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Evaluating the Usability of a Tool for Visualizing the Uncertainty of the Future Global Water Balance

Terry A. Slocum, Daniel C. Cliburn, Johannes J. Feddema, James R. Miller

We describe the development of software that is intended to enable decision makers (and their scientific advisors) to visualize uncertainties associated with the future global water balance. This is an important task because the future water balance is a function of numerous factors that are not precisely known, including the historical climatology, the model of potential evapotranspiration, the soil water holding capacity, and the global circulation models (GCMs) used to predict the effect of increased CO2 in the atmosphere. In developing the software, we utilized the principles of usability engineering. In our case, we utilized six steps: prototype development, evaluation by domain experts, software revision, evaluation by usability experts, software revision, and evaluation by decision makers. Although this approach led to an improved piece of software, decision makers should have been involved earlier in the software design process, possibly at step two (instead of the domain experts). Decision makers found the notion of uncertainty discomforting, but their positive comments regarding the software suggest that it could prove beneficial, especially with improvements in spatial and temporal resolution. One interesting characteristic of our approach was the utilization of a wall-size display measuring 25 x 6 feet. The wall-size display engendered great interest, but determining whether it is truly effective will require a study that directly compares it with more traditional approaches.

KEYWORDS: Usability, uncertainty, decision-making, visualization, wall-size display

Representing Datum-level Uncertainty in Historical GIS

Brandon S. Plewe

Geographic information systems have great potential as a tool for studying and teaching historical geography. However, using traditional GIS data models, even spatio-temporal forms, has been difficult due to the prevalence of uncertainty—both ambiguity and fuzziness—in source information concerning space, time, and theme. Explicitly uncertain assertions of a geo-historical datum can be modeled as an Evidentiary Set, a hybrid of a fuzzy set with probability and Dempster-Shafer evidence theory. This set formalism is designed to represent continuous and discrete value ambiguity (e.g., "about 10"), and fuzzy membership (e.g., "somewhat Central European"), including ambiguous membership and other fuzzy-ambiguous combinations. The formal set structure can be stored in GIS by representing continuous variation with a patch model, producing logical models for object-oriented and relational GIS databases. The relational implementation was tested in two GIS databases focused on human historical geography, showing the potential for the model to represent explicit datum-level uncertainty in a wide variety of GIS applications.

Computing Distance to the Nearest Utility: As the Crow Flies vs. As the Gas Flows

Arthur J. Lembo, Jr., Rachel A. Davidson, Thomas D. O'Rourke, and Linda K. Nozick

The purpose of this paper is to describe an automated geographic information system (GIS) process to estimate the length of pipeline required to provide utility service to a potential customer base using the street rights-of way. Using a case study application for a large gas utility company, we compare this method to the traditional method based on straight-line Euclidean, or as-the-crow-flies, distances. The GIS method using the street rights-of-way provides a substantially more accurate estimate of the length of required pipeline than the as-the-crow-flies method does. The improvement is particularly significant when the potential customers are located a substantial distance from existing pipelines. With improved estimates of required pipeline length, utilities can better pre-qualify potential customers for marketing opportunities.

Scale-independent Land-use Allocation Modeling in Raster GIS

Robert G. Cromley and Dean M. Hanink

A common application of raster-based geographic information systems (GIS) is as an aid in multi-criteria, multi-objective land-use decision problems. However, as the cell resolution increases by reducing cell size, the number of rows and columns in the raster representation also increases. The size of raster representations of land-use problems is often a determining factor in the type of methodology used in solving such problems. Previous land-use allocation models integrated with a raster GIS have used either decision heuristics or exact methods based on linear programming models. The former is fairly scale independent but produces only approximate answers, whereas the latter produces optimal solutions but remains more scale dependent. This paper presents a specialized dual simplex method adapted to the generalized assignment problem that can be used to solve large-scale land-use allocation problems. The dual approach only requires that information for one pixel be stored at a time thus allowing the solution of problems based on any size raster database.

KEYWORDS: Raster GIS, land use, linear programming, Von Thunen model.

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CaGIS vol. 30, no. 3

Editorial

1. Lynn Usery, University of Georgia & U.S. Geological Survey

As I begin my tenure as Editor of Cartography and Geographic Information Science (CaGIS), significant

changes in the American Congress on Surveying and Mapping (ACSM) and in the journal CaGIS are occurring. The changes include a reorganization and restructuring of ACSM, digital publishing, and international recognition for the journal.

The membership of the ACSM has voted to make each of the member organizations an independent society with its own individual members. The member organizations–the American Association of Geodetic Scientists (AAGS), the Cartography and Geographic Information Society (CaGIS), the Geographic and Land Information Society (GLIS), and the National Society of Professional Surveyors (NSPS)–will each be a part of the Congress that forms ACSM and will continue to share mutually beneficial activities, such as the Annual Convention. The restructuring of ACSM takes effect on January 1, 2004. The resulting new organization and other changes underway have significant impacts on the journal CaGIS.

With the new structure of ACSM, CaGIS changes from the journal of the American Congress on Surveying and Mapping to the official journal of the Cartography and Geographic Information Society. Under the new organization, the society CaGIS and its individual members assume complete control of the journal, including the costs of publication and distribution and the revenue generated from subscriptions.

