



INTEGRATED

WATER

RESOURCE

MANAGEMENT

An Interdisciplinary Approach

NEIL S. GRIGG



Integrated Water Resource Management

Neil S. Grigg

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An Interdisciplinary Approach

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Endorsement

‘In this excellent book, Professor Neil S. Grigg, a world-class expert on water infrastructure, argues in favour of “science-to-practice” approach to Integrated Water Resources Management (IWRM). He reminds us that water supply is the highest priority service and that the lack of safe drinking water is the most pressing water issue globally. Water managers can promote good water governance by effective management practices and proper relationships among stakeholders. Integration begins when water and wastewater are operated as one utility. The management of water systems requires sound decisions, while public involvement is also essential. Water resources and services are parts of social systems that extend beyond technology, requiring a balance between competing social and political views. Although access to water is a basic human right, paying for services is also essential. Furthermore, water acts as a connector for security; for food production, environment, economy, and health.’

—**Tapio S. Katko**, UNESCO Chairholder, Adjunct Professor,
Tampere University of Technology, Finland

Foreword

As life on Earth becomes more complex, we need tools to sort out choices and galvanize collective action to solve our many shared problems. Integrated water resources management (IWRM) is such a tool and it can help us address rising demands for water and water services globally. IWRM can bridge gaps between the technical management of water and integrative approaches that consider systemic effects among users and natural water systems. It has a broad scope and its body of knowledge is shared among diverse groups across engineering, science, and the policy and management fields.

How well IWRM bridges gaps and unites disciplines depends on the clarity with which we explain it. Its body of knowledge has evolved from its early technical roots through the birth of the computer age to today's interdisciplinary approaches to complex issues in a changing world. I witnessed this evolution at Colorado State University from the 1960s onward, where a fertile arena to test interdisciplinary approaches unfolded, especially under the leadership of Professor Maury Albertson, who had a vision for water resources management and international development.

No single discipline or job category has a monopoly on IWRM, and a common vocabulary and body of knowledge are needed to forge interdisciplinary cooperation. This book offers these, and its test of effectiveness will be whether any discipline involved with IWRM can use it. The

challenge is that the complexities of IWRM make it hard to understand, no matter the vocabulary. Perhaps the remedy is in the phrase: “The vitality of democracy depends on popular knowledge of complex questions.”¹ Translation: water managers must explain IWRM so that it can be understood by its practitioners, by water users, and by the public.

IWRM can seem abstract and hard to understand. No one actually holds the title “Integrated Water Resources Manager,” and people holding different types of jobs engage in IWRM. To try to bring order into the discussion of IWRM, I have focused on real-world problems and jobs to show how theories apply to real situations. This problem-focused approach leads to the aims of the book: present a basic but comprehensive approach; explain technical, social, and policy analysis tools; present IWRM problem archetypes from developed and developing countries; and provide relevant summaries, problems, and discussion questions.

I have included examples from a number of countries at different levels of development, but many US examples are also given. This is due to my own background, where I have firsthand knowledge of many of them. My hope is that readers from non-US countries will find these examples to be valid because IWRM applies globally and is not restricted to a small number of experts. When examples from the USA and other high-income countries are used, I have added context to explain how they will apply in other situations where water management principles apply broadly. Adding context in this way is key to making IWRM work because IWRM does not depend on principles alone—it also depends on the ability of people and institutions to apply it.

Ultimately, the success of IWRM will depend on whether practitioners can use it to plan effective water management systems, use rational and social tools to support good decisions, and connect water plans to those of related sectors to develop integrated approaches. In today’s rapidly changing and political world, this is a challenge, but a good start on it lies in our explanations of IWRM, why it is needed, and how to apply it.

Neil S. Grigg

¹ *McLure’s* was an illustrated magazine of the early twentieth century. The quote is from Doris Kearns Goodwin, *The Bully Pulpit*, Simon & Schuster, New York, 2013.

