

UC Santa Barbara

NCGIA Closing Reports on Research Initiatives and Projects

Title

The National Center for Geographic Information and Analysis—Illustrated Report

Permalink

<https://escholarship.org/uc/item/84m1k9r4>

Author

National Center for Geographic Information and Analysis (UC Santa Barbara, SUNY at Buffalo, University of Maine)

Publication Date

1995-04-01

The
NATIONAL
CENTER
FOR
GEOGRAPHIC
INFORMATION
AND ANALYSIS

Table of Contents

Introduction	1
A Center for Research	3
Research Initiatives	5
Shared Resources	6
A Center for Society and Its Environment	
For the Nation	9
For the World	10
A Center for Education and Outreach	
NCGIA Core Curriculum	13
Secondary Education Project	14
Workshops for Teachers	14
Professional Training	14
The NCGIA—Who We Are	
Director	
Michael Goodchild	17
Associate Directors	
Helen Couclelis	18
Michael Batty	19
Max Egenhofer	20
The Executive Committee	21
The Scientific Policy Committee	21
NCGIA Board of Directors	21
The Three Sites of the NCGIA	
University of California at Santa Barbara	22
State University of New York at Buffalo	24
University of Maine	26
Who to Contact	28

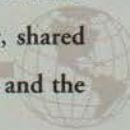


The National Center for Geographic Information and Analysis (NCGIA) is a consortium comprised of the University of California at Santa Barbara, the State University of New York at Buffalo, and the University of Maine, with funding from the National Science Foundation. The Center serves as a focus for activities relating to geographic information systems (GIS), a technology which is utilized in a tremendous variety of applications from oil-spill management to recovery and damage assessment for the fires that ravaged Southern California in the fall of 1993, to detailed mapping and analysis of artifacts from archeological excavations around the world, or local electrical-utility inventory and management.

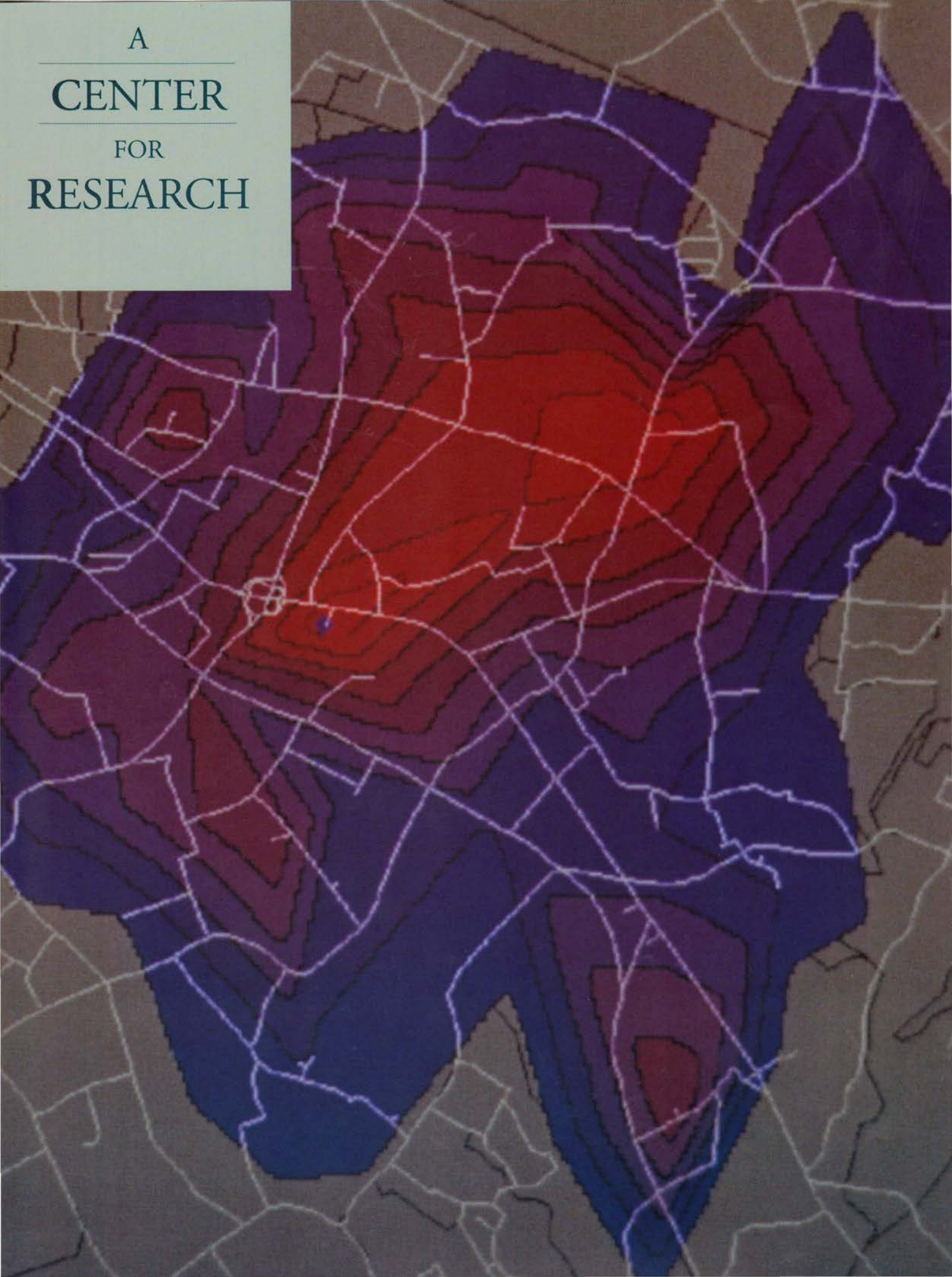
The NCGIA conducts basic research on geographic analysis using GIS. Although GIS technology helps us solve many problems, it also reveals to us problems which may be even more difficult to answer: problems relating to inadequacies in geographic data, errors and uncertainties, and the lack of effective methods for spatial decision making. NCGIA research gives particular emphasis to removing the impediments which have stood in the way of GIS being adopted for even more widespread use and benefit to society and the environment.

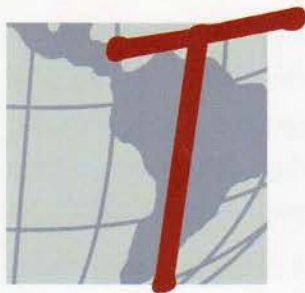
The NCGIA is truly a shared resource fostering collaborative and multidisciplinary research with scientists across the United States and the world. Center researchers are working towards a global vision in our approach to dealing with questions of concern to people or the environment. We are very proud of our achievements as a center of education with widespread curriculum development efforts and training opportunities for both teachers and students across the United States.

Taken together, research, facilities, collaborative work, education and outreach efforts, and technology transfer make the NCGIA a very diverse and productive national center, shared by the research community and society. This report will introduce you to our Center and the varied facets of its nature.



A
CENTER
FOR
RESEARCH





he research program of the NCGIA has sought to advance the theory, methods, and techniques of geographic information systems (GIS) and especially to promote basic research on geographic analysis using GIS. The Center was established in 1988 with the directive from the National Science Foundation (NSF) to carry out fundamental research within five key areas:

- spatial analysis and spatial statistics
- spatial relationships and database structures
- artificial intelligence and expert systems
- visualization
- social, economic, and institutional issues

This research is being undertaken with a view to removing significant impediments that lie in the way of the use of GIS as a tool, such as the inadequate ability to deal with the massive volumes of spatial data becoming available from remote sensing and other automated data-collection technologies, or the inadequate level of understanding of the role of geographic information in decision making. This research agenda has fueled a wide interest in topics relating to these research areas, and encouraged researchers in universities all across the United States to consider the problems of geographical analysis involving GIS, creating a very active community of scholars dedicated to GIS research.

