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The Alexandria Digital Library

*University of California, Santa Barbara
(NSF-ARPA-NASA Digital Library
Initiative, 1994-98)*

The development of the Alexandria Digital Library is part of a Digital Library Initiative that is sponsored by NSF, ARPA, and NASA and that commenced in the Fall of 1994 and is due to end in 1998. In particular, the Alexandria Project at the University of California, Santa Barbara (UCSB) is one of six projects supported under the initiative. The other five universities receiving awards include Carnegie-Mellon University, the University of Illinois at Champaign-Urbana, the University of Michigan, the University of California at Berkeley, and Stanford University. There is significant cooperation among the six projects, which meet formally every six months. UCSB will be hosting the next meeting in November 1995. The six projects are viewed by their sponsors as the cornerstone in a national effort to develop digital libraries.

The Alexandria Project involves a consortium of several groups. Academic groups participating in the project include several groups from UCSB: the Map and Imagery Laboratory (MIL), the Department of Computer Science, the Department of Electrical and Computer Engineering, the National Center for Geographic Information and Analysis (NCGIA), and the Institute for Computational Earth System Science (ICESS). This team is augmented by researchers from the NCGIA at SUNY (Buffalo) and University of Maine (Orono). Libraries participating in the project include the UC Center for Library Automation, the library of SUNY (Buffalo), the Library of Congress, the library of the United States Geological Survey, and the St. Louis Public library. Other partners include Digital Equipment Corporation (DEC), Environmental Systems Research Institute (ESRI), E-Systems, Lockheed, San Diego Super-computer Center, the US Navy, Xerox and Conquest.

The Alexandria Project is focused on the design, implementation, and deployment of

a digital library for spatially-indexed information. The Alexandria Digital Library (ADL) will eventually comprise a set of nodes distributed over the Internet, with each node supporting a variety of library components that include interfaces, catalogs, databases, and ingest facilities. Two major classes of user activity supported by ADL are access to many classes of spatially-indexed materials and the application of procedures that extract useful information from accessed items. The collections of the library currently involve geographically-referenced materials, such as maps, satellite images, digitized aerial photographs, and associated metadata. These collections are being extended to include graphical materials involving more general forms of spatial indexing and referencing, such as astronomical images, digitized plans, digitized images of artwork, multimedia, and remote services (e.g. WWW sites). The library will also contain textual

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From the Director

Welcome to NCGIA's latest newsletter. This edition features information on the new Alexandria Digital Library project, which will research and build technology to implement a library for maps, images, and other kinds of spatially referenced information on the Internet over the next four years. It takes NCGIA in a new direction by focusing on access to data, an emphasis we sorely need if GIS technology is to become as productive as we hope it will. As science becomes more multidisciplinary, and as society as a whole recognizes the need for collaboration and sharing of resources, tools such as digital libraries will become increasingly important as mechanisms for moving information between people, agencies, and projects.

In addition to Alexandria, this edition includes the regular updates on progress under NCGIA's research initiatives, announcements of conferences and work-

shops, and information on how to access and perhaps become personally involved with our other activities. We hope you find it useful. Please feel free to contact me or any of the staff if you would like further information, or if you have problems following up any of the other pointers in the newsletter.

I am very pleased that Dr. Karen Kemp was able to rejoin NCGIA last summer as Assistant Director. Karen has been able to take on responsibility for a number of projects, including NCGIA's role in establishing UCGIS (see Features in this issue), and it's great to have the assistance of someone with her skills, energy, and knowledge of the field. If you haven't met her, she's the one next to me in the Santa Barbara staff picture in this edition.

As you may know, NCGIA was originally planned in 1988 as an eight-year project. The cooperative agreement which

funds the center was renewed by the National Science Foundation in 1993 for three years and ends in December 1996. Currently, the issue of what follows in 1997 is being discussed actively in the center, in the Board of Directors, and within the GIS community at large. Should there be a "center without walls" involving a much larger consortium, and reflecting the expansion that has occurred in GIS and GIS research over the past eight years? Should the UCGIS be the vehicle for an expanded consortium? Has the need for a large-scale, focused effort in basic GIS research grown or diminished? These are some of the questions that will have to be resolved over the next year or so.

— Michael F. Goodchild

The Alexandria Digital Library (continued)

materials, such as gazetteers, containing geographic and spatial references to many classes of objects that possess spatial "footprints."

The need for a digital library supporting such materials arises because spatially-indexed information is currently a largely inaccessible intellectual resource. Many important collections of such information are currently stored in non-digital form (e.g., paper maps, photographs, atlases, gazetteers), and collections of considerable size and diversity are found only in the largest research libraries. While a growing amount of such information is available in digital form, it is still inaccessible to most individuals. The fundamental goal of the Alexandria Project, therefore, is to permit users who are distributed over the Internet to access broad classes of spatially-indexed materials that may themselves be distributed over the Internet and to derive useful information from such materials. The class of intended users ranges from school children to academic researchers, and includes the general public. Access to the library for such users may, for example, take the form of browsing, viewing, or downloading data and metadata, while useful information may be derived by the application of various procedures. The achievement of this goal will be determined by the degree to which ADL is eventually able to answer a broad array

of queries.

In the first five months, the project team developed the Alexandria Rapid Prototype System (RPS) based on commercial, off-the-shelf technology, to demonstrate what might be possible and to act as a strawperson for further development. The RPS uses ESRI's ARCView, Sybase, and the Tcl/Tk interface builder. We are hoping that a distributable version will be available on CD in mid-June, with the cooperation of ESRI, so that as wide a group as possible can test the prototype and provide feedback on its usefulness. While the RPS is stand-alone software for Unix, by November 1995, Alexandria will establish a prototype server on the WWW.

Additional information about the Alexandria Digital Library is available on the Web at URL <http://alexandria.sdc.ucsb.edu/> or from the Project Director, Terence R. Smith (smithtr@cs.ucsb.edu; (805) 893-2966).

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Education

by Steve Palladino

NCGIA continues to support GIS education on a variety of fronts including the K-12 schools in its Secondary Education Project, the Core Curriculum and other university level GIS education materials, and a new project focusing on GIS in the Community Colleges.

Core Curriculum to be Revised

Contrary to our original promises that we would not produce an update for the NCGIA Core Curriculum in GIS, we have finally decided that it is time for a revision. Although we originally felt that Curriculum would be a starting point from which each instructor would diverge too far to find use in an update, we have discovered that the materials have held their relevancy and value much longer than anticipated. In fact, they are still so widely in use, an update is virtually required in order to ensure that those using them do not fall too far behind current practice and state of the art.

Producing an update provides us an exciting opportunity to do it even better the second time around. Initial discussions have suggested that while plenty of opportunities exist for exploring new electronic media, demand for a paper based version similar to the original one is still strong. Although we have only just begun to discuss how to manage and fund this latest project, it is clear that some variation on the original model will be used. That is, a general framework for the organization of materials will be devised and individual contributions from experts world-wide will be solicited. This time around we hope to be able to devote more attention to pedagogic issues as well as to provide a wider geographic and domain-specific range of applications and issues.

Remote Sensing Core Curriculum

As announced in *Photogrammetric Engineering and Remote Sensing* in June 1993, with funding recently granted by NASA, NCGIA is now cooperating in a curriculum development project for Remote Sensing. Using a development model similar to that used for the GIS Curriculum, the RS team, headed by Dr. Timothy Foresman at the University of Maryland, Baltimore County, will develop 4 volumes of teaching materials, including laboratory exercises with the neces-

sary digital and photographic images, for topics covering airphoto interpretation and photogrammetry to digital image processing. Based on our experience with the GIS Curriculum, NCGIA will provide input and advice in the development of the materials and in their evaluation. It is hoped that the final product will be available for distribution through the NCGIA Publications Office by the fall of 1997.

GIS in Education: An International Symposium

The World Computer Graphics Foundation, with cooperation from NCGIA, is sponsoring the latest in a series of symposia on GIS education and training issues. The symposium will be held in Tampa, Florida on November 9-12, 1995 immediately preceding the GIS/LIS conference in Nashville, Tennessee. This event will enable GIS instructors from universities and colleges to identify key issues including the use of multimedia in GIS instruction, accessing data for examples and exercises, spatial analysis foundations for GIS courses, and GIS and distance learning. The symposium will also investigate the nature of a revised Core Curriculum in GIS. This symposium will involve not only four-year collegiate institutions, but also the two-year colleges and a few GIS educators from the K-12 schools. Contact Dr. Bob Aangeenbrug of the WCGF at (813) 974-2386 for more information.

