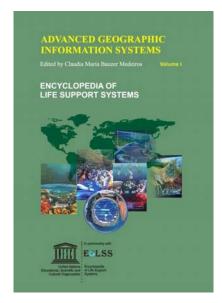
# **CONTENTS**

# ADVANCED GEOGRAPHIC INFORMATION SYSTEMS



Advanced Geographic Information Systems - Volume 1

No. of Pages: 410

**ISBN:** 978-1-905839-91-9 (eBook)

**ISBN**: 978-1-84826-991-0 (Print Volume)

**Advanced Geographic Information Systems - Volume 2** 

No. of Pages: 308

**ISBN:** 978-1-905839-92-6 (eBook)

**ISBN**: 978-1-84826-992-7 (Print Volume)

For more information of e-book and Print

Volume(s) order, please click here

Or contact: eolssunesco@gmail.com

# **CONTENTS**

# **VOLUME I**

Advanced	Geographic Infor	mation Systems				
Claudia M.	Bauzer Medeiros,	Institute of Computing	g, University of C	Campinas, <b>(</b>	Campinas, I	Brazil

- 1. Introduction: the Information Society and Geographic Information Systems
- 2. Geographic Data: What Are They, and How To Integrate Them?
  - 2.1. Defining, Modeling, and Storing Geographic Data
  - 2.2. Gathering and Integrating Geographic Data
- 3. Technology: What Lies Around a GIS?
  - 3.1. Computer Technology
    - 3.2. Data Capture Issues
- 4. Software: What Is a Geographic Information System?
  - 4.1. Names and Meanings of GIS
  - 4.2. GIS architectures
- 5. People and Geographic Systems: Who and Where is the User?
- 6. Geographic Applications: Everything, Everywhere, Everywhen
  - 6.1. Characterization: Application = User Requirements + Data
  - 6.2. A Historical Perspective of Geographic Applications and the Mapping of the World
  - 6.3. Examples of Applications
    - 6.3.1. AM/FM: Mapping our Utility Infrastructure
    - 6.3.2. Land Information Systems: Mapping Our Homes
    - 6.3.3. Transportation Systems: Mapping Where To Go and How To Get There
    - 6.3.4. Agriculture Systems: Mapping How, Where, and When to Grow Food
    - 6.3.5. Demography and Health Systems: Mapping and Managing Sanitation
    - 6.3.6. Environmental and Biodiversity Systems: Mapping How To Preserve Nature
    - 6.3.7. Global Systems: Mapping of the World Revisited
    - 6.3.8. And So On: Mapping Everything
  - 6.4. Education and Geographic Systems: Learning Through Geography
- 7. Future Developments: What Might Lie Ahead?
  - 7.1. A Framework for Envisaging the Future
  - 7.2. Some Open Questions
    - 7.2.1. Geographic Data
    - 7.2.2. Technology Trends
    - 7.2.3. People and Virtual Communities
    - 7.2.4. Geographic Applications: Government, Finance, Leisure, and Education
  - 7.3. From Machine-Aware to User-Aware Software

#### **Spatio-Temporal Information Systems**

51

1

Claudia M. Bauzer Medeiros, Institute of Computing, University of Campinas, Campinas, Brazil

- 1. Introduction
- 2. Historical Background
- 3. Basic Framework
  - 3.1. Characterizing a DBMS
  - 3.2. Temporal DBMS
  - 3.3. Geo-Spatial DBMS
- 4. Characterizing Spatio-Temporal Data in a Database
- 5. Interface Issues
- 6. Query Processing
  - 6.1. Query Components
    - 6.1.1. Query Results
    - 6.1.2. Query Predicates
    - 6.1.3. Query Data Sources

- 6.2. Query Optimization Issues
- 7. Transaction Management
- 8. I/O Processing and Indexing
- 9. Building the Information System on Top of the Spatio-Temporal DBMS
- 10. Conclusions and Future Perspectives

