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Conflict Resolution in Water Resources and Environmental Management

Contents

Chapter 1
A Systems Perspective of Conflict Resolution in Water Resources and Environmental Management

Keith W. Hipel, Liping Fang, Johannes Cullmann and Michele Bristow

Abstract The many contributions contained in this book regarding the theory and practice of effectively addressing conflict in water resources and environmental management are put into perspective in this chapter. More specifically, the contents of each of the subsequent fifteen chapters are categorized within four main parts according to the systems methodology that is employed and the type of case study to which it is applied. A metaphor called the "knowledge ladder" is utilized to explain how one can ascend a ladder from data for evaluation at the first rung, to information for decision making at the second, to knowledge for management at the third, and ultimately to wisdom for peace at the top rung at which conflict is resolved. With respect to the type of application that is investigated, each chapter is designated according to the highest rung reached in the knowledge ladder.

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Keywords Conflict resolution · International Conferences on Water Resources and Environment Research (ICWRER) · Knowledge ladder · Systems thinking · Water resources management

1.1 Overview of the International Conferences on Water Resources and Environment Research (ICWRER)

During the summer of 2013, extensive flooding took place within major river basin systems in Europe. In early June of that year, the mighty Rhine River was starting to overflow its banks in the German City of Koblenz, strategically situated at the confluence of the Moselle and Rhine Rivers. The knife-shaped headland called the "Deutsches Eck" or "German Corner" cuts into these bodies of water at exactly the point where the Moselle joins the Rhine on its long journey to the North Sea. This historical spot is adorned with a spectacular statue of Kaiser Wilhelm I on horseback, flags of Germany and its states, a park and walkways along the shoreline which were threatened to be submerged. Opposite the Deutsches Eck, situated at the top of a steep cliff on the east side of the Rhine River is the impenetrable Ehrenbreitstein Fortress, keeping close guard over Koblenz and the important river navigation system below. Barges and cruise ships plying the Rhine looked like small toy boats from above. Koblenz is truly a fitting location in which to convene a first-class international conference dealing with water and the environment (Figs. 1.1 and 1.2).

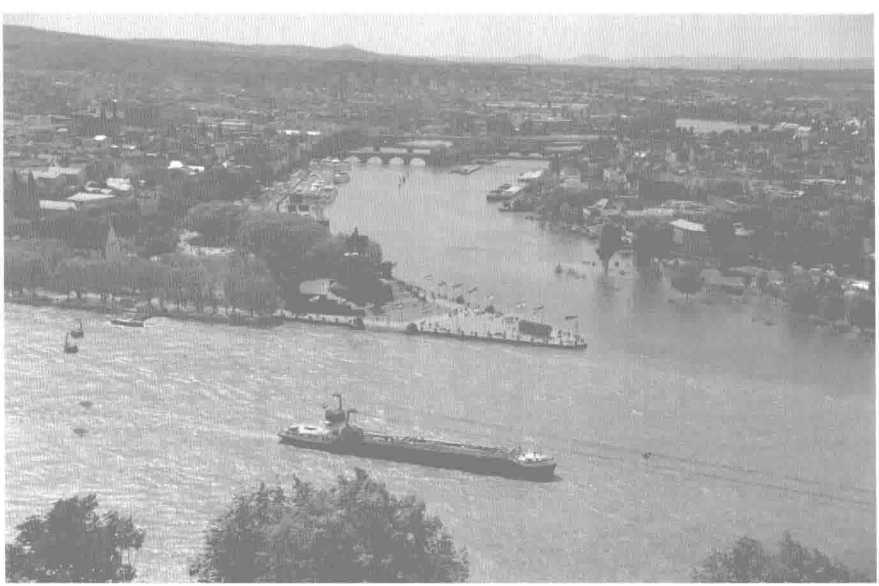

Fig. 1.1 Deutsches Eck from the Ehrenbreitstein Fortress looking westwards to where the Moselle River (*background*) joins the Rhine River (*foreground*) at Koblenz, June 2nd, 2013

