Editorial

Eugene Levner*

Advanced Study Institute for Strategic Management of Ecosystems,
Holon Institute of Technology,
52, Golomb Street, P.O. Box 305,
Holon 58102, Israel
E-mail: levner@hit.ac.il
*Corresponding author

Jacques Ganoulis

Division of Hydraulics and Environmental Engineering,
Aristotle University of Thessaloniki,
Thessaloniki GR 541 24, Greece
E-mail: iganouli@auth.gr

Biographical notes: Eugene Levner is a Professor of Computer Science and Operations Research at Holon Institute of Technology, Holon, Israel. He received an MSc in Computational Mathematics from Moscow Lomonosov University (USSR) and a PhD in Computer and System Sciences from the USSR Academy of Sciences (Moscow, USSR). His research interests include environmental risk analysis, operations research and applications of mathematical and computer models for strategic management of ecological systems. He has published more than 150 papers in scientific journals and conference proceedings, is the author/co-author of five books and is the co-editor of six books including *Strategic Management of Marine Ecosystems* (Springer, 2005) and *Wastewater Reuse – Risk Assessment, Decision-Making and Environmental Security* (Springer, 2007).

Jacques Ganoulis is a Professor of Hydraulics and Environmental Engineering at the Aristotle University of Thessaloniki, the Director of the University's Hydraulics Laboratory and the Coordinator of the UNESCO Chair and Network INWEB (International Network of Water/Environment Centres for the Balkans, www.inweb.gr). He has more than 25 years of experience in Greece, Europe and overseas on water resources management, environmental impact assessment and engineering risk analysis. He cooperates closely with UNESCO and has initiated several UNESCO projects in the Balkans. His research interests include risk-based water quality and flood management, multicriteria decision making and fuzzy logic modelling. He has published more than 180 papers in scientific journals and conference proceedings, is the editor of 10 books and is the author of the book *Engineering Risk Analysis of Water Pollution* (Wiley-VCH, 1994, 2nd edition in print, 2008).

This Special Issue of the *International Journal of Risk Assessment and Management (IJRAM)* is entitled 'Sustainable Management of Water Resources in Transboundary River Basins: Risk Assessment and Modelling'. It covers recent research and

developments in the above area and addresses various topics in theory building, mathematical modelling, design of methodologies and their testing, reviews of case studies and experience from different countries.

The sustainable management of water resources in transboundary river basins is a major topic of concern of many communities. In an increasing number of countries water scarcity and deteriorating water quality have become or may become critical factors limiting national economic development, expansion of food production and/or provision of basic health and hygiene services to the population.

More than 170 river basins are shared by two countries; a further 85, approximately, by more than two countries and 19 involve five or more sovereign states. There is an increasing urgency to develop sustainable and equitable means for the peaceful sharing of water resources. To keep pace with the rapid increase in risky situations, frictions, and water-based conflicts in transboundary water basins, environmental decision-makers and scientists are accelerating research on environmental risk and environmental security, as well as rapidly deploying existing scientific means to offer solutions for improving living and working conditions for the present and future generations and assessing, managing and mitigating risks of water-induced conflicting situations.

The main purposes of this Special Issue are to present and better understand the key aspects of the sustainable management of water resources in transboundary river basins, to illustrate new models using modern tools of system analysis, management and decision making, and to attempt to determine what is needed to improve effective risk management in transboundary river systems. The issue contains six papers discussing a range of techniques for sustainable management of water resources in transboundary river basins, with an emphasis on risk assessment and modelling. It contains contributions of researchers from Botswana, Greece, Israel, Spain and USA. A mix of theory building, modelling and empirical case study papers that have strong relevance to practical problems of water management is presented. The following subjects are discussed:

- principles and theory of risk assessment and sustainable management of water resources in transboundary river basins
- models for sustainable, equitable and peaceful sharing of water resources
- risk-based decision making and risk management in transboundary river basins
- integrated risk assessment, risk ranking and risk prioritisation
- integration of risk models and economic-mathematical regional development models for sustainable management of water resources.

Jacques Ganoulis and Eugene Levner start their paper ‘Risk-based integrated management of transboundary water resources: a general framework’, with a crucial note that the integrated management of transboundary surface waters and groundwater aquifers not only faces difficult problems and uncertainties at a national level, but also problems resulting from the fact that these water bodies cross international borders. After showing the importance of internationally shared waters at the global scale in terms of spatial extension, quantity and water uses, the authors develop an integrated risk-based framework for managing shared waters at the basin scale. They suggest the definition of risk as a performance index in achieving four different objectives, namely technical reliability, environmental safety, economic efficiency and social equity, which allows

different management options to be compared and the most sustainable one to be selected. They discuss the Risk-based Integrated Transboundary Water Resources Management (RITWRM) framework based on the quantification of the four different risk indices, which can be evaluated by combining expert opinions, available data and information and mathematical modelling. The RITWRM problem can be formulated as a multiportfolio choice problem, which allows to find a scientifically motivated compromise between the individual interests of stakeholders where technological, economic and social conditions are taken into account in the form of problem constraints.

