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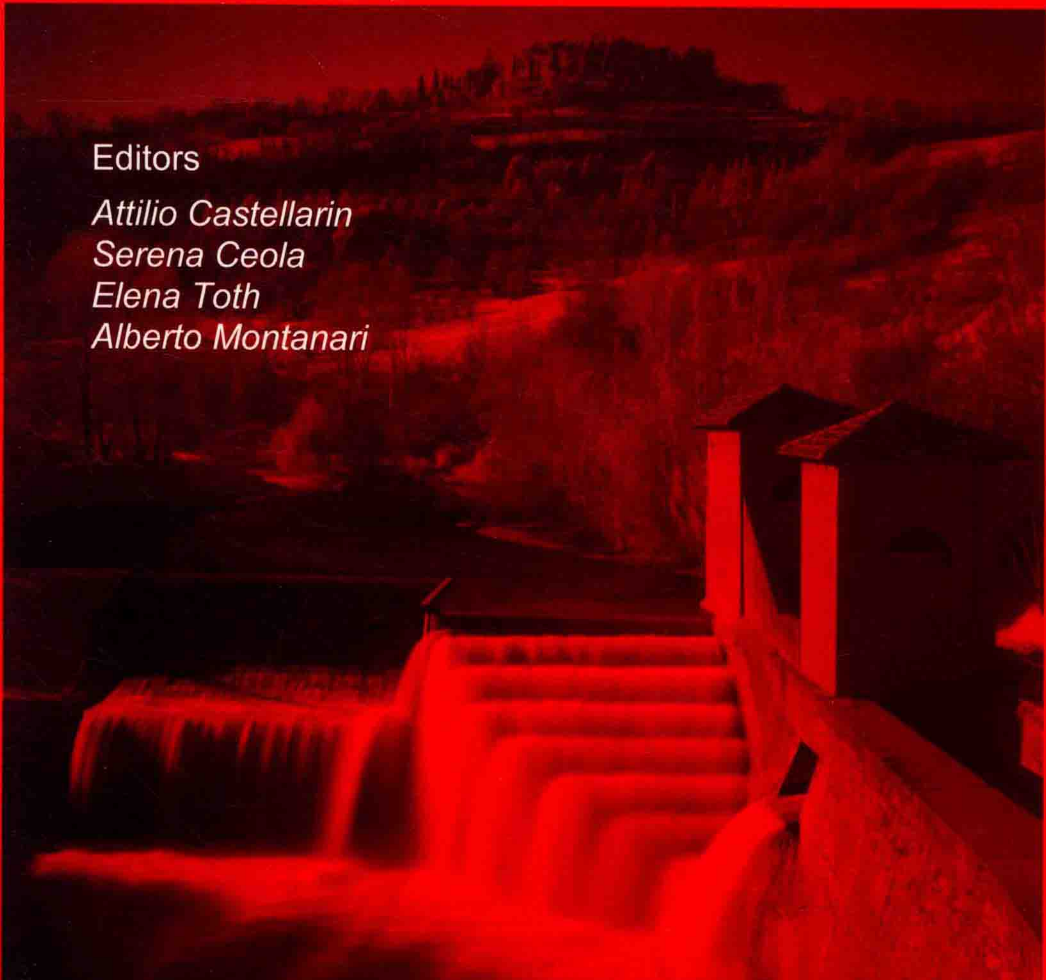
Evolving Water Resources Systems: Understanding, Predicting and Managing Water–Society Interactions



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Evolving Water Resources Systems: Understanding, Predicting and Managing Water–Society Interactions

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Evolving Water Resources Systems: Understanding, Predicting and Managing Water–Society Interactions

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Co-editors: Vladimir Belyaev, Emna Gargouri, George Kuczera, Gil Mahé & Stephen Mallory

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Publ. 362 2013 978-1-907161-40-7 214 + x pp. £61

Understanding Freshwater Quality Problems in a Changing World

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Co-edited by Adrian Collins, Valentina Krysanova, Elango Lakshmanan, Michel Meybeck & Mike Stone

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Associate Editors H. Aksoy, J. Bogen, Al. Gelfan, G. Mahé, P. Marsh & H. Savenije