The journal CaGIS also has several other major changes that are benefits to the membership of the Society and to journal subscribers. Under the leadership of Terry Slocum, the previous CaGIS editor, the journal began digital publishing with the January 2003 issue. All future issues will be available in both printed and digital online form. The online version is completely

text-searchable, providing an excellent service to CaGIS readers. The CaGIS Board of Directors has also authorized conversion of all back issues of CaGIS and The American Cartographer to digital, text-searchable form. While this process will require several years to accomplish, the digital archive of CaGIS will be a valuable resource to the membership.

The International Cartographic Association (ICA) has voted to make CaGIS one of the official journals of the ICA. This status, to be reflected on the journal cover, provides for CaGIS to include manuscripts from ICA and will require CaGIS to develop an international editorial and review process. The final editorial control of CaGIS remains with the current editor and editorial board, but manuscript submission and the content of CaGIS should be greatly enriched by increased international submissions and participation in the review process.

It is a time of exciting change as I assume the editorial responsibilities for the journal. These changes are occurring as a result of the excellent leadership and editorial capability provided by Terry Slocum. I take this opportunity to thank Terry for his stewardship of the journal and for making it a better asset to the readers. His careful guidance has led CaGIS to digital online publication, international status, and maintained the scientific quality that is the measure of a good academic journal. I hope to maintain his high standards and help make CaGIS a better resource for its readers.

Choosing Geographic Units for Choropleth Rate Maps, with an Emphasis on Public Health Applications

Francis P. Boscoe and Linda W. Pickle

Choropleth maps are the most widely used map type for mapping rates, such as those involving disease, crime, and socioeconomic indicators. The essential step of choosing a geographic unit to map is often made in an ad hoc manner. Among the desirable characteristics of choropleth mapping units are high degree of resolution, homogeneity of population size, homogeneity of land area, observation of minimum population thresholds and land area thresholds, temporal stability and currency, compactness of shape, audience familiarity, data availability, and the functional relevance of the unit to the phenomena mapped. Because of the uneven distribution of human populations, no single geographic unit can meet all of these characteristics in practice, and a well designed choropleth map necessarily involves some compromise. We present guidelines for choosing geographic units that take into account the above criteria, considering 12 geographic units ranging from census blocks to states. Even allowing for differences in scale and purpose, some units confer clear advantages over others.

KEYWORDS: Choropleth maps, disease rates, areal units

Testing Popular Visualization Techniques for Representing Model Uncertainty

Jeroen C.J.H. Aerts, Keith C. Clarke, and Alex D. Keuper

Many land allocation issues, such as land-use planning, require input from extensive spatial databases and involve complex decision-making. Spatial decision support systems (SDSS) are designed to make these issues more transparent and to support the design and evaluation of land allocation alternatives.In this paper we analyze techniques for visualizing uncertainty of an urban growth model called SLEUTH, which is designed to aid decision-makers in the field of urban planning and fits into the computational framework of an SDSS. Two simple visualization techniques for portraying uncertainty-static comparison and toggling-are applied to SLEUTH results and rendered with different background information and color schemes. In order to evaluate the effectiveness of the two visualization techniques, a web-based survey was developed showing the visualizations along with questions about the usefulness of the two techniques. The web survey proved to be quickly accessible and easy to understand by the participants. Participants in the survey were mainly recruited among planners and decision-makers. They acknowledged the usefulness of portraying uncertainty for decision-making purposes. They slightly favored the static comparison technique over toggling. Both visualization techniques were applied to an urban growth case study for the greater Santa Barbara area in California, USA.

Using an Energy Minimization Technique for Polygon Generalization

Martin Galanda and Robert Weibel

Snakes are iterative energy-minimizing splines controlled by both internal constraint forces (internal energy) and external forces (external energy). This paper investigates the use of snakes for the resolution of conflicts in polygonal subdivisions (i.e., polygon maps or polygon mosaics) resulting from the violation of metric constraints which exist if a polygonal object is too small, too narrow, or too close to another polygon. Such metric conflicts are denoted as size and proximity conflicts. In the generalization of polygonal subdivisions, internal energy reflects the resistance of an object to deformation and external energy describes the need for generalization. This paper suggests the usage of a snakes-based algorithm which is triggered in such a way that it achieves the translation, a local and global increase (or decrease) of polygons, or an arbitrary combination of these transformations, depending on the conflicts encountered. Hence, size and proximity conflicts within a group of polygons can be solved simultaneously and holistically. Furthermore, snakes support the propagation of a change of a polygon's geometry to all adjacent neighbors. The proposed algorithm has been implemented in a prototype system that also supports a variety of other polygon generalization algorithms. The main difficulties identified are the intricate setup and fine-tuning of the snakes parameters and the computer

resources required by the algorithm. However, the experiments showed that the proposed algorithm is a valuable method for the automated generalization of polygonal subdivisions.

Using Neural Nets to Model the Spatial Distribution of Seasonal Homes

Bradley A. Shellito and Bryan C. Pijanowski

Seasonal and second homes are important aspects of recreational tourism. Owning a summer cottage, time-share condominium, hunting cabin, or a part-time residence in a location away from home affects development patterns in significant ways. This paper presents the results of using an artificial neural network and a geographic information systems-based approach to identify and quantify the principal predictors of seasonal home distribution within the Lake States region of Minnesota, Wisconsin, and Michigan. Representative variables, such as proximity and spatial configuration of lakes, proximity to the Great Lakes shore, surrounding forest acreage, and public land access have been quantified using geographic information systems at the minor civil division (MCD) scale for the three states. The GIS data have then been fed into artificial neural networks to enable these pattern recognition tools to identify the principal predictors of seasonal home distribution in the Upper Great Lakes States.