#### **Conceptual Modeling of Geographic Applications**

87

Silvia Gordillo, University of la Plata, Argentina

Robert Laurini, Claude Bernard University of Lyon - INSA, France

- 1. Introduction
- 2. Modeling GIS Applications: The Nature of Spatial Information
- 3. Conceptual Modeling Approaches
  - 3.1. Conceptual Modeling: The Entity-Relationship Approach
  - 3.2. Models Based on Entity-Relationship Extensions
  - 3.3. Models Based on Object-Oriented Analysis
  - 3.4. Enhancing Modeling via Pictograms
  - 3.5. Modeling Using Database Environments
- 4. An Abstract Object-Oriented Architecture to Construct GIS Applications
  - 4.1. Representing Discrete Objects
  - 4.2. Representing Continuous Phenomena
  - 4.3. General Principles Presented by the Architecture
- 5. Conclusions

#### **Spatial Query Languages**

112

Agne's Voisard, Computer Science Institute, FreieUniversität Berlin, Germany

- 1. Introduction
- 2. Interacting with a Spatial Database System
  - 2.1. Reference Schema
  - 2.2. Reference Queries
    - 2.2.1. Basic Query Constructs
    - 2.2.2. Queries Without a Spatial Criterion
    - 2.2.3. Queries With a Spatial Criterion
  - 2.3. Functionality of a Query Language
- 3. Text-Based Query Languages
  - 3.1. Extended Relational Systems
  - 3.2. Object-Oriented Systems
  - 3.3. Other Approaches
- 4. Visual Query Languages
- 5. Menu-Based Interaction
- 6. Conclusions

# Geographical Information Applications Over the Net

132

Fiona Lee, National University of Singapore, Singapore Cui Yu, Monmouth University, USA

Beng Chin Ooi, National University of Singapore, Singapore

- 1. Introduction
- 2. Web Enabling GIS Processing
  - 2.1. Connecting GIS to the Web
  - 2.2. Progressive Query Processing
- 3. System Architecture
  - 3.1. Server-Side Applications
  - 3.2. Client-Side Applications

- 4. GIS Applications
  - 4.1. Convergence of Technologies
  - 4.2. Wireless and Internet GIS Applications
- 5. Global Searching
- 6. Conclusions

#### **Precision Farming and Geographic Systems**

151

Jansle Vieira Rocha, State University of Campinas (UNICAMP), Brazil

- 1. Introduction
- 2. Positioning Systems
- 3. Mapping Within-Field Spatial Variability of Soil and Plant Properties
  - 3.1. Yield Mapping
  - 3.2. Soil Mapping
- 4. Remote Sensing
  - 4.1. Principles and Sensors
  - 4.2. Vegetation Indices
  - 4.3. Image Processing
- 5. Future Tendencies

# **Biodiversity Information Management**

169

Régine Vignes-Lebbe, Université Pierre et Marie Curie, France

- 1. Naming Living Things
- 2. Systematics
- 3. Computer Science and Systematics
- 4. Who Needs to Access Biodiversity Information?
- 5. To Identify: the First Step to Knowing
- 6. Database Management Systems
- 7. The Nature of the Taxonomic Information
  - 7.1. Imprecision or Uncertainty in the Data
  - 7.2. Case of Geographical Data
  - 7.3. The Evolution of Data
  - 7.4. Data Correlation
- 8. Perspectives

# Issues in Spatio-Temporal Database Systems: Data Models, Languages and Moving Objects 182

Jose' Moreira, Universidade de Aveiro, Portugal

Cristina Ribeiro, Faculdade de Engenharia da Universidade do Porto, Portugal

Jean-Marc Saglio, Ecole Nationale Superieure de Telecommunications, France

Michel Scholl, Cedric, Conservatoire National des Arts et Métiers de Paris & INRIA, Rocquencourt, France

- 1. Introduction
- 2. Characterization of Spatio-Temporal Systems
  - 2.1. Properties of Spatio-Temporal Objects
  - 2.2. Examples of Spatio-Temporal Systems
- 3. Data Models and Languages for Spatio-temporal Systems
  - 3.1. Discontinuous Change
  - 3.2. Continuous Changes
    - 3.2.1. Abstract Data Types Approach
    - 3.2.2. Constraint Database Approach
    - 3.2.3. Other Approaches
- 4. Representation of Moving Objects in Databases
  - 4.1. Characterization of Moving Points

