GIS educator

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GIS Use across the Campus

High School Teacher Paul Tweed Encourages Higher-Level Thinking

This article is part of an ongoing series honoring individuals who have made a difference in the world by applying a GIS solution to challenges or needs within conservation or their communities. Since these unique individuals have been selected for their innovations or special achievements in a particular field, the series is appropriately named GIS Heroes. Esri recognizes Paul Tweed as a GIS hero.

Paul Tweed has spent his career in the field exploring the natural world. Once he finished graduate school at the University of Iowa, he began teaching field ecology courses at his alma mater. The courses took him and his students out of the classroom and into the natural landscapes of states such as Wisconsin and Colorado. Then Tweed decided to teach biology at the high school level in Wisconsin's Augusta Area School District. One day in the early 1990s, he made a discovery that would dramatically influence the rest of his career and enrich the lives of the students he would teach. It was a fortuitous moment at a convention for the National Science Teachers Association when he learned about GIS technology.

continued on page 8

In This Issue

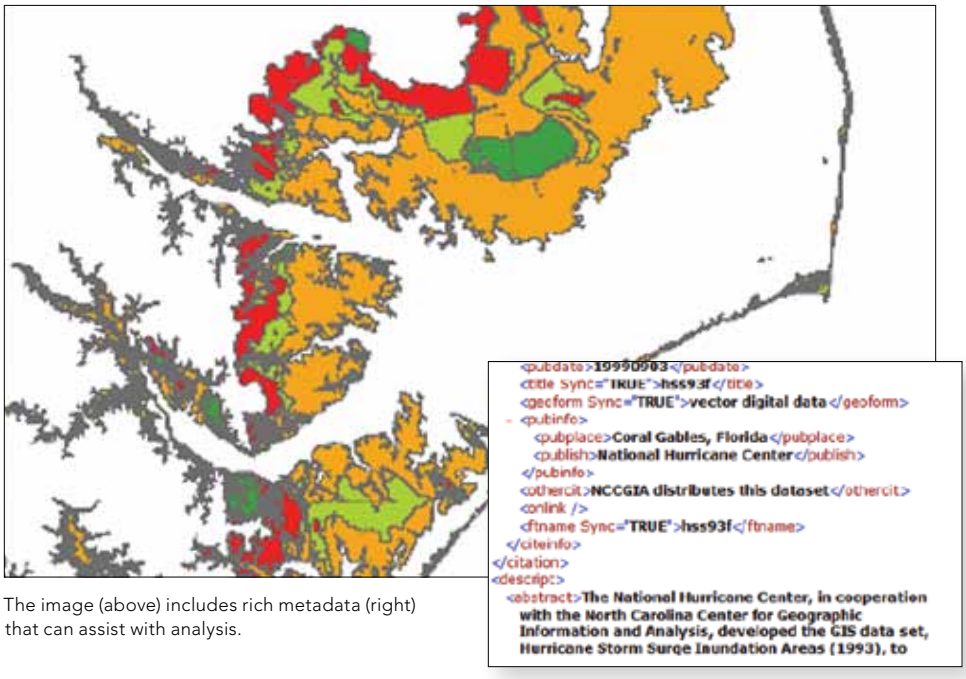
A Revolution in Geographic Education: Virginia's Geospatial Semester	p2
Taking Efficiency to the Next Level	p3
Routing Solution Helps Danes Breathe Easier	p4
School District Charts Path to Transportation Management System	p5
Defining Success in the Geospatial Industry	p7
Web GIS: Evaluation, Application, and Future	p9
Remapping the World's Population	p10

Library of Congress Takes Leadership

The mission of the Library of Congress is to make its resources available and useful to the United States Congress and the American people and to sustain and preserve a universal collection of knowledge and creativity for future generations. In 2000, the library established the National Digital Information Infrastructure and Preservation Program (NDIIPP) with the mission to develop a national strategy to collect, preserve, and make available significant digital content, including geospatial data, for current and future generations.

NDIIPP has established collaborative projects that build on and leverage existing activities and workflows for digital preservation purposes while modeling useful recommendations and approaches. These partnerships between academia; government; and GIS industry players, such as Esri, have served to share research discoveries

continued on page 6



The image (above) includes rich metadata (right) that can assist with analysis.

A Revolution in Geographic Education: Virginia's Geospatial Semester

By Daniel C. Edelson

A high school class in which students learn to use ArcGIS Desktop tools, work on real projects in their community, and get college credits . . . sound too good to be true? Well, it's not.

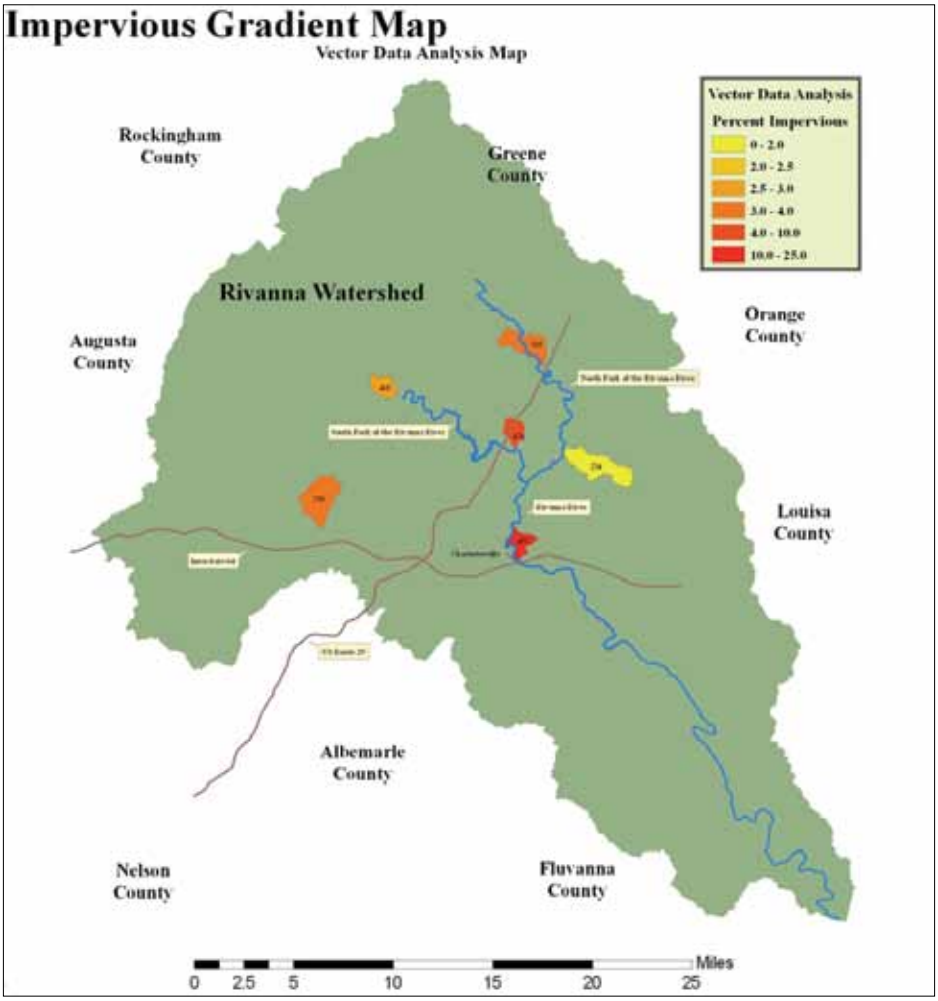
Professor Bob Kolvoord of James Madison University in Harrisonburg, Virginia, has created the Geospatial Semester, a course that is currently being taken by more than 300 students in 12 different school districts across the state of Virginia. Students who enroll in the course have the option of receiving course credit from James Madison, a four-year public university, if their work meets Kolvoord's standards. Because he and a colleague work directly with the participating teachers and students, their work almost always does.

