

March 1993

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NCGIA Board of Directors as of December 1992: Joel Morrison, *Chair* (USGS), Ronald Abler (AAG), Lawrence Ayers, Jr. (Intergraph), Jack Dangermond (ESRI), John Eddy (CIESIN), Herbert Freeman (Rutgers University), John B. Garver, Jr. (National Geographic Society), Roberta Lenczowski (Defense Mapping Agency), Patrick Mantey (IBM), John McLaughlin (University of New Brunswick), David Moyer (URISA), Gerard Rushton (University of Iowa), Jeanne Savage (Savage Associates), William Skinner (University of California, Davis).

Breckenridge Conference

In September, 1991, the First International Conference Workshop on Integrating GIS and Environmental Modeling (Boulder, Colorado) reviewed the state of the art in scientific GIS and their application for modeling the terrestrial environment, atmosphere, land surface and subsurface, ecological processes, hydrology, and integrated modeling. Related sessions examined the use of GIS in risk assessment and policy development, the provision of spatial data, and the uses of spatial statistics. The conference identified many ways in which GIS and environmental modeling could be co-developed to better support environmental management. The meeting attracted over 600 participants, and its invited presentations by leading authorities are the basis of a book, *Environmental Modeling with GIS*, forthcoming from Oxford University Press. The book should be available by April 1993.

The Second International Conference/Workshop (September 26-30, 1993 in Breckenridge, Colorado) is intended to build systematically on the first meeting, but its program is designed to allow intensive examination of progress over the past two years, and to give greater emphasis to the potential for GIS to be an integrating mechanism for environmental modeling. These goals will be achieved using a three-pronged approach in which invited and contributed presentations will address major issues:

(1) Environmental databases and mapping:

- Available databases
- Integration of datasets from remote sensing
- Spatial interpolation
- Land surface characterization
- Sampling design
- Accuracy and spatial resolution

(2) Environmental modeling linked to GIS:

- Atmospheric and ocean sciences
- Hydrology
- Land surface/subsurface processes
- Biology and ecology

(3) Building environmental models with GIS:

- Visualization of spatial data
- 3-D and temporal modeling
- Scale integration of data and processes
- Data modeling and object orientation
- Modeling languages
- Global GIS design
- Risk assessment
- Spatial decision support
- Institutional implementation

Poster sessions and demonstrations will provide examples of GIS use in environmental modeling, and exposure to cutting-edge software. Informal discussion groups will be organized on these issues and in modeling areas. Early efforts will be made to contact vendors, suppliers and developers of GIS, modeling, and decision support software, and to invite their participation in the scientific program. Program details are being developed by a committee of internationally prominent experts.

CONFERENCE OBJECTIVES

- To provide an opportunity for multidisciplinary exchanges among modelers and GIS specialists on common problems and issues.
- To review recent progress, and identify remaining impediments to greater use of GIS in environmental modeling.
- To provide ample opportunity for live demonstrations of current integration capabilities.
- To develop strong recommendations that can help direct future integrating developments in GIS and environmental modeling software. For more information on conference registration and participation, contact: NCGIA Conference Secretariat UCSB, Santa Barbara CA 93106-4060 Phone: 805/893-8224, FAX: 893-8617 ncgia@ncgia.ucsb.edu

A MESSAGE FROM THE DIRECTOR

The NCGIA *UPDATE* began with the Center in 1988 as a means of reaching out to the geographic information community and keeping it informed of Center activities. As the Center has grown, the newsletter has grown with it. The number of people who read our newsletter has expanded beyond those following the work of NCGIA, and now includes many people from a wide array of professional backgrounds who are generally interested in the development of GIS. In response to this widening interest, the Center put out a general call for contributions in the *Newsletter* of the Association of American Geographers last fall, and you will notice that this issue includes pieces contributed from the University of Minnesota, and from the newly-formed GIS program of the European Science Foundation. We want the NCGIA to serve the GIS community as it evolves. To be consistent with our mandate from the National Science Foundation, we are particularly interested in publicizing the research and outreach services of nonprofit educational institutions. If you represent such an organization and have important news for GIS readers, both in the United States and abroad, please consider NCGIA's *UPDATE* as a possible outlet for information about your institution.

As the *UPDATE* broadens its purpose, we are also considering new formats. We have thus far offered a very direct, simple, and low-cost presentation with strong emphasis on the facts and issues related to our research agenda. However, we welcome comments and suggestions from our readers. If you have either an article to submit, or a format suggestion to make, please contact our editor, Judith Parker, via e-mail (judith@ncgia.ucsb.edu) or fax (805/893-8617).

A last request: in this issue, you will find a card which asks you to help us update our mailing list, and to facilitate our move to electronic distribution wherever possible. Please return this card to us by May 1 if you wish to continue receiving the *UPDATE*. Thank you for your interest in NCGIA.

MIKE GOODCHILD

ESF GIS Program

As a result of an exploratory workshop in Davos, Switzerland, in January 1991, a planning committee made up of Antonio Arnaud (Portugal), Ian Masser (United Kingdom), Francois Salge (France), and Henk Scholten (the Netherlands) pursued the possibilities of a European-level GIS research program, to deal with the fragmentation of current efforts in Europe, the border-transcending and discipline-transcending capacities of GIS, and the diversity of public and private sector interests relating to GIS.

This planning group initiated three specialist workshops to draw up a cross-national GIS research agenda for the eleven member nations of the ESF. The first of these workshops was on geographic databases in Aix-en-Provence, in France, March 11-15, 1992. The second was on environmental planning and health, in Bilthoven, the Netherlands, on May 13-17, 1992. The last specialist workshop was on geographic data integration in Portugal, June 10-14, 1992. Two other meetings, a NATO ARW on the use and diffusion of geographic information technology in Sounion Greece (April 8-11, 1992), and an ESF Euroconference on space-time modeling of bounded natural domains, in Lucca, Italy (May 31-June 4, 1992) contributed to the discussions on a European research agenda for GIS. NCGIA was represented at all of these meetings.

The planning period (1991-92) confirmed the need for a European level of GIS research, and the validity of the three areas defined by the workshops. A research program was defined, with its primary objective the stimulation of basic research on geographic data integration and data based design. The program also encourages collaborative research facilitating the transfer of GIS technology between European countries. From the beginning, there has been extensive consultation with other GIS research organizations, particularly the NCGIA, to enhance the transatlantic dimension. NCGIA will coordinate U.S. involvement in the two transatlantic meetings in 1994 and 1996. Mike Goodchild will be the primary contact for NCGIA with ESF.

Minnesota Grant

The University of Minnesota has been awarded a Research and Demonstration Grant under the U.S. Department of Education College Library Technology and Cooperation Grants Program (Title II-D) to establish a model Automated Cartographic Information Center within the John R. Borchert Map Library. Brent Allison, Associate Librarian and Head of the Borchert Map Library, will serve as Project Director. The project is one of two Research and Demonstration Grants funded for fiscal year 1992, from among 55 applicants.

The Automated Cartographic Information Center (ACIC) will be developing innovative approaches for providing library users with direct access to locally owned and remotely accessed digital cartographic and spatial information.