Contents

1	Water as a Connector Among Societal Needs	1
	Why Water Management Is Important	1
	Why an Integrated Approach Is Needed	2
	From Technical to Integrative Water Management	3
	Paradigms for Integrated Management	5
	How the Paradigm of IWRM Evolved	6
	A Vocabulary for IWRM	7
	The Nexus Between Water and Other Sectors	9
	A Structure to Organize the Discussion of IWRM	10
	Map of the Book	13
	IWRM and Water Governance	15
	Making IWRM Work	16
	References	17
2	Framework and Scenarios of IWRM	19
	A Theory of IWRM	19
	Scenarios, Problem Archetypes, and Variables of IWRM	21
	Management Purposes and Organization Types	24
	Management Functions and Job Categories	24
	Management Instruments and Functions	26
	Influence of Scale in IWRM	27
	Conclusions	28
	References	30

3	Purposes and Systems of Water Management	33
	IWRM for Resources, Services, and Infrastructure	33
	Purposes and Systems of Water Management	34
	Water Supply	35
	Wastewater Management and Sanitation Services	41
	Maintenance Requirements for Water and Wastewater Systems	44
	Integration of Water and Wastewater Systems	45
	Agricultural Water	46
	Stormwater and Flood Risk Management	53
	Instream Flows	57
	References	65
4	Planning for Integrative Problem-Solving	67
	Planning as a Coordination Mechanism	67
	Planning Scenarios	69
	Planning as a Technical-Social Process	71
	Frameworks for Water Planning in Large Nations	73
	Water Planning in Smaller Nations, States, and Provinces	77
	State Governments in the USA	78
	Examples from Other Nations	79
	Local-Level Planning	80
	River Basin and Watershed Planning	82
	Watershed Planning	83
	River Basin Organizations	84
	Tools of Planning	88
	Strategic Planning	88
	Scenario Development	89
	Systems Development	90
	Feasibility Assessment Frameworks and Protocols	90
	Performance Indicators	90
	Models	91
	Decision Support Systems and Dashboards	91
	Shared Vision Planning	92
	Social Network Analysis	92
	Public Involvement	92
	Principles of Effective Water Management	93
	References	96

5 IWRM and Water Governance	99
Water Governance Is Essential to IWRM	99
Concepts of Governance and Institutional Arrangements	100
A Simple Model of Institutional Arrangements	102
Roles in Water Management	105
Principles of Water Governance	106
Governance and Management Compared	107
Policy, Empowerment, and Control	108
Institutional Assessment	112
Conclusions	115
References	118
6 Systems Thinking as an IWRM Tool	119
Systems Thinking to Support IWRM	119
Systems Thinking About Water Issues: An Example	121
Interdisciplinary Nature of Systems Thinking	122
Types of Problems to Be Analyzed	124
Socio-Technical Couplings	126
Tools of Systems Thinking	127
Systems Identification	128
System Diagrams	128
Causal Loop Diagrams	130
Process Mapping	131
Modeling	132
Problem-Solving Process	132
Application of Systems Thinking to Water Issues	133
Examples of Systems Thinking in Water Cases	134
Example 1: System Operator with Uncertain	
Decisions to Make	134
Example 2: Regulator with Enforcement	
Action to Decide	136
References	138
7 Watersheds as Social-Ecological Systems	139
Watersheds as Systems	139
Watershed Science and Management	141
The Watershed as a Social-Ecological System	142

Watershed Models	144
Social Science Methods	145
Politics of Watersheds	146
Examples of SES in Watersheds	146
Toward the Future for Social-Environmental Systems	147
References	148
8 Integrated Urban Water Systems	151
Why IWRM Is Needed in Urban Areas	151
Concept of the Urban Water System	153
Attributes of the Integrated Urban Water System	153
Integration of Infrastructures, Services, and Sectors	154
Principles of Integrated Urban Water Systems Management	156
A Scorecard for Integration of Urban Water Systems	157
Examples of Integrated Urban Water Systems	157
Challenges to Integration	158
The Road Ahead	160
References	161
9 Water Conflicts, Compacts, and Treaties	163
Conflicts in Water Management Scenarios	163
Vocabulary of Conflict Management	164
Types of Conflicts	165
Transboundary Conflicts	167
Interbasin Transfer Conflicts	171
Watershed and River Basin Conflicts	172
The Root Issue: Mobilizing Collective Action in Water Decisions	173
Conflict Resolution Techniques	174
Consensus Building	175
Legal Process	176
Search for Solutions	177
References	179
10 Hydrology of Water Supply and Natural Systems	181
Watersheds as Hydrologic Accounting Units	181
Hydrologic Cycle and Natural Water Systems	184
Atmospheric Water and Precipitation	187
Watershed Functions and Management	189

Basin Classification	191
River Flows, Stream Systems, and Riparian Areas	191
Lakes and Reservoirs	192
Wetland Functions	194
Groundwater Systems	195
Estuary Functions	196
Ecology and Natural Water Systems	198
Ecosystem Services	200
Hydrology as a Tool for Water Accounting	201
Yield of Water	203
References	205