- 4.2. Monitoring Systems
- 4.3. Real-Time Systems
- 4.4. Network constrained moving objects
- 4.5. Beyond Moving Points
- 5. Conclusion

#### **Interacting with GIS- From Paper Cartography to Virtual Environments**

205

Tiziana Catarci, Fabrizio d'Amore, *Dipartimento di Informatica e Sistemistica, Università di Roma "La Sapienza," Italy* 

Paul Janecek, Stefano Spaccapietra, Ecole Polytechnique Fédérale de Lausanne-EPFL, Lausanne, Switzerland

- 1. Introduction
- Cognitive Science Aspects of GIS
  - 2.1. Perceptual Aspects of Maps
  - 2.2. Semiotic Aspects of Maps
  - 2.3. Navigation using Maps
  - 2.4. Cognitive Maps: Internal Representations of Space
    - 2.4.1. Cognitive Spatial Development in Children
    - 2.4.2. Cognitive Spatial Development in Adults
    - 2.4.3. Accuracy of Spatial Knowledge from Maps
    - 2.4.4. The Influence of the Environment
  - 2.5. Design Issues for Navigational Maps
- 3. Multimedia and Hypermedia Systems
  - 3.1. Components of Hypermedia
    - 3.1.1. Common Features of Nodes and Links
    - 3.1.2. Nodes
    - 3.1.3. Links
  - 3.2. Problems with Hypermedia
  - 3.3. Functionalities of Hypermedia
    - 3.3.1. Views
    - 3.3.2. Navigation
    - 3.3.3. Annotation
  - 3.4. Design Issues for Hypermaps
- 4. Virtual Reality and 3D GIS
  - 4.1. High-level Interaction
  - 4.2. 3D GIS
  - 4.3. 3D Visualization
  - 4.4. The KarmaVI project
- 5. Visual Querying
- 6. Animation
  - 6.1. Animation in GIS
    - 6.1.1. Temporal Animation
    - 6.1.2. Cartographic Animation
    - 6.1.3. Spatio-Temporal Animation
- 7. Conclusions

#### **Detail Filtering in Geographic Information Visualization**

244

Laura Tarantino, Department of Electrical Engineering, University of L'Aquila, Italy

- 1. Introduction
- 2. Interactive Database Applications
  - 2.1. Levels of Abstraction
  - 2.2. Conceptual Views of Spatial Data
    - 2.2.1. Describing Entities
    - 2.2.2. Representing Continuous Fields

- 3. Displaying Maps at Different Levels of Detail
- 4. Multirepresentation and Multiresolution of Tessellated Surfaces
  - 4.1. Surface Simplification
    - 4.1.1. Height Fields and Parametric Surfaces
    - 4.1.2. Manifold Surfaces
  - 4.2. True Multiresolution Models
    - 4.2.1. A General Framework
    - 4.2.2. Overview of Existing Methods
- 5. Detail Filtering in Entity-Based Models
  - 5.1. Attribute-Oriented Map Generalization
  - 5.2. Spatial-Oriented Generalization
  - 5.3. Filtering-Out Metrics: Topological Models
- 6. When Multiresolution Meets Topology
  - 6.1. Visualization Requirements
  - 6.2. A Topology-Based Interaction Model
    - 6.2.1. The Interaction Strategy
    - 6.2.2. The Interaction Model
- 7. Conclusion

#### **Human-Information Interaction: Technology and Theory**

268

Peter Pirolli, Xerox Palo Alto Research Center, USA

- 1. Introduction
- 2. Emergence of the Global Information Ecology
- 3. The Cost and the Psychological Structure of Gathering and Using Information
- 4. Intelligent Interfaces for Interaction with Information
  - 4.1. Back End: Search Engines
  - 4.2. Front End: Information Visualizations as User Interfaces
    - 4.2.1. WebBook and Web Forager: Workspaces
    - 4.2.2. Table Lens: Fisheye Views and Focus + Context Techniques
    - 4.2.3. Hyperbolic Tree Browser: Navigation through Hierarchies
- 5. Information Foraging Theory
  - 5.1. Influence of Evolutionary Theory: Adaptationism
  - 5.2. Information Scent and Foraging Models
  - 5.3. Example: The Scatter/Gather Browser
  - 5.4. Simulated Users and Web Site Evaluation
  - 5.5. Internet Ecology
- Future Directions

