

# UC Santa Barbara

## NCGIA Closing Reports on Research Initiatives and Projects

### Title

Approved Research Initiatives, 1988 - 1995

### Permalink

<https://escholarship.org/uc/item/2vg03732>

### Author

National Center for Geographic Information and Analysis

### Publication Date

1996-04-01

***NCGIA***

---

**National Center for Geographic  
Information and Analysis**

*Approved  
Research Initiatives  
1988-1995*

April 1996

---

## **NCGIA Research Initiatives**

- I-1 Accuracy of Spatial Databases
- I-2 Languages of Spatial Relations
- I-3 Multiple Representations
- I-4 Use and Value of Geographic Information
- I-5 Architecture of Very Large Spatial Databases
- I-6 Spatial Decision Support Systems
- I-7 Visualization of the Quality of Spatial Information
- I-8 Formalizing Cartographic Knowledge
- I-9 Institutions Sharing Geographic Information
- I-10 Spatio-Temporal Reasoning in GIS
- I-12 Integration of Remote Sensing and GIS
- I-13 User Interfaces for GIS
- I-14 GIS and Spatial Analysis
- I-15 Multiple Roles for GIS in U.S. Global Change Research
- I-16 Law, Public Policy, and Spatial Databases
- I-17 Collaborative Spatial Decision Making
- I-19 The Social Implications of How People, Space, and Environment are Represented in GIS

The National Center for Geographic Information and Analysis is supported by a grant from the National Science Foundation (SBR 88-10917). This support is gratefully acknowledged.

*Designed by Pat Shyhalla, NCGIA Buffalo*

---

## What is a Research Initiative ?

*The Research Initiative is the principal vehicle for focused research by the NCGIA. Research Initiatives provide a mechanism for selecting high-priority topics from the research agenda, scheduling and staffing them, building cooperation with researchers outside the Center and involving them directly in the Center's work, and bringing research to closure in a timely and effective fashion. The Initiative life cycle has evolved steadily since the Center's inception through experience, advice from the NCGIA Board of Directors and external consultants, peer and panel reviews solicited by the National Science Foundation, and informal comments received.*

*The Research Initiative begins with a Specialist Meeting which brings together national and international experts in the field to discuss the topic in question and to prioritize and pursue a research agenda both within and outside the Center. These Specialist Meetings generally include presentations by experts about important ideas which already define the field and provide the opportunity for constructive brainstorming. In addition to academic researchers, representatives from industry and government have always been important participants at Specialist Meeting, contributing their practical viewpoints and concerns. The published research agenda resulting from these meetings have been one of the Center's more important contributions to the development of GIS research.*

*Research activities continue through structured research by faculty and graduate students at all three sites; by proposals leading to in-depth research funded by federal agencies and institutions, often involving cooperation with researchers outside the consortium; and, through the organization of workshops, working groups and conferences.*

Scientific Reports from Initiative Specialist Meetings, Initiative Closing Reports, and other publications are available as part of the NCGIA Technical Papers Series. More information is posted on the WWW at:

<http://www.ncgia.ucsb.edu/pubs/publications.html>

To obtain NCGIA Technical Papers and other documents by mail, please contact:

NCGIA, 3510 Phelps Hall, University of California

Santa Barbara, CA 93106-4060

email: [ncgiapub@ncgia.ucsb.edu](mailto:ncgiapub@ncgia.ucsb.edu)

---

### **Initiative 1: Accuracy of Spatial Databases**

[Leader: Michael Goodchild (Santa Barbara) - begun December 1988, closed October 1990]

This initiative focused upon methods and techniques for dealing with error and uncertainty in geographical data. Such a concern for error and uncertainty has characterized spatial analysis for the last 30 years but it has become critical as models and techniques begin to be applied fairly extensively in professional work often through the vehicle of GIS. The major goals of this initiative, as initially defined through the specialist meeting with which it began, were to improve models of uncertainty, to develop methods for tracking and encoding errors in databases, to formulate methods of computing and communicating error in GIS products, and to develop policies that encourage the implementation of accuracy assessment. In particular, the initiative concentrated on seven key areas which were supported within the Center and without by graduate and faculty research. These areas involved: data structures and models, particularly those involving new methods of data resolution and transformation; models of error and distortion using modeling and simulation; error propagation, product uncertainty and sensitivity; accuracy and risk; experimentation and measurement; interpolation and surface modeling; aggregation, disaggregation and the modifiable areal unit problem.