11 Demand for Water, Water Services, and Ecosystem Services	207
Demand Management as an IWRM Tool	207
Demand Categories	209
Distribution of Water Uses	210
Municipal (Urban) and Industrial Water Provided by Utilities	212
Water Use Auditing in Cities	214
Self-Supplied Industrial Water	215
Irrigation Water Use	217
Instream Uses	220
Demand for Wastewater Services	222
Demand for Flood Control Services	223
References	224

12 Water Infrastructure and Equipment	227
Water Infrastructure in IWRM	227
Water Resources Systems	228
Water Infrastructure by Sector and Operational Function	229
Functionality of Water Infrastructure and Equipment	231
Conveyance by Streams, Rivers, and Canals	231
Conveyance in Pipelines and Water Tunnels	233
Storage	235
Treatment Plants	238
Energy Conversion with Pumps and Turbines	239
Control and Measurement Equipment	239
References	240

13	Water Infrastructure Planning Process	241
	Planning for Water Infrastructure	241
	Planning Process for Infrastructure	242
	Example: Multipurpose Dam	244
	Example: Water Pipeline	247
	Example: Wastewater Plant with Public Opposition	248
	Conclusions	249
	References	250
14	Models, Data, and Monitoring in IWRM	251
	Models, Monitoring, and Data to Support Decisions	251
	Types of Water Data	252
	Monitoring	255
	From Data to Performance Indicators	256
	How to Use Data in Decisions	258
	Modeling	258
	References	263
15	Water Laws and Regulations	265
	Legal Instruments to Control IWRM	265
	Knowledge Base About Law	266
	Law and Institutional Arrangements	268
	Governance and Federal–State Relations	269
	Relationships of Water Laws to Water Management	270
	Watershed Example	271
	The Principal Laws of Water Management	273
	Water Allocation and Use Law	273
	Water Pollution Control	276
	Drinking Water Law	278
	Environmental Laws	279
	Stormwater and Flood Law	280
	Water Power Law	282
	Navigation Law	282
	Planning Law	283
	Laws Governing Public Organizations	283
	Water Finance and Charges	284
	Regulation and Enforcement in the Water Industry	284

Dispute Settlement and Roles of Courts	286
International Water Laws	286
References	289
16 Economic and Decision Tools for IWRM	291
From Water Economics to Decision Science	291
Economic Tools for IWRM	292
Public Versus Private Goods (Public Sector Economics)	294
Water Sector Relationships and Markets (Industrial Economics)	296
Institutional Analysis (Institutional Economics)	298
Valuation of Benefits (Managerial Economics)	300
Comparison of Alternatives (Decision Science)	301
Benefit-Cost Analysis	302
Equity (Social Impact Analysis)	305
MCDA for Sustainability Analysis in Decision Process	306
Resource Allocation (Resource Economics)	308
Incentives and Behavior (Behavioral Economics)	310
Management and Regulation (Utility Economics)	311
Time Value of Money (Managerial Economics)	312
Economic Management Instruments	314
Conclusions	316
References	317
17 Social Aspects of Water Management	319
Social Impacts of Water Management	319
Social Needs for Water and Water-Related Services	320
Water-Related Social Issues	322
Social and Environmental Justice in Water Management	323
Worldviews and Human Rights	324
Social Science Research	326
Collective Action	327
Identifying Social Impacts	327
A Basic Method for Social Impact Assessment	329
Examples	330
Politics in Water Management	333
Conclusions	335
References	337

18	Water Resources and Environmental Assessment	339
	Assessing the Condition of Water Systems	339
	Process of Water Resources Assessment	341
	Demand Assessment	341
	Water Supply Assessment	342
	Water Quality Assessment	342
	Environmental Assessment	343
	Water Resources Assessment in the USA	344
	EU Approach to Water Resources Assessment	348
	International Level	349
	Conclusions	351
	References	353
19	Finance in Water Management	355
	Importance of Finance in IWRM	355
	Financing for Different Water Purposes	356
	Water Industry Financial Flows	357
	Financial Planning	360
	Financial Institutions to Support IWRM	361
	Cost Analysis	361
	Utility Financial Model	362
	Revenue Analysis	363
	Capital Funding	366
	Institutional Strength, Ability to Pay, and Credit Rating	368
	Asset Management	369
	Financial Reporting and Accountability	369
	Case of Flood Insurance	370
	Major Financial Issues Ahead	370
	References	373
20	Water Security, Disasters, and Risk Assessment	375
	Risk, Security, and Disasters in IWRM	375
	What Is Meant by Security and Which	
	Aspects Relate to IWRM?	376
	Natural Hazards	378
	Human-Caused Threats	384
	Risk Assessment Process	384