With first-year funding of \$133,058, six workstations will be equipped with the latest in computer hardware. A range of mapping software and geographic information systems (GIS) will be employed to provide access to, and manipulation of digital information. Electronic links are planned between the ACIC, the University of Minnesota's Government Publications Library, Machine Readable Data Center Digital Cartography Laboratory, and the Minnesota State Land Management Information Center. The project is recommended for a noncompeting continuation award in fiscal year 1993, during which time the ACIC will be expanded to include additional hardware and software.

The John R. Borchert Map Library is a U.S. Government Printing Office regional map depository library, serves as the U.S. Geological Survey Earth Science Information Center for Minnesota, and is a participant in the Association of Research Libraries GIS Literacy Project.

Global Modeling and GIS Conference

NCGIA-Buffalo sponsored a meeting on "Global Modeling and GIS," at the United Nations Plaza in New York, December 15-16, 1992. Sam Cole, from University of Buffalo's Department of Planning and

Design, was the primary organizer. Participants were selected for a balance of theoretical, empirical, and practical experience in areas relevant to improving understanding of long-run global change. The 26 participants included three Nobel laureates: Wassily Leontief and Lawrence Klein (Economics), and Philip Anderson (Physics). Also attending were personnel from the Buffalo and Santa Barbara NCGIA sites, numerous representatives from the United Nations, and academics from the disciplines of Planning, Economics, and Physics.

The conference objective was to define possibilities for research by informing the NCGIA of current progress in global modeling, and by NCGIA's demonstrating to global modelers the state of the art and potential of GIS for modeling applications. The workshop offered panel sessions including formal papers, computer demonstrations, and informal commentary. Presentations addressed "real world" problems and technical challenges posed by those problems. Various presentations will be written up formally for submission as a book.

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INITIATIVES

Use and Value of Geographic Information I-4

The wrap-up session for I-4 research results occurred at the NATO Advanced Research Workshop on "Modeling the Use and Diffusion of Geographic Information Technologies," which was held in Sounion, Greece, on April 8-11, 1992. Over the past six months, Harlan Onsrud (NCGIA-Maine) and Ian Masser (University of Sheffield) have been working as co-editors on a book containing selected papers presented at the workshop, and summaries of the results of the workshop session. The book, *Diffusion and Use of Geographic Information Technologies*, will be published by Kluwer Academic Publishers in 1993.

NCGIA I-4 and the URISA Education and Technology Transfer Special Interest

Group have jointly sponsored a coordinated GIS case study project at various sites throughout the U.S. Work on these case studies by professors and Ph.D. students has been largely completed over the past six months, and several of the case studies were presented at an organized session at URISA in July. A compilation of the case study working papers will be published in the NCGIA Technical Report Series in early 1993.

Bijan Azad, a Ph.D. student at MIT in Urban and Regional Planning, is carrying out research on theory development and testing relative to his GIS implementation research. During the months of June, July, and August, he completed ten case site visits to major city and county GIS operations throughout the U.S. Bijan is actively writing up the case reports for the sites and has prepared for publication a draft paper describing his research framework. Bijan presented an update on his research, titled "Innovation and Research in Diffusing GIS" at URISA '92. Also at URISA, there was an Initiative 4/URISA Education and Technology SIG session on "Diffusion of Geographic Information Technologies: Current Knowledge and Future Prospects." Jeffrey Pinto, Ian Masser, Lyna Wiggins (MIT), Hugh Calkins (NCGIA-Buffalo), and Harlan Onsrud participated.

Cooperative research on the diffusion and adoption of GIS continues at the University of Wisconsin and Ohio State University. In Wisconsin, Ben Niemann and Steve Ventura have been funded by the Institute of Environmental Studies under a state-mandated program to undertake a survey of GIS adoption and use by the counties. In Ohio, Earl Epstein and John Bossler are initiating a similar survey, and NCGIA will provide cooperative support for this effort. The project is expected to continue for two years, and will roll into the organizational and institutional research agenda of I-9.

Efforts on I-4 over the past several months have been directed at completing research projects and publications. Although outgrowth research is continuing in several areas, no further major events or expenditures are contemplated.

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Very Large Spatial Databases I-5

Initiative 5 was closed in August, 1992, with presentations at the Fifth International Symposium on Spatial Data Handling in Charleston, South Carolina. A draft closing report has been written, to be presented to the NCGIA Board of Directors for approval at its June 1993 meeting. Although the initiative has closed, research is continuing on key issues at the heart of the initiative, and the International Symposium Series on Large Spatial Databases that started in Santa Barbara in 1989 will have its third biennial meeting in Singapore in 1993. Other research projects that are likely to have major implications for this field are now in place, such as the Sequoia 2000 project, and some of the principal researchers involved with these projects have significant ties with NCGIA.

At Santa Barbara, Terry Smith's NSF-funded project, to investigate the design and implementation of modeling and database languages that support scientific investigations involving complex spatio-temporal objects, continues. The project involves Smith and Jeff Dozier as Principal Investigators at Santa Barbara, and collaborators at the University of Washington and the University of Wisconsin. Smith spent the 1991-92 academic year on sabbatical leave at the University of Washington, the University of Wisconsin and Brown University. Mike Worboys, a computer scientist from Keele University in the U.K., visited Santa Barbara for a month in November 1992 and worked with Terry Smith on the development of logic-based and object-oriented approaches to spatial databases, and on spatial topologies. Research completed earlier by Mike Goodchild and Yang Shiren on the properties of alternative orderings of tiles in geographical databases will be published by *Computers and Geosciences*.

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Spatial Decision Support Systems I-6

At Santa Barbara, NCGIA has initiated a multi-year project in the area of spatial decision support systems with Hitachi America Ltd. Two Hitachi researchers are now working at Santa Barbara and will be in residence for the next eighteen months, and two research assistants are funded by the project, which involves Richard Church, Mike Goodchild, and Helen Couclelis. The project is investigating: 1) optimization of the spatial arrangement of energy production and consumption in urban areas, including fuel cells, heat pumps and waste treatment plants; and 2) the use of cellular automata and neural networks to model and control urban space-time processes related to energy production and consumption, including urban heat islands and urban growth. Both projects will result in the development of spatial decision support systems for design of "green" cities. A second I-6 related project funded by Caltrans (the California State Department of Transportation) will investigate the design and implementation of "navigable" databases for support of spatial decisions on transportation networks, under the direction of Church and Goodchild. David Lanter (Santa Barbara) spent the Fall quarter of 1992 in Lisbon at the Portuguese National Center for GIS, collecting case studies for his techniques of lineage analysis.

At Buffalo, work is continuing on development of an SDSS for toxic effects modeling of the Great Lakes for the Environmental Protection Agency, under the direction of Hugh Calkins and Paul Densham (NCGIA Buffalo); Joe DePinto, Ralph Rumer, Joe Atkinson and Stewart Taylor are the Principal Investigators from the Great Lakes Program at Buffalo. During the first year, work concentrated on the conceptual design of a prototype system for the Buffalo River. Implementation of this prototype is now underway, and a suite of models is being refined and linked to ARC/INFO. Basic issues in this project include representation of time series data and associated model results; scenario management for data sets and model parameters, input data and results; and visualization of results for complex finite element models.

Paul Densham and Marc Armstrong (University of Iowa) are the Principal Investigators of an NSF-funded project to improve human-computer interaction in locational decision-making. This project investigates the role of parallel processing in locational analysis and cartographic display. Research topics include classification schemes for spatial problems from the perspective of parallel processing; strategies for decomposing spatial problems into parallel processes; and the development of parallel software for shortest path and location-allocation algorithms, and for the display of solutions generated by these algorithms.

