course of my career. I just have never thought of them as such. When something does not work … get excited … because that means there is the possibility that (with some amount of time, energy and dedication) you are actually going to learn something new. When things work as expected, we rarely (if ever) learn anything new :-) ***Hoshin Gupta (The University of Arizona)***

Q4. Not immediately sharing my data freely from my first global permeability map – I wish I had shared it freely from the start. ***Tom Gleeson (University of Victoria)***

Q4. Two of too many come to mind:
- In my earlier work on numerical methods I built a solid basic understanding from reading proper books on the topic. But when I started a PhD in model calibration, I read too many research papers. You cannot learn the fundamentals from papers. So I had to fill those gaps years later, to my chagrin. So I did a few

things back-to-front chronologically. But it worked out ok in the end.
- Maybe not enough networking during my PhD, I was largely just doing my thing. But on the other hand it gave me time to focus on my own work with fewer distractions, and still have lots of time for other non-work-related things. ***Dmitri Kavetski (University of Adelaide)***

Q4. I did not always seek out the best collaborators for research projects. It's essential to find research collaborators that will contribute equally to projects and value your unique contributions. True partners in research are critical to a successful collaborative research program. ***Laura Lautz (Syracuse University)***

Q4. For those in the professoriate, strike an effective balance among teaching, research, and service that is congruent with your institution's mission and be cognizant of workload. Try to align your workload with your strengths and passion. I think that I took on too much institutional service the first few years of my career that was inconsistent with my institution's R1 mission. ***Delphis Levia (University of Delaware)***

Q4. Some research dead-ends could have been avoided, but I would have missed learning opportunities (despite 'losing' time from a purely paper-production perspective). So maybe I would suggest to avoid being too efficient – the exploration of topics outside the main research line may have a return in the long-term. ***Stefano Manzoni (Stockholm University)***

Q4 I chased money in early career to fund my program and my students. But I did so without any real focus (link) As a result, I was 'a mile wide and an inch deep'. It wasn't until I became an Associate Professor that I learned that going more narrow could be helpful and more sustainable (link). ***Jeff McDonnell (University of Saskatchewan)***

Q4. In some phases of my career I was under pressure to publish and I authored some papers that now look poor to me (can you guess them? :-) Fortunately, they are not easy to find). It is definitely better not to submit a poor paper. Now I am doing my best to avoid to repeat such a mistake. ***Alberto Montanari (University of Bologna)***

Q4. All my mistakes were good once - avoidable mistakes are unavoidable as I learnt and moved on - I needed to do all of them. If you try to avoid mistakes then you stop taking risks. Risks are a source of nice rewards. Go ahead and make mistakes & learn to deal with them! ***Florian Pappenberger (ECMWF)***

Q4. Accepting a scholarship to a big-name university that actually couldn't care less about me. Too often, student go for the most money and do not realize the marked differences in mentoring between faculty. Compared to my Peterson's book-based guide to graduate schools that had a 1-page blurb on each program, students today have amazing tools to evaluate faculty for their mentoring. Yet so often they go for the money, not the mentor. It feels good to get a big scholarship, but it feels awful when you underachieve your potential and don't get the career you hoped for. You've come too far to sacrifice your future for a short-term payday. ***Gregory Pasternack (UC Davis)***

Q4. I followed my husband's career to a new "two-year post-doc" when I was finishing my PhD dissertation and we were having our first child. The two-year post-doc turned into a permanent position for him and a career as a research scientist (read that a life chasing soft money) for me. It would have been better for my career to have negotiated for a position of my own at the same time as he was negotiating for his position. In retrospect, I should have sought out a partial FTE position so that there was some commitment to advancement of my career as well, even during what we thought was a temporary position. ***Mary Santelmann (Oregon State University)***

Q4: During my postdoc, I should have changed radically my topic to broaden my horizon, it's the only moment when you can do that. ***Bettina Schaefli (University Lausanne)***