As the Center matured and its research program gained momentum, the research agenda has increasingly reflected the needs and demands of society. The five original categories for research evolved into three broad areas: spatial representation, spatial analysis, and spatial informatics. *Representation of spatial information* focuses on the nature of geographic phenomena, data models, data structures and database issues, languages of geographic data modeling, and topics relating to knowledge representation. *Spatial analysis* refers to the analytic models which represent patterns and processes in geographic space, and incorporates areas pertaining to spatial inference processes, data quality, error propagation, and lineage. The NCGIA research agenda also seeks to address applications of geographic information and information systems involving topics relating to human-computer interaction, visualization and graphics, economic and legal aspects of the technology, impacts on science and on society, and many others included under the broad heading of *spatial informatics*.

Recognizing the importance of technologies to exchange and communicate spatial and visual data in the information society, the NCGIA supports pilot projects relating to the *National Spatial Data Infrastructure*, and considers policy-oriented research at both a national and global level. Efforts in the area of law, and information policy for spatial databases, will address access rights of citizens to publicly held spatial information, intellectual property rights in spatial databases, privacy rights and principles, and liability in the use, sharing, and distribution of geographic data and analysis results.



The NCGIA is taking a leadership role in supporting fundamental research directed at domain-specific applications of geographic analysis. As increased access to spatial information technologies changes the way researchers and practitioners think about their science, the NCGIA is forging links with individuals and organizations working in subject areas where spatial information technologies are of central importance. This includes such fields as environmental modeling, global change, ecology, transportation, and urban planning, as well as areas of more basic inquiry such as anthropology, history, and economics.

The NCGIA is uniquely placed to assist industry and other groups in undertaking research on specialized subjects relating to GIS. At the University of California, major companies such as IBM Corporation and Hitachi America Ltd. participate in programs where researchers are resident on site, and can take advantage of the computing facilities, academic environment, and new work going on in the Center. All three sites collaborate regularly with the National Science Foundation and other federal agencies such as the U.S. Geological Survey, Defense Mapping Agency, Bureau of Land Management, Environmental Protection Agency, and the Soil Conservation Service.

NCGIA researchers typically publish over one hundred articles in refereed journals and conference proceedings per year. In the past five years, some fifteen books have been edited or co-authored by NCGIA researchers. The key research personnel are also regularly invited to attend conferences and meetings all over the world. At present, members of the NCGIA are on the editorial boards of such journals as *Cartography and Geographic Information Systems*, *Computers, Environment and Urban Systems*, *Environment and Planning B*, *International Journal of Geographical Information Systems*, *Journal of the Urban and Regional Information Systems Association*, and *Photogrammetric Engineering and Remote Sensing*.

Very Large Spatial Databases—A Case in Point

During the past decade, the international scientific community has been concerned with the subject of how best to utilize the huge quantities of information being generated through techniques such as remote sensing by satellite. Efforts have been organized under the International Council of Scientific Unions to consider the problems associated with extracting and then sharing the information from these immense and rapidly expanding computer databases. The NCGIA has been much involved with research on topics relating to very large spatial databases, and in 1989 researchers from the University of Maine and the University of California at Santa Barbara organized the international Symposium on the Design and Implementation of Large Spatial Databases, in conjunction with scientists from the National Aeronautics and Space Administration (NASA), the Environmental Protection Agency (EPA), and the U.S. Geological Survey (USGS). The success of this effort led to the development of a series of international symposia on large spatial databases that is held biennially around the world and provides a focal point for experts in computer science, engineering, geography, and other disciplines to gather to discuss scientific issues relating to very large spatial databases. NCGIA researchers continue their work in this area with research on spatial query languages and topological relations as they relate to spatial databases.

Research Initiatives

The principal vehicle for focused research by Center members has been the Research Initiative. 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.

A 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 involve the presentations by experts of important ideas which already define the field, in addition to providing the opportunity for constructive brainstorming. Representatives from industry and government have always been important contributors at Specialist Meetings as they put forward their viewpoints and practical concerns. The published research agendas 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 for in-depth research to be funded by federal agencies and institutions, often involving cooperation with researchers outside the consortium, and through the organization of workshops, working groups, and conferences.



Life Cycle of an Initiative

Languages of Spatial Relations

Specialist Meeting: *January 1989. Considered topics relating to standard query languages, user interfaces, algebraic topology, natural language understanding, cognitive science, navigation, and way-finding.*

**NATO Advanced Study Institute
"Cognitive and Linguistic
Aspects of Geographic Space":**
*July 1990, Las Navas del Marqués,
Spain.*

Initiative Closed: *Fourth
International Symposium on
Spatial Data Handling, Zurich,
Switzerland, 1990.*

Book Published: *David Mark
and Andrew Frank (eds.) (1991)
Cognitive and Linguistic Aspects of
Geographic Space, Kluwer
Academic Publishers, Dordrecht,
Holland.*

Ongoing Research: *As an out-
growth of research on languages of
spatial relations, cognitive and lin-
guistic models dealing with geo-
graphic space are being formalized
and further developed in order to
provide a sound basis for the design
and evaluation of user interfaces.
This work has led to a new research
initiative, "User Interfaces for
Geographic Information
Systems," which began with a
Specialist Meeting in June 1991.*



Shared Resources

In the original solicitation from the National Science Foundation, the NCGIA was "...to provide a central clearinghouse for disseminating information regarding research, teaching, and applications." Since then, the NCGIA has strived to strengthen the channels of technology transfer between the U.S. research and industrial communities; to provide effective mechanisms for the development of common research agendas, and cooperation and coordination of research efforts; to identify and create opportunities to expand the U.S.'s GIS presence within the international community; and to identify and respond to opportunities presented by emerging technologies.

Increasingly, as the NCGIA continues its leadership role in research on GIS, the presence of visiting scholars at all three sites has increased dramatically. Recognizing the critical importance of creating a Center in which every GIS researcher in the United States feels they have a stake, and wishing to increase the collaboration of Center researchers with scholars from elsewhere in the GIS community, the NCGIA instigated a Visiting Fellowships Program in 1993. This program is designed specifically to support U.S. scientists not normally associated with the NCGIA and who wish to participate in NCGIA research activities for extended periods of two weeks to a year at any of the three NCGIA sites. In its first year, the Visiting Fellowships Program brought approximately twenty academics from universities across the country to all three NCGIA sites. Other researchers also came to one or other of the sites through exchange programs, sabbatical leaves, or links with private industry or research laboratories.

In addition to the Visiting Fellowships Program, the Center has also recently adopted a series of new policies and procedures to facilitate collaborative research projects. This enables U.S. scientists not associated with an NCGIA institution to propose and co-lead research initiatives and participate in specific collaborative projects in conjunction with the NCGIA.

The NCGIA has formed a collaborative effort with the GISDATA program sponsored by the European Science Foundation. A GISDATA steering committee consisting of approximately sixteen researchers who are involved in GIS research in Europe coordinates the activity of this group. To date, GISDATA has sponsored several specialist meetings on focused topics such as GIS and spatial analysis, generalization, and GIS diffusion in local government in Europe. In 1995, there will be a summer institute sponsored by ESF and NSF, to be held in the U.S., where fifty or so young researchers from both Europe and the U.S. will attend to discuss and hear presentations on advanced topics in GIS.

The Center's expertise in applying GIS to a wide range of problems has led to collaborative efforts with many research groups across the country. At SUNY Buffalo, for instance, Professor Hugh Calkins and doctoral student Frank Xia have been actively conducting research in cooperation with the Great Lakes Program, a multimillion-dollar, multi-year effort focused on

the development and application of toxic chemical exposure models in the Great Lakes and an investigation of human health risks associated with toxic substances in the Great Lakes. GIS technology has been coupled with water-quality models and an important contamination modeling framework named GEOWAMS has been the outcome of this collaboration.

At the University of California at Santa Barbara, Professor John Estes is working with NASA and USGS on the *Earth Observing System Data and Information System*. This multi-year research and development effort is directed at the acquisition, storage, retrieval, processing, and dissemination of large volumes of satellite remotely sensed and ancillary data in a variety of spatial formats to users around the world.