The most exciting thing about the Geospatial Semester to me is the way it engages students in inquiry-based learning throughout. In my experience, too many introductory GIS courses are taught in the style that I call "peas and carrots," as in, "If you eat your peas and carrots now, you'll get to have dessert later." In the peas and carrots approach to learning GIS, students struggle through days and weeks of learning the mechanics of GIS in the hopes of one day actually getting to work on an interesting problem. How many classes in GIS consist of going through menu options one after another or learning how to do operations without knowing why you would use them?

In Kolvoord's approach, students spend the bare minimum amount of time learning the mechanics of GIS and begin working on interesting, real-world problems from the start. They add to their repertoire of GIS skills by working on increasingly challenging projects, some of which are taken from the book *Making Spatial Decisions Using GIS* (Esri Press, 2008), written by Kolvoord and collaborator Kathryn Keranen, a pioneering high school GIS educator. *Making Spatial Decisions* is the fourth volume in Esri's award-winning Our World GIS Education book series designed for classroom use.

While learning GIS skills is important, the primary focus of the class is the real-world project that every student does. Each student completes a community-based research project involving spatial reasoning and decision making. Student projects have included work with The Nature Conservancy, various city and local governmental agencies, and private businesses.

Their projects have included exploring the water quality in the creeks, streams, and rivers that make up a local watershed; identifying appropriate sites for cellular towers or wind turbines; and creating community evacuation plans. In the process, students develop their critical thinking, spatial reasoning, communication, and teamwork skills, while addressing a problem that's important to them and their community.



Map showing the percentage of impervious surfaces in the Rivanna Watershed. (Courtesy of Paul Rittenhouse and his Geospatial Semester students at Western Albemarle High School in Crozet, Virginia.)

The projects require students to work cooperatively in teams and connect them to their local community as they pursue a solution to their particular problem. The solutions to these community challenges are not simple and require the students to assess the impact of their solution on different constituencies or stakeholders. As Kolvoord describes it, "[The students] get a good look at a rich tapestry of complications that challenge workers every day as they struggle with these types of problems."

Since its beginning in 2005 in four schools, more than 1,000 students have already passed through the Geospatial Semester. Kolvoord is quick to credit the teachers for the success of the program. Not only do the teachers need to develop GIS skills themselves, they also need to be expert at guiding students in doing independent projects.

Kolvoord is now starting to think about how to scale the program up. He envisions it being a nationwide program one day but recognizes that the biggest challenges are limited GIS expertise in schools and the difficulty of finding organizations that will work with students on projects. However, he sees great promise in the GeoMentor program as a way to overcome these challenges.

I can see it now . . . a high school class in thousands of communities across the United States, in which students learn to use ArcGIS Desktop tools, work on real projects in their community, get college

continued on page 4

Taking Efficiency to the Next Level

Central Repository Makes Facilities Information More Accessible

Attended by more than 100,000 students each year, City College of San Francisco (CCSF) maintains and uses 300 facilities spread across 11 campuses in the City of San Francisco, California. People of diverse backgrounds, ages, and occupations have attended the college since its founding in 1935. CCSF is one of the largest community colleges in the country, and the college confers the most associate degrees in arts and sciences in the state of California.

College facilities are managed by two departments: Facilities Planning and Buildings & Grounds. Traditionally, these departments relied on senior engineers and personnel to maintain facility information, which was shared through paper plots or word of mouth. Some existing paper floor plan plots were digitized a decade ago for general reference, but records of maintenance and upkeep of buildings remained firmly entrenched in paper-based methods.

CCSF's campus crime application locates incidents using a grid overlaying the grounds and can be queried by campus, crime type, and date.

Although recent construction of several facilities introduced the use of computer-aided drawings, both departments lacked a system to easily manage and disseminate the data. This resulted in challenges when gathering information; time was lost searching for data and determining if it was up to date. The ability to decipher how many and where assets existed was difficult. The attrition of personnel was also a concern as valuable institutional knowledge was lost when staff members retired. Newly hired staff required a lot of time to learn about the facilities.

Seeking a System for Data Sharing

CCSF needed a centralized and flexible system to help organize and deliver facility information. Part of the system needed to assist the college with correctly identifying the current level of physical accessibility in all classrooms and buildings according to the Americans with Disabilities Act (ADA). This required the collaboration of several additional departments across the campus to deliver all the information on a publicly available online web service.

After reviewing many software packages for functionality and ease of programming, CCSF chose ArcGIS Server. Says Mono Simeone, project manager, CCSF GIS Mapping Collaborative, "The software's scalability, performance and stability, enterprise capability, and built-in AJAX capability make it easy to manage and deploy."

CCSF facility management staff contracted with i-TEN Associates, Inc., an Esri partner located in Berkeley, California, which had previously digitized CCSF's facility data and made it accessible on an internal website.

Several departments, including Facilities Planning, Buildings & Grounds, the Campus Police, and Information Technology Services, and the American Disabilities Act and Health and Safety committees worked together to create the system. Now GIS server technology stores, manages, and displays facility and grounds data in a central repository for everyone to use.

From Paper to Empowerment

First, the team applied a data model to interior spaces or floor plans. ArcGIS Server, using an Oracle relational database management system (RDBMS), stores, edits, and displays the descriptive and spatial data accessible through a simple interface for both secure and public websites. Next, the team created web applications with ArcGIS API for Microsoft Silverlight, an API for building cross-browser and cross-platform rich Internet applications on top of the GIS. The web applications serve data for use throughout the college. "The creation of the applications was very straightforward," notes Simeone.

City College of San Francisco is spread across 300 facilities on 11 campuses.

The first application provides access to ADA information at all campuses in the district. It displays features necessary for persons with mobility issues to navigate the campuses. These features include path of travel, parking for the disabled, accessible entrances, and elevators. The application offers several queries to find buildings, rooms, student services, and staff on campus. The result is a map with helpful features for navigation and a report on the room with a picture. The next iteration of the application will implement a routing service using ArcGIS, which provides point-to-point and optimized routing.

