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The National Center for Geographic Information and Analysis (NCGIA) is an independent research consortium dedicated to basic research and education in geographic information science and its related technologies, including geographic information systems (GIS). The three member institutions are the University of California, Santa Barbara; the University at Buffalo; and the University of Maine. The consortium was formed in 1988 in response to a competition for funding from the National Science Foundation, and continues to receive much of its funding from that source. Today, NCGIA stands as an international focus for basic research, especially in areas such as accuracy and uncertainty in spatial data, spatial cognition, and GIS modeling and representation. Its three sites attract short- and long-term visitors from around the world, and its educational programs address the needs of students at all levels.

This eScholarship repository (based on resources under the custodianship of the Center for Spatial Studies at UC Santa Barbara) holds reports, publications, and curriculum resources completed through initiatives of the NCGIA consortium (1988–1999) in addition to more recent research-oriented events and projects sponsored by the consortium.



For more information, see: <http://ncgia.ucsb.edu>.

88-1: Full Proposal, details the proposed activities and facilities of the National Center for Geographic Information and Analysis: Rationale, Research Plan, Education Plan, Cognate Research Units and Facilities for the Center, Knowledge and Data Dissemination, Management Plan, Institutional, Industrial and Government Support.

88-2: Selected Sections from the Proposal, abbreviated version of 88-1: Rationale, Research Plan, Education Plan, and Knowledge and Data Dissemination.

88-3: Cognitive and Linguistic Aspects of Geographic Space, compiled by David M. Mark, SUNY-Buffalo, provides a commentary on the conceptualization of space and its reflection in language - a critical element in the NCGIA research agenda, especially in respect to Initiative 2.

89-1: Accuracy of Spatial Databases: Initiative 1 Specialist Meeting Report, compiled by Michael F. Goodchild, UCSB, summarizes the goals of Initiative 1, plus a list of feasible research topics. Abstracts of 32 papers presented are also included. An edited volume of selected papers from the meeting has been published elsewhere.

[89-2: Language of Spatial Relations: Initiative 2 Specialist Meeting Report](#), compiled by David M. Mark, et al, SUNY-Buffalo, provides an in-depth look at the issues of spatial relationships and how to accurately describe them in natural language. Discussions from the meeting are summarized and a list of further issues for research is outlined.

[89-2A: Language of Spatial Relations: Researchable Questions & NCGIA Research Agenda](#), compiled and edited by David M. Mark, SUNY-Buffalo, summarizes the researchable questions that arose from Initiative 2 Specialist Meeting.

[89-3: Multiple Representations: Initiative 3 Specialist Meeting Report](#), compiled by Barbara P. Bittenfield, SUNY-Buffalo, outlines the research issues that were identified at the Initiative 3 Specialist Meeting. Such issues as digital feature recognition and linking database resolutions are discussed.

[89-4: What is Special about Spatial Data? Alternative Perspectives on Spatial Data Analysis](#), by Luc Anselin, UCSB, outlines general ideas on fundamental issues related to the distinctive characteristics of spatial data analysis as opposed to data analysis in general. Includes an extensive bibliography.

[89-5: A Hierarchical Spatial Data Structure for Global Geographic Information Systems](#), by Michael F. Goodchild and Yang Shiren, UCSB, describes procedure for projecting the globe onto an octahedron and then recursively subdividing each of the triangle faces into four triangles.

[89-6: Use and Value of Geographic Information: Initiative 4 Specialist Meeting Summary Report](#), compiled and edited by Harlan J. Onsrud and Nancy J. Obermeyer, U. Maine; and Hugh W. Calkins, SUNY-Buffalo, includes goals, meeting format, research agenda, and summaries of presentations for the Initiative 4 Specialist Meeting.

[89-7: Use and Value of Geographic Information: Initiative 4 Specialist Meeting Summary Report and Proceedings](#), compiled and edited by Harlan J. Onsrud and Nancy J. Obermeyer, U. Maine; and Hugh W. Calkins, SUNY-Buffalo, includes text of 89-6 plus position papers presented and discussed at the Initiative 4 meeting.

[89-8: Selective Bibliography: Value of Information](#), compiled by Holly J. Dickinson, SUNY-Buffalo, prepared in conjunction with Initiative 4 as an aid to research: includes references to articles, papers, reports, chapters.

[89-9: Accuracy of Spatial Databases: Annotated Bibliography](#), compiled by Howard Veregin, UCSB, prepared in conjunction with Initiative 1 as an aid to research: includes references to articles, papers, reports, and chapters.