Q4. I don't know of any. Maybe I was lucky. As I said, I did not plan to become an academic. I just wanted to do engineering work that mattered to the developing world and do it science based. I worked for 6 years for the Mozambican government as a hydrologist and later for 6 years as an international consultant in countries all over the world, but mostly in Asia, Africa and South America. After 12 years I decided that consultancy was not my future and I applied for a teaching position at the IHE in Delft, where I expressed my wish to do a phd on the (very practical) estuarine research that I had done in different parts of the world. That's how I started my academic career and everything went smoothly after that. I have always benefited from working with people with different backgrounds: economists, soil scientists, biologists, environmentalists, civil engineers. Normally, in teams, I was the only hydrologist, so I have not benefitted much from working with senior hydrologists. I don't remember anybody giving me guidance, but it helps a lot to receive critical questions from people outside your speciality. It forces you to think better. Also education does that. There are so many things that you take for granted until a student asks you the question why it is so. That's when you have to think deeper and sometimes discover new insights. ***Hubert Savenije (TU Delft)***

Q4. I was too worried about being right, rather than embracing potentially being wrong; the latter opens up a lot of creative space. Science is a work in progress, and we tell the story we can with the information we have now. It contributes to the conversation. If you find a better way to do something two years from now, that's okay--you can tell that story then. ***Kamini Singha (Colorado School of Mines)***

Q4. Don't assume that people know what they are doing. Check it out yourself (especially for field gear). ***Keith Smettem (The University of Western Australia)***

Q4. Do not work with colleagues you don’t trust or can’t rely on – just for the sake of getting project money. Find great, reliable, trustworthy and kind collaborators – and work with them forever. Then your work becomes fun – and most inspiring. ***Doerthe Tetzlaff (University of Aberdeen)***

Q4. Writing many draft manuscripts that never made it to journal publications and spending (significantly) more than four years on getting my PhD degree. ***Remko Uijlenhoet (Wageningen University)***

Q4. Two come to mind. I felt I had to prove myself and was hesitant to collaborate with others. I spent too much time polishing my lecture notes and not enough time writing proposals. ***Al Valocchi (University of Illinois at Urbana-Champaign)***

Q4. In general I feel very lucky and good about how things went. I could have been a bit savvier and moved faster but I doubt that would have made me better scientist or a happier person. ***Nick van de Giesen (TU Delft)***

Q4. Too many to count I am sure, but I guess none of them were bad enough to stand out from the rest :-) I do wish I had sometimes shown more appreciation for those around me that have helped me along the way. ***Albert van Dijk (Australian National University)***

Q4. I didn’t follow my “golden tip;” I didn’t even discover it until well after I received my PhD. ***Todd Walter (Cornell University)***

Q4. I wrote a paper with some new ways of quantifying hydrology (space-time variability of floods), but I didn't follow up with any further papers on examples or case studies. The paper itself was quite hard to read, and so it "slept" for nearly 10 years, with no-one reading it, until someone did the follow-up for me, and then people started to apply and develop my early ideas. ***Ross Woods (University of Bristol)***

Q5. How can young scientists improve their writing or presentations?

Q5. Ask for and pay attention to feedback from peers and mentors. Proof-read your written work carefully and practice your presentations alone and in front of a friendly audience. As you read journal articles and attend presentations at meetings, reflect on what makes some articles or presentations particularly clear and compelling. ***Jean Bahr (University of Wisconsin)***

Q5. This is hugely important. Effective communication is as important as good science, and, unfortunately in some cases, has substituted for good science (think of the TV talking heads). So, work with a good editor and take the editor’s advice and learn from it. It is not personal. It sounds lame perhaps, but work with a group like Toastmasters for public speaking. Learning to speak in a supportive environment is more effective than trying to wing it. Don’t overly rely on slides to communicate, and speak to the audience, not to the slides. Slides should be simple and intuitive: if it takes 2 minutes to explain a visual, then it is too complicated. ***Jerad Bales (CUAHSI)***

Q5. Improving communication must be a career-long process, one of constant improvement through sustained effort. I am frequently disappointed by manuscripts that are wordy, filled with acronyms, poorly organized or unfocused. I am equally disappointed by the many talks that are so dense that the main point gets lost in a stream of modeling results, or ones that have little new insight to contribute. Good communicators have a range of acquired skills, they recognize what makes writing or speaking by others interesting, pay attention to details, and may spend as much time planning as they do in writing a manuscript or preparing a talk. To quote George Bernard Shaw. “The single biggest problem in communication is the illusion that it has taken place." ***Roger Bales (UC Merced)***

