Integrated Water Resource Management

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Cases from Africa, Asia, Australia, Latin America and USA

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Preface

Integrated water resources management (IWRM) is a process toward a sustainable development of water resources. IWRM incorporates economic, societal, and environmental sectors across and along boundaries. IWRM potentializes the integration of sectors, users, and all related interconnections with water resources. Despite its increasing conceptual popularity, the complexity of water systems and their political, social, economic, and environmental features can catalogue the implementation and effectiveness, which are incipient but challenging. As noted in the different chapters of this book, water issues are diverse, and therefore solutions differ from one area to another highlighting the need to adapt the IWRM actions and tools to the personality of each of the river basin contexts.

Operational actions have been contributing to the process of IWRM. Even when implemented at a very specific level, it should be integrated within the management of the whole hydrographic basin. Some countries throughout the world have been implementing many projects with certain IWRM components, as could be seen in many chapters of this book, e.g., the participatory approach in Brazil, evaluation (social impact study) in Costa Rica, transboundary treaties between the USA and Mexico, or framework for adaptation to climate change in Mexico, among others. Such experiences provide other initiatives with a solid groundwork in several fields of water resources management. These projects are proceeding slowly but, according to the sociopolitical and financial capacities and the local context, are always keeping the fundamental IWRM principles in mind as framework and guideline.

A common characteristic is that renewal of management strategies and policy mechanisms always comes after a conflict or as means to adapt the set of instruments to tackle extreme climate events and prevent future sociopolitical and environmental damages. Through the chapters of this book, multiple sources of such conflicts or the lack of flexibility and adaptation on water systems management was exposed. For example, the disconnection of the surface and groundwater management is a major issue that needs to be addressed toward effective planning and implementation of an IWRM framework based on the specific local and broader context.

The experiences presented in this book show that the effective implementation of IWRM can take several decades. Success in some countries is still accompanied by continuous challenges. Some goals, such as reconciliation of human water needs with economic sustainability and ecosystem needs, require considerable changes in the current management process and in the water culture, which may lead to even greater time to achieve these goals. Given the short-term focus of decision-makers and policymakers in most areas, there is always the temptation to seek quick solutions and to abandon the IWRM process if immediate gains are insufficient. Thus, in order to achieve the ultimate goals of IWRM, besides being an approach broadly advocated by international organizations and regional and local communities of experts, IWRM is an ad hoc strategy to facilitate sustainable and adaptive water resources management across scales in the sociopolitical and environmental watershed conditions. Needless to say, the integrated water resources management throughout the world requires a good dose of political will in order to secure water and to foster environmental sustainability and socioeconomic prosperities.

This book will provide some case studies showing important experiences related with IWRM throughout the world bringing a case from Brazil, the USA, Mexico, Costa Rica, Chile, South Korea, Iran, and some countries with severe water shortage problems, such as in Africa. Chapter 1 presents theoretical concepts, basis, responsibilities, and challenges of IWRM, tools necessary for effective IWRM, and economic, social, and environmental conditions of a basin that are related with IWRM. Chapter 2 presents an analysis of policies and regulations for water management in Brazil showing the principles, instruments, and institutional arrangements (National Water Resources Council, catchment basin committees, water agencies, and other bodies and agencies of the federal, state, and municipal governments) that are molding water management in the country. Chapter 3 presents a necessity of IWRM to solve conflicts for water in São Francisco Basin in Brazil. Chapter 4 describes the drivers that guided the State of California toward adapting an integrated water resources management framework. Chapter 5 analyzes international regulations for water markets and water banking in Australia, Chile, and California. Chapter 6 reviews the implications of climate change for water resources systems in Mexico and evaluates how management strategies from California can serve as potential adaptation schemes toward an integrated water resources management framework in Mexico. Chapter 7 illustrates the potential to advance transboundary water resources management in a more comprehensive approach. The focus is given to the transboundary Paso del Norte (PdN) region which is considered as the most environmentally damaged, hydrologically developed, and prolific irrigated area in the Rio Grande/Rio Bravo (RGB) Basin. Chapter 8 intends to give a global overview of the situation of natural resources in Guanacaste, Costa Rica, where a ratio of the water resources is managed addressing the postmodern society in the region. Subsequently, the chapter unfolds with major conflicts that occurred in Guanacaste watershed over the last 20 years and the solutions implemented. In Chap. 9, the current status of water resources in Iran is reviewed through the study of two key critical cases in the country, Zayandehrud River Basin and Lake Urmia. In this chapter, challenges, management practices, and government policies are

investigated. A new perspective is then drawn by the suggestion of implementing systems thinking and consideration of integrated water resources management opportunities. The Chap. 10 presents an overview of the current state of availability and the use of water resources, characteristics of rivers, large reservoirs, water quality management, and the future water resources management in South Korea. Chapter 11 presents the management and international water law instruments of transboundary groundwater in Africa. Transboundary aquifers represent an important source of water in Africa. Huge reserves of groundwater are located in some of the driest parts of this continent. Many of these watercourses and fossil aquifers are the subjects of state practices. This chapter shows few agreements including specific regulations to manage transboundary groundwater in Africa. Chapter 12 concludes with some considerations about the complexity of IWRM and its interrelationships between cultural, religious, and political aspects in different countries. This book will be of broad interest to professionals and students of hydrology and environmental science, politicians, stakeholders, and decision-makers in water resources.