KEYWORDS: Seasonal homes, artificial neural networks, spatial modeling, Upper Great Lakes States

Letter to the Editor

Norman J. W. Thrower, University of California-Los Angeles

The exchange between Sara Irina Fabrikant and the McMasters (Robert and Susanna) in Cartography and Geographic Information Science, Volume 30, Number 1, January 2003, pp. 81-87, overlooked very important considerations, especially the cross-fertilization of European and American academic cartography. In the United States this field, in the first half of the twentieth century, was dominated by Hungarian-born and trained Erwin Josephus Raisz. Raisz served as a cartographer in the Austro-Hungarian Army in World War I and brought the rich traditions of central European mapping to the United States, where he served successively on the faculties of Columbia University, Harvard University, the University of Virginia, and the University of Florida. Raisz's General Cartography, 1938, and later editions, was the leading text used in U.S. college cartography courses until eclipsed by Arthur H. Robinson's Elements of Cartography, 1953, and successive editions (with other authors) to the end of the twentieth century. Robinson, Canadian-born and partly educated in England, was greatly influenced by the thematic cartography of that country and of France as evidenced, respectively, by his seminal articles: "The 1837 Maps of Henry Drury Harness," The [British] Geographic Journal, 121 (1955); and "The Thematic Maps of Charles Joseph Minard," Imago Mundi 21 (1967). It is not necessary to list all the cartographers from other countries who have come to the United States from the time of the visit of

Alexander von Humboldt to President Jefferson in 1804, to appreciate the debt of U.S. cartography to Europe and beyond. The influences have not been entirely one way, especially with recent developments in computer graphics, animation, GIS, GPS, and remote sensing of the environment. But the point to be made is that cartography, more than most subjects is, by its nature, international, global, and extra-terrestrial!

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Preface

Transitions in U.S. Cartography and Geographic Information Science

Francis J. Harvey, Guest Editor

"The entire most beautiful order of things that are very good, when their measures have been accomplished, is to pass away." [Saint Augustine, Confessions (5th Century)]

Cartography and geographic information science are constantly undergoing transitions. Since the 1960s, both disciplines have seen a sea change in the ways people collect, process, and present geographic information. The meta-level changes, associated with the post-industrial transformation to the information society and economy, raise many questions about the past, present, and future of both cartography and geographic information science. The articles in the 2003 United States National Report provide insights into the transitions that have been taking place.

Two years into the new millennium is an opportune moment to collect a representative overview. Many questions can certainly be raised regarding cartography's and geographic information science's first years of the 21st century. Following on the quote from St. Augustine, perhaps the most

fundamental question is whether cartography is fading away in the digital environment of the information society. The articles in this National Report seem to suggest that the opposite is the case. Not only is cartography strong and vibrant, but by developing better connections with other disciplines, notably geographic information science and computer science, we are currently witnessing the strengthening of cartography as a key component of information-age communication.
Communication is a common theme in the articles making up this National Report. Communication of geographic information using maps and related representations is crucial to society and the economy. True to John Borchert's words, cartography and graphics remain, next to words and numbers, one of the fundamental modes of communication. The close linkages of cartography and geographic information science make it difficult to separate the transitions of cartography from the transitions of geographic information science. Many of these transitions somehow involve the World Wide Web that has changed communication and made us aware of the diversity of connections possible between different producers, analysts, and audiences of geographic information. In years to come, they will impact economic opportunities, enable new spatial planning and investment activities, support sustainable development and environmental quality concerns, aid the creation of information infrastructures, and provide information for coping with disasters.
The National Report to ICA is also an opportunity to reflect on these transitions. The relevance of visual communication to society is perhaps made clearest in the contributions that examine aspects of the history of cartography and possible impacts of transitions. As the United States continues to evolve into an information society, we will continuously refine the delicate balancing acts that such a society requires. Two balancing acts with particular relevance are between information access and national security, and between information privacy and information business. Researchers are developing tools and infrastructures for communication that facilitate the creation of infrastructures and resources for the information society at unprecedented rates. How people develop cartographic and geographic information infrastructures and resources involves more than ethical issues; these developments determine society's future.

This National Report contains sixteen articles that paint a broad snapshot of current transitions—in technology and approaches, as well as new concerns. They represent transitions in U.S. private, public, and academic cartography and geographic information science, and internationally. The Report contains two types of articles—peer-reviewed and editor-reviewed. The peer-reviewed papers discuss the substantial impact on cartography and geographic information science occasioned by changes in technology and techniques. The editor-reviewed papers are shorter and more focused presentations of innovative projects made possible by fundamental changes in cartography and geographic information science. The Report's contributors come from private companies, state and federal government agencies, and the academia. They all offer invaluable insights into transitions and milestones for reflection and future study.

The first paper the National Report—by Andre Skupin and Sara Fabrikant—provides a comprehensive overview of research merging fundamental cartographic principles with knowledge-discovery techniques from computer science. Their cognitive approach to the visualization of semi-structured data relies on spatialization methods. They describe several computational techniques that facilitate dynamic inspection of alternatives and properties of dimension reduction and spatial layout methods. This research also highlights the role of scale in spatialization, even for non-geographic information.