Vulnerability Assessment of Assets	386
System Identification	387
Impact Analysis and Consequences	388
Mitigation and Emergency Preparedness	390
References	392
21 Capacity-Building for IWRM: Education, Training, and Research	395
IWRM and Capacity-Building	395
Education and Training to Support IWRM	396
Evolution of Water Management Practice and Education	398
Education Necessary to Work in Water Management	399
Education Programs in Water Management	401
Projects and Case Studies to Foster IWRM	402
Training to Build Organizational Capacity	403
Organizational Development	404
Training of Watershed Leaders	405
Citizen and School Water Education	406
Research and the Learning Organization	407
References	408
22 Case Studies of IWRM Archetypes	409
Case Studies to Integrate the Issues and Solutions of IWRM	409
Case Study Method	410
Representative Cases	412
References	412
Appendix to Chapter: Case Presentations	413
Organization of Cases	413
Presentation of Case Summaries	415
Brazil ANA MN	415
Flood US HN	418
Kenya LN	421
Murray–Darling HS	424
São Francisco MS	426
Egypt Water Users LN	428

Chiclayo Wastewater LL	430
Colombia Water Charges MN	433
Wastewater Plant HL	435
Virginia Beach HL	438
Flint MI HL	441
Missouri River HS	446
Texas Drought HS	449
EC/France HN	451
Spain Groundwater HS	454
Wastewater Enforcement US HL	455
Jeffco Bonds HL	457
Turkey Financial Case ML	461
Serbia Finance ML	463
Cochabamba LL	464
Nile LI	467
Pecos HS	469
Chesapeake Bay HS	471
Lake Victoria LI	473
WaterRF HN	475

List of Figures

Fig. 1.1	Levels of water management from technical to integrative	4
Fig. 1.2	Many facets of IWRM	9
Fig. 1.3	Water as a connector to multiple sectors	10
Fig. 1.4	IWRM and interdisciplinary inputs to problem scenarios	12
Fig. 1.5	How IWRM meets needs of people and the environment	13
Fig. 1.6	Map of the book to explain how IWRM works	14
Fig. 2.1	Interrelationships among variables of IWRM	23
Fig. 2.2	Water management authorities along a stream	25
Fig. 3.1	Water service levels in rural-to-urban systems	38
Fig. 3.2	Water supply to sanitation to wastewater connections	46
Fig. 3.3	Instream flows along a stream	57
Fig. 4.1	Technical-social planning process	71
Fig. 4.2	Dynamic change during a water decision process	72
Fig. 4.3	Evolution of water resources planning and management in the USA	75
Fig. 4.4	Water manager as implementer of good practices	93
Fig. 5.1	Model of institutional arrangements for water management	103
Fig. 5.2	Iron triangle for water issues	104
Fig. 5.3	Framework and roles in water management	105
Fig. 5.4	Governance and management functions compared	108
Fig. 6.1	Watershed with city–farm water quality conflicts	121
Fig. 6.2	System levels with examples of water supply system	125
Fig. 6.3	Systems analysis to support decision-making	127