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Abbreviations

AFB	African Development Bank
AGB Peixe Vivo	Peixe Vivo River Basin Management Support Executive Association
ALD	Alavijeh-Dehagh (sub-basin downstream of the Zayandehrud Dam)
ANA	Agência Nacional de Águas (National Water Agency)
ASADA	Asociaciones Administradoras de Acueductos Rurales
AyA	Instituto Costarricense de Acueductos y Alcantarillados
BCM/year	Billion cubic meters per year
BM	Boein-Miandasht (sub-basin upstream of the Zayandehrud Dam)
BOD	Biochemical oxygen demand
BS	Ben-Saman (sub-basin downstream of the Zayandehrud Dam)
CBHSF	São Francisco River Basin Committee
CCA	Water Advisory Council
CDS	Comisión sobre el Desarrollo Sostenible
CEBDS	Conselho Empresarial Brasileiro para o Desenvolvimento Sustentável
CEMIG	Energy of Minas Gerais Company
CEPAL	Comisión Económica para América Latina y el Caribe
CERH	Conselho Estadual de Recursos Hídricos (State Councils of Water Resources)
CHD	Chadegan (sub-basin upstream of the Zayandehrud Dam)
CHESF	Hydroelectric of São Francisco Company
CHGH	Chelgerd-Ghaleshahrokh (sub-basin upstream of the Zayandehrud Dam)
CHKH	Chel-Khaneh (sub-basin upstream of the Zayandehrud Dam)
CLD	Causal loop diagrams
CNRH	Conselho Nacional de Recursos Hídricos (National Council of Water Resources)

CODEVASF	Development Company of the São Francisco and Parnaíba valleys
CONAGUA	National Water Commission of Mexico
CONAMA	Conselho Nacional do Meio Ambiente
CR	Colorado River
CVP	Central Valley Project
DAD	Damaneh-Daran (sub-basin upstream of the Zayandehrud Dam)
EB	Elephant Butte Dam
ECOLEX	Environmental law database online
FAO	Food and Agriculture Organization of the United Nations
FIRO	Forecast Informed Reservoir Operations
GEAS	Global Environment Alert Service
GIS	Geographic information systems
GPD	Gross domestic product
HAR	Hydrological Administrative Regions
IAEA	International Atomic Energy Agency
IBC	International Boundary Commission
IBWC	International Boundary and Water Commission
IGRAC	International Groundwater Resources Assessment Centre
ILC	International Law Commission of the United Nations
INEC	Instituto Nacional De Estadística y Censos
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated water resources management
KS	Kuhpaye-Sagzi (sub-basin downstream of the Zayandehrud Dam)
kV	Karvan (sub-basin downstream of the Zayandehrud Dam)
LAN	National Water Law
LGCC	General Law on Climate Change
LGEEPA	General Law of Ecological Balance and Environmental Protection
LJ	Lenjanat (sub-basin downstream of the Zayandehrud Dam)
MCM	Millions of cubic meters
MEIM	Meimeh (sub-basin downstream of the Zayandehrud Dam)
MUKH	Murche-Khort (sub-basin downstream of the Zayandehrud Dam)
NGO	Non-governmental organization
NJ	Najafabad (sub-basin downstream of the Zayandehrud Dam)
NM	New Mexico
NMHA	North-Mahyar (sub-basin downstream of the Zayandehrud Dam)
OECD	Organisation for Economic Co-operation and Development
ONS	System National Operator
OSS	Sahara and Sahel Observatory
PCH	Small hydroelectric power stations
PdN	Paso del Norte

PDNWC	Paso del Norte Watershed Council
PdNWTF	Paso del Norte Water Task Force
PE	Petrolina, Brazil
PISF	São Francisco River Integration Project
PND	National Development Plan
PNI	National Infrastructure Program
PNRH	Política Nacional de Recursos Hídricos (National Water Resources Policy)
PVWMA	Pajaro Valley Water Management Agency
Q7,10	Minimum flow of 7 consecutive days and return period of 10 years
Q90	Flow rate associated with flow permanence of 90%
Q90reg	Regularized flow rate associated with flow permanence of 90%
Q95	Flow rate associated with flow permanence of 95%
Q95reg	Regularized flow rate associated flow permanence of 95%
QLT	Long-term average streamflow
Qmo	Maximum water flow granted
Qmr	Minimum flows of reference
Qr	Minimum residual flows
RGB	Rio Grande/Rio Bravo
SADC	Southern African Development Community
SD	System dynamics
SINGREH	Sistema Nacional de Gerenciamento de Recursos Hídricos (National System for Water Resources Management)
SRH	Secretaria de Recursos Hídricos (Secretariat of Water Resources)
SRHU	Secretaria de Recursos Hídricos do Ministério do Meio Ambiente (Secretariat of Water Resources of the Ministry of the Environment)
SWP	State Water Project
TP	Total phosphorus
TR	Tijuana River
Tx	Texas
ULRP	Urmia Lake Restoration Program
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNECOSOC	United Nations Economic and Social Council
UNEP	United Nations Environment Programme
US	United States
USGS	United States Geological Survey
YCH	Yan-Cheshmeh (sub-basin upstream of the Zayandehrud Dam)