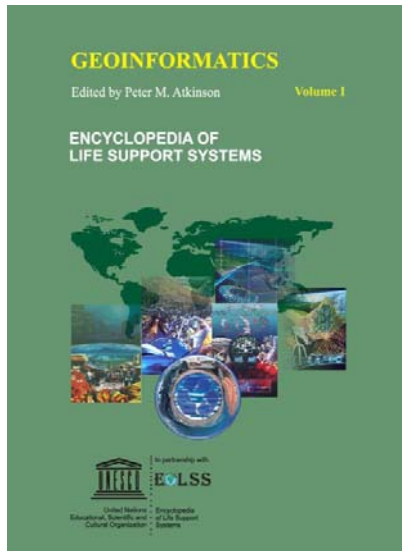


CONTENTS

GEOINFORMATICS



Geoinformatics - Volume 1

No. of Pages: 434

ISBN: 978-1-905839-86-5 (eBook)

ISBN: 978-1-84826-986-6 (Print Volume)

Geoinformatics - Volume 2

No. of Pages: 262

ISBN: 978-1-905839-87-2 (eBook)

ISBN: 978-1-84826-987-3 (Print Volume)

For more information of e-book and Print Volume(s) order, please [click here](#)

[Or contact : eolessunesco@gmail.com](mailto:eolessunesco@gmail.com)

CONTENTS

VOLUME I

Geoinformatics

1

Peter M. Atkinson, *School of Geography, University of Southampton., UK*

1. Introduction
 - 1.1. Geoinformatics
 - 1.2. The Changing Earth
 - 1.3. A Note on Science and Technology
 - 1.4. Scope of this Theme
2. Fundamentals
 - 2.1. The Human Environment as a Surface
 - 2.2. Form and Process
 - 2.3. Measurement of Earth Surface Properties
 - 2.3.1. Phenomena, Properties and Variables
 - 2.3.2. Measurement Error
 - 2.4. Data v. Model
 - 2.4.1. Analytical Models
 - 2.4.2. Statistical Models
 - 2.4.3. Fitting Models
3. Measurement and Spatial Sampling
 - 3.1. Environmental Measurement
 - 3.2. Sampling
 - 3.2.1. Parameters of the Sampling Framework
 - 3.2.2. Issues of Resolution and Scale
 - 3.2.3. Scales of Measurement
 - 3.2.4. Scales of Spatial Variation
 - 3.2.5. Changing the Scale of Measurement
4. Remote Sensing
 - 4.1. The Case for Remote Sensing
 - 4.2. Principles and Systems
 - 4.2.1. Basic Principles
 - 4.2.2. API and Photogrammetry
 - 4.2.3. Remote Sensing in Optical Wavelengths
 - 4.2.4. Remote Sensing at Microwave Wavelengths
 - 4.3. The Remotely Sensed Image
 - 4.4. Models in Remote Sensing
 - 4.5. Classification, Prediction and Dynamics
 - 4.5.1. What is there?
 - 4.5.2. How much is there?
 - 4.5.3. What is going on there?
 - 4.6. Applications of Remote Sensing
5. Geographical Information Systems
 - 5.1. Historical Perspective
 - 5.2. Data Models
 - 5.3. GIS functionality
 - 5.4. Data Transformation
 - 5.5. Spatial and Attribute Query
 - 5.6. Overlay
 - 5.7. Overlay for Landslide Susceptibility Mapping
6. Spatial Statistics
 - 6.1. Characterization
 - 6.2. Prediction
 - 6.3. Simulation
 - 6.4. Optimizing Sampling Design

- 6.5. Dynamics
 - 6.5.1. Space-time Modelling
 - 6.5.2. Spatially Distributed Dynamic Modelling
- 6.6. Accuracy Assessment
- 7. International Cooperation
 - 7.1. Global Remote Sensing
 - 7.2. Global Networks and the World Wide Web
- 8. Conclusion
 - 8.1. Recent Developments
 - 8.2. Summary