Paul Densham organized a paper session on SDSS at GIS/LIS'92. Marc Armstrong chaired the session, which included the following papers: Bruce A. Ralston and Mei Zhang (University of Tennessee), "An Applications Generator for Spatial Decision Support Systems"; Jeff R. Wright (Purdue University) and Jin-Yuan Wang (National Chiao Tung University), "A Spatial Decision Support System for Vehicle Routing"; D. Scott Mackay, Vincent B. Robinson, and Lawrence E. Band (University of Toronto), "Development of an Integrated Knowledge-Based System for Managing Spatio-Temporal Ecological Simulations"; Gerard Rushton (University of Iowa), "Spatial Analysis and GIS in School Facility Location and Service Area Planning."

A panel session on the achievements of I-6 and future directions for research on SDSS has been organized for the 1993 AAG meetings in Atlanta, and the initiative will likely be closed at that time. Participating in the session will be Bruce Ralston (University of Tennessee), Marc Armstrong and Gerry Rushton (University of Iowa), Paul Densham and Mike Goodchild. A journal article is being written which will synthesize the research of I-6 and place it in the context of the research agenda from the Specialist Meeting and the discussion at the panel session.

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Visualization of the Quality of Spatial Data I-7

In July, Barbara Buttenfield and Mike Goodchild attended a conference on "Visualization for GIS," at Loughborough University in the U.K., and presented papers on I-7 research. A book, *Visualization for GIS* based on the conference papers, will be edited by David Unwin and Hilary Hearnshaw, and published by Belhaven Press in 1993. The book devotes a full section to "Issues of Data Quality and Data Validity," with contributions from NCGIA researchers: Barbara Buttenfield and Kate Beard, "Graphical and Geographical Components of Data Quality"; and Mike Goodchild, Chih Chang Lin, and Yee Leung, "Visualization of Fuzzy Scenes and Probability Fields." This latter paper was also presented at the Fifth International Symposium on Spatial Data Handling in Charleston, South Carolina (August 1992), as was Peter Fisher's "Real-Time Randomization for the Visualization of Uncertain Spatial Information," and Geoffrey Dutton's "Handling Positional Uncertainty in Spatial Databases."

In August, Mike Goodchild also presented a paper on error models and data quality visualization techniques for spatial data at the Joint Statistical meetings in Boston, sponsored by the American Statistical Association. At GIS/LIS '92 in November in San Jose, California, Kate Beard and William Mackaness organized one session "Visualization of Spatial Data Quality"; and Mason Hewitt, (EPA) chaired a second session, "Visualizing Uncertainty."

Graduate thesis and dissertation projects continue at all three sites. At Maine, Sarah Clapham defended her thesis, "A Formal Approach to the Visualization of Spatial Data Quality." At Santa Barbara, Diane Schweizer completed her Master's thesis research, "Visualizing Data Quality for Choropleth Maps." At Buffalo, Victor Wu continues work on domain-dependence and object orientation of data quality information. In September, he defended his dissertation proposal "Exploring the Quality of Spatial Data in GIS: Queries Based on Data Objects." He and Barbara Buttenfield interviewed Soil Con-

servation Service employees at the New York State offices in Syracuse to identify the types and amount of data quality information needed by federal agency users.

Barbara Buttenfield, as guest editor for an issue of the international journal *Cartographica* on "Visualizing the Quality of Spatial Data," issued an open call to participants of the Specialist Meeting. Papers were submitted for blind peer review. Accepted papers are currently under revision, and the issue will go to press in early 1993. At Maine, Kate Beard has completed the organization of the *I-7 Challenge on the Visualization of Spatial Data Quality* (below). The objective of the Challenge is to generate external interest in the problem of visualizing spatial data quality. The challenge is co-sponsored by the U.S. Environmental Protection Agency and USDA Soil Conservation Service (who are each supplying data sets), and by the American Statistical Association.

At Maine, research continues on the use of reference grids in two contexts: (1) for the display of geometric changes in the data produced by different GIS processes; and (2) as a method to convey the resolution of vector data sets.

At Santa Barbara, research continues on the roles of alternative visualizations of error models, with three options easily defined: displays can omit any reference to quality, for example by displaying maximum likelihood classes; displays can include descriptions of data quality in the form of error model parameters; or displays can present a sample of realizations of the error model. The last option is clearly more dramatic, and in the spatial context may be much more intelligible to non-statistical users. Techniques have been developed for displaying realizations under the error model developed by Michael Goodchild and others for Initiative 1. Some preliminary results will be published in *Visualization and GIS* (forthcoming).

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VISUALIZATION OF SPATIAL DATA QUALITY CHALLENGE: Call for Participants

Sponsored by the National Center for Geographic Information and Analysis, U. S. Environmental Protection Agency, Center for Environmental Statistics, USDA Soil Conservation Service, and the Statistical Graphics Section of the American Statistical Association.

This announces an open invitation to participate in a challenge to develop techniques for visualizing spatial data quality. The intent of the Challenge is to provide a catalyst for experimental research on effective ways of managing and communicating the quality of spatial data to users of geographic information systems. Two data sets consisting of original observations and metadata (information on collection techniques, instrumentation, and processing or compilation procedures) will be made available.

Challenge participants are invited to submit papers and posters (other display media such as interactive demos or videos are also possible) of their visualization techniques. Best Data Quality Visualization awards, in the form of certificates of recognition, will be presented at GIS/LIS '93. In addition a set of papers will be selected for publication in a special journal issue.

The challenge is open to any interested parties, and there are several ways to participate in the challenge:

- 1) Develop a prototype visualization technique which communicates one or more aspects of geographic data quality. This should indicate what data quality components were modeled and how they were linked to a visual model.
- 2) Implement a visualization technique which communicates one or more aspects of geographic data quality. The implementation may be stand-alone software, or software which links to an existing GIS, or to another existing software package.

To receive a copy of the Challenge rules and information about the data sets contact:

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Formalizing Cartographic Knowledge I-8

In June 1992, the Science Policy Committee approved a proposal for the active phase of the initiative to begin. Due to other commitments, David Mark stepped down as initiative co-leader in late July. Barbara Buttenfield continues to lead the initiative with the assistance of a steering committee. Researchers accepting the invitation to join the steering committee to date include:

Kate Beard, NCGIA-Maine
Peter Fisher, U. Leicester, UK
Roberta Lenczowski, Defense Mapping Agency
David Mark, NCGIA-Buffalo
Robert B. McMaster, U. Minnesota
Robert Weibel, U. Zurich
Jean-Claude Muller, ITC

Plans for the Specialist Meeting will be put into detail over the coming months. It is hoped that the Specialist Meeting can be scheduled immediately prior to the AUTO-CARTO 11 and GIS/LIS meetings in Minneapolis, Minnesota (November 1993) so that Europeans attending the I-8 Meeting will be able to participate in the Minnesota conference. Special Paper Sessions that highlight selected I-8 reports will be proposed to the AUTO-CARTO Program Committee.