NCGIA Summer Institute 1994

The first NCGIA Summer Institute held in Santa Barbara in August 1994 provided a unique opportunity for researchers and instructors from a broad range of disciplines to investigate the latest findings of Geographic Information Science. The Institute was designed to serve academics that regularly use GIS in their research and instruction, but wanted closer contact to cutting edge GIS research and researchers in order to probe the possible role of those GIS theoretical and practical frameworks in their own endeavors.

Twenty researchers from the US, Norway, Mexico, and Brazil attended the one week 1994 Summer Institute. Activities included seminars by NCGIA researchers, Dr. Michael Goodchild (Data Accuracy and Error Visualization), Dr. Max Egenhofer (Knowledge Representation for Spatial

Data), and Dr. Paul Densham (Spatial Decision Support Systems); guest lectures by Dr. Waldo Tobler and Dr. Gary Hunter; computer-based demonstrations; and short research interest presentations by the Institute participants.

Based on the success of this first Summer Institute, NCGIA is investigating the possibility of holding another institute in the summer of 1996 or 1997. Since NCGIA is involved in the 1995 NSF-ESF Summer Institute, we have temporarily suspended the NCGIA Summer Institute series. (In this issue, see "1995 International Young Scholars' Summer Institute in Geographic Information" included under Features.)

GIS in Community Colleges

The two-year colleges are an important and rapidly growing sector for GIS education and training. It is just this flexibility for both education and training that appears to be propelling the use of GIS in these environments. NCGIA is seeking to support efforts to provide GIS learning experiences in the colleges. Steve Palladino, the NCGIA Education Projects Manager, is keeping a master list of community colleges with GIS instructors and other interested parties. Please contact him at (805) 893-4305 or spalladi@ncgia.ucsb.edu if you would like more information or to be added to the mailing list.

NCGIA has sponsored panel sessions on GIS in the community colleges at two recent professional meetings. The 1994 GIS/LIS conference in Phoenix included a panel reviewing examples of GIS courses and programs. This was an initial networking opportunity for community college GIS instructors. At the 1995 Association of American Geographers Annual Meeting in Chicago, NCGIA and the AAG GIS in Community Colleges Task Force sponsored two sessions. The first looked at the role of GIS in education across the spectrum of educational institutions (K-12, two-year college, university, and professional education). A second panel examined specific actions that could be taken to aid GIS efforts in the community colleges and the role of the geography discipline in those activities.

At the WCGF GIS in Education Symposium there will be a parallel track for community college GIS instructors. The sympo-

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sium will provide an opportunity for two-year college instructors to both address GIS issues specific to their level, but also to investigate with colleagues in the four-year institutions the many areas of mutual concern.

Secondary Education Project

The SEP continues to function as the crossroads for information, activities, and materials for using GIS in the pre-collegiate classroom. All three NCGIA sites are continuing outreach activities to schools and the SEP is developing additional materials for GIS education. For more information, contact Steve Palladino at the NCGIA, Santa Barbara.

Color Your World

Color Your World is the latest addition to the set of resources developed by NCGIA SEP to help bring the great educational potential of GIS to the K-12 schools. This module/game introduces students to geographic data and the geographic information system ArcView 2.0, which is a commercially available GIS produced by ESRI.

Color Your World uses ArcView 2.0 sample data and additional thematic data sets to dem-

onstrate the ability of ArcView 2.0 to integrate cartographic data, tabular records, and images. It leads the player through a series of rounds that test knowledge of country names, location, and thematic attributes.

This particular game was conceived, designed, and written by Paul Sutton, Paul Van Zuyle, and Steve Palladino at NCGIA, Santa Barbara. The project was supported by a generous gift from ESRI. It is being distributed as Technical Report 95-5 and through the ftp site, ftp.ncgia.ucsb.edu (see directory pub/arcview2).

K-12 Day at GIS/LIS 1995

Barbara Battenfield and Paul Rooney of NCGIA Buffalo are organizing a day of sessions on GIS and K-12 education at the November 1995 GIS/LIS conference in Nashville, Tennessee. Funding is being provided by ESRI, NCGIA, and ACSM (The American Congress on Surveying and Mapping). The K-12 day will include three paper sessions and a tour of the exhibit hall for junior high and high school students from the Nashville region. Vendors are being contacted now to set up software demos targeted specifically towards these students.

Site Outreach

At Santa Barbara, NCGIA will sponsor a GIS day for K-12 teachers attending the Alliance Summer Geography Institute at UC Santa Barbara in summer 1995.

At Buffalo, NCGIA and the SUNY Geography Department have been working with one of the inner-city K-6 magnet schools to implement the recently published National Geography Standards in the school curriculum. NCGIA will provide support for the exploration of GIS as a part of this curriculum.

At Maine, NCGIA staff participated in the 1994 Maine Geographic Alliance Summer Institute. The theme of that Summer Institute was 'Geography: The Great Integrator' and included an introduction to GIS. NCGIA Maine has also been working with the Maine Mathematics and Science Alliance to produce a geographical information system for local educational agencies for the State of Maine, and is working with a number of Maine and New England High Schools on GIS projects.

GIS-L Moves to URISA.ORG

On March 7, 1995, GIS-L, the general GIS discussion group on email, moved to URISA.org. GIS-L was established in 1988 by Ezra Zubrow, an anthropologist at SUNY Buffalo who is a member of the NCGIA site there. When Professor Zubrow went on leave a couple of years after that, David Mark took over as 'Owner' of GIS-L. In 1992, a Usenet News group, comp.infosystems.gis was established by Usenet voting procedures, and a bi-directional gateway was established between it and GIS-L. GIS-L was maintained from December 1992 to July 1994 by F. Benjamin Zhan, then a Ph.D. student. By late 1994, GIS-L had over 1,100 subscribers in many countries, but with over 30 messages per day, the number of errors returning to the owner account was getting out of hand.

Closing GIS-L altogether was considered since the electronic discussion can be accessed directly through the newsgroup. However, an estimated 400 subscribers who do not have access to centrally managed newsgroups would have been left out if GIS-L disappeared. Fortunately, URISA, the Urban and Regional Information Systems Association, stepped in to rescue GIS-L, in the process establishing their own new Internet node, URISA.org. After NCGIA's successful launch and maintenance of GIS-L, it seems

appropriate that the management of the list would be transferred to one of the key professional societies involved in GIS.

Subscribing to GIS-L:

If you are unable to access the newsgroup and wish to follow the GIS-L discussion, you will need to subscribe to the new GIS-L. At its new home, GIS-L is operating under slightly different software, called ListProcessor 6.0. To subscribe to GIS-L, please send the one-line message: subscribe GIS-L your name to: LISTSERVER@URISA.ORG (Remember to substitute your own name for the 'your name')

Items to be distributed to the list should be sent via email to GIS-L@URISA.ORG (or posted to comp.infosystems.gis). Commands, such as SUBSCRIBE or SIGNOFF, should be sent to LISTSERVER@URISA.ORG. Experienced LISTSERVER users should note that ListProcessor commands are somewhat different from LISTSERV. For a list of commands, send the 1-line command HELP to LISTSERVER@URISA.ORG.

Accessing comp.infosystems.gis:

Although GIS-L is still available as a distribution list, there are several advantages to following the discussions via comp.infosystems.gis rather than through GIS-L:

1. Impersonal messages will not fill your personal mailbox, the discussion can be attended

to at your convenience.

2. Subscription is not an issue — this means that subscribe & unsubscribe messages will diminish.
3. Many newsreaders will "thread" discussion topics. This visually groups all responses pertaining to the same message together and makes it easy to read through an entire theme completely, or to ignore it.

Accessing newsgroups is generally managed centrally in large computer systems such as those found at universities. Ask your system administrator, postmaster, or consultant if you have access to Usenet News.

He or she will need to make sure that your central Usenet gateway receives comp.infosystems.gis and that you have local access to a newsreader. If you use Xwindows or an Internet-networked Mac or PC, there is an excellent threaded newsreader as part of the WWW browser called "Netscape". On UNIX systems you may need to use 'rn' or 'trn' (also a threaded reader). On VMS, it will be VNEWS. If you can use a newsreader, messages to the newsgroup should be sent via the newsreader software, not as email messages, since only the first method allows messages to be properly threaded.