Sample Data and Survey

36

Margaret Ann Oliver, *Department of Soil Science, University of Reading, UK*

- 1. Introduction
- 2. Survey
- 3. Spatial Sampling
 - 3.1. Design-based Sampling Schemes and Estimation
 - 3.1.1. Simple Random Sampling
 - 3.1.2. Stratified Random Sampling
 - 3.1.3. Systematic Sampling
 - 3.1.4. Nested Sampling
 - 3.2. Model-based Sampling Designs and Prediction
 - 3.3. Nested Sampling Design and Analysis
- 4. Geostatistical Theory
 - 4.1. The Variogram
 - 4.2. Geostatistical Prediction: Kriging
- 5. Nested Variation
 - 5.1. Linear Model of Regionalization
 - 5.2. Factorial Kriging
- 6. Optimizing Sampling
- 7. Case Studies
 - 7.1. Nested Survey and Analysis: Wyre Forest Soil Survey
 - 7.2. Regular Sampling in One Dimension: Nottingham Survey of Radon in the Soil Gas
 - 7.3. Data on a Regular Rectangular Grid: Soil loss on ignition data and information digitized from a photograph, Yattendon Estate, Berkshire
 - 7.4. Irregular Sampling in Two Dimensions: Survey of Soil Radon in Derbyshire
 - 7.5. Optimal Sampling: Broom's Barn Farm

Geographic Information Systems in Biogeography and Landscape Ecology

72

Dale Anthony Quattrochi, *National Aeronautics and Space Administration, George C. Marshall Space Flight Center, USA*

- 1. Introduction
- 2. Biogeographic and Landscape Ecological Research Themes
 - 2.1. Ecosystem Structure and Function
 - 2.2. Human/Biota Interactions
 - 2.3. Landscape Pattern and Process
 - 2.4. Zoogeography and Animal Ecology
 - 2.4.1. Continental Drift and Climate Effects on Animal Distributions
 - 2.5. Methodological Analysis and Modeling
- 3. Remote Sensing and Geographic Information Systems in Biogeography and Landscape Ecology
 - 3.1. Remote Sensing and GIS for Analyzing and Modeling the Spatiotemporal Landscape
 - 3.1.1. Questions of Space
 - 3.1.2. Questions of Time
 - 3.1.3. Questions of Dynamics

4. Future Trends and Directions for Biogeography and Landscape Ecology

Landform and Earth Surface**91**Christopher David Lloyd, *School of Geography, Queen's University, Belfast, UK*

1. Introduction
 - 1.1. Earth Surface Processes and Landforms
 - 1.2. Digital Representation of Terrain Form
 - 1.2.1. The Altitude Matrix
 - 1.2.2. The Triangulated Irregular Network
2. Sampling Landform
3. Ground-based Survey
 - 3.1. Traditional Survey Techniques
 - 3.2. Total Stations
 - 3.3. Global Positioning Systems
4. Remote Sensing of Landform
 - 4.1. Photogrammetry
 - 4.2. Radar-based Systems
 - 4.2.1. Radargrammetry
 - 4.2.2. Interferometry
 - 4.3. Laser-based Systems
5. Existing Sources of DEMs
6. Quality of DEMs
7. Application of DEMs
8. Case Studies
 - 8.1. Viewshed Analysis for Minimising the Visual Impact of a Major Development
 - 8.2. Deriving a Drainage Network
9. Mapping Landform: Present Trends
10. Future Developments
11. Conclusions

Land Hydrology**108**Stewart William Franks, *Centre of Environmental Dynamics, University of Newcastle, New South Wales, Australia*

1. Introduction
2. Traditional Hydrologic Field Measurement
 - 2.1. Discharge
 - 2.2. Rainfall
 - 2.3. Evapotranspiration
 - 2.4. Storage (Sub-surface Flows)
3. Spatial Analyses
 - 3.1. Digital Terrain Models (DTM)
 - 3.2. Groundwater Mapping and Management
4. Geoinformatics and Hydrological Modelling
 - 4.1. Distributed Hydrological Catchment Modelling
 - 4.2. Distributed Hydrological Measures
 - 4.2.1. Incorporating Distributed Measures of Water Table Dynamics
 - 4.2.2. Microwave Remote Sensing of Soil Moisture Fields
 - 4.2.3. Incorporating Estimates of Saturated Areas
 - 4.3. Estimation of Evapotranspiration
 - 4.3.1. Energy Balance Approaches to Estimating Spatially-variable Evapotranspiration
 - 4.3.2. Modelling Spatial Variability in Evapotranspiration
 - 4.4. Floodplain Mapping and Inundation Modelling