The interest and expertise of NCGIA personnel in computerized information systems has led to the use of electronic networks for much of the dissemination of NCGIA research results. An electronic access site for NCGIA materials exists for all three sites of the NCGIA with Internet access by using anonymous FTP procedures, Gopher, or WAIS (Wide Area Information Server) software. Materials available over the Internet network include many of the reports from the NCGIA Technical Report series, the GIS Bibliography for 1991, 1992, and 1993, and software and datafiles. In addition, NCGIA is currently setting up a new World Wide Web server to provide access to multimedia hypertext documents describing NCGIA activities. It is planned that the new server will include information on research personnel and programs, examples of current work by faculty and students, and a variety of other data. The server will be accessed with a variety of World Wide Web client software, including Mosaic for Xwindows, Macintosh, and Windows.

GIS-L, an electronic-mail discussion list concerned with topics relating to GIS, was established by Ezra Zubrow of the NCGIA at Buffalo in 1988. GIS-L is a public list, which means that anyone with electronic mail access to the Internet or connected networks may subscribe to GIS-L and subsequently receive posted material. The list currently has about 1,350 subscribers from about forty countries, and many of those are local redistribution lists so that many other readers receive GIS-L postings indirectly. A recent study indicated that during April 1994, GIS-L material reached an estimated 74,000 readers!

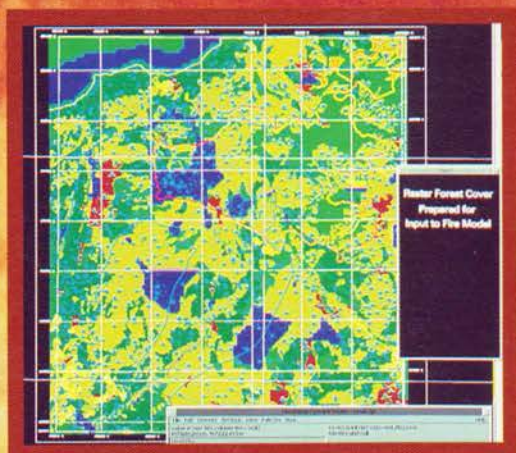
In addition to electronic forms of dissemination, the NCGIA publishes the *NCGIA Update Newsletter*, which circulates to approximately 3,500 readers from around the world. It describes the latest research activities undertaken by Center members and lists upcoming events and other items of interest for the GIS community.

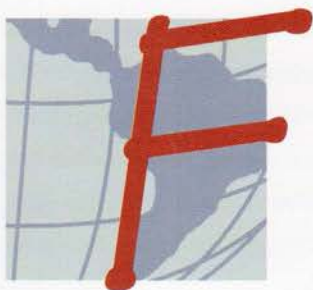


Visiting scholars (from left to right) Robert Raskin and John Odland at NCGIA-Santa Barbara.



A
CENTER
FOR
SOCIETY
AND ITS
ENVIRONMENT





or the Nation

We live in an age of information, and in recent years the nation has made unprecedented investments both in information itself, and in the means to assemble, store, process, analyze, and disseminate information. Given the high costs of these activities, it is important that policies are designed to invest and allocate resources wisely, and to ensure the greatest possible efficiency and effectiveness in the use of information.

Over the past few years, the federal government and other policy makers have focused discussion on the concept of an 'information superhighway' and, in particular, the National Spatial Data Infrastructure (NSDI), defined as "the means to assemble geographic information that describes the arrangement and attributes of features and phenomena on the Earth." The NCGIA is involved in a project to address an important issue within the overall structure of the NSDI, namely the identification of the data sets that will form the backbone of the NSDI. These are data sets that are used by many different types of applications, in many disciplines and fields, to establish geographic location to appropriate levels of positional accuracy. Normally, applications require positional accuracies from one millimeter to one kilometer, and while most applications are two dimensional, in some cases it is necessary to establish position in three dimensions. Specifically, NCGIA researchers will work towards establishing the criteria for identifying the high-priority framework data sets of the NSDI.

Another exciting application of information technology is the development of digital libraries. NCGIA is a partner with the University of California at Santa Barbara Map and Image Laboratory, ESRI (Environmental Systems Research Institute, developer of the ARC/INFO GIS), U.S. Geological Survey, and other organizations in *Project Alexandria*, an effort to develop a digital library for spatial data, accessible over the Internet and able to handle collections as small as a few map sheets, or as large as a major depository. The digital spatial data library will contain digital versions of maps and images, as well as catalog information and other means of access to data. In the long term, it is hoped that efforts such as *Alexandria* will succeed in making maps and images as accessible as other more conventional library materials such as books, and remove the need to handle maps and images separately in special libraries. Other NCGIA researchers are involved in related projects, such as Professor Barbara Battenfield from SUNY-Buffalo who has been advising the Library of Congress Geography and Map Division in Washington, D.C. on automating their map cataloging and bibliographic research operations.

NCGIA researchers have also been involved in studies on subjects that concern us all: from societal problems relating to the economy, health-care delivery, or crime, to environmental issues such as damage assessment of areas devastated by forest fires, pollution, endangered species habitats, and global environmental change. Recently, Lauretta Burke, a graduate student affiliated with the NCGIA at Santa Barbara, completed a study on race and environmental equity in the Los Angeles area.



"It was a great opportunity to see an area of GIS use/implementation/training that I could never have grasped in the classroom, and I loved meeting the resource persons from other countries who are geography (GIS) professionals, government officials, and environmental researchers (etc.). Since I want to work in the international development community when I finish my Ph.D. ... I was really honored to be able to have such an experience."

– Carmelle J. (CJ) Côté,
graduate assistant,
UNITAR/NCGIA
International Networking
Program Feasibility Study
Geneva, Switzerland, 1993

Lauretta's work examined data to determine whether racial minority and low-income communities bear a disproportionate share of exposure to pollution and environmental risk. Her utilization of GIS analysis techniques brought out striking spatial patterns in the data and showed that race and income are indeed significant variables with respect to the location of polluting industries.

In addition, the New York Rural Health Research Center has teamed up with researchers at SUNY–Buffalo who have the expertise in GIS to work on a number of projects relating rural-health data to U.S. census data, including modeling the geographic spread of HIV infection in rural areas, and modeling the spatial aspects of nurse-practitioner legislation and issues relating to practice.

For the World

As we face increasing awareness of the need to work towards a global vision and acquire a global perspective when dealing with questions of society and our environment, the NCGIA is undertaking research in areas that will aid our ability to attain a truly global understanding. Research relating to global change in climate and environment, in the global problems of the world economy, and in issues such as demographic change through aging and migration is being undertaken by Center members.

The NCGIA and the United Nations Institute for Training and Research (UNITAR) Environmental Training Programmes in Geneva, Switzerland sponsored a feasibility study for a UNITAR/NCGIA International Networking Program. This program was seen as an effort to facilitate and

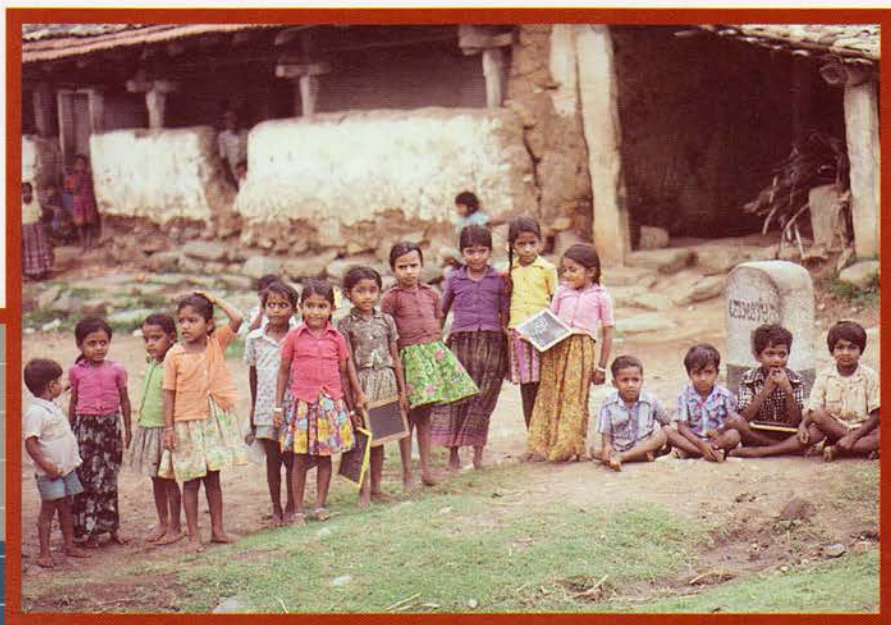


increase global and regional networking and collaboration between environmental management professionals and GIS professionals and institutions, with a focus on GIS as a tool for sustainable development. The network would include all resource persons and alumni of the UNITAR training programs, which would mean that a large number of people from many regions of the developing world would be linked to a central coordinating body for GIS-related activities. This project gave SUNY-Buffalo graduate student, Carmelle J. (CJ) Côté, the exciting opportunity of spending a summer at the U.N. in Geneva, Switzerland, as a graduate researcher and assistant to coordinate the feasibility study.