Features

National Center for Ecological Analysis and Synthesis awarded to UCSB

Ecologists at UC Santa Barbara have received a 5-year \$10 million award from the National Science Foundation (NSF) to establish a National Center for Ecological Analysis and Synthesis. UCSB participated in a nationwide NSF competition to establish the Center, which is the only one of its kind. The winning proposal was submitted by Prof. William W. Murdoch, Department of Biological Sciences, who will direct the Center in its first year and will conduct a national search for the permanent Director, and Prof. Michael Goodchild, Department of Geography. Prof. Frank Davis of the Geography Department at UCSB will be the Deputy Director for the first two years. These scientists note that the Center is the most exciting institutional innovation in the science of ecology in several decades. The award is potentially renewable for an additional 6 years.

The Center has strong support from the State of California in the form of a matching grant of \$2.5 million over its first 5 years. The state sees the Center as an opportunity to enhance the development of environmental technology, especially in the areas of advanced computing and information technology that will be a focus of the Center's activities. The Administration and other faculty in ecology at UCSB have also been enthusiastic supporters of the effort to bring the Center to the campus.

The idea of the Center was developed in a series of national meetings of US ecologists and other environmental scientists. It is designed to serve as a focus for analyzing and integrating existing ecological information, especially by bringing together scientists, from across the nation and, where appropriate, from other nations, who would otherwise have difficulty collaborating. Scientists will come as part of working groups that will stay for periods ranging from a few weeks to a few months. The Center will also house senior fellows on sabbatical leave and postdoctoral fellows. Graduate and undergraduate students will be able to gain research experience as interns.

The Center will focus on collaborative research on the structure and dynamics of ecological systems. The research will be on both fundamental scientific problems and in more applied areas such as biologi-

cal conservation, effects of global climate change and restoration ecology. The Center will have state-of-the-art computing facilities and will occasionally run workshops in new techniques. Through vehicles such as small conferences, the Center will inform resource managers and policy- and decision-makers of results relevant to their activities.

The Center will spend its first 3 years in a location in downtown Santa Barbara, but is scheduled to move to campus at the end of that period. The initial off-campus location emphasizes the university's commitment to the concept that this is a national resource, rather than one focused on UCSB, and also provides an opportunity for the campus to reach out to the local community. The Center is expected to take up residence downtown in August.

Additional information about the National Center for Ecological Analysis and Synthesis can be obtained by contacting William W. Murdoch (murdoch@lifesci.lscf.ucsb.edu; (805) 893-4887) or Frank Davis (fd@geog.ucsb.edu; (805) 893-3438).

1995 International Young Scholars' Summer Institute in Geographic Information

For eight days this summer, 50 junior and senior US and European scientists working in the general area of geographic information will study together at the Wolfe's Neck Conference Center near Portland, Maine. This institute, from July 26 to August 3, is sponsored jointly by the US National Science Foundation (NSF) and the European Science Foundation (ESF).

Fellowships for the young US scholars attending the institute were awarded following a national competition. The US fellows are William Albert, Boston University; Bijan Azad, MIT; Daniel Brown, Michigan State University; Zorica Budic, Virginia Polytechnic Institute; John Evans, MIT; Mark Finco, University of Utah; Puneet Kishor, World Bank and University of Wisconsin; Xavier Lopez, University of Maine; Marianne MacDonald, University of Colorado at Denver; David Olson, CUNY and SUNY Albany; Bruce Rex, Battelle Pacific NW Laboratory; Ramesh Subramanian, University of Alaska at Anchorage; Kongjian Yu, Harvard University; May Yuan, University of Oklahoma; and Ming Zhang, University of California Berkeley.

Senior participants include: K. Beard, K. Clarke, H. Couclelis, M. Domaratz, M. Egenhofer, J. Ferreira, M. Goodchild, D. Marble, D. Mark, R. McMaster, H. Onsrud, J. Pinto, W. Tobler and N. Tosta, from the US; and H. P. Baehr, M. Craglia, J.P. Donnay, P. Fisher, M. Fischer, J.P. Lagrange, I. Masser, J. Raper and F. Salge from Europe. Drs Cora Marrett and Guido Martinotti will open the Institute on behalf of NSF and ESF, respectively.

A copy of the call for applications for fellowships to the 1996 Young Scholars' Summer Institute, to be held in Berlin, Germany, is included in this newsletter.

Collaborative Research Projects

NCGIA invites proposals for research projects involving collaboration between one or more NCGIA sites and other groups or institutions. Funding for such projects is shared between NCGIA and the collaborator. Researchers interested in developing collaborative projects should discuss them with appropriate researchers within NCGIA before beginning joint proposal development. Proposals are considered at the June and December meetings of the NCGIA Science Policy Committee. The following narrative describes two such collaborative projects.

SUNY-Buffalo — Collaborative Research Project

Predator-Prey Modeling of Fish Populations within Three Dimensional GIS
Mike Batty, Stephen Brandt, Hugh Calkins, Joseph DePinto, *PIs*

In mid 1995, the NCGIA at the University at Buffalo, in cooperation with the Great Lakes Program of the University at Buffalo, will be entering a collaborative research project with The Great Lakes Center at Buffalo State College. This 1.5 year effort is being supported by the NSF-NCGIA Collaborative Research Program.

Drs. Hugh Calkins and Mike Batty of NCGIA, and Dr. Joseph DePinto of the Great Lakes Program at the University at Buffalo will work with Dr. Stephen Brandt of Buffalo State College on the project "Predator-Prey Modeling of Fish Populations within Three Dimensional GIS." The Great Lakes Center at Buffalo State College, assisted by funding from the New York

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Sea Grant Program (among other sources), is undertaking a major data collection project using acoustic methods for sampling fish populations in Lake Ontario, and developing predator-prey models using this data. The NCGIA collaborative effort involves visualizing patterns in this data and developing improved models in a geographic information systems environment. Under the collaborative research effort, NCGIA will first develop an integrated framework for existing two-dimensional predator-prey models using GIS, and then extend this work into three-dimensional data and models. The NCGIA effort will also explore alternate spatial data sampling strategies, the spatial aggregation problem for both two- and three-dimensional data and models, and design new predator-prey models based on first-order cell-space diffusion.

UCSB — Collaborative Research Project

Integration of Remote Sensing and GIS, Assessment of Land Cover Change and Regrowth in a Northern California Forested Ecosystem

Dar Roberts, Michael Goodebild, Pls

As a part of NSF-sponsored joint research between NCGIA and outside institutions, a proposal was submitted to integrate GIS into a study of temporal changes in land cover and regrowth in a mixed evergreen forested region of northern California. The primary goal of the research is to assess the success of conifer regeneration in a watershed within the Six Rivers National Forest using remote sensing and to evaluate environmental, biotic and anthropogenic factors that may have influenced regrowth success using GIS.

As a part of a research project at the University of Washington, collaborators at that institution have already assembled an extensive satellite-based data set consisting of a 21-year time series of Landsat MSS, 10 years of Landsat TM and one full-season data set of MSS starting in August of 1987. These data have already been co-registered and are in the process of being intercalibrated. In addition, considerable supporting geographical information including digital elevation data, soils maps, seral stage maps and vegetation associations have been assembled by the U.S. Forest Service. The resulting data set represents one of the most complete temporal records of land use for the Pacific Northwest. This research is designed to contribute to this multitemporal study by integrating GIS into the research program to study regrowth.

Methods employed will combine remotely sensed analysis and geographical analysis using ARC/INFO. Remotely sensed analysis will focus on multitemporal image classification and the establishment of temporal profiles for regrowth. A classification approach based on the use of spectral mixture models will be used to develop temporal maps showing transitions in land cover. The accuracy of the classification will be evaluated through comparison to existing vegetation maps and field work. Spatial and temporal relationships will be used to improve classification accuracy. Regeneration success will be evaluated by comparing regrowth across the study area to a temporal profile of regrowth under optimal conditions. The temporal profile will be generated using existing seral stage maps and spectral mixture analysis to describe canopy attributes. Environmental, biotic and anthropogenic factors will be evaluated with respect to regrowth success through GIS.

Recovery from Computer Thefts of 1993-94

Recovery from last year's thefts is complete. The current computer setup in the NCGIA office at Santa Barbara consists of 7 IBM 250's, 3 IBM 370's, 4 power Macintoshes, 2 Xterminals, 1 Sparc 10, 4 Macintosh laptops and a 486 PC, all networked via ethernet. All services are restored, including our ftp site which now contains about 40% of the technical reports published prior to 1995. We've done the best we could to recover the digital technical report files so any pre-1995 technical reports not currently in the ftp site are unlikely to appear there in the future. However, from January 1995 we have instituted a strict policy of requiring that at least an ASCII version of each new technical report is placed in the ftp site, and ideally also a postscript version. Our anonymous ftp site is at "ftp.ncgia.ucsb.edu" and is mirrored at the other two NCGIA sites.