### **Initiative 2: Languages of Spatial Relations**

[Co-Leaders: David Mark (Buffalo) and Andrew Frank (Maine) - begun January 1989, closed October 1990]

This initiative had as its broad aim the development of an appropriate fundamental theory of spatial relations using natural language and mathematics, based on the formalization of geometric concepts as they are used in GIS and the cognitive aspects of spatial relations. There were twelve related areas which emerged as directions for research from the specialist meeting. These were: computational models of locative expressions; driving directions and narrative theory as a basis for assessing spatial orientation and perception; acquisition and the representation of spatial knowledge; vehicle navigation aid systems; user interfaces for GIS (which evolved into Initiative 13); metaphors for user interfaces; visualization of spatial information (leading to Initiative 7); algebras of space and morphisms between spaces; formal definitions of topological relations; metrical relationships; and qualitative reasoning about space and query languages.

---

### **Initiative 3: Multiple Representations**

[Leader: Barbara Battenfield (Buffalo) - begun February 1989, closed October 1990]

Many databases must include multiple representations of the same field, feature or object so that the data can be generalized at different spatial scales. Of central importance is the need to organize multiple topological and metrical versions of the same data for efficient access, and the implementation of linkages between multiple representations. Rules to ensure consistency and accuracy in cartographic and other forms of generalization are thus central to this research quest. There are five areas which were defined for research from the specialist meeting and these were: data models; linkages between multiple representations; maintenance of materialized views; spatial modeling issues; generalization issues; and problems posed by multi-agency, multi-scale demands for and of data.

### **Initiative 4: The Use and Value of Geographic Information**

[Co-Leaders: Harlan Onsrud (Maine) and Hugh Calkins (Buffalo) - begun May 1989, closed April 1992]

Goals of this initiative were to improve models for tracking the use of geographic information, to expand methods for assessing the value and benefits of geographic information, to formulate methods for better understanding the factors and processes affecting acquisition, implementation, and utilization of geographic information innovations, and to advance methods for modeling the diffusion of geographic information technologies. Several tracer studies and a nationwide survey of local government GIS users were analyzed to identify the critical factors and processes for the class of users tested, to formulate a model of adoption success, and to test the efficacy of the theoretical framework in evaluating the use and value of geographic information innovations. Another research team had postulated that a realistic determination of the economic value of geographic information can most readily be accomplished through a better understanding of the use of the information and the factors which influence the ability of decision makers to use the information. Through in-depth case studies, they worked to develop a use model framework to which quantitative value measures may be more realistically attached.

---

### **Initiative 5: Architecture of Very Large Spatial Databases**

[Co-Leaders: Terence Smith (Santa Barbara) and Andrew Frank (Maine) - begun July 1989, closed August 1992]

This initiative focused on the set of problems posed by very large spatial databases, particularly those anticipated to become available in the 1990s such as those from the EOS program of the NASA. Rates of data generation were becoming far greater than were the current capabilities for their processing and thus the effective processing, storage, manipulation and analysis of such datasets would require radically new approaches to data models, structures, algorithms and user interfaces. Ten themes for research were identified from this initiative and these involved: spatial algebras underlying new approaches to spatial databases; managing changes in such databases in terms of propagation and transactions management; parameterized models of such data; logic based query and manipulation languages; constraint satisfaction for dataset search; metadata content and organization; lineage data; browsing capabilities; data compression; and tiling schemes.

### **Initiative 6: Spatial Decision Support Systems (SDSS)**

[Co-Leaders: Paul Densham (Buffalo) and Michael Goodchild (Santa Barbara) - begun March 1990, closed April 1993]

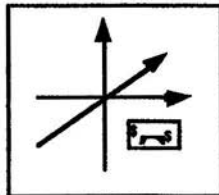
This initiative examined the possible role of GISs and associated techniques in the decision-making process, emphasizing the notion that GISs only provide rudimentary support for decision-making and that more sophisticated methods of decision support are required. Four research themes emerged from the specialist meeting namely: optimal schema for decision support in areas of ill-defined problem-solving; modeling and data requirements for SDSS; technology and the implementation of SDSS; and user requirements and organizational issues. The issues defined involve a wide range of application areas although the research domains discussed at the specialist meeting were narrowed to marketing, retailing, location theory, and socioeconomic models.