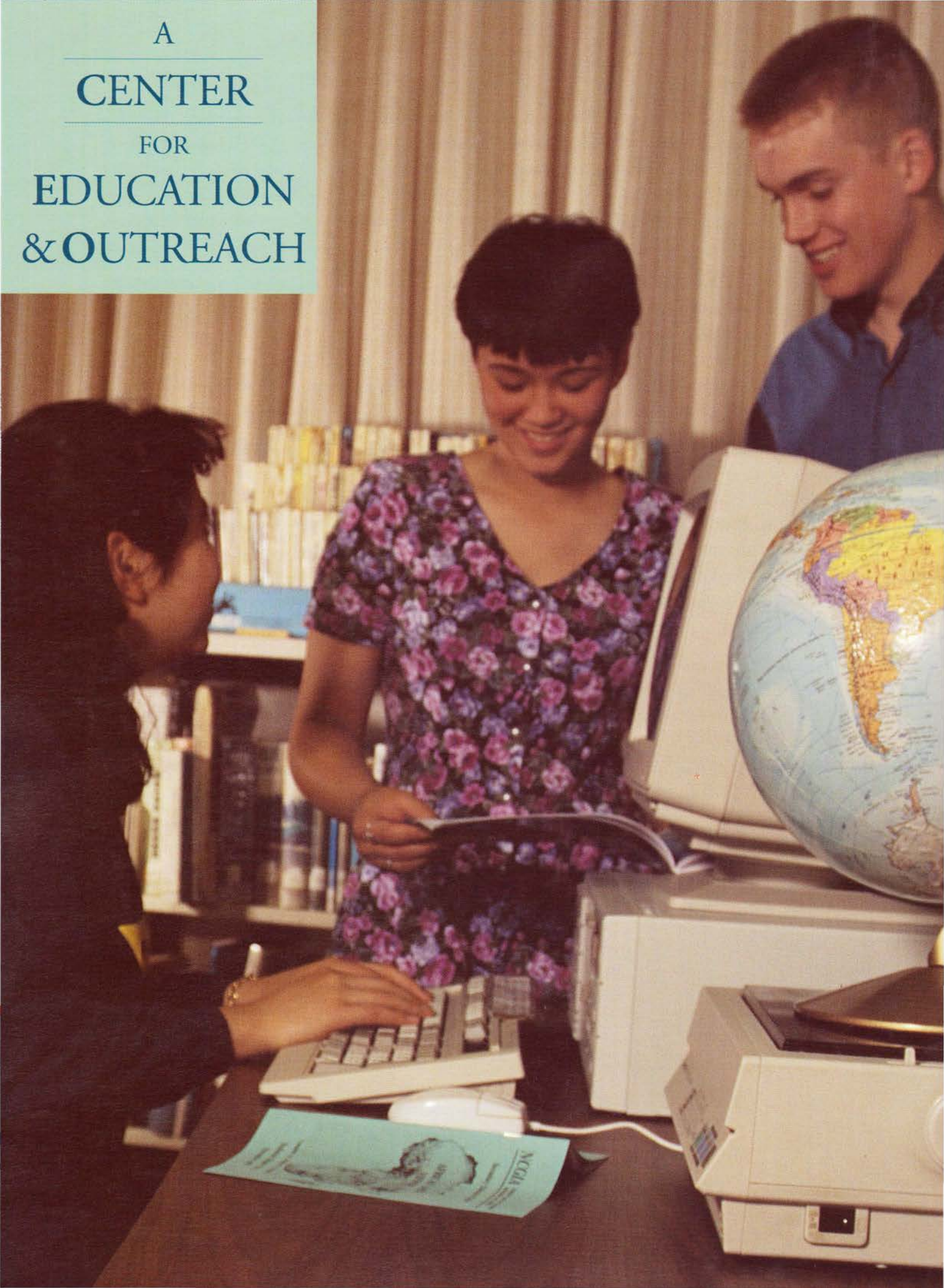
A Research Initiative, "Multiple Roles for GIS in U.S. Global Change Research," is being launched to examine the technical impediments and problems that obstruct our understanding of interactions between human systems and regional and global environmental systems, and to develop methods for dynamically linking human and physical databases within a GIS and for exploring the regional impacts of global change. This Initiative will also examine how GIS and environmental modeling methods can be co-developed to better support environmental management, building on the body of work engendered by two recent NCGIA-sponsored conferences on integrating GIS and environmental modeling.

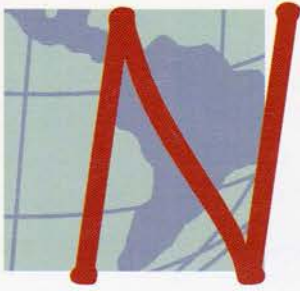
In a related project, the NCGIA is working towards the development of a global population database. This work has grown out of the recognition that global change research often neglects the human dimensions of environmental degradation processes. One reason for this is the lack of suitable data sets describing socioeconomic variables consistently and with suitable detail for large areas. As a first step towards increased availability of such data, the NCGIA is developing a GIS-based global population database. This work is supported by the NCGIA with additional funding from the Consortium for International Earth Science Information Network (CIESIN) and the Environmental Systems Research Institute, Inc. (ESRI). In addition, we are cooperating with several international institutions involved in global research, including the Global Resource Information Database of the United Nations Environment Programme (UNEP/GRID) and the World Resources Institute (WRI).

Other activities relating to global change include a meeting on "Global Modeling and GIS," which was held at the U.N. in New York in December 1992. The meeting linked the work of NCGIA researchers experienced with the potential of GIS for modeling applications, with experts from disciplines such as planning, economics, and physics knowledgeable in the understanding of long-run global change. Among the academic participants were three Nobel laureates.



A
CENTER
FOR
EDUCATION
& OUTREACH





CGIA Core Curriculum

One of the most successful accomplishments of the NCGIA since its inception has been its three-volume Core Curriculum in GIS. This comprehensive set of teaching materials has been developed primarily to help institutions initiate quality GIS courses. In particular, the NCGIA has sought to address the need for a balanced approach to curriculum development which gives students the necessary background in basic principles and concepts of GIS, and an understanding of the theory and tools of spatial information analysis, as well as exposure to working GIS applications. The volumes contain lecture notes with masters for overheads and handouts. A slide set of color transparencies to support the lectures and disks with electronic versions of the notes is also included.

"Arguably the most comprehensive curriculum development project undertaken in higher education to date"
(Ian Heywood, in *Environment and Planning A* 22:849-852, 1990).

The Curriculum has met with resounding success and is distributed in sixty-eight countries around the world. Where necessary, the Curriculum has been translated into a foreign language and modified to reflect local conditions. For instance, a version in Japanese has been prepared and distributed to over four hundred sites in Japan. The Core Curriculum has also appeared in the Hungarian language. The first volume has been translated into Hungarian, and examples contained in the Core Curriculum have been modified to reflect Central European perspectives. In addition, there are efforts underway to translate the Core Curriculum into French. This translation will be distributed in Canada, France, Belgium, and the French-speaking communities in Africa through United Nations agencies. A national distribution plan exists to aid the distribution of the Core Curriculum in developing countries and to date, national distribution sites exist in Brazil, China, the Czech Republic, Estonia, Lithuania, and Morocco. In addition to translation of the NCGIA Core Curriculum into foreign languages, the success of this American program has led to the development of a similar curriculum development effort for Europe led by the Technical University of Vienna.

