Preface

This book presents the proceedings of Symposium H04: *Understanding Freshwater Quality Problems in a Changing World*, convened as part of the Scientific Assembly *Knowledge for the Future*, when the associations IAHS, IAPSO and IAPSEI met together in Gothenburg, Sweden, on 22–26 July 2013. The timing of the Gothenburg Assembly coincided with the official launch of the new scientific decade *Panta Rhei – Everything Flows* within IAHS (the International Association of Hydrological Sciences). This new scientific decade, 2013–2022, will be dedicated to research activities on change in hydrology and society, and the purpose of Symposium H04 was to identify relevant targets for water-quality research during this new decade. The significance of the Symposium was twofold as it aimed to:

- Foster collaboration in the community of water-quality science and promote comparative research;
- Initiate capacity building and knowledge transfer between regions and research groups worldwide.

Great efforts have been made worldwide during recent decades to detect freshwater quality problems and to achieve more sustainable, holistic and integrated water management. Both the problems and their solutions differ between regions, reflecting environmental and societal conditions. Moreover, the knowledge of water-quality status and understanding of processes involved in pollution of the aquatic environment also differ between regions and for different priority substances. Nutrients and oxygen are the best documented water quality determinants (e.g. Neal & Davies, 2000; Billen *et al.*, 2001) with major impacts downstream and on the coast (Rabalais *et al.*, 1996; Humborg *et al.*, 2000), and this evidence base supports modelling at a range of scales. Over the coming decade, the evidence base for other types of issues (micropollutants, faecal-coli) should improve as more representative databases become available, thereby further underpinning conceptual and process-based modelling tools and GIS structures (Seitzinger *et al.*, 2002; Meybeck, 2003).

Protecting the world's freshwater resources requires diagnosis of the threats over a broad range of scales, from global to local (Vörösmarty *et al*., 2010). At present, the world is undergoing accelerated changes in climate, land use and society (e.g. demography, urbanization, economy), which will probably influence water resources and may lead to further decline in water quality. Such global change should now be balanced by a global change in our perception of water, whether considered as a key resource for Human Development, as part of aquatic ecosystems, or as a component of the Earth System. Shared values should be based on common and improved knowledge. There is an urgent need for better overall knowledge about the water quality situation globally, for the definition of common indicators, as well as a deeper understanding of processes involved in water quality degradation. Water quality and its evolution should be considered within its societal and policy context and, if possible, on a long-term basis that allows detection of the general trends and ranking of major issues and threats. More efficient water management and implementation of targeted remedial measures to improve the situation need to be based on robust scientific knowledge. As on-going changes are not well understood, there is a need for the scientific community to embrace this challenge to enhance the level of knowledge globally.

The purpose of *Panta Rhei* (Montanari *et al*., 2013) is to reach an improved interpretation of the processes governing the water cycle by focusing on their changing dynamics in connection with rapidly changing human systems. The practical aim is to improve our capability to make predictions of water resources dynamics to support sustainable societal development in a changing environment. The concept implies focus on *hydrological systems as a changing interface between environment and society*, whose dynamics are essential to

determine water security, human safety and development, and to set priorities for environmental management. The Scientific Decade 2013–2022 will devise innovative theoretical blueprints for the representation of processes including change and will focus on advanced monitoring and data analysis techniques. *Interdisciplinarity* will be sought by bridging with socio-economic sciences and geosciences in general. To meet these ambitions of *Panta Rhei*, Symposium H04 gave examples of the present state of the art of water-quality science in IAHS as a starting point for the new decade by presenting regional overviews of freshwater quality, understanding of underlying processes and on-going changes.

The papers collected in this book describe the present regional or local freshwater quality status worldwide and highlight some future research needs. Contributions are included from each continent to understand better the underlying processes causing problems. The Symposium further discussed how the situation may develop into the future, considering on-going changes in environment and society. Present and future scientific questions addressed during the Symposium in line with the *Panta Rhei* initiative were, for example: How to understand the behaviours of changing hydrological systems and impacts on freshwater quality? How can we effectively bring together theoretical hydrology, experimental hydrology and new measurement techniques to advance our knowledge of water quality processes for the future? How can the typical timescales of change be identified? How to estimate and predict the behaviours and patterns of freshwater quality with uncertainty assessment to support risk evaluation?

The previous scientific decade of IAHS (2003–2012) focused on Predictions in Ungauged basins (PUB). That initiative was successful in merging the water community and advancing science by increasing communication between research groups globally (Hrachowitz *et al*., 2013). One of the major outcomes was the identification of comparative science as a way forward for the next decade. Traditionally, water research has often been site specific for individual water bodies and point observations have been key for understanding catchment processes. The traditional local-scale (case-study) approach in water sciences is not coherent with the presence of significant transnational water bodies and aquifers, and more importantly, not with present societal challenges, which today are increasingly shifted towards regional scales and impact of changes, linking global and local scales.

The new comparative approach in water research entails analysis of many sites in a synoptic way (Blöschl *et al.*, 2013). Rather than analysing or modelling a single site in detail, the idea here is to compare many sites with contrasting characteristics in order to understand the critical process controls of the complex systems. One of the strengths of the comparative approach to water science is that it allows the examination of processes in a more holistic way compared with normal assessments or modelling. In site-specific approaches, only those processes and scales actually represented in the study can be analysed, while in the comparative approach, one can see the summary effect and interplay of all relevant processes if the data from sites of contrasting characteristics are included and compared. Also, the comparative approach provides an opportunity to exploit multiple development histories. Different sites have evolved in a different way as a result of different climates and geologies and that historical legacy is apparent at one time in many places.

The new scientific decade of *Panta Rhei* will adapt this new comparative approach while focusing on Change in Hydrology and Society. It will bring together scientists of different communities and will represent a genuine opportunity to bring people together globally to address problems that can only be solved through community efforts at all levels. This scientific grassroots initiative will provide a forum to share ideas, to target common objectives and to disseminate awareness and results. It will be developed through an enhanced network of hydrological research groups all over the world and an ameliorated global accessibility to scientific research and its outputs.

The outputs of Symposium H04 will ensure that the water-quality aspects of hydrology are also considered in this new IAHS initiative. The Symposium mobilised water-quality researchers worldwide to take an active part in *Panta Rhei* and initiate collaboration and

capacity building by enhancing communication and exchange of experiences and ideas. Symposium H04 and this book thus represent the first trigger in a decade long process of intensified collaboration among the global community of water-quality scientists.

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