---

## Initiative 7: Visualizing the Quality of Spatial Information

[Co-Leaders: Kate Beard (Maine) and Barbara Battenfield (Buffalo) - begun June 1991, closed November 1993]

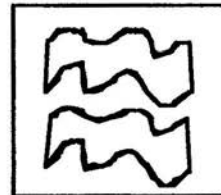
The quality of spatial data and databases is a major concern for developers and users of GIS. All information which is subject to display in GIS, from bedrock geology to cancer statistics and market data, can be characterized in terms of its quality which may vary with location and with the domain of measured variables. The quality of spatial information products is multidimensional, and relates to accuracy, precision, consistency, currency and completeness. The goal in this research initiative was to focus on effective means of managing and visually communicating components of data quality to researchers, decision-makers, and users of spatial information, particularly in the context of GIS. Four themes were identified for the specialist meeting: data quality components (error modeling and derivation of indices of data quality); data models and database issues (management of data quality within databases during manipulation and update); representational issues (visual tools to facilitate internal representation and graphical display); and evaluation of user needs (assessment of the tools and algorithms, and analysis of user demands for data quality information).



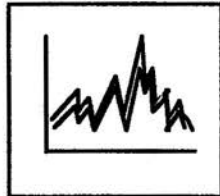
Spatial Currency



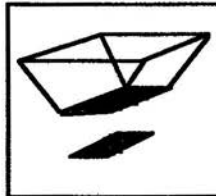
Logical Consistency



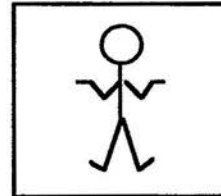
Comparability



Covariability



Resolution



Uncertainty

*Icons developed during the specialist meeting as an outcome of a game of pictorial using common data quality terms.*



---

### **Initiative 8: Formalizing Cartographic Knowledge**

[Leader: Barbara Buttenfield (Buffalo) - begun October 1993, closed August 1995]

The goal of this initiative was to identify and pursue research needs in automated map compilation, generalization and production. Particular emphasis was put on those problem domains where knowledge representation or formalizing rules and criteria will improve the efficiency, accuracy, or consistency of digital cartographic data, cartographic representation or cartometric analysis. The objectives of this initiative, as determined in the specialist meeting, were: formalizing a cartographic language (definition of terms/elements, labels for transformations, and knowledge representations for design and manipulation); formalizing evaluation of design (measures of efficiency/accuracy, modeling communication); knowledge acquisition/elicitation (modeling users knowledge, acquiring knowledge from redesigned user interfaces, new methods to elicit knowledge, reverse engineering and inventory of maps and industrial mapping specifications); and structuring/modeling knowledge (embedding knowledge in data models, exploring promising representations for knowledge, applying complex operators to novel data structures, and developing mechanisms to guide use of knowledge, metaknowledge, and data structures for efficient update).

### **Initiative 9: Institutions Sharing Geographic Information**

[Co-Leaders: Harlan Onsrud (Maine) and Gerard Rushton (San Diego State) - begun February 1992, closed July 1995]

Geographic information is used to satisfy many needs. These include the needs of those who make location-related decisions (i.e. all levels of government and the private sector), scientists and educators. Often, satisfaction of these needs requires knowledge of and access to data and information held by others. This initiative was organized around the issues and problems of sharing geographic information and the technologies which enable this sharing to be made more effective. The three primary components of the research framework include: theories of individual and organizational behavior (particularly their relevance in understanding impediments and incentives to the sharing of information); the arenas among which sharing of spatial data occurs, could occur, or could be enhanced; and observations of the process of spatial data sharing in existing settings. Ultimately, these three components must be brought together to produce models of behavior in regard to spatial data sharing. These results, in turn, should be useful in developing normative proposals for successful spatial data sharing in specific situations.

## Initiative 10: Spatio-Temporal Reasoning in GIS

[Co-leaders: Max Egenhofer (Maine) and Reginald Golledge (Santa Barbara) - begun May 1993]

This initiative concentrates on geographic space, time, and change related to bounded objects in geographic space. Its overall goal is to increase our understanding of reasoning processes that apply to geographic space and time. It builds on efforts of behavioral geography, cognitive science, and environmental psychology and we plan to expand them in a strongly computational (i.e. formalized) framework. The objectives of this initiative are to: study spatial applications to identify properties of different time concepts such as continuous, discrete, monotonic, and cyclic; explore alternative mathematical formalizations to Cartesian coordinates and Euclidean geometry, which represent spatial and temporal reasoning processes better; formalize human reasoning processes about geographic space and time; build computational frameworks, within which geographic phenomena and processes and their temporal changes, can be simulated; examine computational reasoning methods with observations from human subject experiments about human spatial and temporal perception and cognition.