[89-10: Working Bibliography on "Languages of Spatial Relations," First Edition](#), compiled by David M. Mark, Michael D. Gould, Scott M. Freundsuh, SUNY; Max J. Egenhofer, Werner Kuhn, U. Maine; Matthew McGranaghan, U. Hawaii and Soteria Svorou, contains over 500 references for Initiative 2.

[89-11: Multiple Representations: A Bibliography](#), compiled by Barbara P. Bittenfield, Joseph S. Delotto, and James V. McKinney, SUNY-Buffalo, generated as part of research for Initiative 3: "Multiple Representations."

[89-12: A Taxonomy of Error in Spatial Databases](#), by Howard Veregin, UCSB, discusses types of error which occur in spatial databases, and methods for dealing with inaccuracies. A companion paper to the annotated bibliography (89-9) in conjunction with Initiative 1.

[89-13: Research Initiative 5: Very Large Spatial Databases: Report on the Specialist Meeting](#), edited by Terence R. Smith, UCSB; and Andrew U. Frank, U. Maine, summarizes the discussions that took place at Initiative 5 Specialist Meeting.

[89-14: Spatial Relations Representation and Locative Phase Generation in a Map Context](#), by Susan M. Haller, SUNY-Buffalo, research report connected with Initiative 2: "Languages of Spatial Relations."

[89-15: Issues in Vehicle Navigation and Information Systems](#), by Scott M. Freunds Schuh, Michael D. Gould and David M. Mark, SUNY-Buffalo, three research papers presented at the VNIS '89 Conference in Toronto.

[90-1: A Comparison of Complexity Measures for Cartographic Lines](#), by Marcin J. Jasinski, SUNY-Buffalo, research report connected with Initiative 3.

[90-2: Spatial Language and Geographic Information Systems \(El Lenguaje Espacial y los Sistemas de Informacion Geograficos: Temas Interlinguisticos\)](#), by David M. Mark and Michael D. Gould, SUNY-Buffalo; and Joan Nunes, U. Barcelona, Spain, originally written for the Second Latin American Conference on Applications of Geographic Information System Technology, held in Merida, Venezuela, Sept. 1989.

[90-3: Deriving a Method for Evaluating the Use of Geographic Information in Decision Making](#), by Holly J. Dickinson, SUNY-Buffalo, dissertation on the value of geographic information and its analysis in decision making.

[90-4: NCGIA/U.S. Census Multiple Representations Data Set Project Technical Report on Pilot Project: Lee County, Florida](#), by Joseph S. DeLotto and Barbara P. Battenfield, SUNY-Buffalo and Frederick Broome, U.S. Census Bureau, documents a joint effort to produce a multi-scale, multi-agency database for teaching and research.

[90-5: Research Initiative 6: Spatial Decision Support Systems: Scientific Report for the Specialist Meeting](#), by Paul J. Densham, SUNY-Buffalo; and Michael F. Goodchild, UCSB, includes goals, meeting format, research agenda and position papers from participants.

[90-6: Lineage in GIS: The Problem and a Solution](#), by David P. Lanter, UCSB, includes two papers on the issues of lineage and metadata in GIS.

[90-7: NCGIA 18-Month Report](#) contains material requested by NSF in support of 18-month review of the progress of the NCGIA.

[90-8: Models in Temporal Knowledge Representation and Temporal DBMS](#), by Renato Barrera and Khaled K. Al-Taha, U. Maine, describes models found in published literature, useful for advanced researchers dealing with temporal GIS problems.

[90-10: Language, Cognitive Science, and Geographic Information Systems](#) by David M. Mark, SUNY-Buffalo; and Andrew U. Frank, U. Maine, two papers summarizing the major themes of Initiative 2.

[90-11: Two Perspectives on Geographical Data Modeling](#), by Andrew U. Frank, U. Maine; and Michael F. Goodchild, UCSB, two articles addressing a fundamental problem for geographic information: the modeling of space.

[90-12: Query Languages for Geographic Information Systems](#), by Max J. Egenhofer and Andrew U. Frank, U. Maine, three papers showing three different perspectives on interactive query languages for geographic information and analysis, an emphasis of Initiative 2 on "Languages of Spatial Relations."

[90-13: Cognitive and Linguistic Aspects of Geographic Space](#), by Max J. Egenhofer, Werner Kuhn, Andrew U. Frank, and Matthew McGranaghan, U. Maine, addresses different aspects of formalizing human communication about geographic space.