The paper from Kevin Sahr, Denis White and A. Jon Kimmerling takes us to yet another area of research that merges cartographic research on projections with computer science. The discrete global grid systems they describe offer researchers possibilities to represent the Earth's features using spherical coordinates. A reader is presented with a useful overview of different discrete global grid systems and a thorough examination of design choices which more and more cartographers are likely to find relevant as access to global data sets improves.

Shifting to a reflective examination of transition, Jeremy Crampton's paper takes up questions of surveillance and security. This article is specifically about the role of the atlas as the interface between political economy and the scientific systematization of mapping. Complementing work by Brian Harley and others, Crampton's paper serves primarily as a historical reflection on the political roles atlases have been called to

fulfill, yet, it is also a political and ethical touchstone for cartographers and geographic information scientists involved in the development of new technologies for homeland defense and related areas.

Continuing the theme, Aileen Buckley's article describes a fundamental change—that of a shift from a product to service orientation in atlas production. While this change has had little effect on the traditional political role of the atlas, transitions in its' roles leads to new opportunities for cartography and geographic information science. Buckley makes the observation that interactivity is a key distinguishing characteristic of digital atlases. Interactivity increases possibilities of developing dynamic atlases that access geographic information clearinghouses. Atlases, be they in paper or digital format, continue to have a significant, and, in fact, growing importance: compared to 1980 when only eight states had a state atlas, in 2002 their number increased to eighteen, offering some form of an atlas. The growing number of state atlases is an indication that, despite the changing nature of the atlas, it continues to be of importance to cartography in U.S. states.

In conjunction with an increase in the number of state atlases, government agencies are also increasing the number of GIS users who make maps on a regular basis. Cynthia Brewer writes about user experiences with the ColorBrewer web site developed by Mark Harrower and her. ColorBrewer provides specialized tools in choosing classifications and color schemes for a wide range of mapmakers, especially people not confident of their skills, according to Brewer. The tools have been used by an array of government agencies and private companies. As more people without formal cartographic training begin to use GIS for map production, the need for more "brewers"—expert-developed tools that provide focused resources for people set on improving their maps—will, according to Brewer, increase.

Charlie Frye addresses yet another approach to supporting people grappling with the complexities of cartographic representation and geographic information modeling. The solution Frye presents is for a 1:24,000-scale topographic model and deals with cartographic feature names issues. Frye's data model facilitates storage of feature type information for multi-scale cartography. Geographic information modeling integrating cartographic representation issues for individual

product domains and scale ranges may be an important complement to "brewers" in the future.

Geographic information modeling is becoming more relevant as cartography and GIS continue to merge. The article by Douglas Vandegraft describes some fundamental issues encountered and addressed in the Fish and Wildlife Service's cartography of the National Wildlife Refugee System. The Wildlife Refugee System celebrates its centennial anniversary this year, and the revisions described by Vandegraft demonstrate the importance of managing cartographic activities and spatial data for national endeavors that support both regional and national programs. The production of new mapping standards is essential to continued efforts to coordinate these important natural resources.

The article by Demetrio Zourarakis, Susan Carson Lambert, and Mike Palmer demonstrates another facet of the growing inter-connectivity of cartography and geographic information science. They document land-use changes in Kentucky that are of importance for local, tribal, regional, state, and federal levels of government. The program they describe makes good use of limited resources to develop an information product that supports all these levels of government. Cartographers and geographic information scientists will have increasing opportunities to draw on jointly developed information resources. They will also be called on to help develop techniques and "brewers" for clearer cartographic communication.

Thomas Carson writes about complementary activities occurring at the National Imagery and Mapping Agency that may turn into important resources for cartographers and geographic information scientists. These activities center on the Interferometric Synthetic Aperture Radar and the Shuttle Radar Topography Mission, which has been delivering high-accuracy and global data sets for different areas of study within cartography and geographic information science in the near future.

With this variety of transitions, cartographic education in conjunction with geographic information systems and science training is taking on new meanings. Chris Wayne presents an initial and, self-acknowledged, partial study of the cartography courses in GIS certificate programs in the U.S. Wayne's study suggests that these programs offer only limited instruction

in cartography. If a more encompassing study should lead to similar findings, it would behoove cartographers and geographic information scientists to recommend ways of improving cartographic education in GIS certificate programs through new tools (e.g., ColorBrewer) and other means, which will help provide access to cartographic knowledge critical to effective communication.

The paper by John Kelmelis on The National Map is the first of three articles that present various facets of this important program under way at the United States Geological Survey. Kelmelis' paper provides a succinct overview. The articles by John Findley, Keven Roth, and Theodore Saunders et al. discuss activities and programs that provide the reader with a good understanding of current effort and future plans for The National Map. The connection between multiple-source data analysis and the provision of analytical results provided to the community at large through The National Map cannot be stressed enough. When The National Map is fully operational, it could become a key resource for people looking for geographic information relevant to their communities and their families.

Transitions are occurring at USGS and in other areas of government. Timothy Trainor presents historical perspectives and the future goals for the TIGER database. Well known because of its many uses for mapping roads in the United States, TIGER was originally created to support the U.S. Census. As public use, and, concurrently, expectations grew, TIGER acquired dual roles and ran into limitations because of the original design emphasis on topological integrity. TIGER is both a database and a GIS depending who you speak to, but the limitations of the original data model are becoming increasingly problematic. The current modernization of TIGER involves several changes that will improve positional accuracy, integrate TIGER in the NSDI, and provide more geographic analysis functions.