1

"The road crosses the park"						
strongly disagree	1	2	3	4	5	strongly agree

5

"The road crosses the park"						
strongly disagree	1	2	3	4	5	strongly agree

2

"The road crosses the park"						
strongly disagree	1	2	3	4	5	strongly agree

6

"The road crosses the park"						
strongly disagree	1	2	3	4	5	strongly agree

*Four of the stimuli (the top half of the first page of the test instrument) used in the experiment designed to evaluate the concept of a linear feature "crossing" an area feature.*

---

### **Initiative 12: Integration of Remote Sensing and GIS**

[Co-Leaders: John Estes, Frank Davis and Jeffrey Star (all at Santa Barbara) - begun December 1990, closed April 1994]

Remotely sensed images continue to offer a cost effective and popular source of data for GISs. At the same time, GIS data is increasingly used as a means of improving image classification. The objectives of this initiative were to identify impediments to the fuller integration of remote sensing and GIS, to develop a prioritized research agenda to remove these impediments, and to conduct or facilitate research on topics of highest priority. Discussion at the specialist meeting was concentrated around five issues: institutional issues; data structures and access; data processing flow; error analysis; and future computing environments. Research involved several specific topics, including error propagation during raster/vector conversions, improved methods for registration of multitemporal AVHRR imagery, spatial analysis of multiscale map and image data, and use of ground, map and image data in mesoscale land surface climatological models.

### **Initiative 13: User Interfaces for Geographic Information Systems**

[Co-Leaders: David Mark (Buffalo) and Andrew Frank (Maine) - begun June 1991, closed March 1994]

This initiative addressed human-computer interaction methods and related issues in the design and implementation of user interfaces for GIS and other geographical software. This initiative was introduced partly in response to the URISA research agenda, and partly as a natural outgrowth of the applied side of Initiative 2 ('Languages of Spatial Relations'). Specifically, cognitive and linguistic models dealing with geographic space were formalized and further developed in order to provide a sound basis for the design and evaluation of user interfaces. The research initiative had as its broad goals: to investigate ways for people to interact with computers when solving problems concerning geographic space and spatial phenomena; to model some of the ways in which disciplinary background and training, problem domain, culture, natural language and individual differences influence such interaction; to establish criteria and methods for the design of user interfaces for geographic software; and to devise and test prototype interface development tools.

---

### **Initiative 14: GIS and Spatial Analysis**

[Co-leaders: Stewart Fotheringham and Peter Rogerson (both at Buffalo) - begun April 1992, closed May 1995]

There is an increasing demand for GISs to include the ability to analyze the spatial data which they store and display. However, traditional forms of statistical analysis are often unsuitable for spatial applications, or are not easily generalizable to the spatial domain. Space, being more than unidimensional, creates a unique set of problems and impediments to the analyst. This initiative focused upon the statistical analysis of geographic data. In addition to specific spatial statistical techniques (such as point pattern analysis and spatial regression analysis), the initiative also focused upon spatial statistical problems of a general nature. Examples of these more general problems include the effects of geographic boundaries and geographic scale on parameter estimation, the problems associated with spatial sampling and spatial interpolation, and the relationship between GIS data structures and the computation of spatial statistics.

### **Initiative 15: Multiple Roles for GIS in US Global Change Research**

[Co-leaders: John Estes and Michael Goodchild (Santa Barbara), Kate Beard (Maine), and Tim Foresman (University of Maryland) - begun March 1995]

GIS and related technologies can play an increasingly important role in global change research. In particular, GIS is seen as a vehicle for collecting, manipulating, and preprocessing data for models; for integrating data from disparate sources with potentially different data models, spatial and temporal resolutions, and definitions; for monitoring global change at a range of scales; and for visual presentation of the results of modeling in a policy supportive, decision-making environment. The research under this initiative will contribute to the development of a comprehensive, quantitative understanding of global change through enhanced use of GIS and spatial data analysis. Its major scientific objectives are: to identify technical impediments and problems that obstruct our use of GIS in global change research and our understanding of interactions between human systems and regional and global environmental systems; to develop methods for dynamically linking human and physical databases within a GIS and for exploring the regional impacts of global change; to develop theoretical/computational structures capable of building up from knowledge at smaller spatial scales and lower levels of aggregation; to assess critically the quality of existing global data in terms of spatially varying accuracy, sampling methodologies, and completeness of coverage; and develop improved methods for analysis and visualization of such data.