This successful application led to more meetings with campus staff from Facilities Planning and Buildings & Grounds. There was a lot of interest in viewing utilities campus-wide, including identifying individual features. An application was developed allowing staff members to use a secure intranet site to display all underground and some surface utilities. "This was the first time we have been able to view all the utility assets at one time," says Simeone.

CCSF also has a campus crime application that allows incidents to be queried by campus,

continued on page 4

continued from page 3

Taking Efficiency to the Next Level

crime type, and date. Incidents within buildings are easily located using a unique space identifier from the GIS. However, incident locations occurring outside buildings are captured using a grid, or mesh, that covers the entire campus. Future plans include the development of a web-based map service tool to capture x,y coordinate locations of incidents.

GIS Exceeds Expectations

Since the college maintains an Esri campus-wide site license, CCSF was able to add new GIS seats and employ existing GIS-knowledgeable staff. Both of these factors made the application implementation easy and economical.

The system now allows data to be centrally stored for more efficient management and sharing. Staff and administrators are able to view and query the facility data at any time from all over the CCSF campus. Departments can tailor a map service to meet their needs, and data can be updated and served to staff or the public in a timely manner.

This implementation of GIS for facility management has exceeded the goals created by the college. CCSF hopes to introduce GIS and facilities management as even bigger parts of how the college operates, manages its assets, and serves the community in the future.

More Information

For more information, contact Mono Simeone, project manager, CCSF GIS Mapping Collaborative (tel.: 415-239-3988, e-mail: csimeone@ccsf.edu), or Shreepad Ranadive, director, Application Development, i-TEN Associates, Inc. (tel.: 415-516-8633, e-mail: shreepad.ranadive@i10assoc.com).

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continued from page 2

A Revolution in Geographic Education

credit, and work with a GIS professional as a mentor.

More Information

For more information, contact Daniel C. Edelson (e-mail: dedelson@ngs.org). Visit the GeoMentor program at geomentor.org and National Geographic Fund for Geo-Literacy at www.nationalgeographic.com/foundation/geographic_literacy.html.

Routing Solution Helps Danes Breathe Easier

Your cough, headaches, and gasps for air may be symptoms of a cold, or they may be caused by smog. Unfortunately, GIS cannot cure the common cold, albeit we wish it could. But it can be used to significantly reduce air pollutants, the bane of urban living. Denmark's transportation companies are considering how route optimization can reduce their carbon dioxide (CO_2) emissions.

Global green initiatives include information technologies to identify problem areas, create plans, and measure the effects of environmental programs. GIS supports the science for measuring and analyzing environmental impacts, as well as providing environmental management solutions that effect change. One solution is to use GIS for intelligent fleet management. This can reduce CO_2 emissions and provide the benefits of saving time and money.

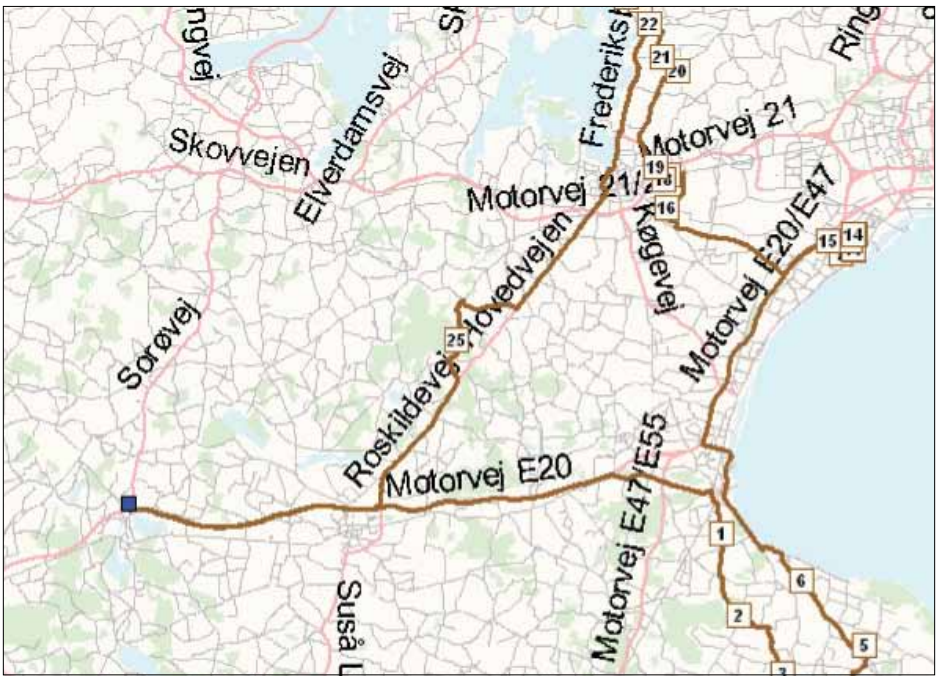
Denmark's University College Sealand is using GIS to efficiently meet cost reduction objectives. One way the university serves the surrounding community is through an outreach program that delivers books and training materials to educational institutions in the region, which includes 17 municipalities. This project has three distribution centers, each with five drivers. Informi GIS A/S—Esri's software distributor in Denmark—created a routing solution for the university using ArcLogistics that optimized these drivers' routes. GIS calculated routes and schedules that reduced kilometers driven by 25 percent, drive time by 8 percent, and number of routes by 13 percent. The solution also revealed a more profitable placement of distribution centers. Day-to-day routing became more responsive to changing routing requirements.

Denmark's transportation sector accounts for more than 20 percent of the country's CO_2 emissions. In an effort to highlight effective pollution solutions that include an element of sustainability, the Danish IT Industry Association and the Ministry of Science organizations hosted an event called the First Danish Championship in Green IT. Informi entered its University College Sealand routing project and received a second-place award.

Contest jurors were impressed that the GIS routing solution both improved the delivery project's efficiency and reduced its fleet's CO_2 emissions by 20–25 percent. The sponsoring organizations will publish the contestants' projects so that the transportation industry and others can consider them.

Read More about How GIS Is Used to Help the Environment

Download the free handbook *GIS for Air Quality* at esri.com/library/bestpractices/air-quality.pdf. Visit the GIS for Environmental Management website at esri.com/environment. Find out more about ArcLogistics at esri.com/arclogistics.



Informi GIS created an award-winning routing solution for University College Sealand.

School District Charts Path to Transportation Management System

District Scolaire 01 is a French-speaking school district that serves almost half the province of New Brunswick, Canada, including the three major cities, Fredericton, Moncton, and Saint John. Prompted by rapid population growth, the school district overhauled its manual transportation planning system and built a dynamic application that enables safe, efficient, consistent, and punctual student transportation.

The district implements an important safety policy stating that students from kindergarten to grade 5 should not have to walk more than 300 meters from the bus stop to their homes. To ensure this policy was being met, district employees would venture out into the field and physically measure the distance from bus stops to students' homes, then plan routes on paper. This process could take months to complete, and rapid population growth and movement were preventing the district from being able to effectively guarantee the policy.