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Floods: From Risk to Opportunity

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Co-edited by X. Cheng, E. Plate, S. Simonovic, S. Uhlenbrook & N. Wright

A paradigm shift from focusing on emergency response and recovery to flood risk management is required to build the capacity necessary to cope with floods. The process should be supported by vulnerability monitoring and development of tools such as standard measures of risk and preparedness in an integrated approach to improve capacity to deal with floods, taking advantage of their benefits while minimizing their social, economic and environmental risks. The papers, selected from ICFM5, cover flood risk management, disaster management, forecasting and early warning, and management in different regions.

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Preface

Today's highly dynamic social development is dramatically dependent on water. Population growth and land-use dynamics are intimately intertwined with freshwater resources. The pressing need for an integrated approach to water resources management that considers both natural and human systems, and accounts for their mutual dependencies, requires an improved understanding of the coupling between societal and hydrological processes.

In addition, water resources are unevenly distributed: access to clean water supplies and sanitation is a crucial problem for billions of people living in water-stressed areas. For this reason, identifying ways for improving water resources systems management and governance in relation to societal changes is critical to addressing water insecurity issues, especially in emerging economies, where a rapid decline in quantity and quality of water resources is already experienced day by day and cannot but increase, given the expansion of demand by a wealthier and always larger population.

With this general picture in the background, the International Commission on Water Resources Systems (ICWRS) of IAHS organized the 6th International Symposium on Integrated Water Resources Management (IWRM) in collaboration with the International Union of Geodesy and Geophysics (IUGG), European Geosciences Union (EGU), Department of Civil, Chemical, Environmental and Materials Engineering, University of Bologna (DICAM) and Italian Hydrological Society (SII-HIS).

The conference title "Evolving Water Resources Systems – Understanding, Predicting and Managing Water-Society Interactions" brings together scientists and practitioners from different countries and areas of expertise to present research ideas and results bringing hydrology into the future by reaching an improved connection with society. The conference is framed within the Panta Rhei IAHS research initiative (http://www.iahs.info/pantarhei) and constitutes an important benchmark for water resources management during the IAHS Scientific Decade 2013–2022.

The present volume collects a selection of 89 peer-reviewed papers presented by research groups active in 31 different countries from five continents (Fig. 1).

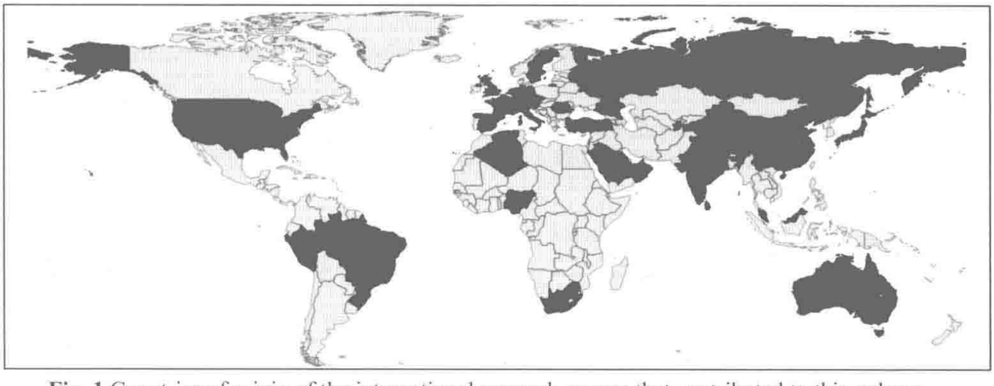

Fig. 1 Countries of origin of the international research groups that contributed to this volume.

The papers focus on a broad variety of topics associated with water resources assessment and management in a changing environment, and concentrate in particular on the two-way interaction between water and society. Water resources systems, catchment hydrology, eco-hydrology, groundwater hydrology, water security and socio-hydrology are driving scientific areas, which are grouped in this volume in four chapters associated with the following main themes (see also Fig. 2): (1) Hydrological processes in a changing environment: Coping with uncertainties; (2) Floods, droughts and water risks in a changing socio-hydrological context: Feedbacks between water resources and social systems; (3) Water resources: Monitoring, integrated assessment and management; (4) Optimization of water resources systems: changing boundary conditions, targets and criteria of water management.

