Contents

Foreword: A Wider View of Wetlands xv
Preface: Toward a Watershed Perspective xvii
Editor xxi
Editorial Advisory Board xxiii
Contributors xxv

PART I Geospatial Technologies for Wetland Mapping

Chapter 1 Application and Assessment of a GIScience Model for Jurisdictional Wetlands Identification in Northwestern Ohio 3

Nathan Torbick, Patrick Lawrence, and Kevin Czajkowski

1.1 Introduction 3
1.2 Study Area 4
1.3 Methods 5
1.3.1 Geospatial Data 5
1.4 Wetlands Fieldwork and Regulations 6
1.4.1 Classification 7
1.4.2 Assessment 8
1.5 Results 8
1.6 Discussion 9
1.7 Conclusion 10
Acknowledgments 10
References 10

Chapter 2 An Expert System–Based Image Classification for Identifying Wetland-Related Land Cover Types 13

Xiaobin Cai and Xiaoling Chen

2.1 Introduction 13
2.2 Study Area and Data 13
2.3 Methodology and Results 14
2.3.1 Water Body Identification and Supervised Classification 15
2.3.2 Expert Knowledge 15
2.3.3 Object Neighborhood Search and DEM Analysis 16
2.3.4 Construction of the Expert System 17
2.4 Conclusion 17
Acknowledgments 18
References 18

Chapter 3 Mapping Salt Marsh Vegetation Using Hyperspectral Imagery 21

Jiansheng Yang, Francisco J. Artigas, and Yeqiao Wang

3.1 Introduction 21
3.2 Study Area and Data 22
3.3 Methods 23
3.4 Results and Discussion 24
3.5 Conclusion 27
References 27

Chapter 4 *Carex* Mapping in the Poyang Lake Wetland Based on Spectral Library and Spectral Angle Mapping Technology 29

Shuisen Chen, Liangfu Chen, Xiaobo Su, Qinhuo Liu, and Jian Li

4.1 Introduction 29
4.2 Data and Methods 30
4.2.1 Data 30
4.2.2 Flooding Area Extraction 30
4.2.3 Spectral Angle Mapping (SAM) 32
4.3 Results and Discussion 33
4.4 Conclusion 36
Acknowledgments 37
References 39

PART II Wetland Hydrology and Water Budget

Chapter 5 Change in the Southern U.S. Water Demand and Supply over the Next Forty Years 43

Steven G. McNulty, Ge Sun, Erika C. Cohen, and Jennifer A. Moore Myers

5.1 Introduction 43
5.2 Methods 44
5.2.1 Calculations for Estimating Water Supply 44
5.2.2 Groundwater Supply Data 44
5.2.3 Historic and Projected Climate Data 45
5.2.4 Historic Land Cover and Land Use Data 46
5.2.5 Historic and Projected Population Data 47
5.2.6 Calculations for Estimating Water Demand 47
5.2.7 Calculations for Estimating the Water Supply Stress Index (WASSI) 48
5.2.8 Water Supply Stress Scenarios 49
5.2.8.1 Scenario 1: Small Population Increase—Wet Year (2020) 49

5.2.8.2 Scenario 2: Small Population Increase—Dry Year (2024) 49
5.2.8.3 Scenario 3: Large Population Increase—Wet Year (2045) 49
5.2.8.4 Scenario 4: Large Population Increase—Dry Year (2043) 49
5.2.8.5 Scenario 5: Large Population Increase—Wet Year (2045), No Groundwater Supply (GS) 50
5.2.8.6 Scenario 6: Large Population Increase—Dry Year (2043), No Groundwater Supply (GS) 50
5.3 Results and Discussion 50
5.3.1 Climate Controls on the WASSI 50
5.3.2 Population and Other Water Use Sector Controls on the WASSI 51
5.3.3 Ground Water Supply Controls on the WASSI 53
5.4 Summary 54
Acknowledgments 56
References 56