---

### **Initiative 16: Law, Information Policy and Spatial Databases**

[Co-leaders: Harlan Onsrud (Maine) and Robert Reis (Buffalo) - begun October 1994]

Geographic information systems (GIS) and their associated databases are significant technological advances substantially affecting the operation of government and business. Current handling of GIS data is raising numerous questions regarding the bounds of appropriate use of such data. Because of the great value of digital spatial data, its potential for altering government's relationships with citizens, and its potential for intrusiveness, concerns over the handling of digital spatial data will be substantial factors in society's reconciliation of competing social, economic, and political interests in electronic data generally. The major scientific objectives of this initiative are to advance scientific understanding of the law and information policy within spatial database environments; raise the quality and content of the debate about law and GIS by identifying issues in concrete terms with a high degree of specificity; observe the law in action in order to explore the effects of large-scale, interconnected, and readily accessible spatial databases on public information policy and law; identify emerging problems at the interface of law, information policy, and spatial databases in order to address those problems prospectively; and divulge, test and contribute knowledge useful in the improvement of public policy and formulation of law with respect to the use of spatial databases and related technologies.

### **Initiative 17: Collaborative Spatial Decision Making**

[Co-leaders: Paul Densham (London), Marc Armstrong (Univ. of Iowa) and Karen Kemp (Santa Barbara) - begun September 1995]

Many spatial problems are intrinsically complex and require an interdisciplinary approach to their solution. Consequently, individuals often collaborate on developing solutions to these problems, working as members of a committee or task force. It is in supporting this collaboration that existing spatial decision support systems are weakest: they are not designed explicitly to provide tools that enable groups to develop and evaluate alternative solutions to complex spatial problems. The purpose of this initiative, therefore, is to extend current conceptual frameworks for spatial decision support systems (SDSS) to help groups of decision-makers generate tractable solutions to ill-defined spatial problems. A specific point of emphasis will be placed on integrating SDSS with new computer supported cooperative work (CSCW) environments. Such environments enable groups of people to work together by providing a set of generic tools that handle many of the tasks that are required of group enterprises: exchange of textual, numerical and graphical information; and group evaluation, consensus building and voting. Focal areas

---

for research are: methods to elicit, capture and manipulate knowledge bases that support individual and collective development of alternative solutions to spatial problems; development of mechanisms for evaluating and comparing alternative spatial solutions; improving decision-makers' interaction with spatial analysis through group-based user interfaces and visualization and display tools; identification, selection and incorporation of methods for resolving spatial conflicts in interactive CSDM environments.

### **Initiative 19: The Social Implications of How People, Space, and Environment are Represented in GIS**

[Co-leaders: Trevor Harris and Daniel Weiner (both of West Virginia University) - begun March, 1996]

The primary objective of this initiative is to develop and support research in which GIS developers and practitioners on the one hand, and critics and social theorists concerned with the nature of GIS use on the other hand, can work together. It is in this context that this initiative is concerned with three broad research themes involving GIS production and use. These are: the administration and control of populations; locational conflict involving disadvantaged populations; and, the political ecology of natural resource access and use. The central goals of the initiative are to: examine how data availability and visualization techniques influence the ways in which natural resources and society are represented in GIS; examine what limits to representation may be intrinsic to the logic of GIS; determine how the representations of environment and society in GIS influence the questions posed, and solutions proposed in practical applications; determine whether and how the knowledge, views, and needs of those affected by the application of GIS can be represented adequately in conflictual social situations where GIS is used as a decision-making tool; examine to what degree new functionalities of GIS may allow the limits of current representations to be extended; investigate the degree to which the application of GIS can be democratized by placing the technology in the hands of a broader spectrum of society; and, investigate (drawing on Initiative 16: Law, Public Policy and Spatial Data Bases) the ethical and legal implications of related activities.