The U.S. National Report's final article by Kent Lee and Andrei Shumakov describes how transitions in cartography and geographic information science have immediate impacts on data access. Their comparison of data access issues outside the United States leads to interesting insights into global geographic information access and the public policy and technological factors impacting data access. Although more data are now

available in spite of secrecy and copyright limitations, the results, or consequences, of increased data access remain unclear.

As Heraclitus so many centuries ago said, “Nothing is permanent but change.” Lee’s and Shumakov’s conclusion speaks to the fundamental ambiguity surrounding the transitions the 2003 U.S. National Report to ICA describes. The Report bears witness to many transitions, but the question remains, What is next? We know that a change or even the most fundamental transition is never the closing chapter of a process. Like a river, it will be followed by other changes and transitions. We can only ever hope to take a snapshot of a process. Brought together in a book, article, or report such snapshots give cartographers and geographic information scientists the means of becoming better aware of the past of cartography, its current status, and possible future transitions. And, what about the future readers of these National Report “snapshots?” It is hoped they will find in the Report an explanation for other transitions, concerns, and perspectives that they may face as a result of current developments.

Indeed, editing the 2003 U.S. National Report to ICA has been a tremendous way to learn about the breadth of cartography and geographic information science in the U.S. and elsewhere. The transitions these articles document underscore the vibrancy and importance of cartography and geographic information science. I offer my thanks to the U.S. National Committee for their support, especially Judy Olson for her support throughout and Bob McMaster who drew my attention to this editing project on. I would also like to thank the contributors for their patience and hard work and Ilse Genovese at the American Congress on Surveying and Mapping for her work in managing the production of the National Report. I hope that the resulting issue engages readers in many fields and serves to remind us of the strength and vitality of American cartography and geographic information science.

Papers

Spatialization Methods: A Cartographic Research Agenda for Non-geographic Information Visualization

André Skupin and Sara Irina Fabrikant

Information visualization is an interdisciplinary research area in which cartographic efforts have mostly addressed the handling of geographic information. Some cartographers have recently become involved in attempts to extend geographic principles and cartographic techniques to the visualization of non-geographic information. This paper reports on current progress and future opportunities in this emerging research field commonly known as spatialization. The discussion is mainly devoted to the computational techniques that turn high-dimensional data into visualizations via processes of projection and transformation. It is argued that cartographically informed engagement of computationally intensive techniques can help to provide richer and less opaque information visualizations. The discussion of spatialization methods is linked to another priority area of cartographic involvement, the development of theory and principles for cognitively plausible spatialization. The paper distinguishes two equally important sets of challenges for cartographic success in spatialization research. One is the recognition that there are distinct advantages to applying a cartographic perspective in information visualization. This requires our community to more thoroughly understand the essence of cartographic activity and to explore the implications of its metaphoric transfer to non-geographic domains. Another challenge lies in cartographers becoming a more integral part of the information visualization community and actively engaging its constituent research fields.
KEYWORDS: Visualization, spatialization, cartography, dimensionality, self-organizing maps, multidimensional scaling, spatial cognition, human-computer interaction

Geodesic Discrete Global Grid Systems

Kevin Sahr, Denis White, and A. Jon Kimerling
In recent years, a number of data structures for global geo-referenced data sets have been proposed based on regular, multi-resolution partitions of polyhedra. We present a survey of the most promising of such systems, which we call Geodesic Discrete Global Grid Systems (Geodesic DGGSs). We show that Geodesic DGGS alternatives can be constructed by specifying five substantially independent design choices: a

base regular polyhedron, a fixed orientation of the base regular polyhedron relative to the Earth, a hierarchical spatial partitioning method defined symmetrically on a face (or set of faces) of the base regular polyhedron, a method for transforming that planar partition to the corresponding spherical/ellipsoidal surface, and a method for assigning point representations to grid cells. The majority of systems surveyed are based on the icosahedron, use an aperture 4 triangle or hexagon partition, and are either created directly on the surface of the sphere or by using an equal-area transformation. An examination of the design choice options leads us to the construction of the Icosahedral Snyder Equal Area aperture 3 Hexagon (ISEA3H) Geodesic DGGS.
KEYWORDS: Discrete global grid systems, spatial data structures, global data models

Cartographic Rationality and the Politics of Geosurveillance and Security

Jeremy W. Crampton
This paper examines the prevalence of geosurveillance and cartographic rationality today by situating it in the age-old practice of governmental surveillance. I approach this question in a broadly Foucauldian historical framework. Foucault outlined a historical transition between a strictly disciplinary society that surveys and disciplines individuals and a "governmental" or biopolitical society that works at the level of a population and its distribution across territory. I argue that this governmental surveillance includes mapping and GIS, which, although they have taken different forms over time, have long been governmental technologies of control. I further argue that surveillance and security operate by establishing norms and statistical averages that allow assessments to be made about risk and threat. In order to illustrate the deployment of these cartographies of surveillance, and to examine their particular effects, I use a case study of crime mapping. I conclude that any assessment of mapping and GIS for surveillance and security uses must consider the genesis of cartographic rationality.
KEYWORDS: Geosurveillance, security, GIS, crime mapping