#### **Cartographic Generalization: Interface Issues**

289

Clodoveu Augusto Davis Jr., Centro de Desenvolvimento e Estudos, Empresa de Informática e Informação do Município de Belo Horizonte – PRODABEL, Brazil

- 1. Introduction
- 2. Representation and Presentation
  - 2.1. Multiple Representations and Multiple Presentations
  - 2.2. Representation Alternatives
- 3. Transformations
  - 3.1. Computational Geometry
  - 3.2. Automated Cartography
  - 3.3. Spatial Analysis
  - 3.4. Auxiliary Operators
  - 3.5. Summary
- 4. Transformations Involving Representations and Presentations
  - 4.1. Introduction
  - 4.2. Multiple Representations and TR Operations

4.2.1. Geo-objects to Geo-objects
4.2.2. Geo-fields to Geo-fields
4.2.3. Geo-fields to Geo-objects
4.2.4. Geo-objects to Geo-fields
4.3. Multiple Presentations and TP Operations
4.4. Application of Operators to TR or TP Operations
4.5. Discussion of an Example: Urban Mapping

4.6. Final Remarks

5.	Conclusions: Output and Artisitics Issues	
Em	eraction Issues and Decision Support in Intelligent GIS manuel Stefanakis, Harokopio University, Athens, Greece nos Sellis, National Technical University of Athens, Greece	323
1. 2.	Introduction Connecting GIS to Other Systems 2.1. Candidate Systems for the Synergy 2.2. Systems Interoperability Issues 2.3. Systems Integration Issues	
3.	Connecting GIS with Human Users 3.1. Types of Human–Computer Interface 3.2. GIS Interfaces 3.3. Decision Support Example: The Site Selection Problem	
4.	Decision Support and Intelligent GIS 4.1. The MEFISTO Prototype 4.2. The ARCHAEOTOOL Prototype 4.3. The PATHFINDER Prototype	
5.	Conclusions and Future Research	
Index		347
Ab	out EOLSS	353
	VOLUME II	
	ntial Data Management: Topic Overview  ry J. Hunter, Department of Geomatics, University of Melbourne, Australia	1
1. 2. 3. 4. 5. 6. 7.	Introduction GIS Project Planning and Implementation Spatial Data Standards Spatial Data Quality Spatial Data Legal Issues GIS and Society Conclusions	
GIS Project Planning and Implementation Rebecca M. Somers, Somers-St. Claire, Fairfax, Virginia, USA		
1. 2.	Introduction GIS Planning and Implementation Process 2.1. Planning 2.2. Requirements Analysis	

- 2.3. Design
- 2.4. Acquisition and Development
- 2.5. Operation and Maintenance
- 2.6. Management Aspects
- 3. GIS Implementation Approaches
  - 3.1. GIS Projects and Programs
  - 3.2. Characteristic Organizational Approaches
- 4. Factors in GIS Implementation
  - 4.1. Implementation Drivers
  - 4.2. Cost Effectiveness
  - 4.3. Data and Software Availability and Characteristics
- 5. Future Directions

### **Geographic Information Legal Issues**

32

Harlan J. Onsrud, Department of Spatial Information Science and Engineering, National Center for Geographic Information and Analysis, University of Maine, USA

- 1. Introduction
- 2. Copyright Law
- 3. Freedom of Information
- 4. Privacy Law
- 5. Conclusions

#### **Spatial Data Quality**

45

Gary J. Hunter and Simon Jones, *University of Melbourne, Australia*Arnold K. Bregt, *Center for Geo-Information, Wageningen University and Research Center, The Netherlands* 

Ewan G. Masters, University of New South Wales, Australia

- 1. Introduction
- 2. The Importance of Spatial Data Quality
  - 2.1. Increased Pressure to Report Data Quality
  - 2.2. Protecting Reputations
  - 2.3. Consumer Rights
  - 2.4. Scientific Advancement
- 3. The Elements of Spatial Data Quality
  - 3.1. A Classification of Error
  - 3.2. Spatial Data Quality Elements
- 4. Error Modeling, Communication, and Management
- 5. Current Issues and Future Trends
  - 5.1. Description Problems
  - 5.2. Communication Problems
  - 5.3. Application Problems
  - 5.4. Future Trends
- 6. Conclusion