xx List of Figures

Fig. 6.4	Basic example of a concept map	129
Fig. 6.5	Simple example of causal loops for water and farm income	130
Fig. 6.6	Causal loop diagram for a complex flood problem	131
Fig. 6.7	A process diagram to illustrate steps in problem-solving	132
Fig. 7.1	Land uses in a watershed that affect water quality (USGAO 1979)	140
Fig. 7.2	Concept of the coupled natural–human system	143
Fig. 8.1	The integrated urban water system	155
Fig. 10.1	Watersheds as couplings between natural and infrastructure systems	182
Fig. 10.2	Watershed with urban and agricultural areas (President’s Water Resources Policy Commission’s 1950)	183
Fig. 10.3	Line diagram of a small watershed	184
Fig. 10.4	Hydrologic cycle	185
Fig. 10.5	Comparison of money and hydrology balances	202
Fig. 10.6	A simple river reach with a reservoir	203
Fig. 11.1	Distribution of water withdrawals and consumption in the USA	211
Fig. 11.2	Water balance for urban areas (After Bruvold 1988)	214
Fig. 11.3	Water balance and losses in distribution systems	215
Fig. 12.1	Watershed showing locations of infrastructure components	232
Fig. 15.1	Formal institutional arrangements for water management	268
Fig. 15.2	How laws affect water management along a stream	272
Fig. 16.1	From choice of water use to value in exchange	309
Fig. 16.2	Growth of value from compound interest	313
Fig. 17.1	Hierarchy of water needs	321
Fig. 17.2	A curve of fairness in water management	324
Fig. 17.3	Appropriate involvement of the water manager in politics	334
Fig. 18.1	Supply and demand balance	340
Fig. 18.2	Definition of water resources assessment	341
Fig. 18.3	Concept of water balance for assessment (After WMO 2012)	350
Fig. 19.1	Financial flows of the water industry	358
Fig. 19.2	Financial structure of water services	359
Fig. 19.3	Utility financial model	363
Fig. 20.1	Risk assessment process (after US Department of Homeland Security)	385
Fig. 20.2	PAHO process of vulnerability analysis	387
Fig. 21.1	Body of knowledge pyramid for water resources management	397

List of Tables

Table 2.1	Categories of water management scenarios	21
Table 2.2	Variables to classify scenarios of water management	22
Table 2.3	Crosswalk between management instruments, functions, and problem archetypes	27
Table 3.1	Water uses, services, and infrastructure for management purposes	34
Table 3.2	Types of rural and urban water services	39
Table 3.3	Participants and roles for instream flow management	59
Table 4.1	Elements of the US Water Resources Planning Act	76
Table 4.2	Planning steps and tools	88
Table 4.3	Practices of effective water management	94
Table 5.1	Principles of effective water governance	106
Table 5.2	Management mechanisms and governance functions by water service	109
Table 5.3	Examples of regulatory controls in US law	113
Table 6.1	Classification of systems problems	124
Table 7.1	Examples of CNH research projects	147
Table 10.1	World water balance (Nace 1964)	186
Table 10.2	Classification of US watersheds and river basins	191
Table 11.1	Demands for water, services, and resource conservation	209
Table 11.2	Estimated water use in the USA (all values in mgd)	210
Table 11.3	Multipliers for nonresidential water use	213

xxii **List of Tables**

Table 12.1	Types of infrastructure components by function and water sector	230
Table 12.2	Types of water pipe materials	234
Table 14.1	Performance indicators linked to decision types	259
Table 14.2	Model scenarios for water management purposes	261
Table 15.1	Types of water law, management actions, and connected sectors	273
Table 15.2	Laws commonly involved in problem archetypes	274
Table 16.1	Economic concepts applied in IWRM	293
Table 16.2	Methods to value water used in different purposes	300
Table 16.3	Simple benefit-cost example, \$	305
Table 16.4	Layout of a simple MCDA table	308
Table 16.5	Regulatory areas as functions of water management purposes	312
Table 17.1	Examples of water issues and social effects	329
Table 19.1	Financial management scenarios for problem archetypes	357
Table 19.2	Functions of financial institutions	361
Table 19.3	Organization types and principal revenues	365
Table 20.1	Scenario matrix for disasters	386
Table 20.2	Services provided by water systems and their security categories	388
Table A.1	Scenario list and abbreviations	414
Table A.2	List of cases	414

1

Water as a Connector Among Societal Needs

Why Water Management Is Important

The importance of water is plain to see because every creature on the planet needs it to survive and prosper. In a perfect world, we would cooperate to manage it as a shared resource so that everyone has enough and water's condition is protected to benefit people and nature. Unfortunately, people do not cooperate that way and the management of water often involves more conflict than it does cooperation. This presents many challenges as we seek to provide access to healthy water supplies in a time of rapid global development and climate change.

In one competing vision of the future, there could be efficient and equitable management to apply water to its highest and best uses for a sustainable future. At the other extreme, global water supplies and quality could spiral downward toward scarcity and pollution and the disease and deprivation they will bring. The factors that will make the difference between these competing visions are the effectiveness of water resources management and the governance that supports it.

Demands for a healthy and adequate water supply are life-or-death issues for people and ecosystems, but only a tiny fraction of the world's water is

available as freshwater. The risk of a water crisis looms in many places that are facing water shortages and drought, rising sea levels, polluted water, floods, and environmental degradation, among other problems.

