

ArcUser

The Magazine for Esri Software Users

Innovative Strategy for Facility Upgrading

Hill AFB uses ArcGIS to manage thermal IR imagery 14

Making Connections

Modeling the relationship between food, energy, and environmental impacts 22

Making a Meaningful Map

A checklist for compiling more effective maps 40



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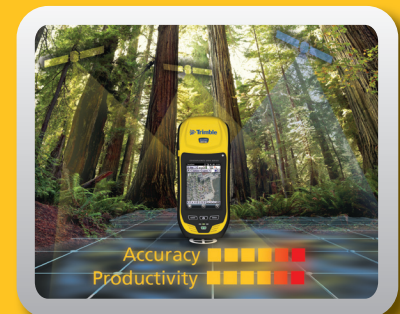
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1,000,000,000,000,000,000,000 Bytes

How much understanding?

According to the 2011 Digital Universe study, *Extracting Value from Chaos*, collectively we will create 1.8 zettabytes (or 2^{70} bytes) of digital data by the end of this year. The study, produced by International Data Corporation (IDC) and sponsored by the EMC Corporation, posits that our information society is on the verge of a major period of exploration. But rather than exploring the physical universe, we will gain insights into the unstructured data that makes up 90 percent of organizations' data holdings.

GIS—Understanding Our World was the theme of the 2011 Esri International User Conference. In explaining this theme during the conference Plenary Session, Esri president Jack Dangermond asserted that GIS is extending our minds by abstracting the world into knowledge objects and creating a systematic framework for understanding.

This understanding is tremendously powerful because it lets us better explore and appreciate the interconnectedness of our world. In this issue, a pair of articles describe how a group of researchers at the University of Chicago is modeling foodsheds and exploring the relationship between local food production potential, energy, and environmental impacts to find more sustainable strategies for producing food.

The tools for exploring data in a meaningful way are becoming much more accessible not only to researchers but also to individuals who want to gain new understanding of their communities and become agents of beneficial change. Candace Tshirki, a student at the University of North Florida, began using Community Analyst, a Software as a Service mapping solution hosted by Esri, to study access to healthy food in her county. This work led her to realize that Community Analyst could also be used to help her church understand and better serve the needs of its members.

The results of analyses can be more easily shared using GIS web and mobile apps that supply robust tools for visualizing and communicating information interactively. This is illustrated in "Transparent Communication Keeps Contributions Coming," an article in this issue that describes how Direct Relief International uses GIS web apps that show donors exactly where and how their contributions were used.

In addition to analysis and visualization, one of the most powerful aspects of GIS is its integrative capabilities. The wealth of information on the natural environment created and maintained in GIS is being combined with vast data holdings in CAD, BIM, and other facilities management systems on the built environment. This will extend the spatial data infrastructure (SDI) inward to encompass campuses, buildings, and rooms.

We know that processes and workflows don't stop at the building threshold. By filling in these gaps in the geospatial fabric, we can use this greater understanding of the built environment and its ever-increasing impact on the natural environment to design a more functional and sustainable world.



Monica Pratt
ArcUser Editor

editor's page

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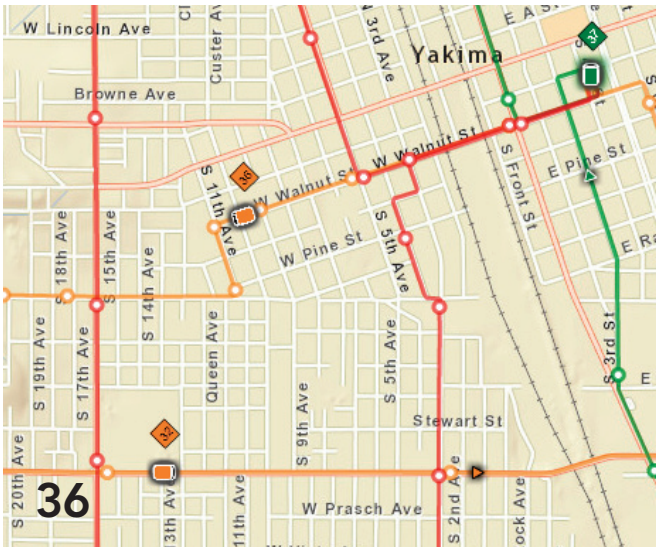
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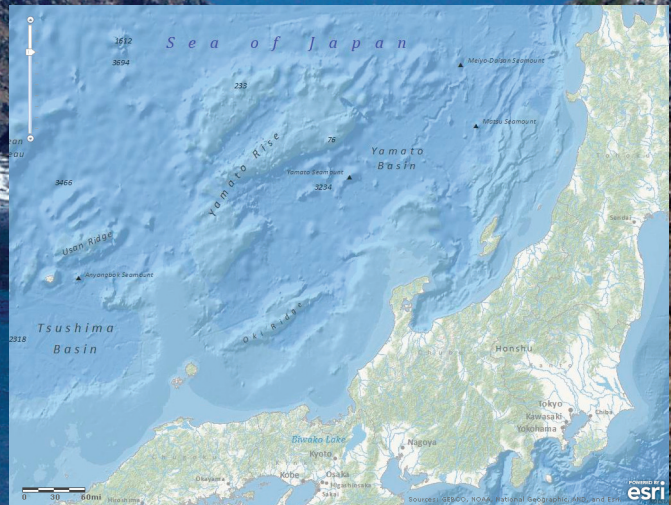