# **Spatial Data Standards**

63

Henri J.G.L. Aalders, *Delft University of Technology, The Netherlands (jointly appointed to the Faculty of Engineering, Katholieke Universiteit Leuven, Belgium)*Gary J. Hunter, *University of Melbourne, Australia* 

- 1. Introduction
- 2. A Background to Standards
  - 2.1. A Brief History of Standardization
  - 2.2. The Aims and Terminology of Standardization

- 3. An Introduction to Spatial Data Standardization
  - 3.1. The Link Between Standards and Spatial Data Infrastructures
  - 3.2. The Organization of Spatial Data Standardization
  - 3.3. The Content of Spatial Data Standards
- 4. Current Spatial Data Standards
  - 4.1. Metadata Standards for Spatial Data Inventory Applications
  - 4.2. Spatial Data Transfer Standards
- 5. The Future of Spatial Data Standards
  - 5.1. The Growth in Standards
  - 5.2. Problems with National Languages
  - 5.3. The Impact of Mobile Applications
- 6. Conclusion

GIS and Society 87

William J. Craig, University of Minnesota, USA

- 1. Introduction
- 2. Origins of GIS
- 3. Application Areas
  - 3.1. Government
  - 3.2. Commerce
  - 3.3. Natural Resource Management
  - 3.4. Community Groups
  - 3.5. Individuals
- 4. Benefits and Costs
  - 4.1. Benefits
  - 4.2. Costs
- 5. Data Issues
- 6. Future

#### **Introduction to Spatial Decision Support System**

100

Piotr Jankowski, San Diego State University, San Diego, USA Timothy Nyerges, University of Washington, Seattle, USA

- 1. Introduction
- 2. Perspectives on Spatial Decision Making
  - 2.1. Functional Perspective
  - 2.2. Tool Perspective
  - 2.3. Organizational Perspective
- 3. A Typology of Spatial Decision-Making Problems
- 4. Fundamental Concepts in Spatial Decision Support
  - 4.1. Objectives of Spatial Decision Support: A Benefit Criteria Perspective
  - 4.2. The Decision-Making Process: A Macro-Micro Approach
  - 4.3. GIS as a Decision Support System
  - 4.4. Decision Analysis and Multiple Criteria Decision-Making Techniques
  - 4.5. Participatory Decision Making
- 5. Future Prospects for SDSS

#### Web-Based Spatial Decision Support: Technical Foundations and Applications

124

Claus Rinner, University of Muenster, Germany

Piotr Jankowski, University of Washington, Seattle, USA

- 1. Introduction
- 2. WebGIS Techniques
- 3. Specific Requirements for WebSDSS

- 4. Sample Applications
- 5. Conclusion and Outlook

# Integrative Data Structures For Collaborative Modeling and Visualisation in Spatial Decision Support Systems 139

Paul J. Densham, University College London, UK

Marc P. Armstrong, University of Iowa, USA

- 1. Introduction
- 2. Context
  - 2.1. A SDSS Architecture
  - 2.2. Location Selection Problems
- 3. Map Types and Map Use
- 4. Integrating Cartography and Locational Analysis in SDSS
  - 4.1. Data Structures
    - 4.1.1. Nodes and Links Files
    - 4.1.2. Distance Strings
    - 4.1.3. The Allocation Table
  - 4.2. Generating Spider Maps
- 5. Creating Summary Maps
  - 5.1. Facility Frequency Maps
  - 5.2. Allocation Consistency Maps
  - 5.3. Network Consistency Maps
- 6. Visual Interactive Locational Analysis
- 7. Conclusions

#### SDSS in the Management of Forest Resources

165

Alan T. Murray, Ohio State University, Columbus, Ohio, USA

- 1. Introduction
- GIS and SDSS
- 3. SDSS in Forest Resource Management
  - 3.1. Hierarchical Management
  - 3.2. System Development
- 4. Issues Addressed Using SDSS
- 5. Future Trends