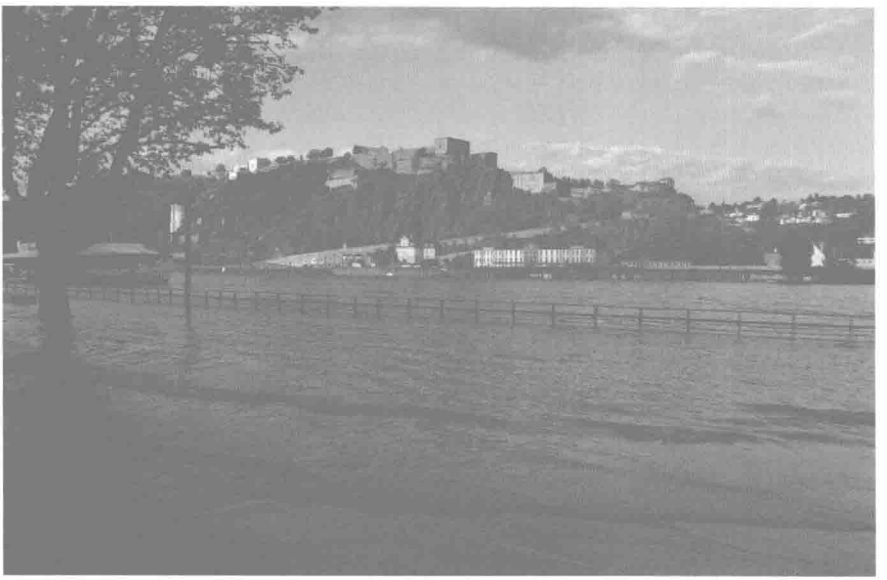

Fig. 1.2 Viewing eastwards across the flooding Rhine River at the Ehrenbreitstein Fortress, June 4th, 2013

From June 3rd to the 7th, 2013, a timely international meeting called "Water and Environmental Dynamics: 6th International Conference on Water Resources and Environment Research (ICWRER 2013)" was held in Koblenz at the Rhein Mosel Halle located along the swiftly flowing Rhine River. About 350 people participated in ICWRER 2013 from exactly 50 countries located in every continent except Antarctica. After a reviewing process, a total of 438 papers were accepted for presentation in Koblenz: 302 were orally delivered by authors while 136 were displayed as posters. In attendance were world renowned scientific researchers, practitioners, government officials, students and consultants. At the Opening Ceremony, Joachim Hofmann-Göttig, Mayor of Koblenz, Blanca Jiménez Cisneros, Director of the UNESCO Division of Water Sciences and Secretary of the International Hydrological Program (IHP), State Secretary Michael Odenwald, Federal Ministry of Transport, Building and Urban Development of Germany, Minister of State Ulrike Höfken, Ministry for Economy, Transport, Agriculture and Viticulture of the State of Rhineland-Palatinate, and Dr. Johannes Cullmann, Conference Chair, and other officials warmly welcomed the conference attendees and stressed the great import of topics to be addressed at the gathering. The conference banquet was held at the imposing Electoral Palace, which was separated from the Rhine River by a beautiful garden where tasty hors d'oeuvres and refreshing Moselle wine were served prior to the main dinner in the ornate Palace at which two outstanding international scientists were awarded the ICWRER Lifetime Achievement Award: Professor Gerd H. Schmitz from the Dresden University of Technology and

Professor Graeme Dandy from the University of Adelaide. Professor Kaoru Takara from Kyoto University introduced the next ICWRER conference which he will host in Kyoto, Japan's cultural heartland, in the summer of 2016.

The succession of ICWRER conferences originated at the University of Waterloo in 1993 with the conference entitled "Stochastic and Statistical Methods in Hydrology and Environmental Engineering" held in honor of the late Professor T.E. Unny. Subsequent to this conference, papers that underwent a thorough reviewing process were published by Kluwer in four edited books (Hipel 1994a, b; Hipel and Fang 1994; Hipel et al. 1994). The next six conferences convened in Kyoto (1996), Brisbane (1999), Dresden (2002), Adelaide (2008), Quebec City (2010) and Koblenz (2013) all adopted the more encompassing title of ICWRER. As just mentioned, the 7th conference having the title of ICWRER will be hosted in Japan in 2016. All of these highly successful conferences were attended by more than 300 attendees from around the globe with the highest registration being about 800. A detailed history of the ICWRER conferences is provided by Hipel et al. (2013a) in an introductory paper to articles initially presented at ICWRER 2010 in Quebec City and subsequently published in the Canadian Water Resources Journal. The authors of this current overview chapter are members of the ICWRER Steering Committee chaired by K.W. Hipel.

As stated by Cullmann (2013) in the Foreword to the ICWRER 2013 conference proceedings: "The ICWRER conference series provides an independent platform for scientists in the fields of hydrology, environmental research, aquatic ecosystem research [to present and discuss their work]. The focus of the 6th conference was set on fostering an integrative understanding of water and the environment. It brought together physical, biological, chemical, statistical, socioeconomic and technical expertise to discuss solutions for transient environmental boundary conditions". The main categories of papers included in the conference proceedings consisting of 665 pages are climate change; hydrological extremes; management; modelling, methods and mathematics; and sediments. In addition to the proceedings, two edited books containing selected papers presented at ICWRER 2013 were published by Springer: "Sediment Matters—The Challenges", edited by Heininger and Cullmann (2015), as well as "Conflict Resolution in Water Resources and Environmental Management", edited by Keith W. Hipel, Liping Fang, Johannes Cullmann and Michele Bristow, for which this chapter constitutes the introduction and overview.

