Preface

Interactions between groundwater and surface water are critical to ecological communities and to resource management. Research over the last decade has actively investigated many aspects of groundwater–surface water interactions, and has succeeded in identifying and understanding many underlying processes and factors such as the dynamics of flow, sediment transport, contaminant transport and chemical reactions in river beds and flood plains and how processes at different spatial scales interact. Advances have been made through field, laboratory, and modelling investigations. Improved computer power continues to expand the possible types of evaluations.

The state of this exciting field of research is well represented in the 42 papers included in this volume. These papers were presented at Symposium H01: *Conceptual and Modelling Studies of Integrated Groundwater, Surface Water, and Ecological Systems* held at the XXV IUGG General Assembly, Melbourne Australia, 28 June–7 July 2011. The symposium was jointly organised and convened by the ICGW (International Commission on Ground Water), ICSW (International Commission on Surface Water), ICWQ (International Commission on Water Quality) and ICWRS (International commission on Water Resources Systems) commissions of the IAHS. The event followed previous successful IAHS symposia and workshops including Symposium HS1002: *A New Focus on Integrated Analysis of Groundwater/Surface Water Systems* (IUGG XXIV General Assembly, Perugia, Italy, 2–13 July, 2007) and Workshop JW1: *Measuring and Modelling Interactions between Surface Water and Groundwater* (Joint IAHS & IAH International Convention, Hyderabad, India, 6–12 September 2009).

This symposium focused on the integrated modelling of groundwater–surface water systems and their ecology. Particular consideration was given to:

- Improved process understanding at different scales and in different regions
- Advanced modelling methods and applications
- Sensitivity analysis and uncertainty evaluation
- Ecohydrological studies: from process understanding to management
- Case studies and large-scale applications

Papers in this publication are organised in sections covering these topics, and each paper contributes to give a holistic view of the current state-of-the-art in integrated groundwater–surface water research, modelling and applications.

It has been established that surface water and groundwater systems interact in many landscapes and via different mechanisms and that problems in one system have the potential to adversely affect the other system. Potential problems include contamination (Gigliuto *et al*., p.93), over-abstraction (Lubis *et al* , p.151*)* and land-use changes (Sarukkalige, p.223), as well as the rise

in water temperatures in surface waters and in the groundwater due to climate change and growing urbanization (Gunawardhana & Kazama, p.10; Qiongfang *et al.*, p.118). Adverse effects are reflected in the degradation of water quality and/or quantity, but inevitably also impact on the health of biota within the surface water and/or groundwater habitats as well as on connected ecosystems. At the same time, biogeochemical and ecological processes can also impact on the water quality (Lewandowski & Nützmann, p.183; Shimizu *et al.*, p. 37) through the important role they play in many surface–subsurface environments, such as the hyporheic zone. Numerous novel approaches and techniques have been developed to investigate and quantify surface water–groundwater interactions in different environments (Marren & Woods, p.229; Xu *et al.*, p.213) as well as to understand process dynamics at different spatial and temporal scales (Rosenberry, p.3; van Geer *et al.*, p.194) using different parameters (e.g. isotopes: Alazard *et al.*, p.253; Kabeya *et al.*, p.163; temperature: Matheswaran *et al.*, p.23; salinity: Morrison *et al.*, p.69; soil moisture: Islam *et al.*, p.48) and techniques (e.g. ERT: Noell *et al.*, p.42). Frequently, these field-based surveys are incorporated into modelling applications as a way to verify and improve the conceptual understanding of the observed processes and interactions (Miyaoka & Kojoma, p.62).

Modelling surface water–groundwater interactions is increasingly important to assess the impact of local or global changes, (e.g. pollution: Saghravani *et al.*, p.249; increasing demands/abstractions: Arlai *et al.*, p.235; You *et al.*, p.80; climate change: Wang *et al.*, p.30; episodic events: Bonnet *et al.*, p.200; Poulsen *et al.*, p.55) on these systems in different environments as well as to holistically manage competing water needs (Cai *et al.*, p.265), plan restoration efforts (Schirmer & Vogt, p.190) or to assess risks associated with any of these measures. Historically, flow and transport processes in surface water and groundwater systems have been modelled separately. Regional groundwater models often simplify exchange with surface flow models, and the interaction between channel flow and the aquifer is often described within the framework of transient storage. Recently, considerable efforts have been made to couple different types of models (Chen *et al.* p.156; Hui *et al.*, p.177) and to develop integrated tools, which could describe interactions between groundwater, surface water and ecological systems. Such integrated models show great potential in enhancing our understanding of underlying processes (Doble *et al.*, p.169; Fleckenstein *et al.*, p.87) and as (forecasting) tools for sustainable water resources planning and management (Steward, p.113; Shokri, p.75; Kapangaziwiri *et al.*, p.127; Minoti *et al.*, p.99).

The output from integrated surface water–groundwater models is strongly controlled by the quality of input data and parameter values as well as by the model structure. In recent years, great efforts have been directed towards the quantification of these model uncertainties (Arheimer *et al.*, p.145; Goderniaux *et al.*, p.139) in order to allow evaluation of model performance and outputs.

In data-sparse regions (e.g. ungauged basins), the ability to model surface–water groundwater interactions is often restricted by inadequate data availability and/or quality. Various regionalization methods (Querner *et al.*, p.242; Souza da Silva *et al.*, p.106; Visessri *et al.*, p.259; Wyatt & Franks, p.133) and parameter estimation approaches (Tshimanga *et al.*, p.17) have been developed to overcome these limitations.

These aspects and more are considered in this publication. We invite you to explore these proceedings as well as previous ones[1] and hope and trust that you will find this compilation useful.

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