[91-1: Fractal Geometry and Spatial Phenomena](#), by Mark MacLennan, A. Stewart Fotheringham and Michael Batty, SUNY-Buffalo; Paul Longley, U. Wales, bibliography prepared in conjunction with Initiatives 1 and 3.

[91-2: A Conceptual Framework for Integrated Metadata Management in Very Large Spatial Databases](#), by Nehal Trivedi and Terence R. Smith, UCSB, discusses metadata as a potential solution to the management of very large sets of spatial data.

[91-3: A Cartographic Animation of Average Yearly Surface Temperatures for the 48 Contiguous United States: 1897-1986](#), by Christopher Weber, SUNY- Buffalo, describes a variable cartographic animation process employing hardware and software; includes diskette.

[91-4: Temporal Relations in Geographic Information Systems: A Workshop at the University of Maine, Orono, October 12-13, 1990](#), by Renato Barrera, Andrew Frank and Khaled Al-Taha, U. Maine, proposes a model of time useful in analysis of temporal accuracy of geographic information.

[91-5: The Integration of Spatial Analysis and GIS: The Development of the STATCAS Module for ARC/INFO](#), by Yuemin Ding and A. Stewart Fotheringham, SUNY-Buffalo, describes STATCAS package within the operating environment of a GIS.

[91-6: User-Centered Graphical User Interface Design for GIS](#), by David Lanter and Rupert Essinger, UCSB, discusses how traditional user interface design focuses on the best way to represent the software functionally rather than on how to meet the expectations of the user.

[91-7: A Framework for the Definition of Topological Relationships and an Algebraic Approach to Spatial Reasoning within this Framework](#), by Max J. Egenhofer, U. Maine, John R. Herring, Intergraph, and Terence Smith and Keith Park, UCSB

[91-8: Spatial Data Representation and Basic Operations for a Triangular Hierarchical Data Structure](#), by Michael Goodchild, Yang Shiren, and Geoffrey Dutton, UCSB, describes the recursive subdivision of an octahedron and the conversion algorithms to and from latitude/longitude.

[91-9: Spatial Decision Support Systems: A Bibliography](#), by Michael Gould and Paul J. Densham, SUNY-Buffalo, bibliography compiled from various sources including journal indices, book indices, and databases.

[91-10: Designing and Implementing Strategies for Solving Large Location- Allocation Problems with Heuristic Methods](#), by Paul Densham SUNY-Buffalo, and Gerard Rushton, SDSU, describes the implementation of the best known heuristic algorithms used to solve large problems in times that are realistic in a microcomputer-based, interactive decision making environment.

[91-11: Connecting ARC/INFO and SNACTOR: Project Report](#), by Stuart C. Shapiro, Hans Chalupsky, and Hsueh-cheng Chou, SUNY-Buffalo, describes an interface between ARC/Info and SNePS, the Semantic Network Processing System, a knowledge representation and reasoning system.

91-12: Replaced by update, Technical Report **[96-12: GIS Laboratory Exercises: Introduction to GIS, 2nd edition](#)**.

[91-13: The Performance of Tests for Spatial Dependence in a Linear Regression](#), by Luc Anselin and Serge Rey, UCSB, compares the properties of Moran's I and Lagrange multiplier tests for spatial dependence.

[91-14: GIS Laboratory Exercises: Volume 2 Technical Issues](#). Howard Veregin, editor.

[91-15: An Annotated Bibliography on Human Computer Interaction for GIS](#), compiled by the students in Course SVE 698, U. Maine, bibliography collected by the instructor and students during a course on human computer interfaces for GIS.

[91-16: Initiative 12: Integration of Remote Sensing and Geographic Information Systems](#), Report of the Specialist Meeting, summarizes planning meetings and work that led to the first Specialist Meeting for Initiative 12.

[91-17: Multiple Topological Representations](#), by Bud P. Bruegger and Werner Kuhn, U. Maine, proposes an approach to support multiple levels of abstraction in a GIS through multiple topological representations (MTR).

[91-18: Visual Interfaces to Geometry](#), by Werner Kuhn and Max J. Egenhofer, U. Maine, presents the results of a two-day workshop on "Visual Interfaces to Geometry," conducted at ACM's CHI'90 Conference on Human Factors in Computing Systems.

[91-19: The Use of a Geographic Information System for Second-Order Analysis of Spatial Point Patterns](#), by Mark J. MacLennan, SUNY-Buffalo, describes a computer program for GRASS which implements second-order neighborhood analysis.

91-20: Replaced by update, Technical Report **[93-10: The NCGIA Guide to Laboratory Materials - 1993](#)**.