The NCGIA is also involved in a project to produce the Core Curriculum in Remote Sensing which will be similarly aimed at providing a source of high-quality materials for courses. This effort is being conducted in conjunction with individuals in universities, industry, and government across the United States.



Secondary Education Project

The Secondary Education Project (SEP) began in 1991 as an extension of the NCGIA educational efforts. The SEP was initiated principally to investigate appropriate roles for GIS software and concepts in the secondary-school curriculum; to promote GIS within the secondary-school system in the U.S.; and to develop the NCGIA as a node connecting those in secondary education, higher education, government, and the business community with various GIS-related efforts for the secondary schools.

Workshops for Teachers

Both the Santa Barbara and University of Maine sites of the NCGIA have presented workshops to teachers on the use of GIS in secondary schools. These workshops have been very successful, and have attracted teachers from the sciences and social sciences, as well as computer-applications teachers. The objective is to introduce GIS through a short course and offer interaction with GIS users and working GIS applications. The teachers are introduced to a number of applications on a variety of platforms. The lectures cover topics including an introduction to GIS, GIS applications, data sources, data entry and data integration, data models, and future trends in GIS. In addition to the lectures, the teachers are given hands-on exercises and a project to complete, and have the opportunity to view working demonstrations.

The NCGIA has produced materials for use by teachers in their classrooms such as a data viewer based on African data designed to introduce students to digital data as it might appear in a GIS package. This allows students to view in 2-D and 3-D the various sets of climate, vegetation, land use, soil condition, and population data drawn primarily from a United Nations Environmental Program (UNEP) study on soil degradation and deforestation in Africa.

Professional Training

NCGIA researchers are often called upon to share their expertise through workshops and professional training courses. In the past, personnel have put on workshops for organizations or agencies such as the Urban and Regional Information Systems Association (URISA), GIS/LIS, the government of Canada, the U.S. Bureau of the Census, and the National Park Service. To meet the demand for further information on topics relating to GIS, the NCGIA has initiated the NCGIA Advanced Topics Summer Institute which will bring the latest advances in GIS analysis to participants. The summer institute will alternate among the three NCGIA sites, and will include outside experts as lecturers in addition to NCGIA personnel.





THE
NCGIA

WHO WE ARE

*University of California
at Santa Barbara*



*State University of New York
at Buffalo*



University of Maine



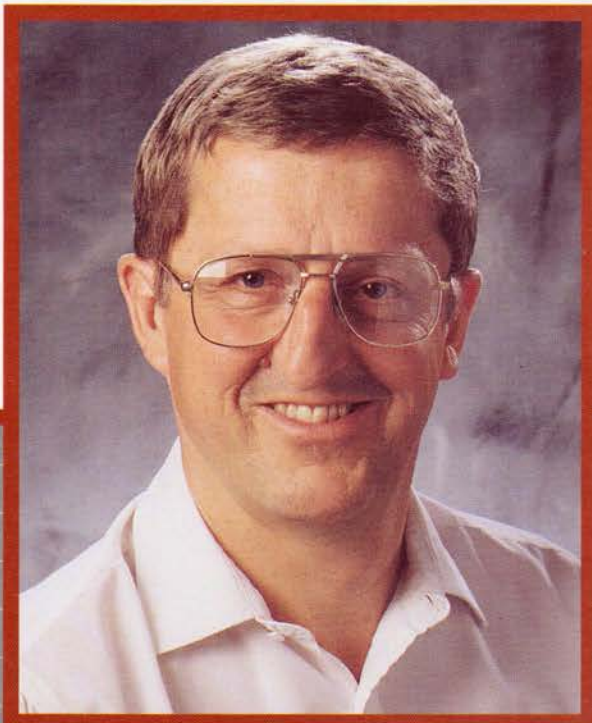


irector of the NCGIA

Michael Goodchild

Michael F. Goodchild is director of the National Center for Geographic Information and Analysis and professor of geography at the University of California, Santa Barbara. He received his B.A. degree from Cambridge University in physics in 1965 and his Ph.D. in geography from McMaster University in 1969. After nineteen years at the University of Western Ontario, including three years as chair, he moved to Santa Barbara in 1988. Dr. Goodchild was awarded the Horwood Prize by the Association for Urban and Regional Information Systems (URISA) in 1993, and in 1990 he was given the Canadian Association of Geographers Award for Scholarly Distinction. He was editor of *Geographical Analysis* between 1987 and 1990, and now serves on the editorial boards of six other journals and book series. He is a member of the National Research Council's Mapping Science Committee. He has been a visiting professor at the University of Auckland, University of Iowa, and McGill University and has given numerous presentations as visiting speaker. Dr. Goodchild has given keynote addresses at many recent conferences, including the Fourth International Symposium on Spatial Data Handling in Zurich, August 1990; the European GIS Conference in Brussels, April 1991; and the Australian Cartographic Conference in Darwin, April 1990. He has served as chair of the GIS Specialty Group of the Association of American Geographers, and as a member of numerous conference program committees. In 1991 and 1993 he served as co-organizer of the First and Second International Conference/Workshop on Integrating GIS and Environmental Modeling held in Boulder and Breckenridge, CO respectively. He has published over two hundred articles and three co-edited books on aspects of spatial analysis and geographic information systems.

Dr. Goodchild's current research interests center on problems of data quality in geographic information, ranging from development of error models to techniques for visualizing uncertainty, and include development of new methods of spatial analysis and new geographic data models.



ssociate Directors

Helen Couclelis, *University of California at Santa Barbara*

Dr. Helen Couclelis is associate director of the NCGIA and professor of geography at the University of California, Santa Barbara. She holds a doctorate from the University of Cambridge, England, a diploma in urban and regional planning from the Technical University of Munich, Germany, and an M.S. equivalent in architecture from the Technical University of Athens, Greece.

Prior to joining the UCSB geography department in 1982, she spent several years as a professional planner and policy advisor in Greece. Former positions include secretary of the Committee for Urban Development and principal editor of the committee's report to the Greek government, Center for Planning and Economic Research, fifteen-year national plan of Greece, (1970–72); assistant manager of a major planning project involving urban development plans for twenty Nigerian cities, with Doxiadis Associates, Greece (1972–73); and member of a policy advisory group supporting a council of ministers responsible for urban and environmental matters (1977–81). In this latter capacity she has been involved in several national and international policy issues such as the upgrading of Greek environmental regulations to EC standards; a tri-national agreement between Greece, Italy, and Yugoslavia on the protection of the Ionian Sea from pollution; the development of the first system of national forests in the country; the implementation of the Athens General Plan, especially with regards to the problem of illegal development; and a study for the Greek president on the feasibility of hosting the Olympic Games permanently in Greece. She also represented Greece in several EC and UNEP meetings and task forces. Dr. Couclelis has also been a visiting research professor at the Department of Civil Engineering of the University of Waterloo, Canada (1981), and a visiting postdoctoral researcher at the Institute of Urban and Regional Development of the University of California at Berkeley (1982).