In order to proactively manage water resources challenges such as flooding in Europe during 2013, an integrative and adaptive approach to water and environmental management is required which takes into consideration the value systems (Keeney 1992; Bristow et al. 2014) of affected stakeholders such as navigation, industrial, agricultural, domestic, recreational and environmental interests (Hipel and Fang 2005; Hipel et al. 2008a, b, 2009, 2013b; International Joint Commission 2009; GWP and INBO 2009; National Research Council 2004). Because these interest groups view the problem and solutions thereof through different lenses, conflict is bound to arise. Accordingly, conflict resolution is of great import in water and environmental management in order to reach fair and sustainable resolutions. Moreover, the fact that the fields of water resources and environmental management span both the societal realm, in which people and organizations interact, and the physical world which

sustains all human activities, makes these conflicts particularly complex and challenging to solve. For instance, when large-scale water diversions take place across political jurisdictions, conflicts may ensue among stakeholders within and across regions, while the water transfers may cause severe damage to sensitive ecological systems (Hipel et al. 2008b). Therefore, to arrive at realistic and fair resolutions, one must take into account not only the economics and politics of the situation but also the water quantity and quality changes that may occur within the altered hydrological system as well as the ecosystems contained therein. When the effects of climate change, and the closely connected activities of energy production and usage are also considered, the complexity of the problem becomes even greater and messier.

The objective of this edited book is to present some of the latest ideas in conflict resolution in water resources and environmental management by scientists and engineers who originally presented their research on this topic at ICWRER 2013 and subsequently submitted their expanded papers for review and possible publication in this book. The purpose of this overview chapter is to put into perspective the range of interesting papers published on this topic in the upcoming chapters. In the next section, the main research contributions contained in the chapters are highlighted, while in Sect. 1.3 the research is compared according to research themes and application areas. Finally, Sect. 1.4 provides valuable insights and guidance for continued research.

1.2 Research Contributions

Shortly after the completion of ICWRER 2013, an announcement was posted on the conference website in which authors who participated in the conference were given the opportunity to submit high quality papers falling under the theme of this edited volume for possible publication. The response to this solicitation of papers was very good and each paper that was received underwent a thorough reviewing process. In fact, the time taken to review the papers and subsequently revise them, usually twice per paper, was just over one year. Ultimately, fifteen papers were accepted for publication as chapters in this book.

The goal of this section is to outline the rich range of contributions contained in the papers appearing in this volume as summarized in Table 1.1. As can be seen in this table, the fifteen accepted papers are listed in the left column as Chaps. 2–16 in the edited book. The second column from the left provides the names of the authors of the chapters. The two columns on the right in Table 1.1 contain a summary of the main contributions appearing in each chapter according to methodologies and associated capabilities (second column from the right) and the case study presented along with connected comments regarding general applicability of this type of application.

The chapters in the book are categorized into four main parts, as shown in Table 1.1. Specifically, the chapters contained in Part I in this book are mainly concerned with Management and Evaluation. Consider, for example, Chap. 2,

Table 1.1 Main contributions of authors of the chapters according to methodologies and applications within four domains of water resources and environmental management

Chapters	Authors	Main contributions	
		Methodologies	Case study
		Capabilities	General applicability
Part I: Management and evaluation			
Chapter 2: Mitigating dam conflicts in the Mekong River Basin	T.B. Wild, D.P. Loucks (2015)	Daily simulation model of flow and sediment in a water network of reservoirs and channels	Hydropower development in the Mekong/Lancang River Basin, Cambodia
		Predicts in relative terms accumulation and depletion of sediment in river channels and reservoirs over time and space under different operating and sediment management policies	Screening of sediment management options: identifies relative tradeoffs between hydropower production and flow and sediment regime alteration
Chapter 3: Groundwater management instruments and induced second-order conflicts: the case of the Paraíba River Basin, Brazil	Z.M.C.L. Vieira, M.M.R. Ribeiro (2015)	Multiple criteria evaluation: Graph Model for Conflict Resolution	Groundwater aquifers in the Paraíba River Basin, Brazil
		Identifies unintended consequences of water quality guidelines, water permits, and bulk water charges and their potential for inducing second order conflicts	Avoidance/mitigation of second-order conflicts in groundwater management: recommends improved monitoring capacity, reduced supply failures and tariffs, and raising awareness in groundwater users to increase acceptance of management measures

(continued)

Table 1.1 (continued)