[91-21: GIS Teaching Facilities: Six Case Studies on the Acquisition and Management of Laboratories](#), edited by Stephen D. Palladino and Karen K. Kemp, UCSB, includes six case studies reviewing the acquisition and management of computer labs established primarily for teaching GIS.

[91-22: Bibliography on Animation of Spatial Data: A Guide to Literature, Video and Movie Media](#), by Barbara P. Battenfield, Christopher R. Weber, Mark MacLennan, and John D. Elliott, SUNY-Buffalo, a collection of sources as part of the research efforts for Initiatives 7 and 10.

[91-23: The Use of Vegetation Maps and Geographic Information Systems for Assessing Conifer Lands in California](#), by Michael F. Goodchild, Frank W. Davis, Marco Painho, and David M. Stoms, UCSB, summarizes research into the sources of error in medium to small-scale vegetation maps used for state-wide forestry conservation planning.

[91-24: German GIS/LIS Standards](#), by Werner Kuhn, U. Maine, investigates cadastral and topographical information management in Germany, 1991.

[91-26: Initiative 7 Specialist Meeting: Visualization of Spatial Data Quality](#), by Kate M. Beard and Sarah Clapham, U. Maine; and Barbara P. Battenfield, SUNY-Buffalo, summarizes the Specialist Meeting discussions and development of research topics.

[91-27: VT/GIS: The von Thünen GIS Package](#), by Rustin F. Dodson, UCSB, provides an interactive tutorial and exercises with which students can explore a spatially-relaxed von Thünen model.

[92-1: Locational Models, Geographic Information, and Planning Support Systems](#), by Britton Harris, U. Pennsylvania, and Michael Batty, SUNY-Buffalo, summarizes the needs and requirements for the development of GIS relevant to urban planning and proposes the idea of Planning Support Systems in linking GIS to predictive and prescriptive land use, activity, and transportation models.

[92-2: Generalization of the Digital Chart of the World \(DCW\)](#), by Frank Fico, SUNY-Buffalo, examines DCW features layer-by-layer and presents specific generalization operators that may be applied to generate a smaller scale dataset from the original product. Some operations are demonstrated using ARC/INFO and the results are displayed.

[92-3: User Interfaces for Geographic Information Systems: Report on the Initiative 13 Specialist Meeting](#), edited by David M. Mark, SUNY-Buffalo, and Andrew U. Frank, U. Maine, contains an account of discussions at the Specialist Meeting; the research agenda for the topic; and the position papers circulated at the meeting.

[92-4: Intelligent Assistants for Filling Critical Gaps in GIS](#), by David Lanter, UCSB, analyzes critical gaps in current geographic information systems that impede their use for spatial decision support, and provides a research agenda adapting expert systems and other technologies to fill these gaps.

[92-5: Initiative 9: Report for the Specialist Meeting: Institutions Sharing Geographic Information](#), compiled and edited by Harlan Onsrud, U. Maine, and Gerard Rushton, SDSU, includes purpose and scope of the Initiative, abstracts of presentations made at the Specialist Meeting, and recommendations for research in sharing geographic information.

[92-6: On the Possible Role\(s\) of a "University Consortium for Geographic Information and Analysis" \(UCGIA\)](#): by the UCGIA Steering Committee, summarizes extensive discussions of possibilities for a new organization.

[92-7: Research Agenda for the NCGIA Renewal 1993-1996](#), by NCGIA, revised and updated research agenda for geographic information and analysis, including references and linkages to NCGIA research initiatives.

[92-8: Initiative-9: Sharing Information in Third World Planning Agencies, Perspectives on the Impact of GIS](#), by Michael Batty, SUNY-Buffalo, explores the 'information sharing' paradigm which is rapidly emerging in mature organizations where information technology is being heavily used for communications and decision making, emphasizing ways in which the paradigm might be used in GIS in the Third World.

[92-9: GIS Videos: An Annotated Bibliography](#), by Amy Ruggles, UCSB, describes over 120 educational videos on GIS and related subjects, from government agencies, software and hardware vendors, and independent video companies. Prepared in cooperation with ASPRS.

[92-10: Spatial Data Analysis with GIS: An Introduction to Application in the Social Sciences](#), by Luc Anselin, UCSB, reviews the linkage between spatial data analysis and GIS with an extensive illustration.

[92-11: GIS and Spatial Analysis: Initiative 14 Specialist Meeting Report](#), compiled by Stewart Fotheringham and Peter Rogerson, SUNY-Buffalo, summarizes the discussion and outlines the research agenda.