Field Geology

128

Paul Francis Carey, *Badley Aston & Associates Ltd, Winceby House, Lincolnshire, UK*

1. Introduction
2. Geological Surveying
 - 2.1. What Basic Measurements do Geologists Make in the Field?
 - 2.1.1. Using the Compass-clinometer
 - 2.1.2. Improving on the Compass-clinometer
 - 2.1.3. Elevation in Hydrogeology
 - 2.1.4. Field GIS Systems
 - 2.1.5. Geological Logs
 - 2.2. Modeling Spatial Data: Stereonets and Rose Diagrams
3. Mapping what you Can't See: Geophysical Surveying
 - 3.1. Gravity Surveying
 - 3.2. Electrical Surveying
 - 3.2.1. Resistivity Surveying
 - 3.2.2. Induced Polarization Surveying
 - 3.2.3. Self Potential (SP) Surveying
 - 3.3. Electromagnetic Surveying
 - 3.3.1. The VLF Method
 - 3.3.2. The Telluric Surveying Method
 - 3.4. Seismic Surveying
 - 3.4.1. Field-based Reflection Surveying
 - 3.4.2. Refraction Surveying
4. Mapping Geological Composition: Geochemical and Mineralogical Surveying
 - 4.1. Mineralogical Variation
 - 4.2. Field X-Ray Fluorescence Analysis
5. Surveying the Flow Characteristics of Rocks in the Field: Geofluids Surveying
 - 5.1. Field Porosity and Permeability Analysis
 - 5.2. Field Probe Permeametry Surveys

Remote Sensing and Environmental Monitoring

166

Paul Michael Mather, *School of Geography, The University of Nottingham, U.K.*

1. Introduction
2. Digital Data Processing
 - 2.1. Image-Enhancement Methods
 - 2.2. Filters, Noise, and Scale
 - 2.3. Pattern Recognition
3. Conclusions

Physical Basis of Remote Sensing

184

Doreen S. Boyd, *School of Earth Sciences and Geography, Kingston University, U.K.*

1. Overview of Remote Sensing and Common Remote Sensing Systems
2. Electromagnetic Radiation
 - 2.1. Basic Wave Theory
 - 2.2. Quantum Theory
3. The Electromagnetic Spectrum
4. Sources of Electromagnetic Radiation
 - 4.1. Natural Sources of Electromagnetic Radiation
 - 4.2. Artificial Sources of Electromagnetic Radiation
5. Interaction of Electromagnetic Radiation with the Atmosphere
 - 5.1. Atmospheric Scattering of Electromagnetic Radiation
 - 5.2. Atmospheric Absorption of Electromagnetic Radiation
 - 5.3. Atmospheric Refraction of Electromagnetic Radiation

6. Electromagnetic Radiation from Earth's Surface
 - 6.1. Solar Radiation
 - 6.1.1. Spectral Reflectance from Vegetation
 - 6.1.2. Spectral Reflectance from Soils
 - 6.1.3. Spectral Reflectance from Water
 - 6.2. Emitted Radiation
 - 6.2.1. Thermal Radiation from Vegetation
 - 6.2.2. Thermal Radiation from Soils
 - 6.2.3. Thermal Radiation from Water
 - 6.3. Backscattered Radiation
 - 6.3.1. Backscatter from Vegetation
 - 6.3.2. Backscatter from Soils
 - 6.3.3. Backscatter from Water
7. Sensors

Field Spectroscopy

209

Edward J. Milton, *Department of Geography, University of Southampton, U.K.*

1. Introduction
2. Principles of Spectroscopy
3. The Natural Radiation Environment
4. Visualisation of the Bidirectional Reflectance Distribution Function
 - 4.1. Polar Plot
 - 4.2. Solar Principal Plane Plot
 - 4.3. Anisotropy Plot
 - 4.4. 3-D Polar Plot
5. Historical Development of Field Spectroscopy
6. Field Measurement of Reflectance Factors
 - 6.1. Active Field Spectroscopy
 - 6.2. Passive Field Spectroscopy
 - 6.2.1. Scenario 1: Point Sample, Fixed View Geometry
 - 6.2.2. Scenario 2: Areal Average, Fixed View Geometry
 - 6.2.3. Scenario 3: Point Sample, Variable View Geometry
 - 6.2.4. Scenario 4: Area Sample, Variable View Geometry
7. Applications of Field Spectroscopy
 - 7.1. As a Remote Sensing Technique in Its Own Right
 - 7.2. In Education and Training
 - 7.3. Calibration of Airborne and Spaceborne Sensors
 - 7.4. As a Source of Data for Quantitative Models and for Spectral Libraries
8. Emerging Technologies for Field Spectroscopy
 - 8.1. Ground-Based Imaging Spectrometers
 - 8.2. Developments in Field Instrumentation
 - 8.3. Developments in Usability