Atlas Mapping in the 21st Century

Aileen Buckley

Atlases are changing. The paper paradigm of maps and atlases has pervaded recent cartographic history. By nature that paradigm serves, as well as defines, a specific audience in terms of use and presentation. In the lab and at the printing press, the paper paradigm demands certain design and production flows that will drastically change through evolutions in data structures, mapmaking techniques, and presentation methods. Technological transformations in mapping influence much of this change. The implications for the creation and distribution of atlases are significant. With that in mind, this paper addresses a number of issues that relate to the technological evolution of atlases from paper to digital products: the distinction between paper and digital products and services and the implications of that distinction for atlas design¾particularly for web-based services; facilitating data and its application to the evolution of map/atlas products; and a redefinition of "atlas" and the "audience" for an atlas.

A Transition in Improving Maps: The ColorBrewer Example

Cynthia A. Brewer

Many map makers seek to share their map design efforts by distributing styles, fonts, templates, software, tips, and other sorts of instructions. For example, offers links to a variety of symbol and font design efforts by mapmakers who use ESRI's GIS products. In this article, I will reflect on the format for offering map design assistance that I have used in ColorBrewer (Figure 1). ColorBrewer is a web tool for selecting color schemes for thematic maps. It has elicited a trickle of enthusiastic e-mail from pleased users who tell me that their maps are improved, and they are relieved to save time on a design challenge for which they are not confident of their skills. ColorBrewer is described in detail in two papers (Harrower and Brewer, in press; Brewer et al. 2003). It is described briefly here to provide context for my reflections on a transition in cartography toward assisting people who want to represent their information spatially

but who have little or no training in the conventions and principles of map design and data representation.

The 1:24,000-Scale Topographic Base Map Data Model

Charlie Frye

The union of cartography and GIS has not always been one of complete cohesion. Designing GIS databases has frequently left mapmakers with a difficult job and mapmakers have no consistent means for communicating cartographic requirements to database designers. Today there is a widely held expectation that GIS means maps, this is partly because maps or things that look like maps are easy to make using GIS software. Many organizations also expect to use their GIS data holdings in multiple mapping and analytical contexts. This article presents key concepts that show that GIS databases can be designed such that they facilitate rapid production of many high-quality cartographic products. At the heart of these concepts is the idea that standard database modeling practices can yield well designed GIS databases that support cartographic purposes as well. This article presents these ideas based on work completed at ESRI over the past two years on how to include cartographic information in a GIS data model to support creating a 1:24,000-scale base map.

Report on Cartographic and GIS Activity in the U.S. Fish and Wildlife Service

Douglas L. Vandegraft

The U.S. Fish and Wildlife Service (FWS) is a federal agency whose mission is, working with others, to conserve fish and wildlife and their habitats for the continuing benefit of the American people. Under the management of fish and wildlife professionals, the National Wildlife Refuge System has become the world's premier network of wildlife habitats. The FWS is making use of modern cartographic methods and implementing Geographic Information Systems to more effectively manage the lands and resources entrusted to them.

Towards Developing Kentucky's Landscape Change Maps

Demetrio P. Zourarakis, Susan Carson Lambert, and Mike Palmer

The Kentucky Landscape Snapshot Project, a NASA-funded project, was established to provide a first baseline land cover/land use map for Kentucky. Through this endeavor, change detection will be institutionalized, thus aiding in decision-making at the local, state, and federal planning levels. 2002 Landsat 7 imagery was classified following an Anderson Level III scheme, providing an enhancement over the 1992 USGS National Land Cover Data Set. Also as part of the deliverables, imperviousness and canopy closure layers were produced with the aid of IKONOS high resolution, multispectral imagery.

The Shuttle Radar Topography Mission and GeoSAR Interferometric Synthetic Aperture Radar Programs at National Imagery and Mapping Agency

Thomas M. Carson

The National Imagery and Mapping Agency (NIMA) is at the forefront of using the techniques of Interferometric Synthetic Aperture Radar (IFSAR) for the production of large volumes of digital elevation models. Two NIMA-sponsored programs, one space- borne and one air-borne, have had very positive results in 2002. These are the Shuttle Radar Topography Mission (SRTM) and the Geographic Synthetic Aperture Radar (GeoSAR).

KEYWORDS: Digital terrain models, topography, interferometric synthetic aperture radar

Profiling Cartographic Education in GIS Certificate Programs

Chris Wayne

In North America there are currently between 50 and 100 widely advertised GIS certificate programs and possibly many more regional programs. The course content of these programs varies widely and

includes topics as diverse as cartography, database design, programming, and graphics. This report assesses the cartographic education offered in forty-six programs and suggests issues for a more thorough study of certificate programs. A list of selected GIS certificate programs in the U.S. and Canada is also provided. The cursory survey of programs for this report indicates that cartography is being taught to a degree in nearly all programs, but few programs require courses specifically in cartography.