In August, at the International Geographical Union Meetings (IGU) in Washington, D.C., a business meeting was held for the Working Group on Map Generalization (part of the IGU Commission on Automated Technology). The group was formed in September 1991 at the International Cartographic Association meetings in Bournemouth, in response to the high level of international research activity in automation of map design, map production, and generation of digital cartographic data. The group discussed research priorities for the general community, and agreed there is a need for a multi-day symposium to prioritize a research agenda. A questionnaire has been distributed to cartographers worldwide, soliciting information on cartographic activities and ongoing research relating to automation and rule bases for map generalization. The questionnaire information will be collated by Robert Weibel, and this information will assist the Steering Committee in I-8 planning activities in coming months.

In Buffalo, Barbara Buttenfield and doctoral student Feibing Zhan have submitted journal articles reporting work on rules for raster generalization of cartographic lines and on an Expert System shell for selection of thematic map symbols (see the publications below).

The initiative has brought a number of visitors to the SUNY-Buffalo NCGIA site:

Peter Fisher (University of Leicester, U.K.) visited NCGIA-Buffalo in July to discuss plans for the initiative with Barbara Buttenfield and David Mark.

Sven Arve Saga (Norwegian Federal Mapping Service) is in residence at NCGIA-Buffalo for the current academic year. Saga is working on dissertation research at the Department of Surveying and Mapping, University of Trondheim, which funded his residency. A research focus on scale dependent impacts of line simplification routines at varying levels of resolution is intended to derive rules for tolerance value selection, to be implemented at the Federal Mapping Service. Last fall, Saga worked with Barbara Buttenfield to establish usable ranges of resolution for coastline features undergoing simplification, using Federal Mapping Service coastline data. Saga's advisor, Rune Aasgaard, will visit NCGIA-Buffalo in February to evaluate his progress and discuss possible research collaboration with the NCGIA.

A number of publications describe I-8 research:

Weibel, W. R. and Buttenfield, B. P. "Improvement of GIS Graphics for Analysis and Decision-Making," *International Journal of Geographical Information Systems*, Vol. 6(3): 223-245 (1992).

Buttenfield, B. P. "Formalizing Rules for Graytone Selection in Computer Mapping," in *Proceedings, Meetings of the American Congress on Surveying and Mapping*, February 1993, New Orleans, Louisiana.

Dutton, G. and Buttenfield, B. P. "Positional Accuracy and Coordinate Transformation at Varying Levels of Map Resolution," in *Proceedings, 16th International Cartographic Conference*, Cologne, Germany, 3-8 May 1993.

Weber, C. and Yuan, M. "A Statistical

Analysis of Various Cartographic Adjectives Predicting Consonance/Dissonance and Intertonal Distance in Harmonic Intervals," in *Proceedings, Meetings of the American Congress on Surveying and Mapping*, February 1993, New Orleans, Louisiana.

Zhan, F. and Mark, D. M. "Object-Oriented Spatial Knowledge Representation and Processing: Formalization of Core Classes and Relationships," in *Proceedings, Fifth International Symposium on Spatial Data Handling*, Charleston, South Carolina, August 1992.

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Institutions Sharing Spatial Information I-9

Geographic information addresses a broad range of critical problems. Sharing of geographic information is important because the more it is shared, the more it is used, and the greater becomes society's ability to evaluate and address the wide range of pressing problems to which such information may be applied.

Thus, the demand for efficient, equitable, and timely access to spatial data by the user community will continue to grow, and there will be a greater need to understand the patterns of institutional, organizational, and individual behavior within the GIS user community. Prospective models and prescriptive strategies for sharing spatial data from the local level to global scales must be developed. The goal of this initiative is to expand the knowledge base of institutional, organizational, and behavioral issues for the future development of such models and strategies.

Work in the past few months has concentrated on the production of a book from the papers prepared for the I-9 Specialist Meeting. Papers were prepared prior to the Specialist Meeting by all participants and peer-reviewed. Co-leaders Harlan Onsrud and Gerard Rushton (University of Iowa) read all the papers and peer reviews and informed authors of those

revisions necessary before their papers would be included in a book proposal to a publisher. The authors have submitted their revisions and the co-leaders are currently re-reading and editing the papers.

At GIS/LIS 92 in San Jose in November, Mike Goodchild organized a special ASPRS session on recent developments in quality assurance and quality control. Panelists included Mason Hewitt III (U.S. Environmental Protection Agency), Howard Veregin (Kent State University), and Douglas Nebert (U.S. Geological Survey). The panelists reviewed recent efforts at controlling data quality and communicating information on quality to users as a means of enhancing opportunities for effective data sharing.

Steven Frank (University of Maine), working with Harlan Onsrud, has developed a Ph.D. dissertation topic on "Cataloging Paradigms for Spatial Metadata." He recently submitted an article for publication titled "Finding Spatial Data in the Information Infrastructure."

Gerard Rushton has recently received a research grant with Marc Armstrong, (University of Iowa) from the Midwest Transportation Research Center to "Develop a Spatial Data Infrastructure for Transportation Planning and Public Policy Analysis."

Following the adoption of the Spatial Data Transfer Standard as Federal Information Processing Standard (FIPS) 173, there has been increased attention to the development of standards for metadata, or data about data, that can improve opportunities for sharing by allowing potential users to assess fitness for use. Mike Goodchild gave a keynote presentation at a workshop on metadata organized by the Federal Geographic Data Committee in Washington in June 1992, and is preparing a response to the proposed spatial metadata standard currently being circulated by FGDC. For more information, please contact:

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Spatio-Temporal Reasoning and GIS I-10

The Specialist Meeting will take place on May 8-11, 1993 at Lake Arrowhead, California with about 30 participants. To focus attention on temporal issues, the meeting has been titled "Time in Geographic Space," as a result of discussions at the pre-specialist meeting in San Miniato last fall.

Participants at that meeting focused their discussions on research issues in *spatial* reasoning. The Specialist Meeting is therefore more geared toward finding the complementary researchable questions on *temporal* reasoning in geographic space.

The Call for Papers/Participation for the Specialist Meeting was distributed in November over e-mail to a large number of people who had expressed interest, and was also posted on all relevant electronic networks. In addition, 500 fliers were mailed to academic institutions and individuals who have worked on the topic. Participants in the Specialist Meeting are being selected by a steering committee review of extended abstracts (2,000 words). Extended versions of selected papers will be peer-reviewed after the meeting and published in an edited volume.

Events contributing to the preliminary discussions for I-10 have been:

1) the International Conference on "Theories and Methods of Spatio-Temporal Reasoning in Geographic Space" in Pisa, Italy, September 1992 (co-chair: Andrew Frank). At the Pisa conference, David Mark gave the keynote address. Two other invited presentations were given by Ben Kuipers and Richard Snodgrass. Reginald Golledge, co-leader of the initiative, wrote a fourth invited paper which was presented by Daniel Montello. Full papers were peer-reviewed before the conference, and the Proceedings of the 23 revised papers, accepted for presentation, were available at the conference and were published by Springer-Verlag in the Lecture Notes in the *Computer Science* series, Volume 639.

2) The workshop on "Reasoning in Geographic Space and Time" in San Miniato,

Italy under the co-chairs: Max Egenhofer and Andrew Frank. The workshop was a combination of small-group discussions and plenary sessions in which group leaders summarized the major ideas. A report about the discussions and conclusions is being prepared. Participants discussed aspects of reasoning about geographic space and they felt that discussion of time-reasoning in geographic space needs to be based on a better understanding of reasoning about geographic space. Max Egenhofer will make a presentation at ACSM/ASPRS '93 in New Orleans on the results from San Miniato.