Adding to this challenge was the fact that student address information was being stored in a Microsoft Access database, and anytime students would move between districts or change addresses, the information would be input manually. Because the provincial standard was based on a single user database, there was limited access to student records, and the process did not provide a spatial view of the region to assign bus stops.

In 2005, the district took the initiative to develop its own student transportation management system that would overcome these limitations. The solution: District Scolaire 01 developed an application that could automatically assign stops to students and provide daily updates to users. District staff no longer had to manually plan routes on paper and could now take advantage of a much quicker, more accurate process for bus route planning.

To build the application, the district worked with the Canada Post postal code database and Service New Brunswick's Civic Address Database (CADB) to validate and geocode student and bus stop addresses. It invested in ArcGIS Desktop technology with the ArcGIS Network Analyst and ArcGIS Publisher extensions to automate the process of analyzing bus route scenarios and to

- Visualize geographic information, planning and managing school bus routes and analyzing and redefining school zones.

A map created in ArcGIS shows bus routes and stops.

- Ensure respect for district policies on walking distances.
- Better respond to inquiries to generate digital maps for district reports and school administrations.

The district also built a public-facing web application that lets parents, students, real estate agents, and other members of the general public search for bus stops and school assignment by postal code.

At the click of a mouse, district staff, bus drivers, and school administrators can view a detailed map of school zones and bus routes within this dynamic district. Student demographic data is automatically fed into the application on a daily basis, which means that the information is always accurate and up to the minute.

"The integration of GIS lets us complete all our measurements and planning right here in the office so that we rarely need to send resources into the field," says Eric Nadeau, transportation manager, District Scolaire 01. "What used to take up to a month to complete can now be done in less than a week."

Using ArcGIS Desktop, district staff can conduct detailed data analysis when planning bus routes, which has significantly reduced the amount of time that empty school buses remain on the road, saving the district money.

School zones that used to take months to reorganize can now be redefined in less than a week. Parents, students, and other members of the general public can keep up to date on changes by plugging in their postal code to view the most current school zones and bus routes.

Most importantly, the district can now honor its walking distance policy to ensure the safety of its students and provide consistent busing service.

The district is planning to switch its web application over to ArcGIS Server so that it is fully GIS enabled and draws from the same data as its internal application.

More Information

For more information, contact Eric Nadeau, transportation manager, District Scolaire 01 (e-mail: eric.nadeau@gnb.ca).

continued from cover

Library of Congress Takes Leadership

and help guide the development of GIS for preservation awareness.

In 2004, NDIIPP funded the North Carolina Geospatial Data Archiving Project (NCGDAP), a collaboration between the North Carolina State University Libraries and the North Carolina Center for Geographic Information and Analysis, to gain a richer understanding of the technical challenges associated with preserving geospatial data.

To help cultivate an understanding of temporal data management as a customer problem, NCGDAP representatives met with selected Esri development teams, including the geodatabase team, in April 2005 to discuss preservation challenges and concerns. NCGDAP later evolved into the Geospatial Multistate Archive and Preservation Project (GeoMAPP), adding the states of Kentucky and Utah and continuing to explore geospatial data preservation issues across state lines.

GeoMAPP has continued the contact with Esri and other industry representatives through the National Geospatial Advisory Committee (NGAC), an organization established under the auspices of the United States Federal Geographic Data Committee (FGDC) to provide advice and recommendations related to the management of federal and national geospatial programs and the development of the National Spatial Data Infrastructure.

Through presentations at the 2010 Esri Federal User Conference and Esri International User Conference, GeoMAPP has continued working with the geospatial industry on the preservation issue.

The engagement with Esri has helped GeoMAPP direct industry attention toward identifying user needs related to preservation activities and initiating a discussion that encourages Esri and other private-sector entities to identify opportunities to enable geospatial content preservation, retention, discovery, and long-term access in their tools and services.

This engagement with industry has helped inform the broader NDIIPP approach to preserving digital geospatial information and has informed a proposal to develop a centralized online environment to share comprehensive information on the challenges and benefits of preserving digital geospatial data.

The Geospatial Data Preservation web portal will promote awareness of the fragility of digital geospatial materials to creators, legislators, funders, users, and the general public while also providing an authoritative resource on preservation strategies and tools for creators, users, and professionals charged with the management of critical geospatial information.

Bill Lefurgy, the Library of Congress manager responsible for the geospatial preservation portal, notes, "Digital geospatial resources have significant value to Congress and to people everywhere. But keeping the data available over time is a challenge. Data stewards have told us that they need a web-based clearinghouse that will provide the most current information about geospatial preservation tools, services, and practices."

NDIIPP will develop the portal in partnership with the Center for International Earth Science Information Network (CIESIN) at Columbia University in New York.

According to Robert R. Downs, the senior digital archivist and senior staff associate officer of research at CIESIN, geospatial data faces the same pressing set of preservation problems affecting many other kinds of digital data and information (degrading media, rapid software and hardware obsolescence, incomplete standards), but geospatial data has unique preservation issues that will be addressed by the portal.

The direct impetus for the information portal came out of observations garnered during NDIIPP's Framing a National Preservation and Access Strategy for Geospatial Data summit held in November 2009. This stakeholders' convening session was designed to understand the broad sweep of stewardship organizations involved with geospatial information creation, preservation, and access; get input about the types of digital geospatial information that are priorities for preservation; learn about current stewardship roles and responsibilities; and identify gaps in the geospatial information life cycle in terms of preservation and access. The summit identified stewardship organizations—such as FGDC, the National Archives, the National Climatic Data Center, the National States Geographic Information Council (NSGIC), and the U.S. Census Bureau—as the initial audience for the discussion, but there are plans to engage the wider geospatial community in the near future.

The clear need emerged from the summit for an outreach program to broadly inform the public, geospatial users, and funders about the value of geospatial data and why it should be preserved. This led to the planning for the portal.

Portal topics include geospatial data policy, provenance, intellectual property rights, confidentiality, appraisal and selection, geospatial data deposit, data preparation, documentation, preservation metadata, software dependence, persistent identifiers, and storage media.

The initial planning phase included inputs from key stakeholders and potential users, development of an informal advisory committee drawn from experts in various disciplines related to geospatial data and its preservation and selected user community representatives, and conduction of an initial requirements analysis.

This planning phase determined the final contents of the portal, which includes introductory documents promoting an understanding of geospatial data preservation; links to current geospatial preservation projects and resources from government agencies, organizations, and associations; information on relevant standards, tools, policies, and examples of successful (and unsuccessful) geospatial data preservation projects and approaches; educational and training opportunities and resources; and a calendar of relevant meetings, conferences, workshops, and seminars on geospatial preservation.