---

## Proposed Future Research Initiatives

### **Initiative 20: Interoperating Geographic Information Systems**

[Co-Leaders: Max Egenhofer (Maine) and Mike Goodchild (Santa Barbara)]

The advent of an open software design philosophy dramatically changes the way GIS software is designed and provides new opportunities for users for integrated analyses. The objectives of this proposed initiative are to define different alternative GIS architectures that would allow for open, distributed access to geographic information; develop new methods (in addition to data exchange standards and current metadata approaches) that will better capture the semantic and linguistic/cultural particularities of geographic information in order to publish, share, and integrate geographic data; design abstract, high-level spatial data models and process models suitable for a wide range of application domains; model the process of search for geographic data and processes and define metrics for assessing fitness of use; develop a benchmark for current systems with respect to usability and level of semantic gaps; investigate the fundamental granularity of geographic data; and examine how an open GIS architecture will make the use of GISs easier for scientists.

### **Initiative 21: Formal Models of the Common Sense Geographic World**

[Co-Leaders: David Mark (Buffalo) and Max Egenhofer (Maine) - to begin October 1996]

The objective of this initiative is to formalize the body of knowledge that people have about their surrounding geographic worlds. Formalization of such a 'Naive Geography' will contribute both to theoretical geography and to geographic information science. The work also will provide the basis for designing future GIS that follow human intuition more closely, and thus will be more easily accessible to the large range of users that are expected to use GIS in their homes, automobiles, and offices in the information age. The preliminary objectives of Initiative 21 are 1) to identify basic elements of common-sense conceptualizations of geographic space, entities, and processes, and develop an integrating framework; and 2) to investigate GIS users' reactions to intuitive geographic inferences, and compare inferences with the results obtained with current GIS technology. These two objectives will be mutually supportive only if they are closely integrated to ensure that mathematically sound models are tested, and that results from tests are brought back to refine the models. If GISs can achieve geographic reasoning in a manner similar to a human expert, these systems will be much more valuable tools for a large range of users, such as family members planning their upcoming vacation trip, scientists analyzing their data collections, or business people investigating how their organizations have performed in various geographic markets.

---

## Life Cycle of an Initiative

### Example: I-9 Institutions Sharing Geographic Information

- 12/90 *Draft Plan* for the initiative presented to Board of Directors
- 4/91 *Pre-Specialist Meeting* held in Chicago with 10 participants, reviewed initiative background, developed a series of scientific questions, outlined the scope of the initiative and considered ways of facilitating non-NCGIA participation
- 6/91 *Detailed planning document* presented to Board of Directors, established steering committee
- 8-9/91 *Open call* for participation distributed and published in magazines, newsletters and electronic bulletin boards
- 11/91 *Abstracts reviewed* by 6 referees, 24 accepted from 47 submissions
- 1/91 *Full position papers* due
- 2/91 *Specialist Meeting* held in San Diego with over 30 participants
- 4/91 *Meeting Report* prepared
- 91 to 94 *Research phase:*
- special sessions and keynote speeches presented at various conferences
  - related dissertation topics developed at two NCGIA sites, several journal articles published by graduate students and faculty at all sites
  - related research conducted at U. Iowa, U. Wisconsin and Ohio State U.
  - visiting researchers at all NCGIA sites work on issues related to I-9
  - NCGIA works with USGS to identify framework datasets for NSDI
  - Annual GIS bibliography first published in 1991, continues annually in on-line version
- 7/95 *Initiative closed* at URISA conference
- 1995 *Book published:* H.J. Onsrud and G. Rushton, eds., *Sharing Geographic Information*, CUPR-Rutgers, Piscataway, NJ
- 12/95 *Closing report compiled*
- 6/96 *Closing report presented* to Board of Directors
- Ongoing research:*
- important issues raised in I-9 have been carried forward to inform later NCGIA initiatives, including I-15, 16, and 17



---

*For further information, please contact:*

**National Center for Geographic Information and Analysis  
University of California  
3510 Phelps Hall  
Santa Barbara, CA 93106-4060  
Phone: (805) 893-8224  
Fax: (805) 893-8617  
ncgia@ncgia.ucsb.edu**

**National Center for Geographic Information and Analysis  
State University of New York at Buffalo  
301 Wilkeson Quad  
Buffalo, NY 14261-0023  
Phone: (716) 645-2545  
Fax: (716) 645-5957  
ncgia@ubvms.cc.buffalo.edu**

**National Center for Geographic Information and Analysis  
University of Maine  
5711 Boardman Hall  
Orono, ME 04469-5711  
Phone (207) 581-2149  
Fax: (207) 581-2206  
ncgia@spatial.maine.edu**

On the WWW at <http://www.ncgia.ucsb.edu>

*April 1996*