A special session, co-sponsored by the AAG, is planned for the 1994 AAAS meetings in San Francisco. This meeting will follow the Specialist Meeting and will represent an opportunity to present Specialist Meeting papers revised for publication. Presenters will be drawn from attendees at the Specialist Meeting.

Khaled Al-Taha (University of Maine) completed his Ph.D. dissertation on "Temporal Reasoning in Cadastral Systems." Egenhofer has continued research into the formalization of spatial topological relations, with papers presented at the conferences on "Spatial Data Handling" and "Vision Geometry" and five manuscripts submitted to refereed outlets. The initial theory, developed under Initiative 2, is frequently cited in the literature and used by an increasing number of other researchers for further studies. Two such papers have been submitted by researchers from England, Italy, and The Netherlands for the "Third Symposium on Large Spatial Databases (SSD '93)" to be held in Singapore. In Egenhofer's graduate seminar on "Object Oriented GIS," students are designing and implementing a prototype of a spatio-temporal reasoning system that integrates qualitative and quantitative spatial and temporal relations.

At Buffalo, May Yuan's Ph.D. topic involves data models for wildfire (forest fires, brush fires, grass fires, etc.) in GIS. The dissertation, supervised by David Mark, has a major focus on spatio-temporal representation, especially regarding different spatial and temporal scales

needed for different uses of wildfire data. A dissertation enhancement proposal to support fieldwork on this project has been submitted to NSF. Also at Buffalo, David Mark's advanced seminar in GIS has discussed temporal reasoning, time geography, and time in GIS. Students in the seminar have initiated a project to look at periodic markets as a case of spatio-temporal distribution of human activities.

At UCSB, Reginald Golledge has completed a paper on "Integrating Information Learned in Unfamiliar Environments." A Ph.D. student, Mai-po Kwan, is preparing a Ph.D. dissertation on the use of GIS in modeling household decision making, and with Golledge and Tommy Gaerling (University of Umea, Sweden), she has submitted two papers on "Using GIS to Build a Computational Process Model of Household Route Choice over Time."

A listserver named TGIS-L is being planned at Buffalo to provide a forum for discussion of temporal GIS issues. Its formation was initiated at a meeting arranged by Gail Landran for a group interested in temporal GIS issues, at GIS/LIS'92.

For more information, contact:

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NCGIA	NCGIA
Univ of Calif	Univ of Maine
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The Science Policy Committee invites suggestions for future NCGIA research activities and initiatives. Research initiatives are normally multi-investigator, interdisciplinary projects lasting 18-24 months. If you have comments on potential research areas, please contact Harlan Onsrud (University of Maine), current Chair of the SPC, or any NCGIA member.

GIS and Remote Sensing I-12

Since the June 1992 meeting of the Board of Directors, there have been negotiations for a close-out meeting, for follow-on funding, and for a memorandum of understanding with the Georgia Institute of Technology, based on joint research interests under I-12.

Based on David Landgrebe's presentation at UCSB under I-12 funding, Frank Davis and Jeff Star (UCSB) are pursuing a modification of Kerekes' and Landgrebe's simulation model to examine a simulation approach to error contributions from an integrated remote sensing/GIS model of biophysical parameters for a grassland. The datasets and models come from Davis' FIFE work over the past several years. Davis and colleagues propose to extend the Purdue model in several ways, including: (1) a more realistic and data-intensive earth surface reflectance simulator; and (2) a model of grassland evapotranspiration based on the FIFE field measurements program.

Based on Manfred Ehlers' residence at UCSB under I-12 funding, Ehlers, Star, and Faust are developing a proposal for a model of agricultural pollution of groundwater which will examine existing approaches to various components of the groundwater pollution problem with the following purposes:

- 1) to understand where components are suited to an integrated remote sensing/GIS approach;
- 2) to posit means to integrate the components into an overall data flow model;
- 3) to understand the requirements for accuracy and precision in a prediction or simulation model.

In order to accomplish closure on I-12, researchers are pursuing several plans:

- 1) There will be a final conference presentation relating to I-12 at the Twenty Fifth International Symposium on Remote Sensing and Global Environmental Change in April 1993. The session will include both invited papers and discussants from within and outside of the initiative research group.

- 2) A contract for a research monograph for the initiative has been signed with Cambridge University Press. Star and Estes will edit the volume. Authors include Mike Goodchild and Kenneth McGwire (UCSB) on accuracy issues, Terry Smith (UCSB) on large spatial databases, Manfred Ehlers (ITC-Netherlands) on registration, Nick Faust (George Institute of Technology) and Jeff Star (UCSB) on visualization, Gassam Asrar (NASA Goddard Flight Center) and Jeff Dozier (UCSB) on measurements, John Jensen (University of South Carolina) and David Cowen (University of South Carolina) on mapping, John Townshend (University of Maryland) and Frank Davis (UCSB) on modeling, and Tim Foresman (University of Maryland) on management.

- 3) A proposal for a monograph on issues of scale in the integration of remote sensing and GIS has been developed by Dale Quattrochi at NASA Marshall Space Flight Center, based in large part on the efforts during I-12 work. This proposal is now under review with potential publishers.

- 4) Frank Davis (UCSB) and Steve Walsh (University of North Carolina) have negotiated a special issue on GIS and remote sensing integration in models of vegetation for the *Journal of Vegetation Science*. Tentatively, the manuscripts are due in June 1993, and the volume will be published in Spring 1994. Articles for the special issue will include approximately ten papers on methodological issues in GIS, biophysical modeling, predicting species distributions, disturbance and community recovery, and conservation analysis.

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User Interfaces for GIS I-13

The Specialist Meeting report, containing 35 position papers as well as a summary of the discussions at the Specialist Meeting of June 1991, has been published as Technical Report #92-3.

David Mark and Werner Kuhn presented papers on spatial metaphors for human-computer interaction at the Fifth Spatial Data Handling Symposium in Charleston, and are continuing their research on this topic. Four other I-13 Specialist Meeting participants also presented papers on user interfaces for GIS at the Charleston meeting: Alan Edmonds (Ohio State University), Greg Elmes (West Virginia University), Tony Lupien (Roadnet), and Steve Smyth (Microsoft). There also were several user interface papers at the recent symposium in Pisa, Italy, described under Initiative 10.

Egenhofer and Richards (Maine) submitted a paper on the "cubes" interface to the *Journal of Visual Languages and Computing*. Richards is now investigating an alternative user interface, which will be compared with the cubes interface. In the spring of 1993, Egenhofer will teach a graduate course on GIS user interfaces, under the title "Interactive Land Information Systems." Gary Volta completed a Master's thesis, "Interaction with Attribute Data in Geographic Information Systems: A Model for Categorical Coverages"; Volta is preparing an article on this topic for submission to a journal.

Michael Gould spent July and August 1992 in Buffalo working on his doctoral dissertation on computer interaction for geographic problem-solving; the defense will be held in May 1993. Also at Buffalo, Todd Crane's Master's degree research is on user interface design for a hydrogeological application.

At Santa Barbara, Reg Golledge and David Lanter are proceeding with a pilot project evaluating the usefulness of selected icons and "earcons" in a variety of GIS packages. The project is expected to be completed in March 1993.