Chapter 6 Study on the Intra-Annual Distribution Characteristics of the Water Budget in the Hilly Region of Red Soil in Northeast Jiangxi Province, China 59

Junfeng Dai, Jiazhou Chen, Yuanlai Cui, and Yuanqiu He

6.1 Introduction 59
6.2 Brief Description of Model 60
6.3 Site Selection and Model Calibration 60
6.3.1 Application Site 60
6.3.2 Data Preparation 61
6.3.3 Model Calibration and Validation 62
6.4 Results and Discussion 63
6.4.1 Precipitation 63
6.4.2 Surface Runoff 64
6.4.3 Evapotranspiration 64
6.4.4 Percolation from the Bottom of the Root Zone 66
6.4.5 Water Surplus-Deficit Status 67
6.5 Conclusions 67
Acknowledgments 68
References 68

Chapter 7 Forest and Water Relations: Hydrologic Implications of Forestation Campaigns in China 71

Ge Sun, Guoyi Zhou, Zhiqiang Zhang, Xiaohua Wei, Steven G. McNulty, and James Vose

7.1 Introduction 71

7.2 Forests and Watershed Hydrology: Experimental Evidence around the World 72
7.2.1 North America 73
7.2.2 Europe 75
7.2.3 South Africa and the Tropics 76
7.2.4 Australia 77
7.3 Debate on Forest–Water Relations in China 77
7.4 Implications of Forest–Water Relations to Forestation Campaigns in China 80
7.5 Forest Hydrology Research Needs in China 83
Acknowledgments 84
References 85

Chapter 8 Application of TOPMODEL for Streamflow Simulation and Baseflow Separation 89

Pei Wen, Xi Chen, and Yongqin Chen

8.1 Introduction 89
8.2 Modified TOPMODEL 90
8.2.1 Subsurface Flow 91
8.2.2 Surface Flow 92
8.2.3 Channel Routing 93
8.3 Application 93
8.3.1 Study Site 93
8.3.2 Model Calibration and Validation 94
8.4 Conclusions 95
Acknowledgments 96
References 98

Chapter 9 Spatially Distributed Watershed Model of Water and Materials Runoff 99

Thomas E. Croley II and Chansheng He

9.1 Introduction 99
9.2 Agricultural Runoff Models 100
9.3 Distributed Large Basin Runoff Model 101
9.3.1 Application 104
9.3.2 Testing 106
9.4 Materials Runoff Model 107
9.4.1 Initial and Boundary Conditions 108
9.5 Example Simulation 109
9.6 Summary 109
Acknowledgments 111
References 111

PART III Water Quality and Biogeochemical Processes

Chapter 10 Estimating Nonpoint Source Pollution Loadings in the Great Lakes Watersheds 115

Chansheng He and Thomas E. Croley II

10.1 Introduction 115
10.2 Study Area 116
10.3 Estimating Soil Erosion Potential 116
10.3.1 Water Erosion Potential 117
10.3.2 Wind Erosion Potential 118
10.4 Estimating Animal Manure Loading Potential 121
10.5 Agricultural Chemical Loading Potential 123
10.6 Critical Nonpoint Source Pollution Areas 124
10.7 Summary 124
Acknowledgments 125
References 125

Chapter 11 Simulating Historical Variations of Nitrogenous and Phosphorous Nutrients in Honghu Lake Basin, China 129

Feng Gui, Ge Yu, and Geying Lai

11.1 Introduction 129
11.2 Study Area 129
11.3 Introduction of the SWAT Model 130
11.4 Boundary Conditions and Simulation Design 131
11.4.1 Boundary Conditions and Model Data Preparation 131
11.4.2 Simulation Procedure and Design 132
11.5 Results and Discussion 133
11.5.1 Simulation Output Analysis 133
11.5.1.1 Variability and Characteristics of Input Flow Flux 133
11.5.1.2 Nutrient Changes in a Year 134
11.5.1.3 Variations of Nutrient Concentration over Time 135
11.5.1.4 Annual TP and TN Production 135
11.5.2 Validations of Simulation Outputs 135
11.6 Conclusions 139
Acknowledgments 139
References 139

