

Contents

Preface xiii

Acknowledgments xvii

Water Unit Conversions xix

1 Introduction 1

- 1.1 An Array of Decision Types 2
- 1.2 Amid the Noise 3
- 1.3 Supply Enhancement and Demand Management 4
- 1.4 Future Forces 6
- 1.5 Economics, Environment, and Equity 8
- 1.6 Organization and Conventions 10
- 1.7 Exercises 11

2 Optimal Allocation and Development 13

- 2.1 Establishing Goals 13
- Part I: Fundamental Economic Theory 15***
- 2.2 Costs of Water Supply 15
- 2.3 Efficiency for a Single Water-Using Agent 19
- 2.4 Aggregation and Acquisition of Marginal Net Benefit Functions 31
- 2.5 (Aggregate) Economic Efficiency 40
- 2.6 The Universal Advisory Term: Opportunity Costs 43
- Part II: Further Adjustments for the Idiosyncrasies of Water 44***
- 2.7 Economic Efficiency in the Presence of Return Flows 44
- 2.8 Economic Efficiency with Nonrivalness 46
- 2.9 Neutral Economic Efficiency 49
- 2.10 Is Water Conservation an Additional Goal? 54
- 2.11 Summary 55
- 2.12 Exercises 56

Appendix 2A: Constrained Optimization Using the Lagrangian Method 59

3	Efficiency in a Dynamic World	63
	<i>Part I: The Whys and Whats of Discounting</i>	64
3.1	Rates of Time Preference	64
3.2	Not Risk, Not Inflation	66
3.3	Market Revelations of the Discount Rate	68
3.4	The Underlying Theory	69
3.5	Time Values of Money	70
3.6	What is the Social Discount Rate?	72
3.7	Collecting the Advice on Social Discount Rate Selection	78
	<i>Part II: Applied Discounting</i>	79
3.8	Dynamic Improvement and Dynamic Efficiency	79
3.9	Other Metrics	80
3.10	<i>NPV</i> versus the Other Measures	82
3.11	Is Dynamic Efficiency/Improvement Neutral or Aggregate?	84
3.12	Dynamic Efficiency: A Two-Period Graphical Exposition	84
3.13	Dynamic Efficiency: The Basic Calculus	86
3.14	A Fundamental Example: Drawing from a Reservoir	87
3.15	Extendable in Many Possible Directions	90
3.16	How Fast Should Groundwater Be Depleted?	91
3.17	Summary	94
3.18	Exercises	94
	<i>Appendix 3A: Amortization and Capitalized Value</i>	97
	<i>Appendix 3B: Advanced Methods of Dynamic Optimization</i>	99
4	Risk and Reliability	101
4.1	Risk, Uncertainty, and Ambiguity	103
4.2	Actions and Instruments	104
4.3	Interpreting Climate Change	106
4.4	Statistical Review	109
4.5	First Steps: Examples That Maximize Expected Net Benefits	114
4.6	Mean–Variance Decision Making	116
4.7	Expected Utility	120
4.8	Aggregation for Social Decisions Involving Water Risk	126
4.9	Quasi-Option Value, Real Options, Learning, and Optimal Postponement	128
4.10	Robust Decision Making	131
4.11	Summary	133
4.12	Exercises	134
	<i>Appendix 4A: Recursive Utility</i>	135

5	Social Institutions	137
	<i>Part I: The Economics of Institutions</i>	138
5.1	What If You Had to Choose?	138
5.2	The Invisible Hand and the First Theorem of Welfare Economics	143
5.3	Market Failure	145
5.4	Consequently ...	151
5.5	The Nature of Property	152
5.6	The Assignment of Property: Who Should Get It?	154
	<i>Part II: Legal Institutions</i>	157
5.7	Water Law	157
5.8	Surface Water Law	158
5.9	Groundwater Law	168
5.10	Conjunctive Management	174
5.11	Treaties and Compacts	175
5.12	Summary	177
5.13	Exercises	179
6	Policy Analysis	181
6.1	Two Policy Analysis Forms: Theoretical and Empirical	182
6.2	Empirical Policy Analysis: The Ins and Outs of Compensation Tests	183
6.3	Consumer and Producer Surplus Measurement	184
6.4	Price-Rationing Policy	186
6.5	Quantity-Rationing Policy	190
6.6	Demand-Shifting Policy	191
6.7	Supply-Shifting Policy	194
6.8	Overview and Analysis of Other Policy Types	198
6.9	Incorporating ΔNB into NPV for Dynamic Policies	198
6.10	Secondary Economic Effects	202
6.11	Incommensurables and Intangibles	205
6.12	Summary	208
6.13	Exercises	209
	<i>Appendix 6A: Input–Output Analysis</i>	211
	<i>Appendix 6B: Footprinting and Virtual Water</i>	214
7	Cost–Benefit Analysis	217
7.1	Policy Background	219
7.2	Required Economic Analyses in the United States	221
7.3	CBA Is More Than NPV	226
7.4	A Spreadsheet in Need of Entries	227
7.5	Obtaining the Benefits and Costs	229