Mark completed a chapter entitled "Human Spatial Cognition" for *Human Factors in Geographical Information Sys-*

terms, a book edited by David Medyckyj-Scott and Hillary Hearnshaw. Andrew Frank and Michael Gould also have chapters in that book. Werner Kuhn has a chapter entitled "The User Interface as a Key to the Usability of GIS" in *Environmental Applications of GIS* (in German), edited by O. Guenther, K.-P. Schulz, and J. Seggelke, and published by Wichmann, Germany, 1992. The same book contains a chapter by Andrew Frank, "GIS in the year 2000."

Werner Kuhn and Andrew Frank (U. Maine) will conduct a workshop on "Spatial Metaphors in User Interfaces" at the INTERCHI conference in Amsterdam, April 23.

Mark is assisting Tim Nyerges (University of Washington) with a proposal, to be submitted April 1993 to the NATO Scientific Affairs Division, for a NATO Advanced Research Workshop on "Cognitive Task Analysis for GIS" in January 1994, in southern Europe, and for the closing of I-13.

The co-leaders plan to close I-13 with a NATO ARW if funded (above), or with sessions at professional meetings (URISA, GIS/LIS'93, and/or COSIT'93, the new European Conference on Spatial Information Theory).

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Spatial Analysis and GIS I-14

Contributing to the NCGIA Software Series, Stewart Fotheringham and Yuemin Ding (SUNY) distributed over 25 copies of SAM (Spatial Analysis Module).

I-14 research is progressing on several fronts, including the following:

1) Evaluation of the potential to integrate exploratory spatial data analysis (ESDA) and GIS. An increasing number of researchers see great potential in linking GIS with ESDA methods of analysis that allow the user to "explore" data (as opposed to using confirmatory statistical methods). Since ESDA is itself a relatively new field of research, this is an extremely fertile area. Current work is aimed at identifying alternative means of

GIS/ESDA integration, as well as identifying impediments in the integration of GIS and ESDA.

2) The development of links between spatial modeling and GIS. Researchers at the Buffalo site have developed a prototype population density modeling system for the Buffalo metropolitan region. The system permits the user to display data, calibrate models, and carry out predictive modeling exercises. ARC/INFO is used to store and display spatial data, and to develop the interface to the models. The development of this prototype has been extremely valuable in identifying the requirements and demonstrating the potential for similar linkages.

I-14 has several activities planned for 1993: Luc Anselin organized a workshop on "Exploratory Spatial Data Analysis and GIS," February 25-27, 1993 in Santa Barbara. Several sessions on GIS and Spatial Analysis have been organized for the AAG meetings in Atlanta, 1993. And two I-14 participants, Paul Longley and Tony Gatrell, are convening a conference on "Spatial Analysis Applications in GIS," to be held at the University of Bristol, U.K., April 1994.

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EDUCATIONAL INITIATIVES

The focus of the NCGIA's education activities has shifted to GIS in the secondary schools. Previous efforts have provided materials and support for GIS education at the collegiate level. Recognizing that the conduit to higher education GIS courses is fundamentally the secondary school, a project has begun that seeks to inquire into the role for GIS in the schools and aid in GIS implementation in that environment. Two impacts GIS may have on the schools have been identified:

1) Presentation of GIS as one of the key technological tools that may help us manage our complex world, and further training and education in GIS may enhance employability.

2) GIS in the schools would be an educational aid to the existing school curricula in geography, earth, life, and social sciences; and would promote critical thinking and computer literacy.

In the first year, the NCGIA Secondary Education Project (SEP) has focused on identifying existing GIS activities in the schools, communicating with educators on the place of GIS in the current school setting, and identifying what is required for teachers to incorporate GIS concepts and software in their classrooms. In order to receive early concentrated input from teachers for the SEP, the NCGIA hosted a seven day workshop in which ten high school teachers from a variety of disciplines worked with NCGIA researchers to identify the potential for GIS and GIS-aided instruction in the schools. The teachers also helped the NCGIA to identify the materials and support that teachers would need to bring GIS into their classrooms.

In addition to discussion of these topics, the workshop included a short course in GIS, demonstrations of GIS applications, and hands-on use of GIS software. A summary of the workshop will be available as an NCGIA Technical Report in the spring. The teachers' comments were unanimously favorable towards some level of GIS activities in the schools. The teachers pointed out the need for pre-packaged GIS activities and low-cost, easy-to-use GIS packages. Although not all the pieces are in place for an easy adaptation of GIS to the secondary school environment, the teachers involved in the workshop attempted some sort of GIS activity in their courses this past fall.

Based on the experience from this workshop and our other investigations, the NCGIA is planning a second phase with additional workshops for teachers to learn about GIS. Another component will be the creation of GIS modules that would complement existing instructional materials. These modules will be produced in collaboration with experienced curriculum writers, GIS developers, GIS educators, and classroom teachers. The Project continues to seek information on GIS activities in the schools, and input on GIS issues at this educational level.

Four hundred Japanese language copies of the NCGIA Core Curriculum in GIS will be distributed free of charge to universities in Japan this fall. Pending agreements will produce Spanish, Russian and Arabic versions. There are plans to develop supplements to the Core Curriculum by groups beyond the NCGIA. The executive committee of the Education Special Interest Group of the European GIS Foundation has recently distributed a call for proposals from people who are interested in preparing new or revised units for the European supplement or who are interested in presenting a paper on using the Core Curriculum at the EGIS conference in Genoa, Italy in March 1993.

For more information about the NCGIA's Secondary Education Project, contact the Project Manager, Steve Palladino (805-893-8652 or spalladi@ncgia.ucsb.edu). Mr. Palladino can also be contacted about other NCGIA education activities. Dr. Karen Kemp, who has been the Coordinator of Education Programs for the NCGIA since its inception, is moving to the Technical University of Vienna to develop a professional level GIS curriculum for the European Community. She will continue to oversee issues related to the use and distribution of the Core Curriculum. Dr. Kemp can be reached at: kemp@ncgia.ucsb.edu.

SITE NEWS

BUFFALO

Education:

M.A. Degrees Received:

David Carey completed his M.A. thesis "Use of Federal Digital Data Products with ARC/INFO" with Barbara Buttenfield. John Sheperd has completed his M.A. thesis "A Quantitative Analysis of Georgia Phytogeography," with Dennis Jelinski.

Ph.D. Degree Received:

Hsueh-Cheng Chou has completed his doctoral dissertation, "Designing a Programming Language for Geographic Modeling," with David Mark.

Visitors:

From August 26 to September 9, Tom Poiker, Professor in the Department of Geography at Simon Fraser University, was in residence at the Buffalo site, assisting with the teaching of graduate

classes, and meeting with faculty and students from the NCGIA and Department of Geography. He presented a colloquium entitled "The Evolution of a Technology: GIS in British Columbia." Poiker also worked with Barbara Buttenfield and David Mark on the preliminary plans for an NCGIA-sponsored meeting in 1993 on "GIS, Geography, and Society," to focus on ethics in GIS, the relationship of Geography to GIS, and related topics.

Personnel News:

-Peter Rogerson is on leave for the 1992-93 academic year, and is spending a year in residence as a Fellow at the Center for Advanced Study in the Behavioral Sciences in Stanford, California.

-Stewart Fotheringham is serving as Acting Chair for the Department of Geography for the 1992-93 academic year, and David Mark is serving as Acting Associate Chair.