More Information

For more information on the Library of Congress digital preservation initiatives, visit www.digitalpreservation.gov or contact Butch Lazorchak, digital archivist, U.S. Library of Congress (e-mail: wlaz@loc.gov). Information on the GeoMAPP project can be found at www.geomapp.net. Information on the Center for International Earth Science Information Network at Columbia University in New York can be found at www.ciesin.org. For more information on the Framing a National Preservation and Access Strategy for Geospatial Data summit, visit www.digitalpreservation.gov/news/events/other_meetings/geosummit09/.

Defining Success in the Geospatial Industry

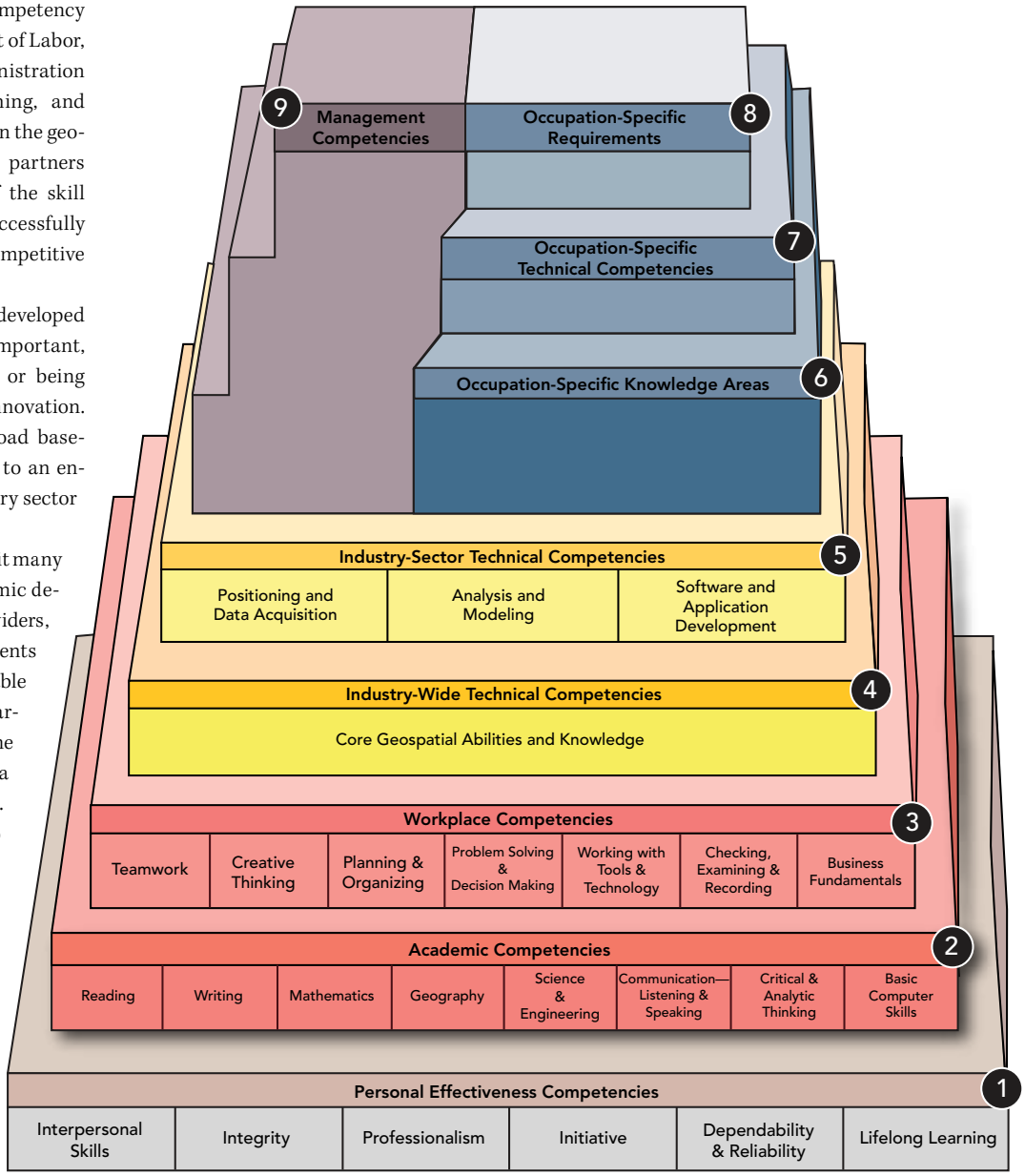
Competency Model Can Aid Staff Hiring, Retention, and Development

With the release of the Geospatial Competency model in July 2010, the U.S. Department of Labor, Employment and Training Administration (ETA), codified the education, training, and skills employees need to be successful in the geospatial industry. ETA joined industry partners to promote greater understanding of the skill sets and competencies essential for successfully educating and training a globally competitive workforce.

Competency models have been developed for industries that are economically important, projected to have long-term growth, or being transformed by technology and innovation. Industry-wide models capture the broad baseline skills and competencies common to an entire industry rather than just an industry sector or occupation.

While competency models can benefit many groups—business and industry, economic developers, educators and training providers, professional organizations, and students and their parents—they can be a valuable resource for managers because they articulate workforce needs and define the requirements for employee success in a job or at different levels during a career. Codifying this knowledge can lead to better hiring and retention practices and provide focus for training and professional development efforts.

In addition to the Geospatial Competency model published by ETA, managers, educators, and others can tailor the model to meet their specific needs using the Build a Competency Model Tool at the ETA site. This tool lets organizations build or customize industry competency models that can serve as the foundation for recruitment, hiring, training, professional development, career planning, and performance management. Customization of a model can start with an industry model or use the generic building blocks model as a framework.



Competency models define successful performance in specific jobs, job groups, organizations, occupations, or industries and are the foundation for recruitment and hiring, training and development, and performance management.

The recently published model had been in development at ETA since 2005. In that year, the geospatial industry, along with biotechnology and nanotechnology, was recognized as a high-growth industry. Not only were these sectors expected to add a substantial number of jobs, but they were also identified as having the greatest potential impact on the economy. In addition to being characterized as having a bright future generally, many specific occupations in the geospatial industry are also characterized as "green"—occupations likely to change as a result of the growth of green economy activities. This model is designed to evolve along with changing requirements of this field.

In creating the Geospatial Competency model, ETA collaborated with the GeoTech Center and industry and education leaders in the development of a comprehensive competency model for geospatial technology. The GeoTech Center works with colleges, universities, and industry to expand the geospatial workforce by supporting the creation of teaching and curriculum resources, assisting in professional development, and establishing career pathways for geospatial technicians. A panel that included Esri staff members, along with representatives from the American Society of Photogrammetry and Remote Sensing (ASPRS), the Urban and Regional Information Systems Association (URISA), academia, and the geospatial industry, drafted the Geospatial Competency model. To learn more about the Geospatial Competency model, visit www.careeronestop.org.

