

Editorial: Challenging hydrological theory and practice

In September 2014, the 12th British Hydrological Society (BHS) National Symposium was held at the University of Birmingham. The BHS brings together academics, researchers and practitioners (regulators and industry) to target critical hydrological issues of national and international significance. The meeting celebrated these strengths with close to 200 participants converging onto campus to challenge current hydrological theory and practice. The meeting explored how the hydrological community can instigate transformative shifts in our conceptualisation and representation of hydrological systems and process interactions and explore new enabling technologies to promote such advances. Presentations and discussions centred around how current theory and practice is challenged by the increasing complexity of multiple environmental pressures and interactions, and how technological innovation and conceptual advancements may be combined to meet increasing societal demands. The symposium recognised the importance of interdisciplinary hydrological research across the sciences and social sciences to target issues of direct relevance to society and environmental sustainability, and the need to effectively engage with and inform decision makers to maximise the exchange and impact of new knowledge. Bi-directional feedbacks and interactions between ecological and hydrological processes within river and terrestrial ecosystems were highlighted alongside the need to address our governance of water to tackle shared hydrological challenges of water supply and demand, pollution/water quality and hazards that often extend beyond regional and national boundaries.

Whilst such trans-/inter-disciplinary research pushed the boundary and scope of what may be considered as 'hydrology', the conference targeted challenges of major significance within the more traditional sub-disciplines of the hydrological sciences too. For example, several symposium contributions sought to improve understanding of complex hydrological interactions in the ocean-atmosphere-land system cascade. Other process-based research aimed to better predict and mitigate extreme events (droughts and floods), and to explore the increasing pressures on water quality that provide substantial risks for water resource management and ecosystem services. Presentations highlighted the need to manage water quality threats

resulting from a complex legacy of (often interacting) point source and diffuse pollution as well as the emergence of new contaminants. Innovative solutions to monitor, model and predict water quality responses to changing environmental conditions were shown. The symposium considered a range of environmental contexts, notably urban spaces that have particular hydrological challenges for researchers and practitioners.

This special issue presents a collection of fully rewritten, peer-reviewed papers, originally presented at the BHS national symposium, that each challenge current hydrological theory and practice. They transcend the research cycle, targeting emerging challenges (Lynch 2016), the development of sampling designs and monitoring networks (Jackson *et al.* 2016), new methodologies (Kretzschmar *et al.* 2016; Mandeville 2016), their associated errors and refinements (Kriechbaumer *et al.* 2016; Lennard *et al.* 2016; Spencer & Essery 2016; Rudd & Kay 2016) and the communication of associated knowledge and ideas to decision makers (Watts 2016).

Lynch (2016) outlines the current status of knowledge regarding nanomaterials fate and transformation in the environment, and the challenges presented by nanomaterials in terms of their detection. The development of a methodology for the design of new hydrological monitoring networks is described and evaluated by Jackson *et al.* (2016). Illustrated using the Scotland River Temperature Monitoring Network as a real-world case study, the network design ensures minimal sampling redundancy and high levels of statistical power.

Through the integration of external sensors and sophisticated data post-processing, Kriechbaumer *et al.* (2016) show how known limitations to ADCP-based 3D flow quantifications can overcome complex flow environments. Mandeville (2016) presents a new hydrograph separation technique that highlights the relative importance of 'slow flow' storm runoff, which has often been ignored in event-based models. The North Atlantic Oscillation and snow cover in Scotland are linked by Spencer & Essery (2016) over a centennial time scale using broad national scale datasets and offering the future potential to plan for heavy snow in advance of a winter season. Kretzschmar *et al.* (2016) show that the main characteristics of effective catchment rainfall can be captured by the inversion of streamflow which incorporates the dominant catchment dynamics.

Lennard *et al.* (2016) highlight the value of long climate series in water resource modelling. They investigate the implications of pre-1920s droughts on water resource management, whilst Rudd & Kay (2016) estimate current and future potential evapotranspiration across southern Britain. Applying the Penman–Monteith formula driven from Regional Climate Model data, Rudd & Kay (2016) reproduce observed potential evapotranspiration and discuss the significance of future alterations in canopy resistance. Finally, the invited manuscript of Watts (2016) addresses the wider engagement and impact of research. It highlights the importance of research in informing good decisions and how such information is translated to decision makers. It recognises the need to respect the expertise of decision makers, and emphasises the role of scientists in providing a balanced view of the current state of knowledge. How researchers can aid this transfer of research into practice is stressed. Notably, the mutual benefits to all involved of engaging practitioners within the early stages of projects, and the importance of producing review papers and participating within professional conferences to inform boundary organisations that bridge the gap between science and policy is highlighted.

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