Satellite Remote Sensing

239

Arthur P. Cracknell, *Department of Electronic Engineering and Physics, University of Dundee, U.K.*

1. Introduction
2. The Components of a Satellite Remote Sensing System
 - 2.1. The Instruments
 - 2.2. The Orbits
3. Ground Facilities
4. Satellite Programs
 - 4.1. Meteorological Remote Sensing Satellites
 - 4.2. Landsat
 - 4.3. Advanced Very High Resolution Radiometer

- 4.4. RESURS-F and RESURS-O
- 4.5. Indian Remote Sensing Satellites
- 4.6. Système Pour l'Observation de la Terre
- 4.7. European Remote Sensing Satellite
- 4.8. TOPEX/Poseidon
- 4.9. Other Systems
5. Applications of Satellite Remote Sensing
6. Land-Based Applications
 - 6.1. Topographic Mapping
 - 6.2. Geological Mapping
 - 6.3. Urban Land Use
 - 6.4. Agriculture and Forestry
 - 6.5. Global Studies
7. Oceanographic Applications
8. Meteorological Applications
9. Atmospheric Sounding
10. Modern and Future Systems
 - 10.1. Current Satellite Systems
 - 10.2. New NASA Programs
 - 10.3. The European Space Agency's Program
 - 10.4. Current Trends in Instrumentation
11. Conclusion

Imaging Spectrometry

282

Freek van der Meer, *Department of Applied Earth Sciences, Delft University of Technology, Delft, Netherlands; Geological Survey Division, International Institute for Aerospace Surveys and Earth Sciences ITC, Enschede, The Netherlands*

1. Introduction and Historical Perspective
2. Physics of Spectroscopy
3. Airborne Imaging Spectrometer Systems
4. Airborne Simulators
 - 4.1. NASA's Airborne Simulators
 - 4.2. The European Space Agency's Airborne Simulator Experiments
5. Spaceborne Imaging Spectrometer Systems
 - 5.1. NASA Activities and Joint Ventures with Industry
 - 5.2. The European Space Agency's Activities
 - 5.3. The German Space Agency Missions
 - 5.4. Other Hyperspectral Satellite Sensor Systems
6. Data Acquisition and Pre-processing of Imaging Spectrometer Data
 - 6.1. Laboratory Set-Up of a Calibration Facility
 - 6.2. The Spectral Pre-processing Chain
 - 6.3. Spatial Pre-processing
 - 6.4. Noise Characterization
 - 6.4.1. The Homogeneous Area Method
 - 6.4.2. The Local Means and Local Variances Method
 - 6.4.3. The Geostatistical Method
 - 6.5. Noise Adjustment
 - 6.6. Atmospheric Correction
 - 6.6.1. Relative Reflectance
 - 6.6.2. Absolute Reflectance
7. Thematic Analysis Techniques for Absorption Feature Extraction
 - 7.1. Binary Encoding
 - 7.2. Waveform Characterisation
 - 7.3. Spectral Feature Fitting
 - 7.4. Spectral Angle Mapping
 - 7.5. Spectral Unmixing

- 7.6. Foreground-Background Analysis
- 7.7. Constrained Energy Minimisation
- 7.8. Classification
- 7.9. Cross Correlogram Spectral Matching
- 7.10. End-member Selection for Spectral Unmixing and Other Feature-Finding Algorithms
- 8. Applications of Imaging Spectrometry
 - 8.1. Geologic Applications Including Mining and Petroleum Exploration
 - 8.2. Soil Science
 - 8.3. Vegetation Analysis and Agriculture
 - 8.4. Hydrology
 - 8.5. Atmosphere