[92-12: Two Perspectives on Data Quality](#), by Helen Couclelis, UCSB, and Kate Beard and William Mackaness, U. Maine. The first report discusses the impediments to effective quality control, and proposes a conceptual model to monitor GIS product quality at any state of deriving an application; the second outlines a research agenda based on the identification of impediments to data integrity.

[92-13: A Glossary of GIS Terminology](#), compiled by Dr. G. Padmanabhan and Jeawan Yoon, North Dakota State University, and Mark Leipnik, UCSB, gives a comprehensive alphabetical listing of technical terms and their common meanings, also an alphabetical list of acronyms related to GIS.

[93-1: Three Presentations on Geographical Analysis and Modeling: Non- Isotropic Geographic Modeling; Speculations on the Geometry of Geography; and Global Spatial Analysis](#), by Waldo Tobler, UCSB.

[93-2: NCGIA Secondary Education Project "GIS in the Schools" Workshop Resource Packet](#), by Stephen D. Palladino, UCSB, materials for GIS outreach to secondary schools, includes: prototype workshop review, GIS short course notes, resource list, and GIS glossary; also helpful to teachers wanting simple resources for GIS teaching.

[93-3: Environmental Modeling with GIS: A Strategy for Dealing with Spatial Continuity](#), by Karen K. Kemp, UCSB, examines the incompatibility between continuous models of environmental processes and computer systems used for storing and manipulating data about environmental phenomena. Outlines an approach for addressing this problem. Includes an extensive bibliography.

[93-4: Remote Sensing and GIS Integration: Towards a Prioritized Research Agenda](#), by John E. Estes and Jeffrey L. Star, UCSB, discusses the process used during NCGIA Initiative 12: Integration of Remote

Sensing and GIS, to develop a consensus on the priorities for research, and summarizes these priorities and presents perspectives from scientists within and without the Initiative.

[93-5: Teaching Introductory Geographical Data Analysis with GIS: A Laboratory Guide for an Integrated Spacestat/Idrisi Environment](#), edited by Rusty Dodson, Preface by Luc Anselin, UCSB, contains student laboratory exercises for an introductory course in spatial analysis, based on an integrated computing environment using the SpaceStat and Idrisi software packages. Topics include exploratory data analysis, spatial weight matrices, spatial autocorrelation, point pattern analysis, bivariate regression, spatial ANOVA, and trend surface regression. Includes a DOS diskette with datasets and linkage software. REQUIRED SOFTWARE: SpaceStat version 1.0 or higher, and Idrisi version 4.0 or higher.

[93-6: Environmental Equity in Los Angeles](#), by Laretta Burke, UCSB, an MA thesis/case study of Los Angeles, investigating the relationship between the placement of environmentally hazardous industrial facilities and demographic variables.

[93-7: Spatial Data Analysis and GIS: Interfacing GIS and Econometric Software](#), by Luc Anselin, Sheri Hudak, and Rustin Dodson, UCSB (with disk), includes software routines for extracting spatial weights matrices from common GIS packages (Arc/Info, packages GAUSS, LIMDEP, RATS, SHAZAM, and SPLUS. Contains one DOS diskette of programs and sample data.

[93-8: Testing Technology Transfer Hypotheses in GIS Environments Using a Case Study Approach](#), edited by Harlan J. Onsrud and Jeffrey Pinto, University of Maine, and Bijan Azad, MIT, presents a scientific approach to case studies and reports two case studies that followed the outlined methodology.

[93-9: GIS and the Coastal Zone: An Annotated Bibliography](#), compiled by Darius J. Bartlett, University College, Cork, Ireland

[93-10: The NCGIA Guide to Laboratory Materials - 1993](#), edited by Rustin F. Dodson, UCSB, an updated version of Tech. paper 91-20: a compendium of information pertaining to GIS laboratory education.

[93-11: African Data Viewer](#) - compiled by Stephen D. Palladino, UCSB, (with disk), includes thirty IDRISI based data sets of climatic factors, population density, elevation, and soil degradation. This product of the NCGIA Secondary Education Project is self-contained, requiring no additional software to view the data. Designed to introduce K-12 teachers and students to digital GIS data; includes DOS disk with data, program and installation instructions.

[93-12: GIS, Cartography, and the Information Society: An Annotated Bibliography](#), compiled by William Dowdy, UCSB, a collection of approximately one hundred references collected by the compiler for specific use as support material at the NCGIA's Workshop "GIS and Society" held at the U of Washington's Friday Harbor Research Center.