Of course, we have also added a WWW server that can be reached through "http://www.ncgia.ucsb.edu". It is constantly being updated and lists our research initiatives, current conferences, calls for proposals, information about our education programs, links to all three NCGIA sites and the ftpservers, and much more.

The Global Demography Project

Waldo Tobler is the principal investigator on this project that is supported by the Consortium for International Earth Science In-

formation Network (CIESIN) and the Environmental Systems Research Institute, Inc. (ESRI). In addition, cooperation is ongoing 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).

A principal motivation for this project is that global change research largely 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. This point has been made convincingly in Clarke and Rhind's 1992 assessment of *Population Data and Global Environmental Change*. As a first step towards increased availability of such data, a GIS-based global population database has been developed under the umbrella of NCGIA research initiative I-15 on Multiple Roles for GIS in US Global Change Research.

In the first phase of the project, a consistent GIS database of about 19,000 subnational administrative boundaries and associated population figures for the whole world has been compiled. As much as possible, existing data sets, produced by various agencies and universities, were utilized. Based on these data, a set of continuous surfaces of population density was developed. The conversion of the data into regular grid format has the advantage that the resulting data will be compatible with many global physical data sets. For instance, one of the statements in the chapter on Demographic Dynamics and Sustainability in Agenda 21, the Report of the U.N. Conference on Environment and Development, calls for the disaggregation of demographic data by ecological regions—a task that clearly requires data of the kind just described.

From a methodological point of view, some interesting issues are involved. The problem of converting socioeconomic data collected for discrete spatial units into continuous representations has already been addressed in work related to NCGIA initiatives I-1 on *The Accuracy of Spatial Databases* and I-14 on *GIS and Spatial Analysis*. However, these approaches have so far focused on data sets of fairly small geographic extent. Assembling and reconciling many heterogeneous databases consisting of data sets collected for different time periods at different scales poses several interesting questions related to database accuracy and

methods of data integration. It is clearly important to find ways of communicating the uncertainty inherent in data products to end users in the global change community.

The project plans to make the resulting data sets freely available via the internet. The databases can be used in many different modeling exercises, such as predicting the population distribution for future time periods under various scenarios, or combining demographic with environmental databases to test hypotheses concerning human induced degradation processes. Further topics for investigation include the development of alternative methods of representing global data, for example by means of spherical harmonics.

The paper *The Global Demography Project* (by W. Tobler, U. Deichmann, J. Gottsegen, and K. Maloy) with an accompanying diskette, has recently been included in the NCGIA Technical Report series as TR 95-6 (April 1995). For further information contact Waldo Tobler (tobler@ncgia.ucsb.edu), Uwe Deichmann (uwe@ncgia.ucsb.edu) or CIESIN (ciesin.info@ciesin.org).

Visiting Scholars Program

Beginning January 1994 NCGIA was able to make available grants of up to \$20,000 per year to support US scientists not normally associated with NCGIA who wish to participate in NCGIA research activities for extended periods of two weeks to a year at any NCGIA site. Funds may be used to support travel, living costs, and salary; other costs associated with research will be covered by the host site. Proposals will normally be considered twice each year, although exceptions will be made. Proposals for fellowships should be submitted by September 30 to be considered at the December meeting of NCGIA's Science Policy Committee, and by March 31 for the June meeting.

NCGIA Board Approves New Research Initiative

Following its December meeting, the NCGIA Board of Directors gave approval in detail to a new initiative on the social implications of GIS. The proposal was developed and submitted by Michael Curry (UCLA), Trevor Harris (West Virginia University), David Mark (Buffalo), John Pickles (University of Kentucky), and Dan Weiner (West Virginia University), and represents the first time that a research initiative has been developed, proposed, and led from

outside the three sites of the NCGIA consortium. The impetus for the initiative came in part from the meeting organized by NCGIA in Friday Harbor, Washington, in October 1993, and many of the issues to be addressed are discussed in a recent book edited by John Pickles, one of the authors of the initiative proposal (*Ground Truth*, published by Guilford Press). The initiative will examine the broader social implications of GIS and geographic data in areas such as privacy, and the processes by which the use of GIS empowers or marginalizes. A specialist meeting will likely be held before the end of 1995, and an open call for participation will be issued shortly.

UCGIS Established

In Boulder on December 4-6, 1994, 42 people from 33 US academic institutions, research labs and the Association of American Geographers met to establish the University Consortium for Geographic Information Science (UCGIS). The UCGIS is a non-profit organization of universities, other research institutions, and professional societies dedicated to advancing our understanding of geographic processes and spatial relationships through improved theory, methods, technology and data.

The consortium will be open to all US academic and research organizations and professional societies that meet the membership criteria established at the Boulder meeting. Member institutions will have the opportunity to participate in reviewing and setting national research priorities in GIS and related specialties, and they will speak with a single voice in helping to formulate national science policy at the highest levels.

Through its member institutions, the UCGIS will include scientists and scholars in all disciplines involved in geographic information science. Its objectives include expanding and strengthening geographic information science education, providing an organizational infrastructure to foster collaborative interdisciplinary research in geographic information science, and promoting the ethical use of and access to geographic information for the benefit of society.

At the Association of American Geographers national conference in Chicago (March 1995), members of the founding group met again to approve a draft set of bylaws and to authorize the interim Board of Directors to proceed with legal incorporation of the organization. All institutions participating in the December meeting will be admitted as found-

ing members. Other institutions may apply for membership by submitting a document outlining their activities in GIS research and teaching. Guidelines for writing this document will be available from the Consortium's office. All member institutions are required to pay a \$3,000 initiation fee and a \$1,000 annual membership fee.

NCGIA and its Board introduced the idea of establishing such a consortium and assisted in its formation. Once formed, NCGIA itself will play no further role in the administration of the UCGIS. Like any other US university member, each of the three NCGIA institutions will become regular members, with officially appointed delegates on the general Council.

NCGIA looks forward to cooperating with an organization which will be in a position to provide authoritative statements on behalf of the Geographic Information Science research and education communities in the United States. NCGIA will continue to focus on basic and applied research. The UCGIS should provide many opportunities for collaboration and exchange of ideas within the multidisciplinary GIS community.

The next business meeting of the UCGIS will be held on Friday, November 17, in Nashville, TN, immediately following the GIS/LIS '95 conference. At this meeting the first official Board of Directors and Executive will be elected by delegates from the founding institutions. New members can be admitted after that date.

Additional information can be obtained by contacting John Bossler, Interim President at: Center for Mapping, The Ohio State University, 1216 Kinnear Road, Columbus, Ohio 43212. Tel (614) 292-1612, Fax (614) 292-8062; email: bossler@cfm.ohio-state.edu.

Initiatives

Initiative 8: Formalizing Cartographic Knowledge

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Many aspects of cartography have been difficult to formalize, such as selection of color progressions or tolerance value modification. The incompleteness of formal cartographic guidelines, which has impeded fully automated mapping, is addressed by this initiative.

Barbara Battenfield will direct the user evaluation component of the Alexandria Digital Library project (see cover story), which relates to I-8 in the context of Knowledge Acquisition and Elicitation. User evaluation is proceeding in parallel with testbed implementation, and low-level interface functions are being tested now. Semi-structured interview methods are being designed to establish guidelines for higher level functions with empirical testing to begin soon in map libraries across the nation. Papers reporting this work have been presented at AUTO-CARTO 12, the AAG meetings, the recent GIS and Libraries Clinic at University of Illinois, and the upcoming ACM CHI '95 meetings in Denver. A conference of federal agency data producers and data archivists is being organized for September, 1995 in Leesburg, Virginia. Meeting coordinators include Battenfield, Larry Carver, and Michael Goodchild.

Research progress has continued on projects with the U.S. Geological Survey. Lee DeCola and Barbara Battenfield formalized methods to automate map compilation for digital line graph (DLG) urban outlines. They rasterized 1:24,000 street centerline data at varying levels of resolution to generate multiple versions of urban outline boundaries, and compared these with 1:100,000 urban boundaries. The objective is to automate map compilation for urban features. Lee DeCola presented a co-authored paper at the Phoenix GIS/LIS meetings in October 1994. A subsequent article appeared in the Dutch publication *International Journal of Geomatics*.