The research interests and publications of Dr. Couclelis are primarily in the areas of urban theory, modeling, and planning, and in behavioral geography and spatial cognition. Recent research and publications include work on cellular automata models of spatial

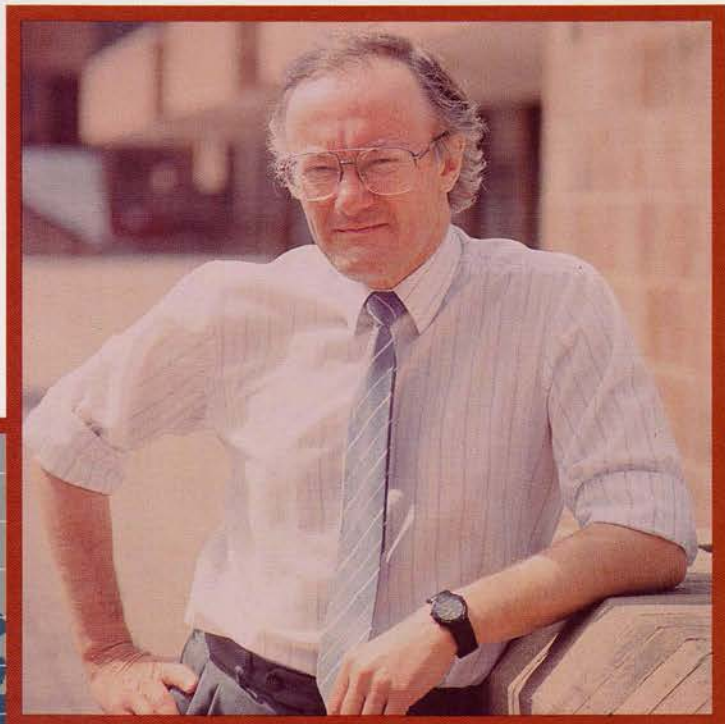
dynamics, on representations of geographic space in both human cognition and computer models, and in the development of GIS-based approaches to help resolve locational conflicts in planning. She is a co-editor of the journal, *Environment and Planning B: Planning and Design*. She has co-edited *A Ground for Common Search* (with P. Gould and R. G. Golledge) and co-organized a symposium on philosophical directions in geography.



Michael Batty, *State University of New York at Buffalo*

Dr. Michael Batty is associate director of the NCGIA and professor of geography at the State University of New York at Buffalo. From 1979 until 1990, he was professor of city and regional planning at the University of Wales at Cardiff where he acted as the dean of the School of Environmental Design (1983–86) and head of the department (1985–89). From 1969 to 1979, he was research assistant, lecturer, then reader at the School of Planning Studies in the University of Reading, England. He has also been a visiting professor at the University of Waterloo, Canada (1974–75), the University of Melbourne, Australia (1982), the University of Illinois at Urbana-Champaign (1986), and the University of Hong Kong (1986). Currently, he is honorary professor of geography at the University of Bristol. He acted as a member of the Computer Board for British Universities and Research Councils (1988–90), as chair (1980–82) and vice-chair (1982–84) of the ESRC (Economic and Social Research Council) Environment and Planning Committee, and as a member of the SERC (Science and Engineering Research Council) Transport Committee (1982–85). From 1986 to 1990, he was a co-director of the Wales and South West Regional Research Laboratory (WSWRRL).

Dr. Batty is editor of the journal, *Environment and Planning B: Planning and Design*, and sits on seven editorial boards of journals concerned with urban studies and planning. His research interests involve the development of computer models and computer graphics in land use and transport planning, the spatial analysis of urban form, geographic information systems technology, the impact of information technology on cities, and formal methods of decision making in policy analysis. He has published *Urban Modelling: Algorithms, Calibrations, Predictions* (Cambridge University Press, 1976), *Microcomputer Graphics: Art, Design and Creative Modeling* (Chapman and Hall, 1987), and *Fractal Cities: A Geometry of Form and Function* (Academic Press, 1994.) He has co-edited four books on the use of computer models in urban studies and planning, and has published many articles ranging from theories of planning and design to the development of models and computers in planning. His recent publications have been in four areas: models of urban shape and form using fractal geometry, information infrastructure and its impact on cities, urban information systems in developing countries, and the development of spatial analysis and models within GIS.



Max Egenhofer, *University of Maine*

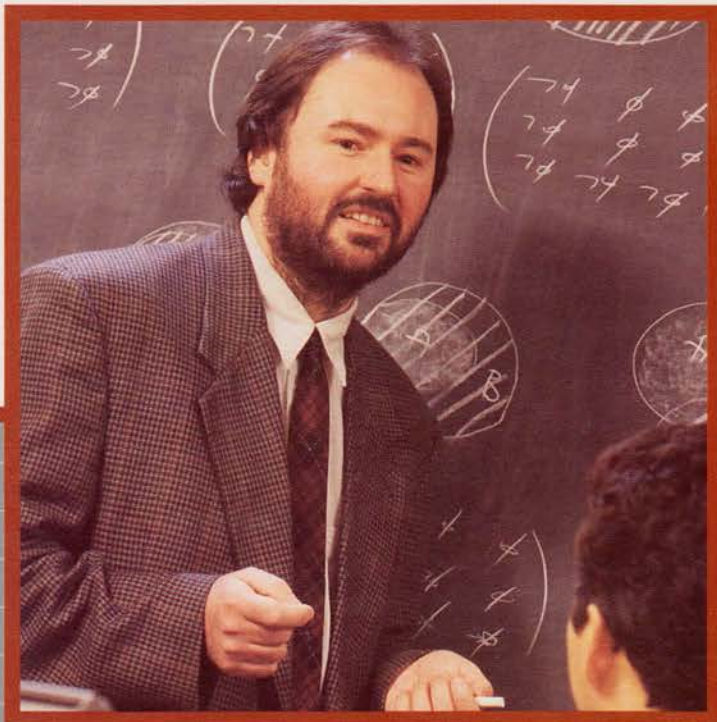
Dr. Max J. Egenhofer is the associate director of the NCGIA at the University of Maine, an assistant professor in surveying engineering, and a cooperative assistant professor in computer science. In the summer of 1993, he was a visiting professor at the Università de L'Aquila, Italy. He received a Dipl.-Ing. in surveying engineering from the University of Stuttgart, Germany in 1986, and his Ph.D. from the University of Maine in surveying engineering in 1989.

Dr. Egenhofer's research interests include reasoning in geographic space, formalizations of spatial relations, user-interface design for geographic information systems, spatial query languages, and the design of geographic databases. His funded research includes grants from the National Science Foundation, Intergraph Corporation, Digital Equipment Corporation, and Environmental Systems Research Institute, Inc.

Dr. Egenhofer is currently a co-leader of an NCGIA Research Initiative, "Spatio-Temporal Reasoning in GIS." He has authored or co-authored over sixty articles in journals, books, and conference proceedings relating to GIS and computer science on various aspects of GIS design, and is the co-editor of the forthcoming book, *Temporal Reasoning in Geographic Space*.

Dr. Egenhofer has co-organized international workshops entitled Spatial Relations, Methods of Spatio-Temporal Reasoning in GIS, and Visual Interfaces to Geometry. He has served on the program committees of various conferences on spatial information systems and spatial databases, is the general chair of the Fourth International Symposium on Large Spatial Databases, to be held in Portland, Maine in August 1995, and is on the editorial boards of the *International Journal of Geographical Information Systems*, *Cartography and Geographic Information Systems*, and *International Journal of Applied Software Technology*. Dr. Egenhofer is a member of the Association of Computing Machinery (ACM), the IEEE

Computer Society, and the Association of American Geographers (AAG).



The Executive Committee

The Executive Committee consists of the Center Director and the Associate Directors of the NCGIA. The Executive Committee decides on allocation of resources to research and other Center activities as laid out in the NCGIA's research, education, and data-dissemination plans.

The Scientific Policy Committee

The Scientific Policy Committee consists of representatives of the faculty from the member campuses, the Director, and the Associate Directors. The Committee decides on the policies guiding the research, education, and dissemination activities of the NCGIA, and annually updates the research plan, the education plan, the dissemination plan, plans for facility enhancements, and plans for obtaining external support from institutional, industrial, and governmental agencies for the Center.

NCGIA Board of Directors

The Board of Directors is drawn from representatives of all aspects of the GIS community and includes university researchers, representatives from private and government agencies, user organizations, professional associations, and nonprofit organizations. The Board of Directors meets twice a year, and discusses and forwards comments and proposals regarding Center activities, especially any suggested changes in Center research priorities, to the Scientific Policy Committee and Executive Committee.

The Board of Directors also advises the Scientific Policy Committee on long-term goals and revisions of the plans for research, education, and dissemination. It advises the Executive Committee on management issues and brings to its attention opportunities for Center activities, funding, cooperative research, and appropriate new initiatives.

