Contents

List of figures and tables *vii*
Preface *xv*
Companion website and GIS software *xvii*

1 GIS overview **1**

1.1 Introduction to GIS 1
1.2 GIS for environmental applications in a historical perspective 11
1.3 Roles of GIS in environmental research, management and planning 17
1.4 A general framework for environmental problem solving with GIS 19
1.5 GIS software 24
1.6 A tour of ArcGIS for Desktop 28
1.7 Summary 34

2 Spatial data and data management **37**

2.1 The nature of spatial data 37
2.2 Georeferencing systems 43
2.3 Spatial data models 59
2.4 Spatial database management 77
2.5 Summary 84

3 Spatial data input and manipulation **87**

3.1 Spatial data capture 87
3.2 Spatial data transfer 101
3.3 Spatial data transformation 103
3.4 Spatial data editing 116
3.5 Spatial data quality 127
3.6 Summary 133

4 Spatial analysis **137**

4.1 Scope of spatial analysis and modelling 137
4.2 Spatial query and reclassification 138
4.3 Geometric and distance measurement 147
4.4 Overlay analysis and map algebra 160
4.5 Spatial interpolation 173
4.6 Summary 187

5 Spatial data exploration with statistics 189

5.1 Exploratory spatial data analysis 189
5.2 Spatial sampling 190
5.3 Measures of spatial distributions 194
5.4 Analysis of spatial patterns 202
5.5 Detection of spatial clusters 211
5.6 Modelling of spatial relationships 217
5.7 Summary 228

6 Remote sensing data analysis 231

6.1 Nature of remote sensing data 231
6.2 Image preprocessing 245
6.3 Image enhancement 250
6.4 Image transformation 261
6.5 Image classification 267
6.6 Summary 277

7 Terrain analysis 279

7.1 Digital terrain analysis and terrain models 279
7.2 Hydrologically correct DEMs 281
7.3 Digital terrain data sources 283
7.4 Terrain attributes 286
7.5 Visibility analysis 306
7.6 Solar radiation mapping 311
7.7 Summary 319

8 Spatial visualisation 323

8.1 Cartographic representations 323
8.2 Map design 334
8.3 Multivariate mapping 345
8.4 3D mapping 357
8.5 Animated mapping 362
8.6 Summary 374

9 Spatial decision analysis and modelling 377

9.1 Multi-criteria decision analysis 377
9.2 Cellular automata 388
9.3 Agent-based modelling 393
9.4 Weights-of-evidence 405
9.5 Artificial neural networks 413
9.6 Summary 421

10 Environmental applications of GIS 423

10.1 Hydrological modelling 423
10.2 Land use analysis and modelling 427
10.3 Atmospheric modelling 436
10.4 Ecological modelling 441
10.5 Landscape valuation 450
10.6 Summary 458

Index 461