- ■ Hydrological processes in a changing environment: Coping with uncertainties
- □ Floods, droughts and water risks in a changing socio-hydrological context: Feedbacks between water resources and social systems
- □ Water resources: Monitoring, integrated assessment and management
- ■ Optimization of water resources systems: changing boundary conditions, targets and criteria of water management

Relative no. of contributions

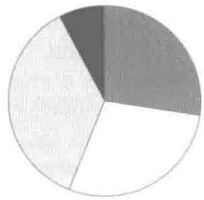

Fig. 2 Main themes of "Evolving Water Resources Systems: Understanding, Predicting and Managing Water–Society Interactions" and relative number of contributions in this volume.

The collection of papers included in this volume, by virtue of the broad spectrum of geographic and climatic conditions, and the composite palette of emerging and topical water issues addressed by the studies, represents a unique piece of knowledge for advancing our understanding of water–society interactions, improving integrated water resources systems management and governance, and addressing the water problems for the next generations.

EDITORS

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3 Water resources: Monitoring, integrated assessment and management

1 Hydrological processes in a changing environment: coping with uncertainties

Variational data assimilation with the YAO platform for hydrological forecasting

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Abstract In this study data assimilation based on variational assimilation was implemented with the HBV hydrological model using the YAO platform of University Pierre and Marie Curie (France). The principle of the variational assimilation is to consider the model state variables as control variables and optimise them by minimizing a cost function measuring the disagreement between observations and model simulations. The variational assimilation is used for the hydrological forecasting. In this case four state variables of the rainfall–runoff model HBV (those related to soil water content in the water balance tank and to water contents in rooting tanks) are considered as control variables. They were updated through the 4D-VAR procedure using daily discharge incoming information. The Serein basin in France was studied and a high level of forecasting accuracy was obtained with variational assimilation allowing flood anticipation.

Key words variational assimilation; YAO; HBV model; hydrological forecasting; optimisation; SCE-UA

INTRODUCTION

Floods represent one of the most destructive hazards to human lives and properties. To mitigate such a hazard, lots of research has focused on improving real-time monitoring and flood forecasting (Droegemeier *et al.* 2000). Numerous techniques were developed to improve hydrological forecasting, especially high flood prediction. Data assimilation was found to be one of the main tools to achieve this task (Seo *et al.* 2003, 2009, Ouachani *et al.* 2007, Lee *et al.* 2012). The 4D-Var method (variational data assimilation) is used in geophysics, applied to physically-based numerical models, in particular in meteorology (Schlatter 2000) and oceanography (Nodet 2007). It consists of estimating the control parameters of a direct numerical model (the hydrological model in our case), by minimizing a cost function quantifying the mismatching between the forecast values and actual observations. Gradient methods are adopted for the minimisation process. At University Paris VI, the research team of LOCEAN has developed a computation platform named YAO implementing the 4D-Var technique (Nardi *et al.* 2009). In this study, it is proposed to apply variational assimilation using the YAO framework to perform hydrological forecasting. Thus, the rainfall–runoff model HBV is adopted as a forecasting tool whose state variables are updated by 4D-Var to reduce the forecasting uncertainty.

METHODS AND TOOLS

The HBV Rainfall–Runoff Model

The HBV model is one of the most successful conceptual rainfall–runoff models that has been applied in more than 30 countries. In the current study, a lumped modelling is adopted. The main model outputs are daily mean flows (m^3/s) as well as daily actual evapotranspiration (mm/day). The principal water balance components of the HBV model are snow accumulation and melt, actual evapotranspiration and infiltration evaluation, soil humidity evolution, and water transfer through soil (Fig. 1). A further description of the HBV model version used in this study can be found in Dakhlaoui and Bargaoui (2013). The model includes several state variables evolving continuously, which decide the flows values. They are mainly the soil moisture level (SW), the water level in the rooting tanks (STW1, STW2, and STW3) and the depth of the snow accumulated (SD).

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