-Sam Cole, Professor of Planning and Design at UB, and a Research Scientist with the Buffalo site, will join the Department of Geography on a half-time basis in January 1993.

-Rajan Batta is serving as Interim Chair of the Department of Industrial Engineering.

Meetings:

1) On April 30, the Buffalo site hosted a Wetlands Mapping Scoping Meeting in conjunction with the New York State Department of Environmental Conservation. Thirty participants from federal, state, and local agencies, and the private sector attended the meeting, which featured presentations, open discussion, and a GIA lab tour with demos. Mike Batty, Barbara Buttenfield, and Dennis Jelinski, representing NCGIA, discussed needs in the area of wetlands mapping, the technology available to address those needs, and the resources available to support the mapping projects. Buttenfield and Jelinski are continuing discussions with participants about wetlands mapping issues.

2) NCGIA-**Buffalo** was one of the sponsors of the first annual Chinese Professionals in GIS (CPGIS) Conference, held at the Center for Tomorrow, SUNY-**Buffalo** on August 15th and 16th, 1992. There were approximately 120 participants from Australia, Canada, Germany, the Netherlands, United Kingdom, United States, and China. About one third of the participants came from China for the meeting.

Hui Lin (Ph.D. in Geography, SUNY-**Buffalo**) acted as Chair for the opening session. Stephen Dunnett, Associate Provost for International Programs, SUNY-**Buffalo**, and Michael Batty, Associate Director of NCGIA, gave welcoming addresses. Professor Chen Shupeng of the Laboratory of Resources and Environment Information System, Beijing, gave the keynote address. During the two day meeting, there were 46 paper presentations in 17 technical sessions. Personnel from the Buffalo site of the NCGIA presented seven papers, and chaired four paper sessions.

3) NCGIA-**Buffalo** sponsored a conference on Spatial and Contextual Models of Political Behavior, held at University of Buffalo from October 23-25, 1992. Munroe Eagles, NCGIA Research Scientist from UB's Department of Political Science, was the primary organizer. The meeting brought together 35 invited scholars (21 from outside UB) from the disciplines of Political Science, Geography, Sociology, and Urban and Public Affairs, to consider modeling and empirically investigating the spatial dimension of political attitudes and behavior; and how spatial analysis and GIS might advance research in these areas. Graduate students and other faculty attended the meeting informally.

Conference participants attended an opening session that provided an overview of the NCGIA, GIS and GIA, and then observed numerous related hardware/software demos in the GIAL. Eighteen papers were presented in six panel sessions. A number of the papers will be submitted for a possible issue of *Political Geography*, co-edited by John O'Loughlin (University of Colorado) and Munroe Eagles.

4) In May 1992, NCGIA-**Buffalo** signed a cooperative agreement for scholarly exchange with the Sharjah Municipality of the United Arab Emirates. This agreement is similar to those the Buffalo site has with the Wales and Southwest Regional Research Laboratories and the National Laboratory of Resources and Environment Information System in Beijing. Stewart Fotheringham will represent the NCGIA at Sharjah's First Annual GIS and Applications Conference in February 1993.

Grants:

NASA has awarded \$165,000 to Dennis Jelinski for the project "Surface Energy and Water Balances of Forest and Wetland Subsystems in the Boreal Forest: Surface-Atmosphere Links and Ecological Controls." *The Natural Sciences and Engineering Research Council of Canada (NSERC)* has awarded \$300,000 to J. Harry McCaughey (Queen's University) and Peter M. Lafleur (Trent University) as Co-Principal Investigators on the same project. The project dates are January 1993 through December 1996.

World University Games awarded \$42,635 for the project "Construction of Digital Representations of the Buffalo Metropolitan Area" to Principal Investigators Stewart Fotheringham (Project Director) and Barbara Battenfield, for the period December 1992 through August 1993.

Equipment and Software Grants Awarded: *Sun Microsystems, Inc.* supported the "Proposal to Expand the Electronic Research and Instructional Facility at the Buffalo Site of the National Center for Geographic Information and Analysis," to fund nine workstations, a server upgrade, and associated peripherals, at the educational discount price of \$80,840, to Co-Principal Investigators: Hugh Calkins, Paul J. Densham, and Michael Batty. This is the second phase of an earlier award from Sun of five SPARCstations in February 1990 (educational discount price of approximately \$66,000).

MAINE

Visitors:

-Keith Clarke of Hunter College (currently on sabbatical with the National Mapping Division, USGS), presented "Dynamic Modeling of Wildfire Propagation and Extinction" on October 9, 1992.

-Hank Emery, President, Emery & Associates, Inc., (Colorado) and University of Maine alumnus, gave a presentation on setting up comprehensive municipal AM/FM systems in foreign countries, on October 14, 1992.

Meetings:

1) An international "Think Tank" on issues relating to the process of change in surveying, mapping and geo-information science education was held at the Roosevelt-Campobello International Park and Conference Center on the Maine-

New Brunswick border, October 4-6, 1992.

This meeting continued the process of self-examination for members of academic disciplines such as surveying engineering, civil engineering and geography and representatives of industry and federal agencies, building on the success of a previous workshop held in Berlin, Germany in May, 1991. Participants were from the U.S., Canada, Germany, Switzerland, Austria, and Norway. The meeting also further developed the goal of a common global vision for surveying and mapping educators.

2) Faculty and researchers at NCGIA - Maine cooperated with colleagues from the Maine Space Grant Consortium at the University of Maine to put on a one day GIS seminar for staff from Acadia National Park and the Regional Headquarters for the National Park Service, in October 1992. Kate Beard (NCGIA) and Sarah Clapham (Department of Forest Management), provided hands-on tutorials in PC ArcInfo and IDRISI, presenting GIS concepts and applications in contexts relevant to current park management issues, including conservation easement acquisition and vista management. Topics such as applications development, implementation planning, personnel training, and internships were outlined for potential future cooperation between the University of Maine and Acadia National Park.

3) Further links with the Maine Space Grant Consortium were established at a conference on "Integrating Spatial Information Technology," held in Portland, Maine in November 1992. David Tyler attended this conference and gave a presentation on "GPS as a Data Collector for GIS," and he participated in a panel discussion on "GIS and Education."

SANTA BARBARA

Education:

Sheri Hudak received her M.A. degree in Geography, having completed her thesis on "Spatial Econometrics in Practice," with Luc Anselin.

Karen Kemp received her Ph.D., having completed her doctoral dissertation, "A Strategy for Dealing with Spatial Continuity," under Mike Goodchild. She is now an Assistant (Professor) at the Technical University of Vienna.

Visitors:

-Julio D'Alge, Visiting Researcher from INPE Brazil (Instituto Nacional de Pesquisas Espaciais), has been working on cartographic generalization since his arrival in January 1991. Because the subject embraces different approaches, he is pursuing the subject as a Ph.D. student as of January 1993. Over the next two years, he will design a method that combines mathematical morphology and the common algorithms for line simplification or line smoothing.