Q5. Think about papers you've read that influenced you – clarity of presentation, writing style, and flow – and then study those papers in terms of "technical structure" to emulate the style. Aim for conciseness and well-justified statements. And – cite references that are truly directly relevant to your manuscript, rather than laundry lists… ***Brian Berkowitz (Weizmann Institute of Science)***

Q5. How can young scientists improve their writing or presentations? – see [Advice to a Young Hydrologist] ***Keith Beven (Lancaster University)***

Q5. Learn by watching others. Read a lot of papers (also papers in general high-impact journals; nature, science etc.) and watch talks by prominent speakers. Also: follow courses on writing and presenting. ***Marc Bierkens (Utrecht University)***

Q5. Writing, see EGU presentation, Presentation: Take the audience's perspective (analogously to the writing pdf). ***Günter Blöschl (TU Vienna)***

Q5. Don't be afraid to tell a story. We often think that science writing is supposed to be dry and formulaic. It's true that efficiency and precision in writing are important, but they are irrelevant if your reader isn't interested in the material you're presenting. ***Gabriel Bowen (University of Utah)***

Q5. Don't hide them from people. Open yourself up to allow colleagues to read things and provide feedback before presentation or submission. ***Laura Bowling (Purdue University)***

Q5. Practice writing and presenting together in a friendly early career forum. Write a review paper together on something interesting. ***Hannah Cloke (University of Reading)***

Q5. Read your writing out loud, and make your presentations (lectures, posters, etc.) less cluttered. ***Matthew Cohen (University of Florida)***

Q5. Good writing obviously requires good reading. Not too much reading, but a proper selection of high-quality papers and books. For presentation skills, I suggest switching off the computer whenever possible and spend more time explaining your research and exchanging ideas with colleagues or friends. ***Giuliano Di Baldassarre (Uppsala University)***

Q5. To be a good writer, you need to be a hungry reader. Reading sorts out ideas leading to clarity which is key to good writing. For presentation, practice, practice, and practice. Each time you practice, you notice flaws in your logic and redundancy in your expression. Do so until you can tell your story with a beginning and an ending, and without a single word wasted. ***Ying Fan Reinfelder (Rutgers University)***

Q5. Writing is only improved by practice and by reading and emulating good authors. Presentations - keep it simple and visual. It is better to not present than to present and be memorably uninteresting. ***Ty Ferre (The University of Arizona)***

Q5. Writing: Write a page a day. (I wish I did that!) Get in a situation where your writing is critiqued regularly by a really good editor. Presentations: Design the talk around the two or three key points that you want to make and weed out the material that does not help make those specific points. ***Graham Fogg (UC Davis)***

Q5. Reading good literary books! ***Konstantine Georgakakos (Hydrologic Research Center in San Diego)***

Q5. Be themselves, be passionate and clear – and know your audience. ***Tom Gleeson (University of Victoria)***

Q5. Young scientists can improve their writing and presentations by doing several things. One is to examine carefully what people who communicate well are doing … analyze their papers and presentations. Another is to not copy them blindly, but bring your own ideas and personality to bear so that whatever you do feels natural to you (is an expression of who YOU are). Ultimately it is helpful to write/present as often as you can, analyze how well it is going, and get critical but constructive feedback. For example, my students regularly critique their own and each other's presentations, not so much for substance as for presentation style and success in communication :-). If necessary, form a peer group that meets regularly to do this.