Another project at USGS extends work begun by Dave Catts, who developed a series of ARC/INFO AMLs to simplify

1:100,000 DLG data for depiction on a 1:500,000 New Jersey state transportation map. Catts is working now with a student at Buffalo to formalize the AMLs in the form of a rule base. The student, Jeff Janak, will apply Catts' rules to other scales of map data for masters thesis research.

Bob McMaster (U. Minnesota, and a member of I-8 Steering Committee) just completed a sabbatical semester in Europe working on I-8 topics. He spent several months in residence at the Royal Institute of Technology in Sweden collaborating with Hans Hauska (another I-8 participant) on research in raster-based map simplification. McMaster's final weeks in Europe were in residence at IGN-Paris, collaborating with Jean-Phillipe Lagrange on data modeling for generalization. Both of these opportunities have developed in part from discussions held at the NCGIA I-8 Specialist Meeting.

Initiative 8 activities in Europe continue as they have since the 1993 Specialist Meeting. A two-day workshop will be held immediately prior to the Barcelona International Cartographic Association Meetings this coming August, to hear reports on European work in map generalization. The workshop will be jointly sponsored by NCGIA, the European Science Foundation, and the Canada Centre for Mapping. A call for participation has just been released, and NCGIA funds will be used to support travel for a number of American researchers to participate.

Initiative 9: Institutions Sharing Geographic Information

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This initiative focuses on developing models and strategies for sharing spatial data at every level, from local to global.

NCGIA researchers completed work on a one-year project with the USGS to evaluate criteria for identifying high priority

framework data sets for the National Spatial Data Infrastructure (NSDI), surveyed minimum technical specifications that must be met by these data sets to meet use needs, including content and positional accuracy, and initiated further discussion of these criteria and specifications. The work included convening a "focus group" of experts in a wide range of areas of application of spatial data to identify and refine questions, conducting a survey of a broad sample of spatial data users, and analyzing the results and compiling them into a major report on framework data specifications. Dr. Steven Frank (New Mexico State University, Las Cruces) developed a mail survey and coordinated the document review and survey distribution. Jeff Pinto (Pennsylvania State University-Erie) advised on the survey structure and the analysis of survey results. Among other objectives the questionnaire attempted to identify the technical specifications required by the users of framework data sets, including geographic content, data format, geocoding scheme, positional accuracy, vertical accuracy, updating interval, and need for historical data. Users were also queried about their current sources for data meeting such criteria. Michael Goodchild and Harlan Onsrud served as co-PIs. The final report will be published in the NCGIA Technical Report series, and the data will be made available via the NCGIA ftp site.

Work by Steven Frank at the University of Maine in investigating cataloging paradigms for spatial metadata was completed. "Cataloging Digital Geographic Data in the Information Infrastructure: A Literature and Technology Review" was published in *Information Processing & Management* and "The National Spatial Data Infrastructure: Designing Navigational Strategies" has been accepted by the *URISA Journal*. Frank's PhD "Cataloging Paradigms for Spatial Metadata" is available by ftp at the Maine site.

Wrap-up findings of the various research efforts undertaken in affiliation with Initiative 9 will be reported in two sessions at the 1995 annual URISA conference. The first session will include presentations on a survey of user requirements for framework GIS data, a review of GIS organizational and implementation research, approaches for sharing geographic data among scientists, and developments in sharing geographic data for transportation purposes. Speakers include Michael Goodchild (UC,

Santa Barbara), Steven Frank (New Mexico State University, Las Cruces), Harlan Onsrud (Maine), and Mark Armstrong (Iowa). The second session will focus on a range of social science studies that address implementation, organizational, and institutional impediments and incentives to the sharing of geographic information. Speakers in this session will include Zorica Budic (Illinois), Hugh Calkins and Rick Weatherbee (Buffalo), Jeffrey Pinto (Pennsylvania State University-Erie), and Bijan Azad (Massachusetts Institute of Technology.)

Sharing Geographic Information, twenty-nine chapters prepared by authors who participated in the I-9 Specialist Meeting, has been published by the Rutgers Center for Urban Policy Research.

Initiative 10: Spatio-Temporal Reasoning in GIS

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Research into spatial and temporal reasoning focused on the development of formalizations for spatial relations and the interaction with time through direct-manipulation user interfaces.

The report of the Specialist Meeting, which took place in early May 1993, is now available as NCGIA Technical Report 94-9. Also, a book derived from the papers presented at the meeting is currently in production. Another major publication is forthcoming with Scott Freundschuh (formerly at Maine and now at the University of Minnesota-Duluth) and Daniel Montello (UC, Santa Barbara), in the form of a special issue of *Geographical Systems* with papers on "Spatial Cognition and Geographic Information Systems," for which the two researchers serve as editors.

Max Egenhofer collaborated with David Mark on the testing of formalisms for natural-language spatial predicates. This work included cross-linguistic studies between Spanish and English, and between Malay and English. Max Egenhofer and Mike Gould (Departamento de Geographica Humana, Universidad Complutense de

Madrid) received a grant from the Scientific Division of the North Atlantic Treaty Organization (NATO) to investigate "Cross-Cultural Differences in Spatial Concepts: Application to Spatial Information System Use." The objective of this project is to identify spatial data abstraction primitives—those core concepts that are universal across language groups—in Spanish and English. To include non-European languages, support is being provided for Rashid Shariff, a graduate research assistant at the University of Maine, to test spatial predicates in Malay, the native language spoken in Malaysia that has a different root than Germanic or Romance languages. Opportunities to test native-Americans are also being investigated.

Scott Freundschuh and Madhu Sharma undertook research on theories of development of spatial concepts and spatial perception abilities in children and the relationship to the frequency and type of spatial terms/concepts that are used in books for children.

Jung-Hong Hong completed his Ph.D. dissertation "Qualitative Distance and Direction Reasoning in Geographic Space" at the University of Maine. His thesis builds models for qualitative distances (such as *near* and *far*) and qualitative directions (such as *North* and *Southwest*) with two criteria: complete coverage and mutual exclusiveness. These models serve as the basis for the design of a reasoning model, which is based on the transformation between qualitative and quantitative locational relations, and the well-developed quantitative reasoning methods.

Tony Sleezer completed his M.S., "Direct Manipulation of Temporally Constrained Activities for Geographic Modeling," which explored the visual semantics of time in a user interface for complex modeling. By decomposing a complex system into discrete activities, the activities may be represented as temporal intervals.

Several visitors were involved with I-10 research. Stephen Hirtle, Chair, Department of Information Science, University of Pittsburgh, PA, worked on his project "Geometries for Spatio-Temporal Reasoning" under the NCGIA Visiting Scholars Program July 24-August 6, Orono, ME. The plan of the project is to survey the current literature, propose appropriate extensions, and develop a logical framework for the study of geometries.

Mike Worboys (University of Keele, UK) visited Maine to work on a taxonomy of spatial change. This work has been complemented by a recently developed categori-

zation temporal identity by Khaled Al-Taha (Louisiana State University) and Renato Barrera (Intergraph Corporation), both formerly with NCGIA Maine.

At Buffalo, Ann Deakin and David Mark are conducting research on the effects of the January 1994 Northridge earthquake on both motorists that frequent those freeways and on neighborhoods that received the displaced motorists. The research focuses on several major east-west boulevards that parallel the Santa Monica Freeway, as well as official detours.

At Santa Barbara, Danette Coughlan began work on the design of a system for determining instantaneous water depth based on hydrographic and tidal data, and the appropriate data models.

Initiative 13: User Interfaces for GIS

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This initiative addressed the practical design of user interfaces. In essence, it attempted to reconcile the view that user interfaces should be simple to use with the sharply contrasting view that ease of use is fundamentally at odds with the complexity of spatial concepts and reasoning. Research was closed in the summer of 1993.

The International Meeting at the close of Initiative 13 was a NATO Advanced Research Workshop (ARW) held in Palma de Mallorca (Spain), March 21-25, 1994, and entitled "Cognitive Aspects of Human-Computer Interaction for Geographic Information Systems." Timothy Nyerges (Geography, University of Washington) was Director of the ARW, and Mark was the co-Director. NATO provided only about half of the funds requested to conduct the Workshop, but Nyerges obtained a grant from NSF's International programs and Max Egenhofer (NCGIA Maine) obtained a grant from ARPA, also to support the meeting. Because about 2/3 of the funding was from US sources, NATO relaxed its usual 20 per-

continued on page 10

cent ceiling on participants from any one country, and allowed us to have almost half of the participants from the US. The meeting has led to a book edited by Nyerges, Mark, and Egenhofer and to be published by Kluwer.