[94-1: The 9-Intersection: Formalism and Its Use for Natural-Language Spatial Predicates](#), edited by Max Egenhofer, U. Maine; David Mark, SUNY-Buffalo; John Herring, Intergraph Corp, contains two papers, plus supplementary material. The first paper develops and presents the formal mathematical definitions of the 9-intersection. The second paper reports of cognitive testing based on the mathematical mode presented in the first paper. Lastly, it contains the complete set of stimuli used in Mark and Egenhofer's experimental work up to January 1994.

[94-2: Selected Bibliography on Law, Information Policy, and Spatial Databases](#), compiled by Harlan J. Onsrud, Jeffrey Johnson, and Xavier Lopez U. Maine, a selected bibliography prepared as part of the preparation for an NCGIA Initiative of Law, Information Policy, and Spatial Databases. Articles are placed within the following categories: Freedom of Information, Open Records, and Government Charges for Information; Privacy, Copyright, Patent, and Trade Secrets; Computer Contracts, Licensing, Electronic Document Interchange, and Encryption; Liability and Admissibility; General Books, Articles, and Bibliographies.

[94-3: Land Information Systems in Developing Countries: Bibliography](#), compiled by Harlan Onsrud, Jeffrey Johnson, et al.

[94-4: Gap Analysis of the Southwestern Region](#) by Frank W. Davis. This report describes a geographic information system based Gap Analysis of biodiversity in the Southwestern California Ecoregion. The project is part of an ongoing effort by many groups to provide this regional overview by mapping the distributions of plant community types and vertebrate species habitats and relating these distributions to existing patterns of land ownership and land management.

[94-5: Integrating Normative Location Models into GIS: Problems and Prospects with p-median Model](#), by Richard Church and Paul Sorenson, UCSB, June 1994.

[94-6: Final Report for Caltrans Agreement 65T155 \(MOU 1\)](#) by Richard Church, Danette Coughlan, Thomas Cova, Michael Goodchild, Jonathan Gottsegen, and David Lemberg, included four sections: Section I. Overview; Section II describes the major functions of IVHS (intelligent vehicle highway systems); Section III discusses alternative data models; and Section IV examines the design of a distributed navigable map database and the capabilities of current GIS and database management products.

[94-7: Spatial Analysis on the Sphere: A Review](#), by Rob Raskin, UCSC, examines the methods of analysis on a spherical earth. The use of spherical analysis in conjunction with global geographic information systems is detailed. This review is relevant to researchers in geography, global change, and related fields who study processes at global scales; with bibliography.

[94-8: Topological Relations in the World of Minimum Bounding Rectangles: A Study with R-trees](#) by Dimitris Papadias UCSD, Yannis Theodoridis, National Technical University of Athens, Timos Sellis, National Technical University of Athens, and Max J. Egenhofer, U of Maine, discusses the retrieval of topological relations in Minimum Bounding Rectangle-based data structures.

[94-9: Time in Geographic Space: Report on the Specialist Meeting of Research Initiative 10](#), edited by Max J. Egenhofer, U. Maine, and Reginald G. Golledge, UCSB, describes the Specialist Meeting of the NCGIA Research Initiative on "Spatio-Temporal Reasoning in GIS" which addresses space and time as it relates to objects and people in geographic space.

[94-10: Selected Annotated Bibliography on Visualization of the Quality of Spatial Information, Research Initiative 7](#), by William A. Mackaness and M. Kate Beard, U. Maine, and Barbara P. Battenfield, SUNY-Buffalo, a collection of approximately two hundred references which support such issues as uncertainty, quantitative and qualitative descriptions of quality, management and quality control, as well as many others.

95-1: Framework Data Sets for the NSDI, by Steven M. Frank, Harlan Onsrud, Jeffrey Pinto, U. Maine; and Michael Goodchild, UCSB, reports on the results of a survey conducted in 1994 to help identify and prioritize framework data sets to be included in the NSDI.

95-2: Two papers on Triangulated Surface Modeling, by Carlos Fegueiras, Instituto Nacional de Pesquisas Espaciais (INPE), and Michael Goodchild, UCSB, examines three TIN surface modeling methods and associated algorithms for fitting surfaces: linear, quintic and stochastic, through the use of both qualitative and quantitative criteria.

95-3: Multiple Roles for GIS in US Global Change Research: An Annotated Bibliography, compiled by Ashton Shortridge, UCSB, in conjunction with Initiative 15, presents a collection of articles concerned with the application of GIS in global change research.