Remember, the secrets to success include BOTH "innovation" (creativity) and "marketing" (communication). If people don't understand you, then your genius is likely to not receive the attention it deserves. ***Hoshin Gupta (The University of Arizona)***

Q5. Tips for writing: Tip #1 - pretend you are a picky reviewer looking for flaws in your own paper. Once you identify these flaws, pretend the paper has been rejected and make a genuine effort to address them, and repeat. Tip #2 - read fewer recent papers and more classic papers from the 80's and 90's. Frankly they were (on average) much better structured and written, probably because the authors were not rushed and took their time to develop, present and refine their arguments. I know, radical advice! :-)

Tips for presentations: Tip #1 - give frequent lectures and presentations, both in short (15min/talk) and long (4-5 hrs/day) formats. Tip #2 - Ask yourself if your slides are comprehensible to people other than yourself, and look inquisitively for weaknesses to address. Before you can improve something, you need to find what to improve! ***Dmitri Kavetski (University of Adelaide)***

Q5. Peer-to-peer feedback. Find a peer with whom you can practice presentations and review one another's writing. This should not be a co-author or collaborator, but rather a peer mentor who can give you honest, constructive, and comprehensive feedback. Get that feedback early and often! ***Laura Lautz (Syracuse University)***

Q5. Presenters often make the mistake of trying to cover too much material in oral presentations. Choose a few points that you want to hammer home and focus only on those. Present the ideas in different ways so that the audience better gets your message. A convoluted fast-paced presentation that covers too much information detracts from the initial purpose of the presentation. ***Delphis Levia (University of Delaware)***

Q5. Quoting Josh Schimel (UCSB), we are 'storytellers' after all and having a good story line helps tremendously in structuring a paper. Analyze articles you found easy to understand to find out which presentation style works best, and do not be afraid to re-write until the message becomes more linear (yes, it takes time). Have a look at Josh's book "Writing Science" (2012, Oxford University Press). ***Stefano Manzoni (Stockholm University)***

Q5 Doing effective writing and presentation-making means telling a good story. See my recipe for this. Excellent papers and talk always answer 3 things: what is the status quo, what is wrong with the status quo and how does the work go beyond the status quo? Telling the story 'right' is balancing these 3 elements to engage the widest possible audience while at the same time, satisfying the narrow specialist. ***Jeff McDonnell (University of Saskatchewan)***

Q5. Be an attentive and reflective reader/ audience member. For example, when you read a paper that strikes you as being exceptionally clear and convincing, try to identify what aspects made it that way. Pay particular attention to the introduction. As a reviewer and associate editor, I find that one of the weakest points in many manuscripts is a failure to draw upon the literature to identify clear knowledge gaps in the introduction and then to use these to frame the research objectives/questions/ hypotheses. ***Dan Moore (University of British Columbia)***

Q5. By reading a lot, reviewing a lot and attending conferences. Definitely, reviewing papers has been the most rewarding activity in my career. ***Alberto Montanari (University of Bologna)***

Q5. I think sometimes it is a misconception that young scientists are the once which have the greatest need to improve their writing and presentations. My first drafts are always terrible (maybe even my final drafts): have a story, focus on the story and do not deviate & less is more (latter is a cliche but unfortunately true). ***Florian Pappenberger (ECMWF)***

Q5. Practice, practice, practice. There is no other way. You don't build muscles by watch YouTube videos of people lifting weights. Yes, it helps to study how to give good presentations and how to write well, but most of the time the gainz come through very hard work. it is so hard and it really never gets easier, because your career gets more complicated. You have the most time to practice right now, so just get to it. If it helps, write conversationally first and then tighten up to formal science writing second- just put words on the page by any means necessary. ***Gregory Pasternack (UC Davis)***

Q5. Read excellent papers and analyze them for what they do well- get in the habit of reading the literature on a regular schedule. When you attend an excellent presentation, take notes on what was done well and why it was excellent, then try to incorporate some of those ideas into your own writing. Read your own work out loud before submitting the paper to a journal, also run your draft manuscripts by colleagues who write well who can help you spot errors and suggest edits to improve your work. ***Mary Santelmann (Oregon State University)***

Q5. By doing it. ***Hubert Savenije (TU Delft)***

Q5. take a class on writing newspaper articles, this will change your way of thinking about how to communicate: stop thinking about your science but think about the reader / audience. ***Bettina Schaefli (University Lausanne)***

Q5. There are a lot of talented people who think about science writing and presentation, and it's worth reading that literature. ***Kamini Singha (Colorado School of Mines)***