The initiative closing report was prepared in the Fall of 1994 and received Board approval at the December 1994 Board of Directors Meeting.

Initiative 14: GIS and Spatial Analysis

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This initiative explores the ability of GIS to support a wide range of forms of spatial analysis, from simple intuitive exploration to complex confirmatory tests of statistical hypotheses.

NCGIA Initiative 14 was formally closed in June 1994. Its official closing event was the two-day conference "Spatial Modeling and GIS", held at the School of Advanced Urban Studies, University of Bristol, Bristol, UK, June 7-8, 1994. The conference was co-organized by Mike Batty of NCGIA Buffalo and Paul Longley of the University of Bristol, and had sponsorship from NCGIA/NSF, the UK Economic and Social Research Council and the University of Bristol. An edited book based on the proceedings of this conference is in progress and incorporates papers under the general categories of "Analysis of Spatial Distributions", "Scale Issues in Geographical Analysis", "Locational Modeling", "Spatial Forecasting", and "Simulating Space-Time in GIS".

The forthcoming publication of *Interactive Spatial Data Analysis* by Trevor Bailey and Anthony Gatrell also joins the list of major publications stimulated by Initiative 14. This work is scheduled for publication by Longman in 1995. Rogerson and Fotheringham's edited book *Spatial Analysis and GIS* (Taylor and Francis: Fotheringham and Rogerson, eds.), and a special issue of the journal *Geographical Systems* (Fotheringham and Rogerson, Guest Editors) include subsets of the papers pre-

pared for the initiative specialist meeting. Part of the genesis of Bailey and Gatrell's forthcoming work can be traced to that same meeting.

Although formally closed, research on Initiative 14 topics continues within the Center. In spring and summer 1995, NCGIA Buffalo will be hosting two visitors to work on related research. Carl Amrhein of the University of Toronto will make two one-week visits to study the modifiable areal unit problem, and Donald Myers of the University of Arizona will be visiting for two weeks in July to develop methods for quantifying space-time variability and dependence.

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

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Initiative 15 concerns the ways in which GIS could better support regional and global change research. GIS could play an important role in enhancing models of Earth system phenomena operating at a variety of spatial and temporal scales across local, regional, and global landscapes, as well as in improving assessments of the effect of global change on ecological systems over a range of spatial and temporal scales. The importance of GIS can only increase as global change research becomes more computationally and data intensive, as it moves from studies of single processes to integrated modeling, and as it struggles to link human and physical processes.

Unlike previous initiatives, I-15 has a two-tiered specialist meeting structure. The goal of the first meeting was to solicit input from researchers involved in global change research, including evidence of impediments to their use of GIS. In the second meeting, GIS researchers and vendors will respond to the research needs identified by global change scientists.

The first specialist meeting for I-15 was held March 9-11, 1995 at the Upham Hotel in Santa Barbara, California. It was attended by fifty participants from several domains of the global change research community. Participants included invitees as well as participants selected from an open call. The open call was intended to target young researchers, researchers with interest in linkages between human and physical systems, researchers with international links, and researchers who could provide specific examples of the strengths and weaknesses of GIS in global change research.

The Steering Committee, consisting of agency personnel and researchers from the global change and geographic information science communities, identified eight topics which were deemed to be significant in clarifying areas where research is needed in order to enhance the ability of GIS/GIA to contribute to the US global change research program. These topics include atmosphere, climate; oceans, ocean-atmosphere coupling, coasts; biogeochemistry; hydrology, water; ecology, biodiversity; demography, population, migration; production, consumption; and policy, decision-making.

Each participant selected submitted a two-page position paper on the advantages and impediments of current GIS/GIA for global change. During the Specialist Meeting, small groups were formed to discuss three main topics: 1) data access, 2) representation/analysis, and 3) communication/integration. Each of the three groups were tasked with identifying impediments to the use of GIS for global change and a set of researchable topics to address these impediments. Some of the key research topics identified included:

- Integrating GIS with user-based or user-defined models
- Inclusion of temporal analysis and links to spatial statistics
- Uncertainty representation
- Research on describing change
- Reconciling different descriptions of

- space
- User interface issues and the interoperability of analysis functions among systems
- Research on aggregation and generalization of data
- Development of distributed systems, in which both data and analysis tools will be distributed
- Integration of data from different sources and scales

The second Specialist Meeting is planned for Fall 1995 with participants selected from the GIS vendor community. A more complete discussion of I-15 research topics will be forthcoming as an NCGIA technical paper. An annotated bibliography on GIS and Global Change has been developed by Ashton Shortridge (Santa Barbara) and is available as Technical Report 95-3.

It is anticipated that internal NCGIA research will focus on a selection of topics within the initiative's broad objectives, and that various forms of collaboration will emerge from the specialist meetings as is customary with NCGIA initiatives.

Initiative 16: Law, Information Policy, and Spatial Databases

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This research initiative explores four interrelated aspects of information law that affect the handling of geographic information: access rights of citizens to publicly held information, intellectual property rights in spatial databases, privacy rights and principles, and potential liability of using, sharing, and distributing GIS data and analysis results.

A Conference and Specialist Meeting were held October 28-30, 1994, at the Center for the Study of Law, Science and Technology in Tempe, Arizona. At this one day and a half Conference, more than 150 persons attended and about 30 papers were presented on the range of issues relevant to the initiative. During the following day and a half specialist meeting, 35 GIS, legal, and

policy experts gathered to discuss these issues in small working groups. Several of the presenters at the meeting submitted articles which will be published this summer in *Jurimetrics Journal of Law, Science and Technology*. Most of the presenters have submitted papers for the *Conference Proceedings*, which will also be released this summer.

"Information Policy for Local Government Geographic Information Systems: Adoption, Implementation and Results" was the subject of Jeff P. Johnson's (Maine) master's thesis. The work includes six case studies of local government GIS agencies throughout the United States and an extensive literature review of legal and policy issues related to the initiative.

Initiative 17: Collaborative Spatial Decision-Making

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The major objectives of Initiative 17 are to:

1. **examine the body of theory on the design, implementation and use of computer supported cooperative work (CSCW) environments and evaluate its utility for GIS/GIA**
2. **identify impediments to the development of highly interactive, group-based spatial modeling and decision-making environments**
3. **develop methods for eliciting, capturing and manipulating knowledge bases that support individual and collective development of alternative solutions to spatial problems**
4. **develop methods for supporting collaborative spatial decision-making (CSDM), including methods for managing spatial models**
5. **extend capabilities for supporting multicriteria decision-making in interactive, CSDM environments; and**
6. **characterize CSDM processes to un-**

derstand how CSDM technology is and potentially can be used in various CSDM subject domains.

The Specialist Meeting for I-17 will be held September 16-19, 1995, in Santa Barbara. The Steering Committee is comprised of scholars who represent several perspectives on system development and use: Michael Batty (Buffalo and University College London), Joseph Ferreira, Jr. (Massachusetts Institute of Technology), Timothy Nyerges (University of Washington), and Britton Harris (University of Pennsylvania).

In an attempt to foster greater interaction among I-17 participants, as well as the international community of GIS researchers, a World Wide Web homepage dedicated to this initiative has been established. It can be found under the Research section of NCGIA's main page at "<http://www.ncgia.ucsb.edu>". The I-17 pages will contain up-to-date news about activities under I-17 and the text of I-17 Position Papers. To help readers exploit the hypertext capabilities of web-browsers, common terms, themes and ideas will be hyperlinked.

Conferences

Geographic Information Analysis and Human Capital Research Conference

July 10-12, 1995

Hotel Boulderado, Boulder, Colorado

In July 1995, NCGIA Buffalo will sponsor a conference, Geographic Information Analysis and Human Capital Research. The purpose of this conference is to explore the possible contributions that GIS and GIA can make to research into the variety of pressing social, economic and political problems that fall under the National Science Foundation's Human Capital research agenda. This NCGIA conference will bring together approximately 30 scholars, including those working in areas related to human capital research and geographers with both substantive interests in human capital themes and an awareness of geographic research methods.