-Dr. Robert Barr, lecturer at the University of Manchester, is a visiting research scholar sponsored by a Harkness Fellowship from The Commonwealth Fund of New York, from August 1992 to August 1993. He is continuing his research on social applications for GIS, urban monitoring, and policy analysis, focusing on the delivery of health and social services. He presented a talk at UCSB in October and at SUNY-Buffalo in January on "Data Data Everywhere, but Ne'er a Drop to Link," or "British Spatial Data Infrastructure, or the Lack of It." He attended the January 1993 Mapping Science Committee of the National Academy Sciences as an observer, and visited the founders of the Center for Geosocial Analysis in Albany, New York. He gave a talk at MIT in February on "Urban Monitoring."

-Valentina Boytcheva is visiting NCGIA from the Solar-Terrestrial Interactions Laboratory at the Bulgarian Academy of Sciences, and is sponsored by the Central European University's Environmental Sciences Program for six months, through June 1993, to study remote sensing. Since GIS is not well-known in Bulgaria, she will be learning its applications in a variety of areas: investigation of air and water pollution in industrial zones; capacity for finding new natural resources; and making compatible the existing remote sensing data in her laboratory with GIS.

-Gary Hunter, lecturer from the University of Melbourne Department of Surveying and Land Information, is visiting NCGIA from January through July of 1993 to study error modeling and uncertainty in spatial decision-making.

Personnel:

Dan Montello joined the UCSB faculty in September and will be participating in the coming Initiative 10 Specialist Meeting on Spatio-Temporal Reasoning. An environmental psychologist by training, Montello's research centers on how people learn and reason about the spaces in which they live.

Grants:

The IBM Environmental Research Program has funded a \$1.2 million, four-year project at UCSB, titled "A Spatial Modeling and Decision Support System for Conservation of Biological Diversity," to design and test a computing facility to address complex problems in the analysis of species distributions and planning of nature reserve networks. The facility will allow researchers to develop new tools to analyze the vast amount of environmental and biological data that currently exists but is difficult to access and integrate. These tools will be used to study the distributions of species and to guide conservation efforts to locations with the greatest concentrations of species and habitats at risk of future extinction. The project involves collaboration with the USFWS Gap Analysis Program, the Southern California Multi-Species Conservation Planning Program and the USGS EROS Data Center. Frank Davis is the Principal Investigator, and Mike Goodchild is Co-Principal Investigator.

Project objectives are to:

- 1) Design and enable a prototype regional computing facility for storage, analysis and visualization of biodiversity data.
- 2) Program a set of specific software applications to support national (and potentially international) Gap Analysis and conduct an analysis of the Intermountain Sagebrush Ecoregion over six western states.
- 3) Develop software to support reserve siting and reserve design and apply products to reserve planning for the Coastal sage scrub ecosystem in southern California.

Software Update: SpaceStat

The latest version of SpaceStat, the spatial data analysis software developed by Luc Anselin, is compiled in GAUSS386-i 3.0, by Aptech Inc. This software runs on 386 and 486 personal computers with at least 4 megabytes of RAM. SpaceStat is now distributed with the Run Time module for GAUSS-386i VM3.0, which includes a virtual memory manager. This eliminates the limitation on the size of the problem that may be analyzed that was due to RAM constraints. Due to the new license agreement between NCGIA and Aptech Inc. for the distribution of the Run Time module, a separate Run Time module

must be purchased for each copy of SpaceStat. Note that this Run Time module is not needed if GAUSS-386i is installed. SpaceStat is now available with the Run Time module (\$250) and without the Run Time module (\$200), and includes a Manual/Tutorial (NCGIA Technical Software Series S-92-1). The tutorial is also available separately (\$50). Additional copies of SpaceStat (with the Run Time module, but without the manual) may be obtained for \$65 each. This is geared to users who intend to install the software in a laboratory. Further illustrations of SpaceStat in the integration of spatial data analysis and GIS are given in a recent Technical Report by Luc Anselin, "Spatial Data Analysis with GIS: An Introduction to Application in the Social Sciences" (NCGIA Technical Report 92-10, \$17.00).

The NCGIA UPDATE is published twice yearly by the National Center for Geographic Information and Analysis at Santa Barbara. It is edited by Judith Parker. Send submissions, requests, or change of address to:

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COSIT'93

The first Conference on Spatial Information Theory (COSIT) will be in Marciana Marina, Elba, Italy, on September 19-22, 1993. It will concentrate on theoretical aspects of spatial information and deal with all aspects of "large scale" or "geographic" space and description of objects, processes or events in large scale space, as typically relevant for GIS. Some of the topics of are: simulation of processes in geographic space, time in geography and geographic information, virtual reality, and treatment of incomplete or imprecise spatial data. The deadline for submissions is March 15.

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BOOKS PUBLISHED BY NCGIA RESEARCHERS:

I-1: *Accuracy of Spatial Databases*, edited by Michael F. Goodchild and Sucharita Gopal. London: Taylor & Francis, 1989. ISBN: 0-85066-847-6.

I-2: *Cognitive and Linguistic Aspects of Geographic Space*, edited by D. M. Mark and A. U. Frank. Dordrecht: Kluwer, 1991. ISBN: 0-7923-1537-5.

I-3: *Map Generalization: Making Rules for Knowledge Representation*, edited by B. P. Buttenfield and R. B. McMaster. London: Longman House, 1991. ISBN: 0-582-08062-2.

I-5: *Design and Implementation of Large Spatial Databases* (First Symposium SSD '89, Santa Barbara, California, July '89, Proceedings), edited by A. Buchmann, O. Gunther, T. R. Smith, and Y. F. Wang. New York: Springer-Verlag, 1989. ISBN: 3-540-52208-5.

I-12: *The Integration of Remote Sensing and Geographic Information Systems*, edited by Jeffrey Star. Bethesda: ASPRS, 1991. ISBN: 0-944426-49-2.

Jeffrey Star and John Estes, *Geographic Information Systems: An Introduction*. Englewood Cliffs: Prentice Hall, 1990. ISBN: 0-13-351123-5.

Geographical Information Systems: Principles and Applications, edited by D. J. Maguire, M. F. Goodchild, and D. W. Rhind. London: Longman House, 1991. ISBN: 0-582-05661-6.

Cities of the 21st Century: New Technologies and Spatial Systems, edited by J. Brotchie, M. Batty, P. Hall, and P. Newton. New York: Halsted Press and London: Longman Cheshire, 1991. ISBN: 0-470-21742-1.

Theories and Methods of Spatio-Temporal Reasoning in Geographic Space (International Conference GIS--From Space to Territory: Theories and Methods of Spatio Temporal Reasoning, Pisa, Italy, September 1992, Proceedings), edited by A. U. Frank, I. Campari, U. Formentini. Berlin, New York: Springer-Verlag, 1992.



The photograph for this issue features NCGIA personnel at the University of Maine. From left to right, they are: William Mackaness (Postdoctoral Research Associate), Troy Jordan (Systems and Network Manager), David Tyler (Associate Director), Max Egenhofer (Researcher), Harlan Onsrud (Science Policy Committee Chairman), Kate Beard (Researcher), Blane Shaw (Administrative Assistant), and Kathleen Hornsby (Administrative Officer).

RECENT NCGIA TECHNICAL PAPERS:

91-21: GIS Teaching Facilities: Six Case Studies on the Acquisition and Management of Laboratories, edited by Stephen D. Palladino and Karen K. Kemp, UCSB,\$27.00
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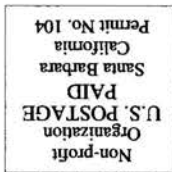
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NCGIA UPDATE
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