NCGIA Board of Directors

(as of June 1994)

Joel Morrison, (*Chair of Board of Directors*) *United States Geological Survey*

Prue Adler, *Association of Research Libraries*

Lawrence Ayers, Jr., *Intergraph Corporation*

Jack Dangermond, *Environmental Systems Research Institute, Inc.*

Susan Hanson, *Department of Geography, Clark University*

Lawrie Jordan III, *ERDAS, Inc.*

Malvin Kalos, *Center for Theory and Simulation in Science & Engineering, Cornell University*

Annette Krygiel, *Defense Mapping Agency*

John McLaughlin, *Department of Geodesy and Geomatics Engineering, University of New Brunswick, Canada*

Jeanne Savage, *Savage & Associates*

Eric Sheppard, *Department of Geography, University of Minnesota*

John Sprague, *Department of Political Science, Washington University of St. Louis*

Peter Thacher, *World Resources Institute*

Giovanni Wiederhold, *Computer Science Department, Stanford University*

Cort Willmott, *Department of Geography, University of Delaware*





he Three Sites of the NCGIA

University of California at Santa Barbara

The core group of NCGIA researchers at the University of California at Santa Barbara consists of faculty members of the Department of Geography. The department is particularly strong in the fields of quantitative modeling and remote sensing and views these as key elements in addressing large scientific questions concerning the spatial and temporal dependencies of natural and social processes. The focus on GIS is a natural extension of this vision, with its ability to integrate the theoretical and technological approaches that help unify the physical and human sides of the discipline.

Faculty participating in NCGIA research represent the following systematic areas:

- biogeography
- behavioral geography
- geographic information systems
- remote sensing
- spatial analysis
- spatial cognition
- urban and regional modeling and planning

Faculty members in numerous other departments participate in NCGIA research. The computer science department has strong interests in spatial databases, and image processing is a focus of research in the Department of Electrical and Computer Engineering. Projects using GIS can be found in anthropology, economics, political science, sociology, biological sciences, and geological sciences. NCGIA is also closely associated with several Organized Research Units and groups which have additional facilities and where much graduate research takes place. These include the Department of Geography Remote Sensing Research Unit, the Computer Systems Laboratory/Center for Remote Sensing and Environmental Optics, the Institute for Crustal Studies, the Social Sciences Computing Facility, and the Marine Sciences Institute. In addition, the Map and Imagery Laboratory, a division of the University Library, provides access to one of the world's largest collections of maps, images, and digital spatial data.

The Santa Barbara site is the administrative head of the NCGIA consortium and coordinates the education and outreach activities of the Center, as well as inter-site communication. This site produces and distributes the *NCGIA Update Newsletter*, the NCGIA Technical Report series, the Core Curriculum, and the NCGIA Software series.



The NCGIA at Santa Barbara shares its computing facilities with the Department of Geography, and possesses substantial research and instructional equipment. It boasts 'showcase' undergraduate and graduate teaching facilities for courses in GIS, remote sensing, cartography, and statistics. A digital cartographic laboratory and a laboratory for undergraduate and graduate courses in GIS and cartographic programming contain a network of color graphic workstations plus a server system, color screen printers, color plotters, large-format digitizers, scanners, and other peripheral devices. Other cartographic facilities include a fully equipped darkroom, process camera, drafting space and equipment, digitizer, and computer graphic terminals and plotters. In addition, there is a large-format matrix camera for high-quality output, particularly for use in research relating to GIS and remote-sensing topics, and there is a large-format raster electrostatic plotter which the department shares with the Department of Geology. The Santa Barbara site is fully networked and is supported over the integrated campus computing network.



Selected Publications

Couclelis, H. (1991)
Requirements for planning-relevant GIS: A spatial perspective. *Papers in Regional Science* 70(1): 9–19.

Estes, J. E. and J. L. Star (1993)
Remote Sensing and GIS Integration, Towards a Prioritized Research Agenda, *Proceedings 25th International Symposium on Remote Sensing and Global Environmental Change*, Env. Res. Institute of Michigan: 448–464.

Goodchild, M. F. (1992)
Geographical information science. *International Journal of Geographical Information Systems* 6(1): 31–45.

Goodchild, M. F., B. O. Parks and L. T. Steyaert (eds.) (1993)
Environmental Modeling with GIS. New York: Oxford University Press.

D. J. Maguire, M. F. Goodchild and D. W. Rhind (eds.) (1991)
Geographical Information Systems: Principles and Applications. London: Longman Scientific and Technical.

Smith, T. R. and K. K. Park (1992) Algebraic approach to spatial reasoning. *International Journal of Geographical Information Systems* 6(3): 177–192.

Tobler, W. R. (1992)
Preliminary representation of world population by spherical harmonics. *Proceedings of the National Academy of Sciences* 89: 6262–6264.



State University of New York at Buffalo

NCGIA researchers at SUNY–Buffalo are drawn from across the university, emphasizing the interdisciplinary nature of the research program. Faculty represent several disciplines, including anthropology, computer science, economics, industrial engineering, law, linguistics, planning and design, and political science, as well as geography, the department from which the core members are drawn.

The Department of Geography at SUNY–Buffalo serves as the Buffalo Center's academic partner. The department offers long-established graduate and undergraduate programs in GIS and cartography, urban and regional planning, physical geography, and international trade. A number of the department's Ph.D. students participate in Center research and programs each semester.

Researchers in the NCGIA at Buffalo are specialists in the following areas:

- cartography and map design
- computational linguistics
- demographic and migration modeling
- environmental and ecological modeling
- global economic modeling
- land use and fire regimes
- planning methods
- spatial analysis
- spatial cognition
- spatial models of political behavior
- transportation routing
- urban and regional modeling
- visualization of data quality

The Center and Department of Geography at SUNY–Buffalo share a multipurpose computing facility, the Geographic Information and Analysis Laboratory (GIAL). Faculty associated with the NCGIA use GIAL resources for Center-related research, and the laboratory also supports the teaching and research needs of geography faculty, staff, and graduate and undergraduate students. Over two hundred undergraduate and graduate students use the GIAL computing facilities on a regular basis for courses including statistics, spatial data-handling algorithms, cartographic design, animation, demographic analysis, and GIS applications. The GIAL offers basic computing services for geography and its associated research centers, and also provides facilities for representatives from business and government organizations for project-based contracts. The GIAL includes cartographic production facilities, and provides services for graphics and illustrations.

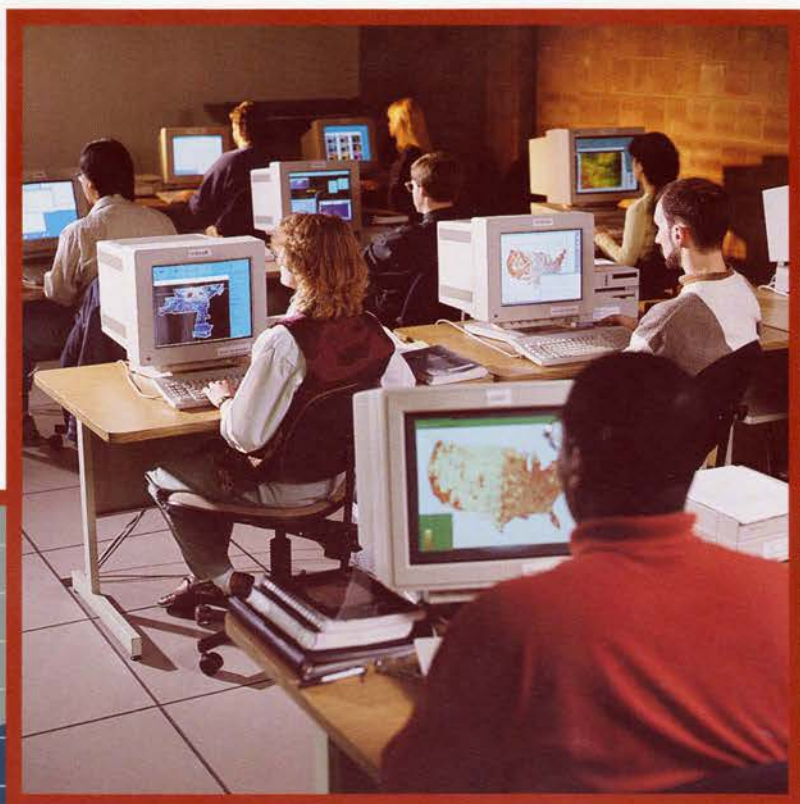
The computers in the GIAL are fully networked via fiber optics with computer facilities on campus. There are currently three computer platforms in use: a Sun network, which is used primarily for geographic information systems (GIS); a Novell



network, which supports studies in location analysis and decision-support systems; and a Macintosh cartographic laboratory which supports instruction and research on cartography and scientific visualization. The laboratory is also fully equipped with an array of peripheral devices including printers, plotters, and digitizing tablets. There are additional workstations located in faculty and staff offices.