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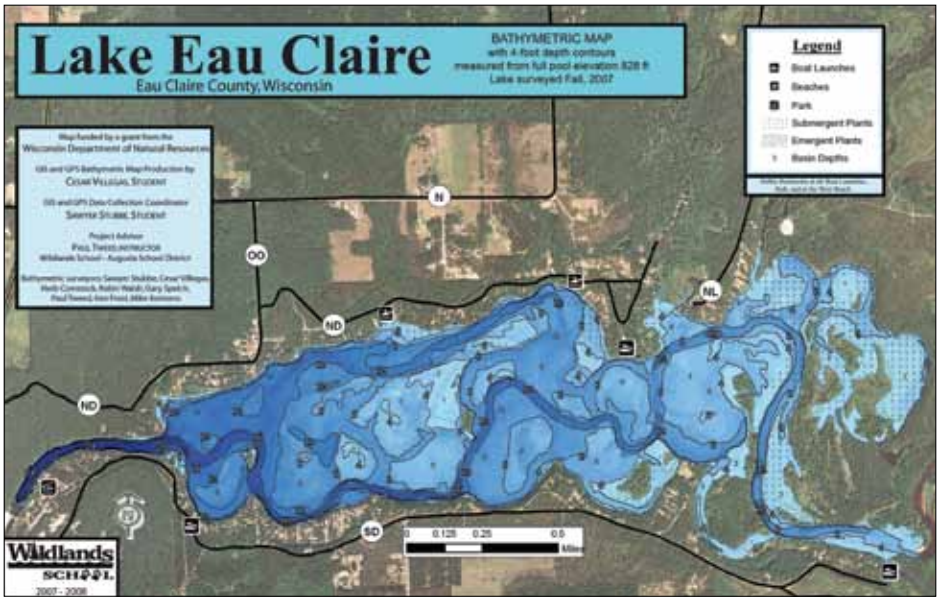
High School Teacher Paul Tweed Encourages Higher-Level Thinking

"I thought, 'Wow, look at all the things I could do with the field biology topic if I could make these quick maps and analyze data!'" Tweed remarks. He began gathering information on GIS and learning techniques that would allow him to incorporate GIS into his lesson plans.

Eventually, Tweed and a fellow teacher, Jeff Hadorn, began a summer school science research program at Augusta High School that was designed to have students work on research-based field projects. That program evolved into a two- to three-hour-a-day field research course Tweed offered to high school students during the regular school year. GIS was a significant part of the course, as it was used for tracking, mapping, and analyzing data.



The bathymetric map created as a senior research project at Wildlands School has been distributed in the community and is helping lake association members make better decisions about managing this resource.

Tracking Black Bears

One of the projects for the research course was done in cooperation with the Wisconsin Department of Natural Resources (DNR) and spanned a seven-year period. DNR was raising orphaned black bear cubs in captivity, then releasing them into the wild. With radio telemetry, the students tracked the bears and analyzed their locations with GIS. Students looked at how far the bears traveled, their habitat choices through the seasons, and which animals became problem bears.

When the cubs were in captivity, the DNR staff had been driving up to the bears' cages to drop food off, then driving away. When the bears were released, the radio telemetry showed that they would often appear around or in running vehicles.

"They had been trained to eat when they heard a car," Tweed relates. "Fishermen would leave their cars running during cold spring months while they prepared their tackle, and the bears would come out of the woods and sit on their hoods.

"One of the teachers I was working with to track the bears got out of his car, left it running with the door open for a moment, and found that he was getting a very close read on a nearby bear," Tweed continues. "When he turned around, the bear was in his car."

The information from this study improved the way DNR raised orphaned bear cubs, including a more hands-off approach to delivering food. When released into the wild, these bears stayed away from people.

"Kids love to be in the field," Tweed says. "They have an interest in animals, so projects like this allow us to teach many concepts related to GIS and GPS, as well as things related to habitats, behavior, and wildlife management. It becomes a much larger focus than just putting dots on a map."

Three years ago, this field research course evolved into the Wildlands School, a charter school dedicated to science and fieldwork in a project-based format.

Learning in the Field

The students at Wildlands (grades 7–12) participate in various large-group, small-group, and individual research projects each year. All the students at Wildlands have used GIS to build data files and collect and visualize data. Tweed estimates that 80 percent use it in their independent projects.

Recently, two seniors conducted their final research project, mapping nearby Lake Eau Claire. Community members suggested this project to the school because they didn't have enough accurate volumetric and depth data to make informed management decisions. The two students teamed up with the Lake Eau Claire Association, members of which volunteered to take the students out on the 860-acre lake to collect more than 90,000 data points during a seven-week period. Six thousand copies of the bathymetric map of Lake Eau Claire have been printed and shared with the community.

"Being an impounded lake, it's fed by the river that comes down and carries nutrient load and sediment load that gets deposited in the lake," says Marlo Orth, former president of the Lake Eau Claire Association. "Now we will be able to see where it is being deposited, so when we do a vision project, we can ascertain where we need to dredge. We also need this kind of data so that when we go to DNR, we have accurate information to show what's taking place and how the lake is changing over the years."

Looking at the Big Picture

Wildlands School was built with two goals in mind. One is helping students understand the way the natural world operates; this focus runs throughout all learning experiences, including writing and math. The second is providing technology that will allow the students to spend much of their time analyzing data and critically examining their observations. Technology allows them to see the big picture and ask questions about why things are happening and how they relate to one another instead of spending all their time manually collecting data.

"When I was in school, it took a long time to do things by hand," Tweed says. "Now we have the tools, especially through ArcGIS software, that allow us to look at data and ask larger-scope questions. The big shift I see is we now have the tools that allow students to be higher-order thinkers instead of just technique learners."

Tweed likened the school to a small engineering or consulting firm for the community. "We use the projects for learning and skill building for the students," he points out, "but it has an outcome that is tied in with community interest."

More Information

For more information on Wildlands School, contact Paul Tweed, director, at tweedpau@augusta.k12.wi.us.

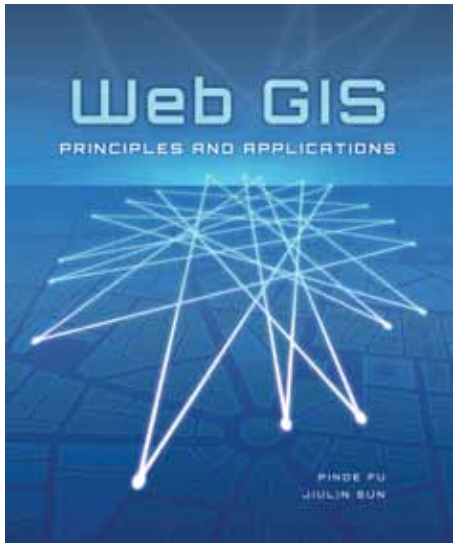
Web GIS: Evaluation, Application, and Future

From basic architecture to new frontiers, a new book from Esri Press explains how GIS on the web emerged and evolved and where it is going. *Web GIS: Principles and Applications*, by Pinde Fu and Jiulin Sun, concentrates on principles, concepts, and techniques to provide the reader with an understanding of how web GIS is revolutionizing the way GIS functions.