To The National Map and Beyond

John Kelmelis

Scientific understanding, technology, and social, economic, and environmental conditions have driven a rapidly changing demand for geographic information, both digital and analog. For more than a decade, the U.S. Geological Survey (USGS) has been developing innovative partnerships with other government agencies and private industry to produce and distribute geographic information efficiently; increase activities in remote sensing to ensure ongoing monitoring of the land surface; and develop new understanding of the causes and consequences of land surface change. These activities are now contributing to a more robust set of geographic information called The National Map (TNM). The National Map is designed to provide an up-to-date, seamless, horizontally and vertically integrated set of basic digital geographic data, a frequent monitoring of changes on the land surface, and an understanding of the condition of the Earth's surface and many of the processes that shape it. The USGS has reorganized its National Mapping Program into three programs to address the continuum of scientific activities—describing (mapping), monitoring, understanding, modeling, and predicting. The Cooperative Topographic Mapping Program focuses primarily on the mapping and revision aspects of TNM. The National Map also includes results from the Land Remote Sensing and Geographic Analysis and Monitoring Programs that provide continual updates, new insights, and analytical tools. The National Map is valuable as a framework for current research, management, and operational activities.

It also provides a critical framework for the development of distributed, spatially enabled decision support systems.

Initial Implementation of The National Map

Keven Roth

The development of The National Map is “national” in the broadest sense of the word. Although the U.S. Geological Survey is taking the lead, local governments, states, and regions are active and essential partners in the process, contributing, for example, data updates, problem-solving data integration, and map development from multiple data layers.

Geographic Analysis and Monitoring at the United States Geological Survey

John Findley

The Geographic Analysis and Monitoring (GAM) Program of the U.S. Geological Survey assesses the Nation’s land surface at a variety of spatial and temporal scales to understand the rates, causes, and consequences of natural and human-induced processes and their interactions that affect the landscape over time. The program plays an important role in developing National Map tools and application. The GAM is a science and synthesis program that not only assesses the rates of changes to the Earth’s land surface, but also provides reports on the status and trends of the Nation’s land resources on a periodic basis, produces a land-use and land- cover database for the periodically updated map and data set—the Geographic Face of the Nation, and conducts research leading to improved understanding and knowledge about geographic processes. Scientific investigations provide comprehensive information needed to understand the environmental, resource, and economic consequences of landscape change. These analyses responds to the needs of resource managers and offers the American public baseline information to help them understand the dynamic nature of our national landscape and to anticipate the opportunities and consequences of our actions.

The U.S. Geological Survey Land Remote Sensing Program

Theodore Saunders, Jay Feuquay, and John A. Kelmelis

The U.S. Geological Survey has been a provider of remotely sensed information for decades. As the availability and use of satellite data has grown, USGS has placed increasing emphasis on expanding the knowledge about the science of remote sensing and on making remotely sensed data more accessible. USGS encourages widespread availability and distribution of these data and through its programs, encourages and enables a variety of research activities and the development of useful applications of the data. The science of remote sensing has great potential for assisting in the monitoring and assessment of the impacts of natural disasters, management and analysis of environmental, biological, energy, and mineral investigations, and supporting informed public policy decisions. By establishing the Land Remote Sensing Program (LRS) as a major unit of the USGS Geography Program, USGS has taken the next step to further increase support for the accessibility, understanding, and use of remotely sensed data. This article describes the LRS Program, its mission and objectives, and how the program has been structured to accomplish its goals.

1. S. Census Bureau Geographic Support: A Response to Changing Technology and Improved Data

   Timothy Trainor

   The TIGER system was developed by the Geography Division of the U.S. Census Bureau to support agency censuses and surveys. The system has been crucial to meeting the demands placed on the U.S. Census Bureau. It has been widely used by the public for a large and diverse number of uses. As public uses evolved, demands evolved. In parallel, technology and spatial data collection evolved. TIGER should now support a larger purpose. This article discusses some developments of the TIGER system and presents some of the key components of TIGER modernization: improvement of positional accuracy, connection to the National Spatial Data Infrastructure (NSDI), and improved geographic analysis.

Access to Geospatial Data in 2003: A Global Survey of Public Policy and Technological Factors

Kent D. Lee and Andrei Shumakov

Access to global geospatial data, and the way these data are being used, has changed dramatically in the past decade. This is true for a variety of reasons, many of them not readily apparent. This article will explore some of the essential changes in this sphere since the early 1990s, as seen from the perspective of a commercial distributor and service bureau involved with international maps and related data.

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ColorBrewer in Print: A Catalog of Color Schemes for Maps

Cynthia A. Brewer, Geoffrey W. Hatchard, and Mark A. Harrower

ColorBrewer is a tool that assists mapmakers in choosing and creating color schemes. It is available online at www.ColorBrewer.org. The color schemes range from 3 to 12 classes and are organized into three basic categories: sequential, diverging, and qualitative. Each of these scheme types has general perceptual characteristics which are described using Munsell hue, value, and chroma specifications. Each scheme has been proofed from color-separated negatives and adjusted to offer CMYK (cyan, magenta, yellow, and black) specifications that produce a readable map when they are used in process-printed publications. This paper offers a printed catalog of all of the ColorBrewer schemes to allow mapmakers to evaluate the appearance of each scheme before they commit to using them in print publications. Since process-color proofing is expensive, this catalog will reduce mapmakers' costs and allow them to be more confident that their maps will make the transition from the

desktop computing environment to publication without compromising the intended message through poor color specification.
Keywords: Symbolization, color, design, thematic mapping, printing