# Spatial Decision Support for Subsidized Housing Location and Residential Mobility

178

Michael P. Johnson, Carnegie Mellon University, Pittsburgh, PA, USA

- 1. Introduction
- 2. Traditional Planning Methods for Residential Housing
  - 2.1. Introduction
  - 2.2. Market-Rate Housing
  - 2.3. Subsidized Housing
- 3. Quantitative Planning Models for Subsidized Housing Location and Residential Mobility
  - 3.1. Introduction
  - 3.2. Individual Planning
  - 3.3. Aggregate Planning
- 4. Multi-Stakeholder Decision Support for Aggregate Planning
- 5. Links Between Full-Equilibrium and Partial-Equilibrium Planning Models
- 6. Future Prospects

Rob Kol Dja 1.	S Interoperability, from Problems to Solutions  Deert Laurini, LIRIS Laboratory, INSA de Lyon, Villeurbanne, France  Scou Yetongnon, LE21-Equipe Ingénierie Informatique, Université de Bourgogne, Dijon, France  mal Benslimane, LIRIS Laboratory, Claude Bernard Lyon I University, Villeurbanne, France  Introduction 1.1. An introductory example 1.2. Definitions 1.3. Levels of interoperability 1.4. Presentation of the paper structure  Syntactic GIS Interoperability  Semantic GIS Interoperability: Nonspatial Aspect 3.1. The federation approach	195
4. 5.	3.2. The mediation approach 3.2.1. Schema mediation 3.2.2. Context mediation Semantic GIS Interoperability: Spatial Aspect Conclusions and Perspectives	
	ng Ontologies for Geographic Information Integration erico Torres Fonseca, Pennsylvania State University, USA	212
1. 2.	Introduction Ontologies and Interoperability 2.1. GIS Interoperability 2.2. Ontology and Interoperation 2.3. Ontology Levels	
3.	A Conceptual Framework for Geographic Information Integration 3.1. Abstractions of the Geographic World 3.2. The Use of Multiple Ontologies 3.2.1. Phenomenological Domain Ontology 3.2.2. Application Domain Ontology 3.2.3. Semantic Mediators 3.2.4. The Architecture of an Ontology-Driven GIS	
4. 5.	Ontology Integration The Next Generation of Information Systems	
	ospatial Interoperability: The OGC Perspective en Geospatial Consortium, Open Geospatial Consortium, Wayland, MA, USA	233
	Introduction	

- 2. OGC Process
  - 2.1. Specification Program
  - 2.2. Interoperability Program
- 3. Interoperability Initiatives
  - 3.1. Web Mapping Testbeds
  - 3.2. GeoSpatial Fusion Testbed
  - 3.3. Open Location Services Initiative
  - 3.4. OGC Web Services Initiatives
- 4. OGC Specifications
  - 4.1. GML Simple Features Profile
  - 4.2. OpenGIS® Catalog Service Implementation Specification (2.01)
  - 4.3. OpenGIS® Coordinate Transformation Service Implementation Specification (1.0)
  - 4.4. OpenGIS® Filter Encoding Implementation Specification (1.1)
  - 4.5. OpenGIS® Geography Markup Language Encoding Specification (GML 3.1.1)
  - 4.6. OpenGIS® GML in JPEG 2000 for Geographic Imagery (GMLJP2 1.0)

- 4.7. OpenGIS® Geographic Objects Implementation Specification (GO)
- 4.8. OpenGIS® Grid Coverage Service Implementation Specification (GC 1.0)
- 4.9. OpenGIS® OGC Web Services Common Specification (1.0)
- 4.10. OpenGIS® Open Location Implementation Specification (OpenLS): Core Services Parts 1-5 (OLS Core 1.1)
- 4.11. OpenGIS® Simple Features Implementation Specifications
- 4.12. OpenGIS® Styled Layer Descriptor Implementation Specification (SLD 1.0)
- 4.13. OpenGIS® Web Coverage Service Implementation Specification (WCS 1.0)
- 4.14. OpenGIS® Web Feature Service Implementation Specification (WFS 1.1)
- 4.15. OpenGIS® Web Map Context Implementation Specification (WMC 1.1)
- 4.16. OpenGIS® Web Map Services 1.3 (WMS 1.3)
- 5. Conclusions: OGC and the Future

Index 247

About EOLSS 251