This book explores the evolution, applications, and future trends of web GIS. The topics discussed include geospatial web services, REST web services, cloud computing, geoportals, mashups, mobile GIS, Gov 2.0, business intelligence, virtual reality, volunteered geographic information, geotagging, and geotargeting. *Web GIS* collects information on a range of topics related to this rapidly evolving platform. This information is not covered elsewhere. New web technologies addressed include ArcGIS Server, REST services, JavaScript API/Flex API, and ArcGIS Mobile.

Fu, a senior GIS application developer and project lead at Esri, earned his PhD in GIS from the University of Kansas in Lawrence. He is a member of the Association of Chinese Professionals in Geographic Information Systems. In 2008, he was named honorary director of the ArcGIS Education and Application Research Center at Henan University in China.

Sun is academician of the Chinese Academy of Engineering. He has authored or coauthored four books on GIS. In addition, Sun is chairman of the Scientific Advisory Committee of the State Key Lab of Resources and Environmental Information Systems in China, as well as the Scientific Database and Information Engineering Science Committee of the Chinese Academy of Sciences. *Web GIS: Principles and Applications*, 2010, 312 pp., ISBN: 9781589482456.



Remapping the World's Population
Visualizing Data Using Cartograms

By Benjamin D. Hennig, John Pritchard, Mark Ramsden, and Danny Dorling,
Department of Geography, the University of Sheffield

The Worldmapper project has successfully produced a series of maps to visualize data concerning a range of issues facing the modern world based on the idea of density-equalizing maps. With this approach, ArcGIS plays a crucial role as an interface to convert suitable raster datasets and produce updated cartograms. The data is converted using ArcMap's ArcToolbox, while the cartograms were calculated using a geoprocessing tool available from Esri's ArcScripts site. The final visualization was performed in ArcMap. This article introduces and further evaluates new mapping approaches that move depictions beyond their simple descriptive form. It gives an insight into these new developments, focusing on subnational-level data that has, until now, been neglected.

Worldmapper and Its World Population Cartogram

The world population cartogram demonstrates the first attempt to include subnational density data. In the first stage of the Worldmapper project, a wide range of maps depicting various human dimensions of the world have been published on the project's website (www.worldmapper.org). Since the publication of the first new world population cartogram in 2006, nearly 600 maps have been produced, going far beyond the depiction of the world's population and covering topics such as education, poverty, and pollution. The Worldmapper cartograms show the data for 200 territories, thus making this new view on the world to some extent an arbitrary view: territorial borders are artificial and are subject to change. Furthermore, the assignment of territories in Worldmapper is also arbitrary, as different thoughts on these territories might exist. Therefore, the world population cartogram was taken as an example to test different ways to calculate these cartograms beyond the territorial borders. [Additional information on the calculations used in and the design of existing Worldmapper cartograms is given in "Worldmapper: The World as You've Never Seen It Before," by Danny Dorling, Anna Barford, and Mark Newman, published in the September 2006 issue of *IEEE Transactions on Visualization and Computer Graphics*.]

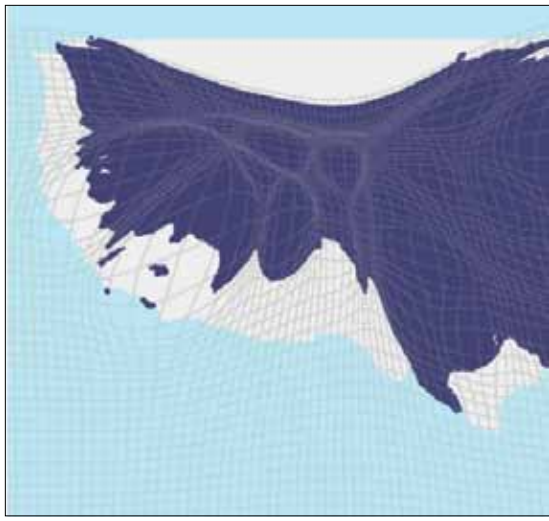


Figure 1: Grid-Based Population Cartogram of the Contiguous United States (2000)

Data and Cartogram Calculation

Data used in this work was derived from the Socioeconomic Data and Applications Center (SEDAC) of Columbia University, New York. The Gridded Population of the World (GPW) database contains the distribution of the world's population on a gridded base (sedac.ciesin.columbia.edu/gpw/), including population data and estimates from 1990 to 2015. This data is available in resolutions of up to 2.5 arc minutes, leading to a population grid of 8,640 x 3,432 pixels. Data from the year 2000 has been used to make results com-

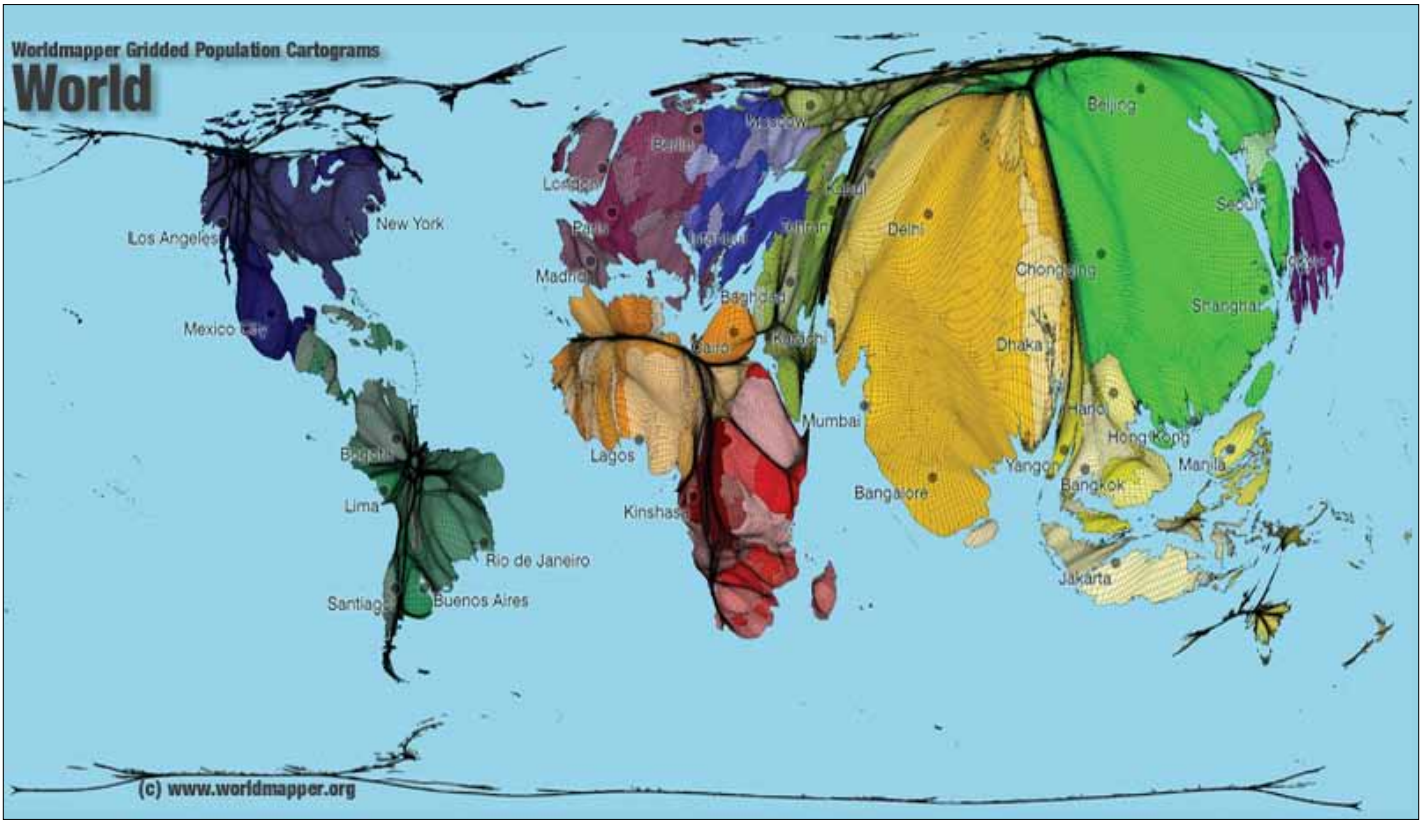
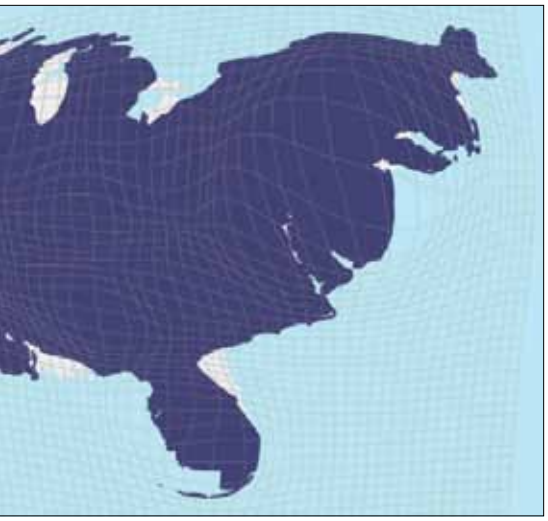