95-4: A Comparison of Strategies for Data Storage Reduction in Location-Allocation Problems, by Paul A. Sorensen and Richard L. Church, UCSB, describes a set of comparative tests evaluating the effects on solution quality of imposing different distance string definitions and sizes. Two new methods for the selection of nodes to be included within distance strings data structures are outlined.

95-5: Color Your World, An Exploration with ArcView 2.0, compiled by Paul Sutton, Paul Van Zuyle, and Steve Palladino, UCSB (with disk), an interactive GIS based computer game designed for secondary school students to expose them to fundamental and essential geographic information necessary for understanding not only geography but politics, economics, demography, and other disciplines. The game produces thematic maps which show patterns and distributions of important phenomena. REQUIRED SOFTWARE: ArcView 2.0.

95-6: The Global Demography Project, by Waldo Tobler, Uwe Deichmann, Jon Gottsegen, and Kelly Maloy, UCSB (with disk), a three part report which explores demographic data using populations extrapolated to 1994 and converted to a piecewise continuous population surface, gridded by latitude/longitude quadrangles. Part I gives the motivation and several possible approaches, Part II provides the results to date, and Part III describes needed extensions, as well as the appendices containing detailed information on the results with maps and data sources; includes PC disk with data and BASIC programs.

95-7: Formalizing Behavior of Geographic Feature Types, by Robert D. Rugg, Max J. Egenhofer, U. Maine, and Werner Kuhn, Tech. Univ. Vienna, addresses the problem of formalizing the natural language definitions of spatial features. An approach using functional algebra is developed.

95-8: Naive Geography, by Max J. Egenhofer, U. Maine, and David M. Mark, SUNY-Buffalo, defines the notion and concepts of Naive Geography, the field of study that is concerned with formal models of the common-sense geographic world.

95-9: Direction Relations and Two-Dimensional Range Queries: Optimization Techniques, by Theodoridis Yannis, Emmanuel Stefanakis, and Timos Sellis, Technical University of Athens; and Dimitris Papadias, U. Maine, defines direction relations (east, southeast, etc.) between two-dimensional objects at different levels of qualitative resolution and shows how these relations can be efficiently retrieved in existing DBMSs using B-, KDB- and R-tree-based data structures.

[95-10: Research Initiative 15: Multiple Roles for GIS in US Global Change Research](#), Report of the First Specialist Meeting, Santa Barbara, compiled and edited by Michael Goodchild and John E. Estes, UCSB; Kate Beard, U. Maine; Tim Foresman, U. Maryland Baltimore County, Jenny Robinson, SUNY-Buffalo and Kenneth McGwire, Desert Research Institute, summarizes the Specialist Meeting discussions and provides a synthesis of emerging research topics and activities.

[95-11: Geographic Information/GIS Institutionalization in the 50 States: Users and Coordinators](#), by Lisa Warnecke, GeoManagement Associates, Syracuse, New York, analyzes recent information about the use and institutionalization of geographic information and related technologies in the US state governments.

[95-12: On Information Modeling to Support Interoperable Databases](#), by Nectaria Tryfona and Jayant Sharma, U. Maine, deals with the special semantics of spatial data in an information systems context and describes a geographic model to encapsulate the distinguishing properties of space.

[95-13: Understanding Guidance on GIS Implementation: A Comprehensive Literature Review](#), by Roberto Ferrari and Harlan J. Onsrud, U. Maine, documents a comprehensive review of the literature on GIS implementation and analyzes it in terms of issues addressed, theoretical consistency, and theoretical diversity.

[95-14: Collaborative Spatial Decision-Making: Scientific Report for the Initiative 17 Specialist Meeting](#), by Paul J. Densham, U. College London; Marc P. Armstrong, U. Iowa; and Karen K. Kemp, UCSB, summarizes the meeting discussions and outlines some critical areas for research.

[95-15: NCGIA Research Initiative 8 Formalizing Cartographic Knowledge: Scientific Report for the Specialist Meeting](#), by Barbara P. Battenfield, U. Colorado, and Catherine Dibble, UCSB, summarizes the meeting discussions and lays out an international research agenda.

[96-1: Image Registration using Multiquadric Functions, the Finite Element Method, Bivariate Mapping Polynomials and the Thin Plate Spline](#), by David N. Fogel, UCSB, and Larry R. Tinney, DOE Las Vegas, reports on an evaluation of several methods of image-to-image registration using control points.

[96-2: Algorithms for Hierarchical Spatial Reasoning](#), by Dimitris Papadias and Max Egenhofer, U. Maine, examines two types of inference for reasoning about spatial relations using multiple local frames of reference organized in aggregation hierarchies.