Q5. A good and clear structure is everything for a strong paper. Each paper should have one main take message – try not to put everything you have ever done into one paper. Presentation: you can never practice enough. Practice, practice: people give you their (precious) time to listen to your talk: value this time and reward them by a great, well prepared presentation. You will be never too good / established to NOT practice your presentations. Never be too cool to practice ;-) ***Doerthe Tetzlaff (University of Aberdeen)***

Q5. By trying to limit the size of their papers to four to six pages in final format and limit the length of their presentations (not just at conferences, but also at university) to 15-20 minutes. Cut the crap and get to the heart of the matter right away! ***Remko Uijlenhoet (Wageningen University)***

Q5. Practice and get serious evaluation and feedback from peers and from communication professionals (e.g., a campus teaching center). Practice explaining your work to non-scientists. ***Al Valocchi (University of Illinois at Urbana-Champaign)***

Q5. Be concise. ***Nick van de Giesen (TU Delft)***

Q5. Both writing and presenting can be learned. You don't need much talent to begin with, and almost anyone can learn to do it well. Do it as often as you can, practice is everything. Science writing is much less an art than a skill. Find examples that impress you, try and analyse why, and then emulate it. Find mentors or co-authors that can make your writing better. ***Albert van Dijk (Australian National University)***

Q5. Firstly, consider your audience's perspectives; what are they interested in hearing. Then, write often and practice-practice-practice presentations. Be cognizant of and write down what you like or don't like about papers you read and presentations you see and hear; this will become your guide for how to write your own papers and develop your own presentations. Lastly, listening to your audience and brevity should not be underrated. ***Todd Walter (Cornell University)***

Q5. Practice, practice, practice. And, while practicing, actively solicit feedback from others you consider particularly skilled at writing and/or presentations. With respect to writing, it can be useful to read your own writing aloud to yourself – this can help to highlight poor sentence structure or gaps in logic between sentences or between paragraphs. ***Ellen Wohl (Colorado State University)***

Q5. Ross presented this at EGU 2017 (author comment*) ***Ross Woods (University of Bristol)***

List of respondents

- Jean Bahr (University of Wisconsin)
- Jerad Bales (Consortium of Universities for the Advancement of Hydrologic Sciences, Inc)
- Roger Bales (University of California, Merced)
- Brian Berkowitz (Weizmann Institute of Science)
- Keith Beven (Lancaster University)
- Marc Bierkens (Utrecht University)
- Günter Blöschl (TU Vienna)
- Gabriel Bowen (University of Utah)
- Laura Bowling (Purdue University)
- Hannah Cloke (University of Reading)
- Matthew Cohen (University of Florida)
- Giuliano Di Baldassarre (Uppsala University)
- Ying Fan Reinfelder (Rutgers University)
- Ty Ferre (The University of Arizona)
- Graham Fogg (University of California, Davis)
- Konstantine Georgakakos (Hydrologic Research Center)
- Tom Gleeson (University of Victoria)
- Hoshin Gupta (The University of Arizona)
- Dmitri Kavetski (University of Adelaide)
- Laura Lautz (Syracuse University)
- Delphis Levia (University of Delaware)
- Stefano Manzoni (Stockholm University)
- Jeff McDonnell (University of Saskatchewan)
- Alberto Montanari (University of Bologna)
- Dan Moore (The University of British Columbia)
- Florian Pappenberger (ECMWF)

- Gregory Pasternack (University of California, Davis)
- Mary Santelmann (Oregon State University)
- Hubert Savenije (TU Delft)
- Bettina Schaefli (University Lausanne)
- Kamini Singha (Colorado School of Mines)
- Keith Smettem (The University of Western Australia)
- Doerthe Tetzlaff (University of Aberdeen)
- Remko Uijlenhoet (Wageningen University)
- Al Valocchi (University of Illinois at Urbana-Champaign)
- Nick van de Giesen (TU Delft)
- Albert van Dijk (Australian National University)
- Wolfgang Wagner (TU VIENNA)
- Todd Walter (Cornell University)
- Ellen Wohl (Colorado State University)
- Ross Woods (University of Bristol)

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