B-spline Functions and Wavelets for Cartographic Line Generalization

Eric Saux

Most line processing algorithms developed so far in cartographic generalization focus on polygonal curves (or polylines). This representation model is sometimes not sufficient for certain processes due to its lack of continuity or smoothness. Indeed, it may provide poor results for lines having “smooth” initial shapes such as roads. Thus, we suggest using a modeling method based on B-spline curves. A maritime case study described in this paper shows that this representation provides good results at a fixed scale and is suitable for several automatic line cartographic generalization operators (smoothing, displacement, aggregation and compression). Lastly, we discuss the application of B-spline wavelets used in dealing with multi-scaling.
Keywords: B-splines, line generalization, B-spline wavelets

Representation of Generalized Map Series Using Semi-Structured Data Models

Emmanuel Stefanakis

Large cartographic organizations worldwide produce generalized map series (GMS) in order to meet various user requirements. A GMS consists of maps of the same geographic region at different scales. Most of these maps currently are designed in a digital environment, and recently some of them have been distributed through the web. One important issue is the appropriate modeling and handling of cartographic entities composing individual maps in a GMS. Since these entities have rather complex descriptions and may be provided by various agencies, they usually do not conform to a fixed schema (i.e., they do not have a common structure). Hence, their representation in traditional data models, such as the relational or object-oriented, is not always feasible. This paper investigates the use of semi-structured data (SSD) models—an

innovative approach recently developed in Information Technology for representing and handling entities in a GMS. Specifically, the Object Exchange Model (OEM), a popular database model for SSD, has been adopted to represent a GMS. How useful information can be extracted from such a representation using the LOREL query language—a popular language for SSD— is also shown.

Keywords: Map generalization, generalized map series (GMS), semi-structured data (SSD), Object Exchange Model (OEM), Lightweight Object REpository (LORE) system, LORE query Language (LOREL).

Projecting Global Datasets to Achieve Equal Areas

1. Lynn Usery, Michael P. Finn, John D. Cox, Thomas Beard, Sheila Ruhl, and Morgan Bearden

Scientists routinely accomplish global modeling in the raster domain, but recent research has indicated that the transformation of large areas through map projection equations leads to errors. This research attempts to gauge the extent of map projection and resampling effects on the tabulation of categorical areas by comparing the results of three datasets for seven common projections. The datasets, Global Land Cover, Holdridge Life Zones, and Global Vegetation, were compiled at resolutions of 30 arc-second, ½ degree, and 1 degree, respectively. These datasets were projected globally from spherical coordinates to plane representations. Results indicate significant problems in the implementation of global projection transformations in commercial software, as well as differences in areal accuracy across projections. The level of raster resolution directly affects the accuracy of areal tabulations, with higher resolution yielding higher accuracy. If the raster resolution is high enough for individual pixels to approximate points, the areal error tends to zero. The 30-arc-second cells appear to approximate this condition.

Commentary on “A History of Twentieth-Century American Academic Cartography” by Robert McMaster and Susanna McMaster

Sara Irina Fabrikant

In their contribution to the recent special issue of Cartography and Geographic Information Science on “Exploratory Essays: History of Cartography in the Twentieth Century” (Vol. 29, No. 3, pp. 305-321), McMaster and McMaster make the claim that “although the main development of thematic mapping can be traced to nineteenth-century Europe, it is in the twentieth-century United States that thematic cartography evolved as an academic discipline” (p. 306). In this commentary, I will argue and provide evidence for the idea that fundamental contributions to the development of academic thematic cartography were made in Europe, and that these developments occurred earlier than those implied by McMaster and McMaster in the U.S. In other words, I intend to show that the McMasters’ conclusion is a serious overstatement, possibly a blatant misstatement. Unfortunately this is not the first time such an inaccurate statement has been made in a U.S. publication; such statements are sometimes regrettably recited as received wisdom by others. Appearing as it does in a special issue on the history of 20th century cartography, the claim by McMaster and McMaster deserves to be elaborated further and supported by evidence, as it is an important yet doubtful assertion.

Keywords: History of cartography; thematic cartography, 20th century cartography, Germany, Austria, Switzerland

Response

Robert B. McMaster and Susann a McMaster

We appreciate the willingness of Sara Fabrikant to thoroughly review our recent paper on the “History of U.S. Academic Cartography,” and her thoughtful commentary. We are somewhat surprised that such a statement, while obviously being subjective in nature and rather tangential to the paper’s main point, could evoke such a response. Whether or not one is convinced by her argument depends on two issues—the validity of the scale of the analysis, and the meaning of the

term “discipline,” as we use it in our paper. In our response, we will demonstrate how these two issues are key to making comparisons to our study meaningful. First of all, it is a pity that the History of Cartography editor of this paper requested the removal of the following paragraph from the penultimate version of our paper. Inclusion of this paragraph might have defused the obvious confusion over our premise about the “position” of United States’ academic cartography. We wrote:

In the length of a journal paper, unfortunately, we are unable to document the very rich cartographic activity in other countries. Cartographic programs in the United Kingdom, for instance David Bickmore at the Experimental Cartographic Unit and J.S. Keates at the University of Glasgow, Jacques Bertin at the University of Paris, activity in Germany at the Universities of Hanover and Berlin, Ferjan Ormeling at the ITC in the Netherlands, and Salichchev at the University of Moscow, and the long tradition of cartographic activity in China at Wuhan, are examples. We leave the identification, documentation, and analysis of such programs to those more knowledgeable about their significance.