[96-3: A Review of Spatial Population Database Design and Modeling](#), by Uwe Deichmann, UCSB, an overview of issues and options for the development of population related databases, including discussion of critical demographic variables required for integrated spatial analysis and modeling approaches for reconciling population data with other geographically referenced databases.

[96-4: Creation of a Comprehensive Managed Areas Spatial Database for the Conterminous United States](#), by R. Gavin McGhie, UCSB, describes the methodology employed and problems encountered in creating the Managed Areas Database (MAD), a GIS database containing spatial extents for all types of managed areas including land held by federal, state, tribal and private agencies and organizations.

[96-5: Research Initiative 15: Multiple Roles for GIS in US Global Change Research](#) - Report of the Second Specialist Meeting, by Michael F. Goodchild and John E. Estes, UCSB, Kate Beard, U Maine, and Tim Foresman, U Maryland-Baltimore County, summarizes the informal presentations and discussions held on advanced geographic data models for global change research and the meeting's conclusions.

[96-6: Critical Issues in GIS-Based Educational Module Development: NCGIA's ArcView-based Color Your World Module](#), by Steve Palladino and Paul Van Zuyle, UCSB, provides a framework for the development of GIS based education modules for K-12 schools, discusses critical design and process issues.

[96-7: GIS and Society: The Social Implications of How People, Space, and Environment are Represented in GIS](#) - Scientific Report for the Initiative 19 Specialist Meeting, by Trevor Harris and Daniel Weiner, West Virginia U, summarizes the meeting discussions and outlines four continuing research projects.

[96-8: Spatial Theory for the Integration of Resolution-Limited Data](#), by Beat (Bud) P. Bruegger, Swiss Federal Institute of Technology, addresses the integration of data sets of different levels of resolution and different formats (i.e. raster and vector)

[96-9: Conference on Object Orientation and Navigable Databases: Report of the Meeting](#), by Richard Church, Thomas Cova and Michael Goodchild, UCSB, and Ramez Gerges, Caltrans, reports on the conference objectives, discussion and conclusions. Includes a participants' list and background papers presented.

[96-10: Spatial Technologies, Geographic Information, and the City](#), compiled by Helen Couclelis, UCSB, is a research conference report, includes an outline for a national research agenda.

[96-11: Modeling Behavior of Geographic Objects: An Experience with the Object Modeling Technique](#), by Nectaria Tryfona and Dieter Pfoser, U Maine and Thanasis Hadzilacos, University of Patras, Greece, presents the semantics and graphical notation for a prototypical object-oriented model for the conceptual design of spatial databases supporting semantic interoperability.

[96-12: GIS Laboratory Exercises: Introduction to GIS, 2nd edition](#), by Jeremy Taylor, Jane Fletcher, and Karen Kemp, UCSB an update of Report 91-12 with data and exercises for introductory GIS courses, written for use with *Idrisi for Windows* and *ArcView 2*. Note: *ArcView* data is part of the standard software installation.

[97-1: Multipurpose Land Information Systems Development Bibliography: A Community-wide Commitment to the Technology and its Ultimate Applications](#), by David L. Tulloch, Bernard J. Niemann, Jr., and Stephen J. Ventura, U Wisconsin-Madison, and Earl F. Epstein, Ohio State U, brings together literature covering the many aspects of MPLIS development, including initiation, implementation, operation and maintenance.

[97-2: Formal Models of Commonsense Geographic Worlds](#): Report on the Specialist Meeting of Research Initiative 21, by David M. Mark, SUNY-Buffalo, and Max J. Egenhofer and Kathleen Hornsby, U Maine, documents the discussions held during the meeting in San Marcos TX, 30 Oct-3 Nov, 1996. It includes a set of researchable questions that forms the basis for future research in this area.

97-3: Report on the ICA Workshop on Map Generalization, by William A. Mackaness, U Edinburgh, Robert Weibel, U Zurich, and Barbara P. Battenfield, U Colorado, reports on the discussions and key findings of a workshop held in Gävle Sweden, 19-21 June 1997. Discussion focused on impediments to automated map generalization, the current state of knowledge and progress on specific problem areas.

97-4: Spherekit: The Spatial Interpolation Toolkit, developed by Robert G. Raskin, Jet Propulsion Laboratory, Pasadena, CA, Christopher C. Funk, UCSB, and Scott R. Webber, U Delaware, conceived by Cort J. Willmott, U Delaware, is a reference guide to a software toolkit for performing spatial interpolation over continental regions or the whole earth by computing distances and orientations from geodesics on the surface of the globe. Software is available on this website.