To respond to these challenges, methods for effective water resources management are being applied around the world at various levels of success. The context of applying them matters as much as the methods themselves because of large differences in requirements and capacities from one place to another. The widest gaps are between prosperous countries with highly-developed governance systems and those with struggling economies and societies where governance is largely ineffective. In between are many emerging nations where water management is a work in progress and needs are being addressed incrementally.

Depending on how it is defined, water resources management can fall short of the responses needed for a sustainable future. If it is defined as a mostly technical discipline which plans and builds infrastructure, it will certainly fail to respond fully to the needs of people and the planet. If it is focused more on nonstructural and regulatory tools, it may also fail by not providing the infrastructure needed to serve people and protect the environment. If it fails to respond to the urgent needs of water-related sectors such as food, health, and urban development it will also be inadequate. In short, the requirements of water resources management are demanding and it must be comprehensive and integrated with parallel management activities in other sectors.

Why an Integrated Approach Is Needed

Solutions are available, but current management systems fall short in meeting needs. Meanwhile, conflicts block progress and rapidly-increasing demands for water shortchange natural systems. Better approaches based on the best available practices must build on solid technical systems and infrastructure and extend to management systems that integrate water decisions with those in water-dependent sectors such as food, health and environment. The technical systems require tools from science and engineering, and integrative management tools draw from interdisciplinary founts of knowledge.

This book offers a three-level model of water management that includes technical approaches based on science and engineering, management and decision tools, and integrated approaches to link these with actions of water-dependent sectors. Integrated approaches require interdisciplinary inputs and the framework of Integrated Water Resources Management (IWRM) can be used to explain them.

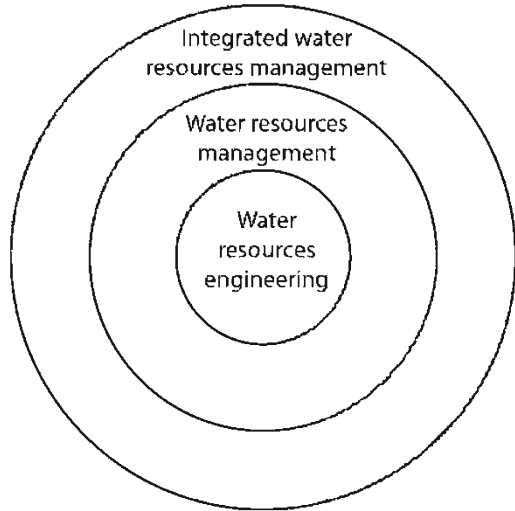
The proven principles of water resources management endure and the tools and methods of the three levels of application apply globally. How they should be applied will depend on the contextual situations at hand. The examples and cases presented here range across different types of problems that occur at different levels of national development and in different cultures.

From Technical to Integrative Water Management

The three levels of water management from technical to integrative are (Fig. 1.1):

- A *technical level* of handling water, as in use of pipes, pumps and other water infrastructure and equipment. This can be called *water resources engineering* but it also includes a wide range of operations and maintenance activities and it can be focused on science issues, such as aquatic ecology for example.
- A *management level* involving decision-making about allocation of the resource values of water and the use of water infrastructure. This scope is often called *water resources management*. This might seem like the same thing as IWRM, but it must go further to deal with related sectors to reach the integrative level.
- An *integrative level* involving a broad set of activities to link water decisions to actions in water-dependent sectors, such as health, environment, and food. The intersection of water issues with those of another sector is sometimes called a *nexus* as for example the water-energy nexus. These linkages between water management and other sectors define the discipline of *Integrated Water Resources Management*.

Fig. 1.1 Levels of water management from technical to integrative



Technical work is at the core of all levels; management inputs are needed for decisions involving funding and resource allocations; and the linkages with decisions of other sectors extend the concept to IWRM. Thus, anyone working in water management participates in IWRM at one level or another. While there are other ways to classify these levels, this approach can be used to explain the overall set of tasks involved in water resources management.

As an example, a reservoir operator may use well-defined engineering criteria to make decisions about releases of water. Then, the analyst who advises on allocating the water to farms or cities would support water management decisions by also considering resource values of the water. At the IWRM level, planners would also evaluate how water decisions are linked to community development and goals of other sectors.