Chapter 12 Predictive Modeling of Lake Nitrogen, Phosphorus, and Sediment Concentrations Based on Land Use/Land Cover Type and Pattern 141

Pariwate Varnakovida, Narumon Wiangwang, Joseph P. Messina, and Jiaguo Qi

12.1 Introduction 141
12.2 Methods 143
12.2.1 Land Use/Land Cover (LULC) Data 143
12.2.2 Digital Elevation Model (DEM) 143
12.2.3 Lake Sampling Method 143
12.2.4 Lakeshed Generation 144
12.2.5 Landscape Pattern Metrics 144
12.2.6 Relationships among Landscape Metrics and Water Quality Parameters 145
12.2.7 Simulation Model 145
12.2.8 Model Verification and Validation 145
12.2.9 Sensitivity Analysis 145
12.3 Results 146
12.4 Conclusion and Discussion 147
References 149

PART IV Wetland Biology and Ecology

Chapter 13 Soil Erosion Assessment Using Universal Soil Loss Equation (USLE) and Spatial Technologies—A Case Study at Xiushui Watershed, China 153

Hui Li, Xiaoling Chen, Liqiao Tian, and Zhongyi Wu

13.1 Introduction 153
13.2 Study Area 154
13.3 Methods 155
13.3.1 Governing Equation 155
13.3.2 Determining the USLE Factor Values 155
13.3.2.1 Rainfall Erosivity (R) Factor 155
13.3.2.2 Soil Erodibility (K) Factor 156
13.3.2.3 Topographic Factor (LS) 156
13.3.2.4 Crop and Management Factor (C) 157
13.3.2.5 Erosion Control Practice Factor (P) 157
13.4 Results and Discussion 158
13.4.1 Factors in USLE 158
13.4.2 Erosion Intensity 161
13.5 Conclusions 162
Acknowledgments 163
References 163

Chapter 14 Evaluation of Rapid Assessment Techniques for Establishing Wetland Condition on a Watershed Scale 165

Vanessa L. Lougheed, Christian A. Parker, and R. Jan Stevenson

14.1 Introduction 165
14.2 Methods 166
14.3 Results 170
14.4 Discussion 174
Acknowledgments 176
References 176

Chapter 15 Development of Geospatial Ecological Indicators in Jiangxi Province, China 179

Peng Guo and Xiaoling Chen

15.1 Introduction 179
15.2 Materials and Methods 180
15.2.1 Building an Evaluation Indicator System 180
15.2.2 Extraction of Water Bodies and NDVI 180
15.2.3 Statistical Methods 180
15.2.4 Principal Component Analysis 180
15.2.5 Quality Index of Ecological Environmental Background 181
15.3 Results and Discussion 181
15.4 Conclusions 185
Acknowledgments 185
References 186

Chapter 16 A Conceptual Framework for Integrating a Simulation Model of Plant Biomass for *Vallisneria spiralis* L. with Remote Sensing and a Geographical Information System 187

Guofeng Wu, Jan de Leeuw, Elly P. H. Best, Jeb Barzen, Valentijn Venus, James Burnham, Yaolin Liu, and Weitao Ji

16.1 Introduction 187
16.2 Ecology and Production of *Vallisneria* 190
16.3 SAV Simulation Models 190
16.4 Conceptual Framework Integrating the SAV Simulation Model with RS and GIS 191
16.5 Environmental Variables and Their Measurements in Poyang Lake 192
16.6 Questions to Be Addressed 196
Acknowledgments 197
References 197

Chapter 17 Soundscape Characteristics of an Environment: A New Ecological Indicator of Ecosystem Health 201