Figure 2: Grid-Based World Population Cartogram (2000) © Copyright 2009 SASI Group (University of Sheffield)



parable to the original Worldmapper population cartogram.

This raster format data was imported to ArcGIS, converted to polygons, and combined with additional metadata (e.g., country labels) to match grid cells for further visualization tasks. The cartogram script uses a 4,096 x 2,048 pixel-sized lattice for its map results.

The cartogram itself was calculated using the Cartogram Geoprocessing tool created by Tom Gross of Esri and available from the Esri ArcScripts site (esri.com/arcscripts). It uses density-equalizing methodology developed by Mark Newman and Michael Gastner at the University of Michigan. Unlike the Worldmapper cartograms that distort an initial projection of the boundaries of the territories, each population grid is treated as a separate part for the calculation, not taking any territorial information of borders into account. Thus each grid cell marks a border so that distinct shapes of countries are intentionally of no interest in the calculation.

Changes in the distortion of the resulting cartogram thus are only possible by adjusting the factor to smooth the original density. In addition, data from the USA has been extracted from the 2.5 arc minutes population grid and is calculated separately in the same way to produce a more detailed view of the resulting grid and its interval variation.

Results

The resultant cartograms require some final visualization steps to adapt them to appear similarly to the original Worldmapper cartograms. The polygons of the calculated world population cartogram are dissolved according to their affiliation to the Worldmapper territories and colored according to the distinctive Worldmapper color scheme. The gridlines in the USA cartogram are preserved to show the degree of distortion within the grid.

A Redrawn World Population Cartogram

Compared to its predecessor (figure 1), the redrawn world population cartogram (figure 2) shows considerable differences. For example, in China, the sparsely populated Himalayan regions can be distinguished from the densely populated eastern coastal regions. Internal variation within the United States and Mexico can also be recognized. Somewhat harder to identify but still evident are north–south differences in Great Britain and west–east differences in Germany. Hence, our goal to take the varying distributions of population on a subnational level and make them visible on a global view has been achieved. However, subnational variation can be difficult to analyze in more detail because the grid cells are eliminated to sustain the view on the global scale. In addition, more distinctive national shapes are far more distorted than in the original cartogram, which for some users might appear odd when interpreting such maps.

Down to Earth: A Population Cartogram of the United States

To counter the loss of familiar national boundary shapes, a separate population cartogram was produced for the contiguous United States (figure 1) and several other countries. The shape of the cartogram has more detail compared to the shape of the USA on the world population cartogram. This is because more grid cells are used in the calculation of the cartogram and no other polygons (e.g., from the European continent) influence the calculation. The different scale also allows the visualization of each grid cell so that subnational variation can be recognized. An "original" map of the USA with its familiar shape is shaded in underneath the grid to aid interpretation.

This visualization on a different scale is an improvement that goes far beyond the current capabilities of the Worldmapper project by using gridded base data to allow a different view of population distribution not only worldwide but also within separate regions. By using cartogram techniques, a different view on the regional variations of human geography is created, which can hardly be achieved with traditional mapping techniques.

Outlook

The most significant obstacle to the realization of gridded depiction for Worldmapper will be the vast quantity of different topics covered and availability and reliability of data. Reliable gridded social and economic data for the whole world is rarely available and rarely of such good quality as the population data. The estimation of missing national data for some topics has already been a serious matter in the existing Worldmapper cartograms. Such estimations will not meet the demands of gridded datasets, so new ways of data estimation are needed.

Current approaches to estimate data commonly use the GPW data, and these have the potential to be adapted to Worldmapper's requirements. Revised gridded cartograms offer great potential to enhance the variety of Worldmapper's visualization capabilities. A different view of the "real" location of the depicted topic can present a better understanding of human action and human patterns on the globe.

However, distortions associated with the gridded method are a disadvantage and undermine the purpose of Newman and Gastner's algorithm to preserve the familiar shapes of countries. The potential of the gridded approach and the desire to preserve the familiar shapes must therefore be carefully balanced. Nevertheless, much potential lies in adding more user interactivity and detail to Worldmapper. Grid-based cartograms have the advantage of allowing a user to zoom in to view national and regional details, within a global context. As one of the authors, Danny Dorling, has commented, "Our maps could be made more interactive, certainly, and there are probably many other features that could be added."

GIS technology is a key tool to make this happen. A GIS environment not only facilitates data conversion and calculation of cartograms but also allows different geographic scales to be brought together under one map. An easy transfer to popular digital globes can thus be realized, allowing viewers to identify the regional dimension of a subject. Separate regional editions of gridded population cartograms can be generated to visualize the regional variation of population distribution.

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Related websites: www.worldmapper.org and www.sasi.group.shef.ac.uk/

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