7.6	An Example Project Analysis: Applewhite Reservoir	232
7.7	Multipurpose Projects	236
7.8	Using Alternative Costs as a Benefit Measure	237
7.9	The Costs of Borrowed Funds	239
7.10	Cost Allocation	240
7.11	Summary	242
7.12	Exercises	243
	<i>Appendix 7A: The Conduct of Cost Allocation</i>	245
8	Water Marketing	255
8.1	The Instruments of Water Marketing	256
8.2	The Upside: Unlocking the Resource from Low-Valued Applications	259
8.3	Water Trade and Valuation Tools	260
8.4	Transaction Costs	264
8.5	A Typical Exchange Framework	265
8.6	The Downside: Guarding against Market Failures	268
8.7	Can the Downside Be Fixed?	271
8.8	The Worldwide Extent of Marketing	273
8.9	Leading Surface Water Markets	273
8.10	Groundwater Marketing	288
8.11	The Grounds for Area-of-Origin Protectionism	291
8.12	Summary	296
8.13	Exercises	297
9	Water Pricing	301
9.1	The Terms of Pricing	303
9.2	The Customary Objectives of Rate-Setting	311
9.3	The Equity of IBRs Question	314
9.4	Financial Practice	316
9.5	The Economic Theory of Pricing	318
9.6	Seasonal Volumetric Rates	329
9.7	The Influences of Risk	331
9.8	Wastewater Charges: A Complication	333
9.9	Summary	334
9.10	Exercises	336
10	Demand Analysis	339
10.1	Demand Is More Demanding Than Value	340
10.2	The “Requirements” Approach	341

Part I: Demand Methodology 342

- 10.3 Point Expansion 343
- 10.4 Residual Imputation 345
- 10.5 Activity Analysis and Math Programming 346
- 10.6 Production Functions 354
- 10.7 Direct Statistical Regression 356
- 10.8 Nonmarket Valuation Techniques 360

Part II: Empirical Demand Findings for Three Sectors 367

- 10.9 When Considering Prior Empirical Studies ... 367
- 10.10 Residential Water Demand 369
- 10.11 Industrial and Commercial Water Demand 370
- 10.12 Agricultural Water Demand 372
- 10.13 Summary 375
- 10.14 Exercises 376

Appendix 10A: Joining Point Expansion and Residual Imputation 377**11 Supply Analysis 381**

- 11.1 The Roles of Supply Information 382
- 11.2 The Primary Feature of Supply Empiricism: Single Suppliers 383
- 11.3 The Process of Processing Water 384
- 11.4 Conceptualizing Costs 385
- 11.5 Basic Methods of Supply Estimation 387
- 11.6 Economies of Scale and Scope 394
- 11.7 The Privatization Question 396
- 11.8 Summary 404
- 11.9 Exercises 405

12 Modeling with Demand and Supply 407

- 12.1 From Theory to Empiricism 408
- 12.2 Features of More Advanced Models 409
- 12.3 Economics and Hydroeconomics 411
- 12.4 A First Model 412
- 12.5 What Has Been Gained, Really? 414
- 12.6 The Work of Prior Studies 416
- 12.7 A Second Model 419
- 12.8 Summary 424
- 12.9 Exercises 424

Appendix 12A: Converting Functions for Water Type 425

13	The Water Challenge	427
13.1	Economically Inspired Principles	428
13.2	Making a Difference	433
Glossary		435
References		443
Index		467