Jiaguo Qi, Stuart H. Gage, Wooyeong Joo, Brian Napoletano, and S. Biswas

17.1 Introduction 201
17.2 Acoustic Signal Classification 202
17.3 Soundscape Analysis 203
17.3.1 Ecological Soundscapes 203
17.3.2 Development of Soundscape Indicators 203
17.4 A Sample Application 205
17.5 Discussion and Conclusions 206
Acknowledgments 210
References 210

PART V Watershed Assessment and Management

Chapter 18 Geospatial Decision Models for Assessing the Vulnerability of Wetlands to Potential Human Impacts 215

Wei "Wayne" Ji and Jia Ma

18.1 Introduction 215
18.2 Geospatial Decision Models 216
18.2.1 Determination of Indicators and Metrics 217
18.2.2 Determination of Decision Criteria 220
18.2.3 Calculation of Wetland Vulnerability Index 221
18.3 Decision Support GIS for Model Implementation 222
18.3.1 Geospatial Data Management Function 222
18.3.2 Analytical Query Function 223
18.3.3 Vulnerability Assessment Modeling Function 225
18.3.4 Assessment Result Output Function 225
18.4 Model Application 225
18.4.1 Study Area and Geospatial Data 225
18.4.2 Results and Validation 227
18.5 Conclusions and Discussions 228
References 229

Chapter 19 Watershed Science: Essential, Complex, Multidisciplinary, and Collaborative 231

R. Jan Stevenson, Michael J. Wiley, Stuart H. Gage, Vanessa L. Lougheed, Catherine M. Riseng, Pearl Bonnell, Thomas M. Burton, R. Anton Hough, David W. Hyndman, John K. Koches, David T. Long, Bryan C. Pijanowski, Jiaquo Qi, Alan D. Steinman, and Donald G. Uzarski

19.1 Watershed Science: Essential 231
19.2 Watershed Science: Complex 233
19.2.1 Assessment Design 233
19.2.2 Assessment Characterization 237
19.2.3 Assessment Diagnosis 238
19.2.4 Assessment Forecasting 240
19.2.5 Managing Complexity 240
19.3 Watershed Science: Multidisciplinary and Collaborative 240
Acknowledgments 242
References 242
Appendix: Muskegon Partnership Data Sharing Agreement 244

Chapter 20 Integrated Modeling of the Muskegon River: Tools for Ecological Risk Assessment in a Great Lakes Watershed 247

Michael J. Wiley, Bryan C. Pijanowski, R. Jan Stevenson, Paul Seelbach, Paul Richards, Catherine M. Riseng, David W. Hyndman, and John K. Koches

20.1 Introduction 247
20.1.1 Methodology 248
20.1.2 MREMS Component Models 250
20.1.3 The MRI-VSEC Framework 251
20.2 Preliminary Results for a Rapid Development Scenario 253
20.2.1 Discussion 256
20.2.2 Future Plans and Benchmarks 256
Acknowledgments 257
References 257

Chapter 21 Watershed Management Practices for Nonpoint Source Pollution Control 259

Shaw L. Yu, Xiaoyue Zhen, and Richard L. Stanford

21.1 Introduction 259
21.1.2 Effects of Urbanization on the Water Environment 259
21.1.2.1 Hydrology 260
21.1.2.2 Water Quality and Ecological Impacts 261
21.2 Watershed Management Strategy and Practices 262
21.2.1 The TMDL Control Strategy 262
21.2.2 Best Management Practice (BMP) Technology 263
21.3 Practices for Eco-Friendly Urban Development and Highway Construction 263
21.3.1 Low-Impact Development (LID) Techniques 263
21.3.2 Bioretention 264
21.3.3 Grassed Swales 265
21.3.4 Ecological Detention Systems 266

21.4 The Big Challenge Ahead 267
21.4.1 Implementation Issues in China 268
21.4.1.1 Regulatory Framework 268
21.4.1.2 Cost and Maintenance 268
21.4.1.3 Technical Issues 269
21.4.1.4 Other Issues 269
21.5 Conclusions and Recommendations 269
References 270

Index 273