Using such examples, it is clear that IWRM should be of practical use as well as useful for academic discussions. To apply it effectively, a manager must implement effective infrastructure systems and management programs, ensure that these are managed well, and work successfully with water-dependent sectors to meet their needs.

Water resources engineering has evolved over centuries as humans sought to put water to work to meet needs for drinking, farming, and providing energy. The concept of management principles for complex decisions came

later, along with emergence of modern systems of governance. IWRM is the most recent paradigm of water resources management and is evolving in response to complex and interconnected problems of society. Practitioners in other complex fields are also seeking to develop integrated approaches, such as in health care, education, and the environment.

Paradigms for Integrated Management

As IWRM has evolved, it has come to replace or expand earlier concepts with similar purposes. Examples of earlier concepts are multipurpose, comprehensive, and holistic water management. Multipurpose water management was a popular concept decades ago, and the World Bank used the term comprehensive in development of its policies during the 1990s. Holistic water management focused on water management in developing countries and applied mostly to the irrigation sector with emphasis on interagency coordination, performance standards for water users and staff, use of indigenous knowledge, local participation for corollary activities; top-down and bottom-up coordination and the linkage between water and agriculture policy.

The recent concept of Total Water Management (TWM) is similar to IWRM, but its concepts have not been extensively developed and it was not designed for development situations. It was developed within the membership of the American Water Works Association (AWWA) and builds on their understanding of the needs of utility managers. A definition of TWM was developed by a group of water industry professionals: “Total Water Management is the exercise of stewardship of water resources for the greatest good of society and the environment. A basic principle of Total Water Management is that the supply is renewable, but limited, and should be managed on a sustainable use basis. Taking into consideration local and regional variations, Total Water Management: encourages planning and management on a natural water systems basis through a dynamic process that adapts to changing conditions; balances competing uses of water through efficient allocation that addresses social values, cost effectiveness, and environmental benefits and costs; requires the participation of all units of government and stakeholders in

decision-making through a process of coordination and conflict resolution; promotes water conservation, reuse, source protection, and supply development to enhance water quality and quantity; and fosters public health, safety, and community good will” (Grigg 2008).

This definition was crafted by a group of highly-experienced managers and each phrase in it was chosen carefully. A short explanation of TWM was provided by John Young (2006), Chief Operating Officer of American Water, who wrote that it is to “...assure that water resources are managed for the greatest good of the people and environment and that all segments of society have a voice in the process.” Currently, AWWA has shifted to a concept of One Water, which is interpreted as managing water no matter what form it is in, whether as raw water, water in pipes, recycled water, or groundwater.

Comparing TWM to IWRM shows the importance of nuances to explain differences in concepts that seem similar. At a high conceptual level, TWM and IWRM seem to have the same goals for meeting needs and being good stewards of water. However, TWM focuses on management in the context of water utility decisions and IWRM focuses on the nexus connections among sectors, even as wise decisions about water are made. As a result, IWRM concentrates more on the issues of linked issues among sectors.

Combining technical and non-technical tools requires a more sophisticated approach to water management than in the past. Technical tasks are better-defined than non-technical tasks but still require complex tools, while non-technical skills range across the policy, management and decision science fields and focus on social capacity and collective action. Given these needed skills water management must be interdisciplinary and not limited to a single academic field. Rather than try to invent a new, interdisciplinary field, the more viable course of action is to work within existing specialty areas and build capacity for the solution of problems by interdisciplinary cooperation.

How the Paradigm of IWRM Evolved

The origins of IWRM are in water resources engineering and management, which stem back to the 19th Century rise of science and empiricism as problem-solving methods. Prior to about 1970, these were mostly

technical fields dominated by engineers. Their complexity grew with rising expectations and new technologies, and in response they blended social and environmental objectives with structural solutions to water problems. Now, it is recognized that water management involves more than water as a resource and is also a connector among sector issues in health, food, energy, and environmental protection.

How this interdisciplinary focus developed can be traced to global attention to human issues of equity and opportunity and water issues such as climate change, species diversity, and shared international waters. After the devastation of World War I and the failed League of Nations, World War II created enormous hardships and led to the formation of the United Nations in 1945. As the UN confronted global issues, a series of international conferences addressed needs of the environment, women, and social development. These were followed in 1977 when first UN Water conference was held at Mar del Plata, Argentina and the stage was set for emergence of the IWRM concept. In parallel, the 1970s were an activist decade in environmentalism and multi-sector planning, such as use of environmental impact statements and awareness of social issues was rising globally.