Radar Remote Sensing**326**Shaun Quegan, *Sheffield Centre for Earth Observation Science, University of Sheffield, U.K.*

- 1. Introduction
- 2. Basic Properties of Radar Systems
- 3. Characteristics of Radar Systems
 - 3.1. Frequency
 - 3.2. Polarisation
 - 3.3. Incidence Angle
- 4. What a Radar Measures
- 5. Radar Sensors and Their Applications
 - 5.1. Microwave Scatterometry
 - 5.2. Radar Altimetry
 - 5.3. Synthetic Aperture Radar
- 6. Synthetic Aperture Radar Applications
 - 6.1. Topographic Mapping
 - 6.2. Agriculture
 - 6.3. Forestry
 - 6.3.1. Forest Mapping
 - 6.3.2. Biomass
 - 6.3.3. Forest Flooding
 - 6.4. Soil Moisture and Roughness
 - 6.5. Hydrology
 - 6.6. Hazards
 - 6.7. Oceanography
 - 6.8. Sea Ice
 - 6.9. Land Ice and Snow
- 7. Future Prospects

NASA Earth Science Enterprise: A New Window on our World**352**Ghassem R. Asrar, *National Aeronautics & Space Administration (NASA) Headquarters, Code Y, Washington, D.C., USA*Gregory J. Williams, *National Aeronautics & Space Administration (NASA) Headquarters, Code Y, Washington, D.C., USA*Pierre Morel, *National Aeronautics & Space Administration (NASA) Headquarters, Code Y, Washington, D.C., USA*

- 1. Introduction
- 2. A Scientific Vision—The Earth as a System
- 3. A View From Above—Characterizing the Earth System
 - 3.1. Biosphere–Atmosphere Interactions
 - 3.2. Ocean–Atmosphere Interactions
 - 3.3. Climate–Chemistry Interactions
 - 3.4. Polar Regions–Atmosphere Interactions

4. Taking It All In—Understanding the Earth System
5. Getting There From Here—Predicting Earth System Change
6. Conclusion

Index **369**

About EOLSS **375**

VOLUME II

Statistical Analysis in the Geosciences **1**

Eric Christopher Grunsky, *Geological Survey of Canada, Ottawa, Ontario, Canada*

1. Introduction
 - 1.1. Exploratory Data Analysis
 - 1.2. Target and Background Populations
 - 1.3. Modeled Data Analysis
 - 1.4. Special Problems
 - 1.4.1. Leveling Geochemical Data
 - 1.4.2. Compositional Data
2. Examining Multivariate Geochemical Data
 - 2.1. Exploratory Methods
 - 2.1.1. Histograms
 - 2.1.2. Box Plots
 - 2.1.3. Density Plot
 - 2.1.4. Quantile-quantile (q-q)-plots
 - 2.1.5. Summary Statistical Tables
 - 2.1.6. Spatial Presentation
 - 2.1.7. Scatterplot Matrix
 - 2.1.8. Multiple Box Plots
 - 2.2. Defining the Threshold and Pathfinder Elements
 - 2.3. Censored Data
 - 2.4. Outliers
 - 2.5. Robust Estimation
 - 2.6. Transformation of Data
3. Exploratory Multivariate Techniques
 - 3.1. Robust Estimation of Mean and Covariance Matrices
 - 3.2. Principal Components Analysis
 - 3.3. Cluster Analysis Methods
 - 3.3.1. K-Means Clustering
 - 3.4. D^2 Plots: A multivariate extension of (q-q)-plots
 - 3.5. The Use of Empirical Indices
 - 3.5.1. Weighted Sum Index
4. Modeled Approaches for Assessing Multi-element Geochemical Data
 - 4.1. Multivariate Data Analysis: Grouped Data- Target vs. Background
 - 4.2. Analysis of Variance
 - 4.3. Regression Methods
 - 4.4. Canonical Variate Analysis
 - 4.4.1. Testing Populations
 - 4.5. Classifying Unknown Observations
 - 4.5.1. Posterior Probability
 - 4.5.2. Index of Typicality
5. Sequence of Data Analysis
 - 5.1. Preliminary Data Analysis
 - 5.2. Exploratory Multivariate Data Analysis

