

CONTENTS

Contributors, xiii

I SIX INTRODUCTORY PERSPECTIVES

1. Environmental Research: What We Must Do, *John A. Eddy* 3
2. The State of GIS for Environmental Problem-Solving, *Michael F. Goodchild* 8
3. A Perspective on the State of Environmental Simulation Modeling, *Louis T. Steyaert* 16
4. The Need for Integration, *Bradley O. Parks* 31
5. GIS and Environmental Modeling, *Kurt Fedra* 35
6. The Role of Software Vendors in Integrating GIS and Environmental Modeling, *Jack Dangermond* 51

II GIS FOR MODELERS, *Michael F. Goodchild* 57

7. Cartographic Modeling: The Analytical Capabilities of GIS, *Joseph K. Berry* 58
8. Understanding the Scope of GIS: Its Relationship to Environmental Modeling, *Timothy L. Nyerges* 75
9. Data Models and Data Quality: Problems and Prospects, *Michael F. Goodchild* 94

III ENVIRONMENTAL SIMULATION MODELING, *Louis T. Steyaert* 105

Atmospheric Modeling

10. Atmospheric Modeling and Its Spatial Representation of Land Surface Characteristics, *T. J. Lee, R. A. Pielke, T. G. F. Kittel, and J. F. Weaver* 108
11. An Approach to Bridge the Gap Between Microscale Land-Surface Processes and Synoptic-Scale Meteorological Conditions Using Atmospheric Models and GIS: Potential for Applications in Agriculture, *Roni Avissar* 123
12. Land Surface Data: Global Climate Modeling Requirements, *W. C. Skelly, A. Henderson-Sellers and A. J. Pitman* 135

13. Regional Air Quality and Acid Deposition Modeling and the Role for Visualization, *Joan H. Novak and Robin L. Dennis* 142

Hydrological Modeling

14. GIS and Hydrological Modeling, *David R. Maidment* 147
15. Integrated Use of a GIS and Three-Dimensional, Finite-Element Model: San Gabriel Basin Groundwater Flow Analyses, *Jonathan Harris, Sumant Gupta, Greg Woodside, and Neil Ziemba* 168
16. Modeling the Effects of Climate Change on the Water Resources in the Gunnison River Basin, Colorado, *Lauren E. Hay, William A. Battaglin, Randolph S. Parker, and George H. Leavesley* 173
17. Linkage of a GIS to a Distributed Rainfall-Runoff Model, *Xiaogang Gao, Soroosh Sorooshian, and David C. Goodrich* 182
18. Graphical Innovations in Surface Water Flow Analysis, *D. R. Richards, N. L. Jones, and H. C. Lin* 188

Land-Surface-Subsurface Process Modeling

19. GIS and Land-Surface-Subsurface Modeling, *Ian D. Moore, A. Keith Turner, John P. Wilson, Susan K. Jenson, and Lawrence E. Band* 196
20. A Spatial Decision Support System for Modeling and Managing Agricultural Non-Point-Source Pollution, *Bernard A. Engel, Raghavan Srinivasan, and Chris Rewerts* 231
21. Use of 3D Geographic Information Systems in Hazardous Waste Site Investigations, *Thomas R. Fisher* 238

Biological/Ecological Systems Modeling

22. Spatial Models of Ecological Systems and Processes: The Role of GIS, *Carolyn T. Hunsaker, Robert A. Nisbet, David C. L. Lam, Joan A. Browder, William L. Baker, Monica G. Turner, and Daniel B. Botkin* 248
23. Integrating a Forest Growth Model with a Geographic Information System, *Robert A. Nisbet and Daniel B. Botkin* 265
24. Combining Ecological Modeling, GIS and Expert Systems: A Case Study of Regional Fish Species Richness Model, *David C. L. Lam* 270
25. Introduction to Quantitative Methods and Modeling in Community, Population, and Landscape Ecology, *Carol A. Johnston* 276

Integrated Modeling

26. Spatial Interactive Models of Atmosphere-Ecosystem Coupling, *David S. Schimel and Ingrid C. Burke* 284
27. A Brief Review of the Simple Biosphere Model, *Yongkang Xue and Piers J. Sellers* 290

28. Regional Hydroecological Simulation System: An Illustration of the Integration of Ecosystem Models in a GIS, *Ramakrishna Nemani, Steven W. Running, Lawrence E. Band, and David L. Peterson* 296
29. Simulation of Rangeland Production: Future Applications in Systems Ecology, *Jon D. Hanson and Barry B. Baker* 305

IV FROM MODELING TO POLICY, *Michael F. Goodchild* 315

Risk and Hazard Modeling, *Mason J. Hewitt III* 317

30. GIS and Risk: A Three-Culture Problem, *David Rejeski* 318
31. Spatial Analysis in GIS for Natural Hazard Assessment, *G. Wadge, A. P. Wislocki, and E. J. Pearson* 332
32. The Use of GIS in Assessing Exposure and Remedial Alternatives at Superfund Sites, *Margrit von Braun* 339
33. U.S. EPA Region 6 Comparative Risk Project: Evaluating Ecological Risk, *David A. Parrish, Laura Townsend, Jerry Saunders, Gerald Carney, and Carol Langston* 348

Role of Modeling in Policy

34. Models, Facts and the Policy Process: The Political Ecology of Estimated Truth, *John Leslie King and Kenneth L. Kraemer* 353

V SPATIAL DATA, *Louis T. Steyaert* 361

35. Spatial Databases: Sources and Issues, *Karen K. Kemp* 363
36. What is a Scientific Database? Design Considerations for Global Characterization in the NOAA-EPA Global Ecosystems Database Project, *John J. Kineman* 372
37. Experimental AVHRR Land Data Sets for Environmental Monitoring and Modeling, *Thomas R. Loveland and Donald O. Ohlen* 379
38. Digital Soils Databases for the United States, *Dennis J. Lyle* 386
39. Development of a Continent-Wide DEM with Applications to Terrain and Climate Analysis, *Michael Hutchinson* 392

VI SPATIAL STATISTICS, *Donald E. Myers* 401

40. Spatial Statistical Analysis of Environmental and Ecological Data, *Noel Cressie and Jay M. Ver Hoef* 404
41. Geostatistics: A Tool for Environmental Modelers, *Noel Cressie* 414
42. Explanatory Models for Ecological Response Surfaces, *Henriette I. Jager and W. Scott Overton* 422

- 43. Spatial Simulation: Environmental Applications, *Evan J. Englund* 432
- 44. GRASS Used in the Geostatistical Analysis of Lakewater Data from the Eastern Lake Survey, Phase I, *Hannah Rasmussen Rhodes and Donald E. Myers* 438
- 45. Universal Kriging for Ecological Data, *Jay M. Ver Hoef* 447
- 46. Discrete Space Autoregressive Models, *Luc Anselin* 454
- 47. Probability Sampling and Population Inference in Monitoring Programs, *W. Scott Overton* 470

- Epilog, *Michael P. Crane and Michael F. Goodchild* 481

- Index, 485