Gregory A. Kiker, Rafael Muñoz-Carpena, Piotr Wolski, Anna Cathey, Andrea Gaughan and Jongbum Kim in their paper, 'Incorporating uncertainty into adaptive, transboundary water challenges: a conceptual design for the Okavango River Basin', present a review of a conceptual design to integrate hydrological/ecological models, global uncertainty and sensitivity analysis, integrated modelling and decision analysis for complex and adaptive transboundary water challenges. For this purpose, they refer to transboundary issues within the Okavango River Basin, a water resource shared among the countries of Angola, Namibia and Botswana, as an example for constructing these integrated tools. The authors provide a design that integrates a set of tools permitting to incorporate the inherent uncertainty of the system and its application for answering practical water resources management questions.

The paper 'Risk management of trans-boundary water resources: sustainable water management of Jordan River Basin area', by Nava Haruvy, Sarit Shalhevet and Yehuda Bachmat, studies the risk aspects related to sustainable water management of the Jordan River Basin, which is one of the most vulnerable transboundary river basins in the world, owing to the combination of regional water scarcity, large economic discrepancies and the long-lasting dispute over land ownership in the area. Today the Jordan River faces a serious risk of drying up in the next few decades, resulting in the loss of a unique ecosystem of international, religious and cultural significance. Adapting sustainable management practices that will reduce the risk to the river basin should take into account the local physical and hydrological conditions, the available technologies, the economic costs and the potential policy options. The authors present a case study in Israel where a multidimensional model is applied that takes all these factors into account and provides a decision making tool for planning the water management for urban and agricultural uses at a predetermined quality. Building on the lessons learnt from that case study, the authors present a framework for applying the model for transboundary water management by adjusting the model to include different costs and technologies for each of the countries that rely on the same river and to consider a variety of potential international agreements as scenarios in the model.

Eugene Levner, David Alcaide Lopez de Pablo and Jacques Ganoulis in their paper, 'Risk management of transboundary water resources using the green supply chain approach', consider the problem of coordinating the ecological risks of all stakeholders in a transboundary river basin and use for this purpose the 'green' (environmental) supply chain approach. Using a combination of two managerial concepts – 'the green supply chain' and 'the house-of-quality' – they construct a decision-making model that quantitatively estimates the integrated risk level for all stakeholders. Their model permits to assess and mitigate the integrated risk to population in a transboundary river basin under geo-hydrological, economic and technological constraints.

The paper ‘Using risk management to increase the flexibility of transboundary water conflict resolutions’, by Amnon Gonen and Naomi Zeitouni, notes that surface and groundwater that cross international boundaries present increased challenges to regional stability because hydrological needs can often be overwhelmed by political considerations. The success of an agreement over water conflicts heavily depends on the flexibility of the agreement in the presence of new risks and challenges. This flexibility may be accomplished through the establishment of formal institutions and/or legislation set up for the purpose of problem solving. These institutions are essential for the maintenance of cooperative interactions over water. These authors suggest the use of the risk management method most commonly utilised in the planning and developing of complex industrialised projects to increase the flexibility of transboundary agreements.

The paper ‘A model for risk minimisation on water resource usage failure’, by Laureano F. Escudero and Juan F. Monge, presents a framework for solving the strategic problem of assigning under uncertainty transboundary water resources in reservoirs and other segments of the basin system in order to satisfy various demands. Uncertainty is treated by use of a scenario tree and a sophisticated stochastic integer programming model. The objective functional, which is to be maximised, is the probability of satisfying different targets of the stored water and different demands over a set of scenarios. A scenario tree-based scheme is used to represent the deterministic equivalent model of the stochastic one. An illustrative example is presented and discussed for transboundary water resources management for the case of two reservoirs, three hydroelectric demand nodes and two non-hydro ones over a time horizon of two characteristic periods and under a set of two scenarios defined by the water resources manager.

This Special Issue is the result of many collaborating parties. We gratefully acknowledge the assistance provided by Dr. M.A. Dorgham, Editor-in-Chief of *IJRAM*, who initiated this project and the referees who reviewed the submitted manuscripts.