- 5.3. Modelled Multivariate Data Analysis
- 6. Future Trends

Spatial Data Handling and GIS**65**Peter M. Atkinson, *School of Geography, University of Southampton, UK*

- 1. Background
- 2. Geographical Data
- 3. Data Models
- 4. Measurement and Sampling
 - 4.1. The Support
 - 4.2. Measurement Error and Accuracy
 - 4.3. Sampling
- 5. Data Entry, Archiving and Retrieval
- 6. Data Organization
- 7. Analysis
- 8. Accuracy assessment
- 9. Conclusion

Classification and Fuzzy Sets**82**Giles Martin Foody, *Department of Geography, University of Southampton, UK*

- 1. Introduction
- 2. Major approaches to classification
 - 2.1. Unsupervised classification
 - 2.2. Supervised classification
 - 2.2.1. Commonly used approaches
 - 2.3. Problems in classification
- 3. Crisp and fuzzy sets
 - 3.1. Crisp sets
 - 3.2. Complexity and uncertainty
 - 3.3. Fuzzy sets
- 4. Fuzzy classification
 - 4.1. Fuzzy classifiers
 - 4.2. Softened classifications
- 5. Conclusions

Geostatistical Analysis of Spatial Data**96**Pierre Goovaerts, *Biomedware, Inc. and PGeostat, LLC, Ann Arbor, Michigan, USA*

- 1. Introduction
- 2. Description of Spatial Patterns
- 3. Modeling Spatial Variation
- 4. Spatial Prediction
- 5. Modeling the Local Uncertainty
- 6. Stochastic Simulation
- 7. Accounting for Uncertainty in Decision-making
- 8. Conclusions

Stochastic Modelling of Spatio-Temporal Phenomena in Earth Sciences**115**Amilcar Oliveira Soares, *CMRP- Instituto Superior Técnico, University of Lisbon. Portugal*

- 1. Introduction
- 2. Joint Space - Time Models

- 2.1. Stationary Joint Space-Time Models
- 2.2. Spatial Models with Time and Space Trends
3. Space-time Uncertainty Assessment
4. Discussion

International Cooperation for Data Acquisition and Use

134

Michael Jeremy Clark, *Department of Geography, University of Southampton, UK*

1. A background to data cooperation
 - 1.1. Data as a scientific asset
 - 1.2. Data as a commodity
 - 1.3. Data origination, archiving and rescue
2. Value from data integration: the case for data cooperation
 - 2.1. Integrated data as the basis for comparison
 - 2.2. Integrated data as a basis for identifying process drivers
 - 2.3. Integrated data as a basis for change detection
 - 2.4. Integrated data as a basis for hypothesis testing
 - 2.5. Integrated data as a basis for regional or global typology and model
 - 2.6. Integrated data as a basis for impact evaluation and management response
3. Data cooperation in practice
 - 3.1. Cooperative origination of data: sampling and data quality
 - 3.2. Cooperation in practice: archiving and distribution
4. The global data networks: principle into practice
5. An example of data cooperation: cold regions science (geocryology)
6. Data cooperation in perspective
 - 6.1. The ethics of data cooperation
 - 6.2. A perspective on international data cooperation

Global Data Networks in the Environmental and Life Sciences

160

Matthew D. Wilson, *School of Geographical Sciences, University of Bristol, Bristol, UK.*

1. A background to global data networks
 - 1.1. A brief history of data cooperation
2. World Data Centres
 - 2.1. WMO World Data Centres
3. Global Resource Information Database
4. Global Observing Systems Information Centre
 - 4.1. Global Terrestrial Observing System
 - 4.2. Global Climate Observing System
 - 4.3. Global Ocean Observing System
5. Conclusions

Developments in Global Land Cover Mapping

183

Alan S. Belward, *Institute for Environment and Sustainability, EC Joint Research Centre, Italy*

1. Growing Demand for Global Land Cover Information
 - 1.1. Scientific Users and Uses
 - 1.2. Policy Users and Uses
2. Past Experiences
 - 2.1. The IGBP Land Cover Project DISCover
 - 2.2. Lessons from DISCover
3. Present Trends
 - 3.1. New Products, new Challenges
 - 3.2. Prerequisites
 - 3.3. The Global Land Cover 2000 project

4. Conclusions

Index **201**

About EOLSS **205**