Chapters	Authors	Main contributions	
		Methodologies	Case study
		Capabilities	General applicability
Chapter 4: Paying to conserve watershed services in Pangani River Basin, Tanzania	M.C.S. Lalika, P. Meire, Y.M. Ngaga (2015)	Field Studies: hydrological data collection through site visits; socio-economic data collected by documentary review and structured questionnaires	Ecosystem services valuation of the Pangani River Basin, Tanzania.
		Findings: actual water sold is lower than billable water due to water leakages and/or theft; actual revenue is lower than projected revenue causing water supply problems	Watershed management: enhances sustainable water flow through integrated payment for watershed conservation
Chapter 5: Economic valuation for decision making on the protection of water sources	H. Castanier (2015)	Natural Resources Valuation: Contingent Valuation Method utilizing in-person surveys	Protection of natural water sources for the drinking water supply of the city of Quito, Ecuador
		Elicits individuals' willingness-to-pay for environmental resources with the use of multiple scenarios of water sources protection.	Watershed protection: takes into account the economic value of water in its natural state to prevent land degradation and water pollution

(continued)

Table 1.1 (continued)

Chapters	Authors	Main contributions	
		Methodologies	Case study
		Capabilities	General applicability
Part II: Global, trans-boundary and international dimensions			
Chapter 6: Is water really a scarce resource? Initiating entrepreneurship for global clean water supply: implications of a global economic policy on water security and entrepreneurial technology strategy	A. Presse (2015)	Three-level model (1: sufficiency, 2: efficiency, 3: equivalence) for global economic policy development to assure purchasing power for drinking water to survive	Global auctioning process to enable entrepreneurs to provide water and payouts to ensure that everyone can pay for water
		Develops incentives for global entrepreneurship and the application of the latest technologies	Global response to climate change and water insecurity: access to clean water can be secured through a per-capita-payout of the scarcity rent of the atmosphere
Chapter 7: Trans-boundary river basin management: factors influencing the success or failure of international agreements	H. Mianabadi, E. Mostert, N. Van de Giesen (2015)	Review of significant challenges of trans-boundary river basin management; overview of primary factors that can potentially increase conflict among riparian countries	Examination of Indus River Agreement (1960), Nile River Agreement (1959), and Euphrates River Agreement (1987)
		Points out uncertainty in hydrological conditions, impacts of climate change, lack of comprehensive water laws, ambiguity in international water laws, power asymmetry and non-integrated water management	Trans-boundary water management: design of resilient water treaties to decrease the likelihood of the collapse of international water agreements and potential for conflict among riparian countries

(continued)

Table 1.1 (continued)

Chapters	Authors	Main contributions	
		Methodologies	Case study
		Capabilities	General applicability
Chapter. 8: Drinking water treatment and supply in developed countries in 2045—where will we be?	P.M. Huck (2015)	Descriptive analysis of technical, institutional and human aspects of development and maintenance of robust systems	Adequate and secure drinking water supply infrastructure in developed countries
		Highlights future trends affecting the robustness of the following: (1) the source, (2) treatment, and (3) distribution	Provision of public water supply: decision makers need to consider changing environments as well as water consumers and their expectations
Chapter 9: The Keystone XL Pipeline dispute over transferring bitumen from the Alberta oil sands to US refineries	S. Payganeh, A. Obeidi, K.W. Hipel (2015)	Conflict description of environmental, political and economic dimensions; Graph Model for Conflict Resolution	Construction of the Keystone XL pipeline from the Alberta oil sands, Canada, to southern part of the United States
		Investigates a real-world conflict through a systems methodology so that stakeholders gain strategic insights into its resolution	Resolution of conflict among economic and environmental issues: uncovers pathways to equilibrium states that are desirable for all participants

(continued)

Table 1.1 (continued)

Chapters	Authors	Main contributions	
		Methodologies	Case study
		Capabilities	General applicability
Part III: Consensus-building, bargaining, and negotiations			
Chapter 10: A data mining tool for planning sanitary sewer condition inspection	R. Harvey, E. McBean (2015)	Data Mining: Classification And Regression Tree (CART) methodology	Assessment of sanitary sewers in Guelph, Ontario, Canada
		Predicts pipe condition (good vs poor condition) with an overall accuracy of 76% and effectively identifies individual pipes for future rounds of inspection	Proactive management of aging sewer pipes: enhances understanding of life-cycle degradation of pipes and serves as a consensus-building tool for the allocation of funds towards future pipe inspection
Chapter 11: Bargaining under uncertainty: a Monte-Carlo Fallback Bargaining method for predicting the likely outcomes of environmental conflicts	K. Madani, L. Shalikarian, A. Hamed, T. Pierce, K. Msowoya, C. Rowney (2015)	Monte-Carlo selection with Fallback Bargaining (FB): Unanimity FB, q-Approval FB, and FB with impasse	Water export problem in California's Sacramento-San Joaquin Delta (US)
		Ranks alternative plausible outcomes of a bargaining game, and further determines the ranking robustness	Decision analysis of two-participant, two-criteria decision making, which can be extended to multi-participant, multi-criteria problem: finds acceptable compromises so that decision makers can reach an agreement

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