Software available on GIAL computers covers a wide range of development tools and applications. Most common language compilers are available, as well as object-oriented languages and Lisp and Prolog. GIS software can be used on a variety of platforms including the Sun workstations; DOS machines; or for use in the Macintosh cartographic area. Access is also available to university site-licensed software residing on University Computing Services hosts.

The Center at SUNY-Buffalo is affiliated with many of the university's other research units, and has joined with them in a number of cooperative projects. Those with which the NCGIA has links include the National Center for Earthquake Engineering Research, the Great Lakes Center, the Rural Health Research Center, the Center for Regional Studies, and the Canada/U.S. Trade Center.



Selected Publications

Batty, M. (1991) New technology and planning: reflections on rapid change and the culture of planning in the post-industrial age. *Town Planning Review* 62(3): 269-294.

Batty, M. and P. Longley (1994) *Fractal Cities: A Geometry of Form and Function*. London and San Diego: Academic Press.

Buttenfield, B. P. and R. B. McMaster (eds.) (1991) *Map Generalization: Making Rules for Knowledge Representation*. London: Longman.

Calkins, H. and N. J. Obermeyer (1991) A taxonomy for surveying the use and value of geographic information. *International Journal of Geographical Information Systems* 5(3): 341-351.

Densham, P. J. and G. Rushton (1992) A more efficient heuristic for solving large p-median problems. *Papers in Regional Science* 71(3): 307-329.

Fotheringham, A. S. and P. Rogerson (eds.) (1994) *GIS and Spatial Analysis*. London: Taylor and Francis.

Mark, D. M. and M. J. Egenhofer (1994) Modeling spatial relations between lines and regions: combining formal mathematical models and human subjects testing. *Cartography and Geographic Information Systems*.

Plane, D. A. and P. A. Rogerson (1994) *The Geographical Analysis of Population with Applications to Planning and Business*. New York: John Wiley and Sons, Inc.



University of Maine

The core group of NCGIA researchers at the University of Maine consists of faculty members of the Department of Surveying Engineering. The department places importance on the acquisition, modeling, and use of spatial information. Courses in advanced software engineering, database management, spatial database design, and visualization of spatial data quality, as well as institutional and legal topics, are offered in addition to geodesy, remote sensing, photogrammetry, and surveying engineering. There is a well-established graduate program offering a Ph.D. degree and M.S. and M.E. degrees, as well as an M.S. in Geographic Information. The programs are popular with both traditional and nontraditional students, creating a setting which offers considerable exposure to GIS and surveying professions.

At present, those faculty participating in NCGIA research work on topics relating to:

- geographic databases
- information systems law
- query languages
- remote sensing and image processing
- sharing of spatial data
- spatial reasoning
- user interface design
- visualization of spatial data quality

Additional research staff complements the work of the faculty including a research faculty member, a postdoctoral research associate, and graduate research assistants. Sponsored research is balanced between fundamental and applied topics with support from both industry and government.

NCGIA researchers at the University of Maine have access to state-of-the-art computing facilities which are shared with the Department of Surveying Engineering. Two separate computing laboratories exist at present for student and faculty use, with a third laboratory in the planning stage. A GIS/remote sensing computing laboratory houses the latest workstations and PCs. All machines are linked with Ethernet and have access to the Internet. A full range of GIS and image-processing software is running on the workstations and is used for both applied and theoretical research. Another microcomputer laboratory contains Macintoshes and PCs on a Novell network. In addition, high-end Macintoshes are available for more demanding multimedia applications. GIS and image-processing software is also available on these machines. Peripherals, such as laser printers, plotters, digitizers, and scanners, are also available in each of the two laboratories. A new computer laboratory which will be shared with the College of Engineering will offer a large suite of GIS software running on workstations.

At the University of Maine site of the NCGIA, the faculty and graduate student offices are all equipped with Macintoshes or PCs and software for word processing, and programming software is freely available on a keyed basis through campus site-



licensing agreements. Compilers for the most common programming languages are available on a wide variety of platforms including object-oriented languages such as C++ and visual programming languages such as Prograph. In addition to the laboratory and equipment, there is also a departmental library which houses journals, conference proceedings, and books related to geographic information sciences.

Cognate research units at the University of Maine with links to the NCGIA are the Institute for Quaternary Studies, Canadian-American Center, Image Analysis Laboratory of the Department of Forest Management, and Fogler Library. Faculty from anthropology, the College of Business Administration, computer science, geology, and mathematics cooperate regularly with Center members on various research topics.



Selected Publications

Beard, M. K. and W. A. Mackaness (1993) Visual access to data quality in geographic information systems. *Cartographica* 30(2-3): 37-45.

Egenhofer, M. J. and A. U. Frank (1992) Object-oriented modeling for GIS. *Journal of Urban and Regional Information Systems Association* 4(2): 3-19.

Egenhofer, M. J. and J. R. Richards (1993) Exploratory access to geographic data based on the map-overlay metaphor. *Journal of Visual Languages and Computing* 4(2):105-125.

Frank, S. (1994) The national spatial data infrastructure: Designing navigational strategies. *Journal of the Urban and Regional Information Systems Association*.

Masser, I. and H. J. Onsrud, (eds.) (1993) *Diffusion and Use of Geographic Information Technologies*. Dordrecht: Kluwer Academic Publishers.

Onsrud, H. J. and J. K. Pinto (1993) Evaluating correlates of GIS adoption success and the decision process of GIS acquisition. *Journal of the Urban and Regional Information Systems Association* 5(1): 18-39.

Onsrud, H. J., J. Johnson, and X. Lopez (1994) Protecting Personal Privacy in Using Geographic Information Systems. *Photogrammetric Engineering and Remote Sensing*.





Who to Contact

We welcome any inquiries about the research and education programs run by the National Center for Geographic Information and Analysis. For further information, please contact:

The Director

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

In addition, you may contact the NCGIA at either of its other sites.

The Associate Director NCGIA

State University of New York at Buffalo
301 Wilkeson Quad
Buffalo, NY 14261-0023
Tel (716) 645-2545
Fax (716) 645-5957
ncgia@ubvms.cc.buffalo.edu

The Associate Director NCGIA

University of Maine
5711 Boardman Hall
Orono, ME 04469-5711
Tel (207) 581-2149
Fax (207) 581-2206
ncgia@mecan1.maine.edu



Editor Kathleen Hornsby, NCGIA, University of Maine
Design Carol Nichols, Public Affairs, University of Maine
Printing University of Maine Printing Services
Photography BOBENDAVE, Buffalo, NY
Andrew Curtis, Buffalo, NY
Jerry Cunningham, East Corinth, ME
Environmental Systems Research Institute, Inc., Redlands, CA
Rina Ganassa, Santa Barbara, CA
Michael Goodchild, University of California at Santa Barbara
Intergraph Corporation, Huntsville, AL
Damon Kiesow, University of Maine
Louis Steyaert, Reston, VA
Tom Stewart, Penobscot, ME
University of California at Santa Barbara Photographic Services
University at Buffalo Office of Publications
Jack Walas, University of Maine

This report represents work related to research being carried out at the National Center for Geographic Information and Analysis, supported by a grant from the National Science Foundation/ NSF (SBR-88-10917). The government has certain rights in this material; and support by the NSF is gratefully acknowledged. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the NSF.