The UN declared the 1980s as the International Water Supply and Sanitation Decade and interest in water management increased further with the 1990s formation of the World Water Council, which was initiated at the VIIIth World Water Conference organized by the International Water Resources Association. The Global Water Partnership (GWP) grew out of these meetings and was founded in 1996 to foster IWRM and link it with development goals. At the 6th World Water Forum in 2012 twelve priorities for action were identified, including one (No. 2.1) for IWRM “Balance multiple uses through Integrated Water Resource Management” (Biswas 2011; World Water Council 2015).

A Vocabulary for IWRM

As IWRM emerged, its practitioners realized that they faced a challenge created by the different vocabularies that emerge from separate disciplines. For this reason, definitions are needed to provide common ground for

cooperative work, starting with the definition of IWRM itself. The most common definition is by the GWP (2015), which was organized to foster the development of IWRM.

The GWP defined IWRM as: "...a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment." The concept of IWRM as a process provides flexibility through a conceptual framework for responding to diverse water demands in many situations as they are coordinated with needs of multiple sectors.

While the GWP was organized to promote IWRM, other groups also embrace it and its acceptance as a conceptual framework seems to be increasing. For example, the American Water Resources Association (AWRA 2015) established an IWRM technical committee in 2014 with the goal to lead a conversation about making it standard practice and to promote common understanding of what people mean by IWRM. AWRA adopted a position statement for water management goals, policies, programs, and plans to be organized around the concept of IWRM and defined it as the "coordinated planning, development, protection and management of water, land and related resources in a manner that fosters sustainable economic activity, improves or sustains environmental quality, ensures public health and safety, and provides for the sustainability of communities and ecosystems."

The multi-faceted nature of IWRM is explained by Fig. 1.2 by showing demand processes on the left (water for economy, society, and environment) and supply processes on the right with water systems and managers working under systems of regulation and supported by an enabling environment. Many contextual situations occur where water is needed for different purposes and requirements in water-dependent sectors, including natural ecosystems. The governance forces are represented by policy and regulation for controls with the enabling environment supporting the processes.

This concept explains how IWRM is different from traditional water management due to its web of connections and nexuses across multiple sectors. Given this broad scope, it is a mechanism for collective action

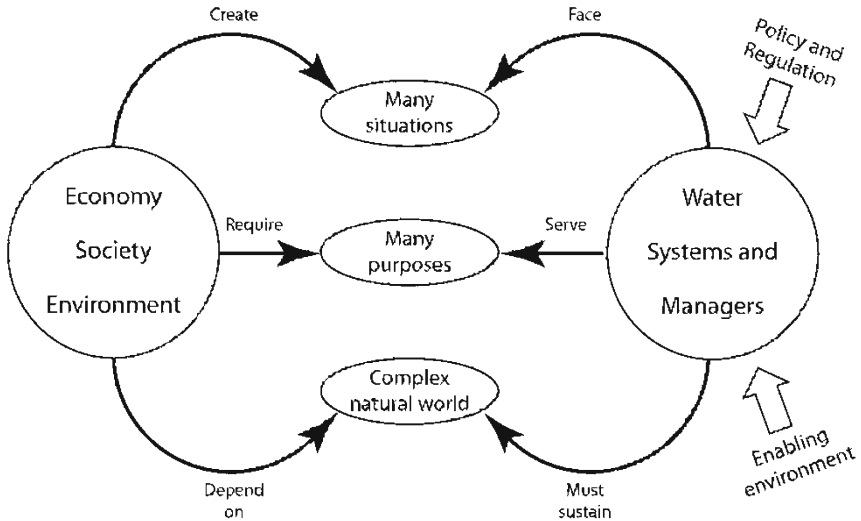


Fig. 1.2 Many facets of IWRM

and is not the job of only one entity called the IWRM Department. There is normally not a job description for an “IWRM Manager,” but there are job descriptions which, when summed up, lead to IWRM.

The Nexus Between Water and Other Sectors

The concept of IWRM as a multi-sector activity explains how it provides a nexus approach where water is a connector with other water-dependent sectors, such as in the water-food-energy nexus. The nexus concept requires water governance to be inter-sectoral to address its multiple purposes and require integrative work among sectors. This makes water unique as a connector among policy issues to create policy linkages such as these:

- Water supply to poverty, health, and social policy
- Wastewater to housing, health, social policy, and environment
- Irrigation to food policy
- Flood to disaster and emergency management