CONTENTS

Preface xiii
Definition of Terms xv

1 Watersheds, Hydrologic Processes, and Pathways 3

1 Introduction 7
Overview 7
Watersheds 10
Integrated Watershed Management 12
Sustainable Use and Development of Natural Resources 14
Watersheds, Ecosystem Management, and Cumulative Effects 20
Reconciling Watershed and Political Boundaries 21
Summary and Learning Points 24
References 24
Webliography 26

2 Hydrologic Cycle and the Water Budget 27
Introduction 27
Properties of Water 27
The Hydrologic Cycle 30
Energy and the Hydrologic Cycle 38
Water Flow in Soil 43
Water Flow on Land and in Stream Channels 47
Summary and Learning Points 47
References 48

3 Precipitation 49
Introduction 49
Precipitation Process 50
Rainfall 53
Snowfall 63
Summary and Learning Points 78
4 Evaporation, Interception, and Transpiration 81
   Introduction 81
   The Evaporation Process 82
   Evaporation from Water Bodies 83
   Evaporation from Soil Surfaces 85
   Interception 85
   Transpiration 92
   Potential Evapotranspiration 103
   Estimating Actual Evapotranspiration 105
   Summary and Learning Points 109
   References 110

5 Infiltration, Pathways of Water Flow, and Recharge 113
   Introduction 113
   Infiltration 113
   Pathways of Water Flow 125
   Summary and Learning Points 138
   References 138

6 Streamflow Measurement and Analysis 141
   Introduction 141
   Measurement of Streamflow 141
   Methods for Estimating Streamflow Characteristics 148
   Summary and Learning Points 170
   References 171
   Webliography 172

7 Groundwater and Groundwater–Surface Water Exchange 173
   Introduction 173
   Groundwater 174
   Groundwater–Surface Water Exchanges 187
   Summary and Learning Points 193
   References 194
   Webliography 195
2 Physical, Chemical, and Biological Linkages of Water Flow  197

8  Soil Erosion Processes and Control  199
Introduction  199
Surface Soil Erosion  199
Erosion from Gullies and Ravines  221
Soil Mass Movement  230
Summary and Learning Points  237
References  238
Webliography  241

9  Sediment Supply, Transport, and Yield  243
Introduction  243
Sediment Supply and Transport  244
Measurement of Sediment  255
Sediment Yield  258
Cumulative Watershed Effects on Sediment Yield  260
Summary and Learning Points  263
References  264

10  Fluvial Processes and Implications for Stream Management  267
Introduction  267
Fluvial Geomorphology  268
Valley and Stream Evaluation and Classification  272
Stream Classification  285
Summary and Learning Points  293
References  293
Webliography  295

11  Water-Quality Characteristics  297
Introduction  297
Chemistry of Precipitation  298
Physical Characteristics of Surface Water  300
Dissolved Chemical Constituents  311
Biological Characteristics  319
Groundwater Quality  323
3 Integrated Watershed Management 329

12 Managing Wildland Watersheds 333
   Introduction 333
   Forests 333
   Woodlands 364
   Rangelands 367
   Upland-Downstream Considerations 371
   Cumulative Watershed Effects 377
   Summary and Learning Points 379
   References 380
   Webliography 387

13 Managing Riparian Communities and Wetlands 389
   Introduction 389
   Riparian Communities 389
   Wetlands 401
   Cumulative Effects 422
   Summary and Learning Points 422
   References 423

14 Watershed Management Issues 427
   Introduction 427
   Fragmentation of Watershed Landscapes 427
   Water Harvesting 439
   Best Management Practices 442
   Regulatory Compliance 446
   Climatic Variability 451
   Insufficient Information for Decision Making 455
   Summary and Learning Points 456
   References 458
   Webliography 461
Contents

15 Socioeconomic Considerations in Integrated Watershed Management 463
   Introduction 463
   Policies and Policy Processes 464
   Planning and Implementation 470
   Economic Appraisals 475
   Summary and Learning Points 486
   References 487

16 Tools and Emerging Technologies 489
   Introduction 489
   Generalized Hydrologic Simulation Models 490
   Technologically Advanced Tools 495
   Using the Stable Isotopes of Hydrogen and Oxygen 500
   Summary and Learning Points 507
   References 508
   Webliography 511

Appendix: Units Commonly Used in Hydrologic Work, USA 513

Index 517

Color plates appear between pages 512 and 513