The topics that NSF has identified as key areas for human capital research are: Employing a Productive Workforce, Educating for the Future, Fostering Successful Families, Building Strong Neighborhoods, Reducing Disadvantage in a Diverse Society, and Overcoming Poverty and Deprivation. Rather than attempting to cover all these issues, however, the conference will focus on three substantive areas of research,

namely, urban crime, social networks and neighborhoods, and migration and aging. These three themes were selected to allow us to represent human capital issues across the full range of geographic analysis methods—disaggregated event data (points), spatially linked events or phenomena (networks), and aggregated statistics (zones or areas). The geographic perspective will form the integrating function across the three themes and also provide the necessary link to the full range of human capital research issues.

The multidimensional nature of human capital investments makes it important to identify unifying and coordinating themes for optimizing research across a range of disciplines. Geography offers one such complementary integrating perspective, since human capital decisions are located both in time and in geographic space. Both GIS and the techniques of spatial analysis are able to make use of the spatial context of human capital data to assist in the identification of common themes that might not otherwise be apparent from research adopting a non-spatial perspective. In this way, a geographic perspective may contribute significantly to advances in human capital research. (For more information, contact Pat Shyhalla at NCGIA Buffalo, (716) 645-2545 ext. 49, email: NCGIA@ubvms.cc.buffalo.edu.)

Fourth International Symposium on Large Spatial Databases — SSD '95

August 6-9, 1995

Portland, Maine, USA

With conferences in Santa Barbara (1989), Zurich (1991), and Singapore (1993), the International Symposium on Large Spatial Databases (SSD) has become the premier meeting for researchers, developers, and practitioners focusing on integration between database management systems and geographic information systems (GISs). SSD '95 will again bring together computer scientists and GIS specialists to explore advances in modeling, storage, and retrieval of massive spatial data sets, and to discuss the requirements from new, demanding application domains.

The major topics of interest include but are not limited to:

- Architecture of geographic databases and GIS
- Benchmarks
- Digital Libraries

- Interoperability
- Spatial data models
- Spatial data on Information Highways
- Spatial query languages
- Spatial query processing and optimization
- Spatio-temporal reasoning
- User requirements for new applications

As with the previous symposia, it is intended to publish the proceedings with Springer-Verlag as part of their series, *Lecture Notes in Computer Science*.

Program Chair: John R. Herring, Oracle Corporation, Suite 1400, 3 Bethesda Metro Center, Bethesda, Maryland 20814 USA 35894-0001. Email: jrherin@oracle.us.com

General Chair: Max J. Egenhofer, National Center for Geographic Information and Analysis, University of Maine, 348 Boardman Hall, Orono, ME 04469-5711. Email: max@mecan1.maine.edu, Tel (207) 581-2114, Fax (207) 581-2206.

Symposium Venue:

Portland, Maine, USA. Maine's largest city, Portland, is only 100 miles (2-hour drive) north of Boston, Massachusetts. Situated on the rocky coast of Southern Maine, Portland has a charming historic Old Port Exchange (restored waterfront district) which features numerous unique shops and restaurants along cobblestone streets.

For further information, please contact:

SSD '95 Conference Coordinator, National Center for Geographic Information and Analysis, University of Maine, 348 Boardman Hall, Orono, ME USA 04469-5711. Email: ncgia@grouse.spatial.maine.edu, Tel (207) 581-2149, Fax (207) 581-2206.

Santa Fe Conference

January 21-25, 1996

The Third International Conference/Workshop on Integrating GIS and Environmental Modeling will be held under the auspices of the National Center for Geographic Information and Analysis in Santa Fe, New Mexico, from January 21-25, 1996. The conference follows previous meetings in Boulder (1991) and Breckenridge (1993)—each attended by over 600 participants.

MAINE NCGIA Announcement:

The Department of Surveying Engineering at the University of Maine announces that it has changed its name to the Department of Spatial Information Science and Engineering. Degrees offered:

- *B.S. in Spatial Information Engineering*
- *M.S. in Spatial Information Science and Engineering*
- *Ph.D. in Spatial Information Science and Engineering*

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The conference has three interrelated objectives:

1. To review the current status of digital geographic information for environmental modeling, with particular emphasis on the technical and institutional issues affecting its usefulness and accessibility.
2. To review progress, with emphasis on the period since the previous conference, in the development of environmental models, and in the exploitation of geographic information technologies, particularly GIS, to support modeling.
3. To identify areas where progress in the integration of GIS and environmental modeling is likely to be made in the next few years, through improvements in technology, institutional structures, and modeling methods.

The program will be organized around three themes, each addressing one of the three objectives:

Data Issues: topics include but are not limited to data quality, reports on new data sources, spatial data infrastructures, new technologies for data access including digital spatial data libraries, intellectual property issues, economics of spatial data provision, metadata and format standards, methods of discretization, data modeling and data structures, methods of spatial analysis including interpolation and regionalization, integration of GIS and remote sensing.

Progress in Modeling: reports and demonstrations of progress in integrating GIS and environmental modeling in such fields as atmospheric science, ecology, oceanography, hydrology, spatial decision support, biodiversity, water and air quality, risk assessment, global environmental change, coupled systems or integrated modeling, and appropriate contributions to the global modeling of carbon, trace gas fluxes, etc.

New Research Frontiers: discussions or demonstrations of research offering potential for new approaches to environmental modeling with GIS, including such topics as cellular automata models, modeling languages, computational modeling systems, new approaches to data modeling including time, 3D, 4D, and global modeling, object-oriented systems, and agent- or event-based programming.

In addition to sessions on each of these themes, the conference will follow the pattern of previous conferences by including tutorials on significant topics, informal discussion sessions, poster sessions, demonstrations, and workshops.

Sandi Glendinning (NCGIA Santa Bar-

bara) will be happy to provide more information. Email: sandi@ncgia.ucsb.edu, Tel (805) 893-8224, Fax (805) 893-8617.

1996 International Young Scholars' Summer Institute in Geographic Information

Berlin, Germany

In the summer of 1996, the U.S. National Science Foundation (NSF) and the European Science Foundation (ESF) will jointly sponsor the second Summer Institute in Geographic Information which will be held in Berlin. The first such Institute is being held this summer at the Wolfe's Neck Conference Center near Portland, Maine, U.S.A. The Summer Institute is organized by the National Center for Geographic Information and Analysis (NCGIA) for the US side and by the GISDATA program for the European side. The Institute will offer an exciting opportunity for young GIS researchers from both sides of the Atlantic to meet with each other, attend seminars and presentations given by leading American and European experts, discuss common areas of research, attend hands-on demonstrations, and visit GIS application sites.

We are now inviting applications for participation in the 1996 Summer Institute from young scholars who are currently working on, or have completed relevant doctoral research within the past few years at a US institution. Applications must include a brief Curriculum Vitae and an extended paper abstract (1500-2000 words) on one of the following themes:

- User interfaces and visualization for GIS
- Progress in spatial decision making using GIS
- Multiple roles of GIS in global change research
- Spatio-temporal data sets, data structures, and methods
- Information ethics, law, and policy for spatial databases
- Spatial information technologies and societal problems

Participants will be required to present a paper at the Summer Institute. The papers will also be considered for publication in a refereed volume or journal. Selection will be based on the potential of the abstract submitted to be developed into a publishable paper, as well as the apparent fit of the applicant's interests with the multi-perspective, multidisciplinary spirit of the Institute.

Up to 15 fellowships will be awarded based

on an open competition and will cover reasonable travel, accommodation, and meal costs. Researchers with a current or previous formal institutional affiliation with NCGIA will be considered for fellowships only if there are remaining funds after external applicants have been selected. This restriction applies primarily to current and former doctoral students supported by NCGIA funding at the three Center sites.

The closing date for applications is September 30, 1995. Further information and application forms may be obtained from:

Sandi Glendinning, NCGIA, Department of Geography, University of California, Santa Barbara, CA 93106-4060; Tel (805) 893-8224; Fax (805) 893-8617; E-mail: ncgia@ncgia.ucsb.edu

U.S. Summer Institute Program Committee: Helen Couclelis, Chair, NCGIA, University of California - Santa Barbara
Keith Clarke, Hunter College - CUNY, NY
Harlan Onsrud, NCGIA, University of Maine

Available Later This Year:

GIS and Environmental Modeling: Progress and Research Issues, edited by Michael F. Goodchild, Louis T. Steyaert, Bradley O. Parks, Michael P. Crane, Carol A. Johnston, David R. Maidment, and Sandi Glendinning. GIS World, Inc., Ft. Collins, CO: 8.5x11, hardcover, illustrated, color plates, approximately 600 pp, ISBN 1-882610-17-2.

An important collection of interdisciplinary papers that summarizes recent progress and identifies key research issues. Organized in three sections — Environmental Data Bases and Mapping, Environmental Modeling Linked to GIS, and Building Environmental Models with GIS — the book promotes recognition of mutual goals among environmental modelers, remote sensing scientists and GIS specialists. The 86 invited papers were presented at the Second International Conference/Workshop on Integrating Geographic Information Systems and Environmental Modeling at Breckenridge, Colorado, September 26-30, 1993.

Publications

Recent NCGIA Technical Papers

94-1: *The 9-Intersection: Formalism and Its Use for Natural-Language Spatial Predicates*, edited by Max Egenhofer (Maine), David Mark (Buffalo), and John Herring (Intergraph Corporation) \$14.00

94-2: *Selected Bibliography on Law, Information Policy, and Spatial Databases*, compiled by Harlan J. Onsrud, Jeffrey Johnson, and Xavier Lopez (Maine) \$4.50

94-3: *Land Information Systems in Developing Countries: Bibliography*, compiled by Harlan Onsrud, Jeffrey Johnson, Patrick Kirby, Ricardo Moreno, and Bheshem Ramlal (Maine) \$3.50

94-4: *Gap Analysis of the Southwestern California Region* by Frank W. Davis (Santa Barbara) \$15.50

94-5: *Integrating Normative Location Models into GIS: Problems and Prospects with the p-median Model*, by Richard L. Church and Paul A. Sorensen (Santa Barbara) \$3.50

94-6: *Final Report for Caltrans Agreement 65T155 (MOU 1)* by Richard Church, Danette Coughlan, Thomas Cova, Michael Goodchild, Jonathan Gottsegen, and David Lemberg (Santa Barbara) \$16.50

94-7: *Spatial Analysis on the Sphere: A Review*, by Rob Raskin (UC, Santa Cruz) \$7.50

94-8: *Topological Relations in the World of Minimum Bounding Rectangles: a Study with R-trees*, by Dimitris Papadias (UC, San Diego), Timos Sellis and Yannis Theodoridis (National Technical University of Athens), and Max J. Egenhofer (Maine) \$5.00

94-9: *Time in Geographic Space: Report on the Specialist Meeting of Research Initiative 10*, edited by Max J. Egenhofer (Maine) and Reginald G. Golledge (Santa Barbara) \$7.50

94-10: *Selected Annotated Bibliography on Visualization of the Quality of Spatial Information, Research Initiative 7*, by William A. Mackaness and M. Kate Beard

(Maine) and Barbara P. Battenfield (Buffalo) \$6.50

95-2: *Two papers on Triangulated Surface Modeling*, by Carlos Felgueiras and Michael F. Goodchild (Santa Barbara) \$7.50

95-3: *Multiple Roles for GIS in US Global Change Research: Annotated Bibliography*, compiled by Ashton Shortridge (Santa Barbara) \$5.00

95-4: *A Comparison of Strategies for Data Storage Reduction in Location-Allocation Problems*, by Paul A. Sorensen and Richard L. Church (Santa Barbara) \$6.50

95-5: *Color Your World, An Exploration with ArcView 2.0*, compiled by Paul Sutton, Paul Van Zuyle, and Steve Palladino (Santa Barbara) \$5.00

95-6: *The Global Demography Project*, by Waldo Tobler, Uwe Deichmann, Jon Gottsegen, and Kelly Maloy (Santa Barbara) \$25.00

A complete list of NCGIA Technical Papers may be obtained from NCGIA, University of California, 3510 Phelps Hall, Santa Barbara, CA 93106-4060, Tel (805) 893-8224, Fax (805) 893-8617, ncgia@ncgia.ucsb.edu.

NCGIA Software

S-92-2: **GEOLINEUS**, developed by David Lanter, UCSB, assists ARC/INFO users on the SUN4 and SPARC-station workstations in lineage tracking, data management, and graphic interface for GIS. (Available through NCGIA to academics only. Updated version). \$120

S-92-3: **LADSS**, developed by Paul Densham, SUNY-Buffalo, a Locational Analysis Decision Support System, requires a PC or compatible with math coprocessor, color video adapter, hard disk and 640 Kb of RAM. (An 80386 or better is recommended). \$40

S-92-4: **SAM**, developed by Yuemin Ding and Stewart Fotheringham, SUNY-Buffalo, is a Spatial Analysis Module in cartridge form running on the UNIX operating system. It consists of AML and C programs and is run entirely within ARC/INFO. SAM is provided on one high density floppy disk unless a data cartridge is required — if the data cartridge is required, buyer must specify this format. \$50

S-92-5: **DIRIGO**, developed by Manfred Ehlers and students, U. Maine, is a fourth generation, multispectral, digital image processing system designed specifically for remote sensing applications on the Macintosh II computer. It requires a Mac II, 2 MB RAM, 8-bit display monitor, 20 MB (or larger) hard disk; optional laser printer for hardcopy output. \$50

NOTE: NCGIA will no longer be distributing SPACESTAT software. Please contact Luc Anselin at: Regional Research Institute, West Virginia University, 511 N High Street, P.O. Box 6825, Morgantown, WV 26506-6825, Tel: (304) 293-2896, Fax: (304) 293-6699, E-mail: luc@lambik2.rr.i.wvu.edu.

NCGIA Technical Papers and Software may be ordered from NCGIA, University of California, Santa Barbara, CA 93106-4060. Prepayment is preferred. Make check/money order payable to: UC Regents/NCGIA. (Funds must be payable in US dollars and drawn on a US bank.) Postage and handling are included in the price.

Books Published by NCGIA Researchers

Accuracy of Spatial Databases. Michael F. Goodchild and Sucharita Gopal, eds. London: Taylor and Francis, 1989.

Design and Implementation of Large Spatial Databases (First Symposium SSD '89, Santa Barbara, California, July '89, Proceedings). A. Buchmann, O. Gunther, T.R. Smith, and Y.F. Yang, eds. New York: Springer-Verlag, 1989.

Geographic Information Systems: An Introduction. Jeffrey Star and John Estes. Englewood Cliffs: Prentice Hall, 1990.

Geographical Information Systems: Principles and Applications. David J. Maguire, Michael F. Goodchild, and David W. Rhind, eds. London: Longman House, 1991.

Map Generalization: Making Rules for Knowledge Representation. Barbara P. Buttenfield and Robert B. McMaster, eds. London: Longman House, 1991.

The Integration of Remote Sensing and Geographic Information Systems. Jeffrey Star, ed. Bethesda: ASPRS, 1991.

Cognitive and Linguistic Aspects of Geographic Space. David M. Mark and Andrew U. Frank, eds. Dordrecht: Kluwer Academic Publishers, 1991.

Environmental Modeling with GIS. Michael F. Goodchild, Bradley O. Parks, and Louis T. Steyaert, eds. New York: Oxford University Press, 1993.

Diffusion and Use of Geographic Information Technologies. Ian Masser and Harlan J. Onsrud, eds. Dordrecht, Boston, London: Kluwer Academic Publishers, 1994.

Cities in Competition: The Emergence of Productive and Sustainable Cities for the 21st Century. J. Brotchie, M. Batty, E. Blakely, P. Hall, and P. Newton, eds. London and Melbourne: Longman-Cheshire, 1994.

Spatial Analysis and GIS. Stewart Fotheringham and Peter Rogerson, eds. London: Taylor and Francis, 1994.

Managing Geographic Information Systems. N. Obermeyer and J. Pinto. New York: Guilford Publications, 1994.

Fractal Cities: The Geometry of Form and Function. Paul Longley and Michael Batty. London: Academic Press, 1994.

The Geographical Analysis of Population: With Applications to Planning and Business. David A. Plane and Peter Rogerson. New York: John Wiley & Sons, 1994.

Sharing Geographic Information. Harlan J. Onsrud and Gerard Rushton, eds. New Brunswick, New Jersey: Rutgers, The State University of New Jersey, Center for Urban Policy Research, 1995.



The Santa Barbara NCGIA includes (l to r): Michael Goodchild (Director), Karen Kemp (Assistant Director), Terry Figel (Computer Resource Manager), LaNell Lucius (Executive Assistant and Operations Manager), Sandi Glendinning (Visitor/Program Coordinator), Andrea Walker (Publications Assistant), and Steve Palladino (Education Projects Manager). Not pictured: Helen Couclelis (Associate Director, Santa Barbara).

NCGIA Update

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