A Foundation for Ocean GIS

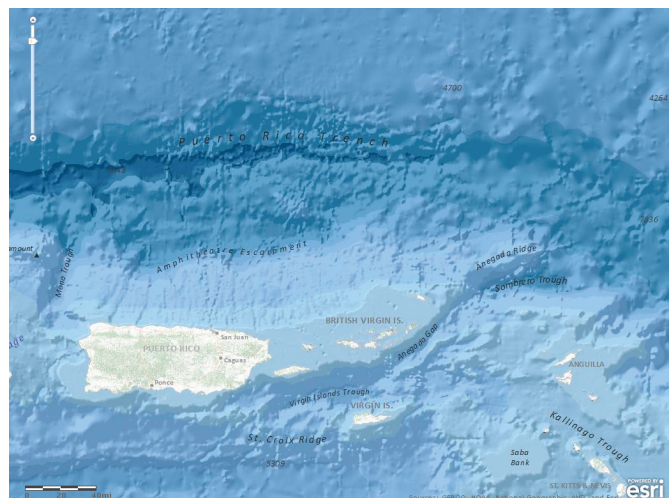
Esri creates ocean basemap service

→ The Ocean Basemap contains more information about the ocean than any existing terrestrial basemap service, including bathymetric data, marine water body names, undersea feature names, and derived depth values in meters.

↑ Much of the detailed data in the Ocean Basemap is located along the coastal regions, which are the most surveyed parts of the ocean. Shown here: The shoreline on East Anacapa Island off the California coast. (Photograph courtesy of NOAA/Claire Fackler, CINMS)



On World Hydrography Day 2011, Esri officially released the world's first ocean basemap as a cached map service available on ArcGIS Online. The first basemap of its kind, the Ocean Basemap was designed by Esri to support a variety of maritime and hydrographic GIS applications. Esri maritime managers Beata Van Esch and Rafael Ponce recently sat down with Esri's Matthew DeMeritt to discuss the importance of the basemap and how the data in it was obtained.



↑ Anyone can begin using the Ocean Basemap by simply going to arcgis.com and choosing it from the Basemap Gallery for display in the ArcGIS Online map viewer.

Matthew DeMeritt: What specifically is the Ocean Basemap, and what kind of data does it contain?

Beata Van Esch: The Ocean Basemap is a free map service at ArcGIS Online designed to be used by marine GIS professionals and as a reference map by anyone interested in ocean data. Think of it as the negative of a land map—a basemap of the coastal regions and ocean seafloor rather than dry land masses. It contains more information about the ocean than any existing terrestrial basemap service, including bathymetric data, marine water body names, undersea feature names, and derived depth values in meters. Much of the detailed data is along the coastal regions, which are the most surveyed parts of the ocean. Generally, the data gradually gets coarser the farther you venture into the ocean.

Rafael Ponce: Because most of the world's oceans remain poorly surveyed, the main need for the data is around the coasts, where human activity and commerce are concentrated. What we want to do is represent that small percentage of mostly coastal data—but also deeper areas—as accurately as possible.

DeMeritt: There are many basemaps for terrestrial GIS, such as topo, aerial, and streets, and yet there are so many maritime fields that use GIS as well.

Ponce: Yes, with the oceans covering so much of the earth, you can imagine all the potential applicability of GIS to the ocean. Ocean GIS is integral to oceanography and hydrography and very important to any other science that interacts with the ocean. In fact, it's just as important in resource exploration and extraction as land GIS. Oil and gas, for example, aren't just located in the crust on dry land but are just as abundant in the continental shelf under the seabed off the coasts. This becomes even more relevant if you consider the rights over natural resources in the subsoil that gives the UN [United Nations] Law of the Sea in the extended continental shelf. In marine geology, it's just as crucial a tool as land GIS is to terrestrial geology. That's one of the main reasons we wanted to create a comprehensive backdrop of the ocean. It was long overdue. You see, for example, that NOAA [the National Oceanic and Atmospheric Administration] incorporated the service into its National Geophysical Data Center map viewer soon after we released it (visit maps.ngdc.noaa.gov/viewers/nos_hydro).

DeMeritt: When did the subject of an ocean basemap come up in your department?

Ponce: We began thinking about it seriously when Esri created the Community Maps program and we saw the success of that project. We thought, "Why not have something similar for the marine community?" We had the technology in place to develop and promote such a basemap to be used by the hydrographic and maritime communities, so it just made sense.

Right now, we have built the basemap at the global scale. As we go into the national and local levels, that's where we seek contributions.

Esri has built a foundation for developing that kind of comprehensive, information-rich basemap. For that, we require authoritative content. We want to approach hydrographic offices around the world, mainly because they officially produce bathymetric information. Of course, we have other institutions, universities, and research institutes that also produce bathymetric data. Their data is important, too, but we mainly want that quality-checked data from national hydrographic offices. Sometimes you receive a lot of data from a research institute or a research vessel, but because their main objective isn't collecting bathymetry, it can have gaps or what we call noise. You have to consider many different aspects to correct the depth measurements such as sound velocities that bend the signal. The temperature across the water column must be measured to straighten it out and make it perfectly vertical. Hydrographic offices rigorously make those corrections and calculations.

DeMeritt: What does putting together a project like this entail?

Van Esch: First, we want to be sure we're getting authoritative data, and second, we've got the proper permissions in place to use the data. On the production side, we've got cartographers working on the construction of the map, adding data as it comes in. As the project manager, I work to ensure we meet the product's objectives and that we stay on task and on schedule with our next release.

Ponce: As adviser and stakeholder, I preside over the map's development. I also draft value propositions for hydrographic offices so they can see the benefit of contributing their data. Understandably, they don't want to share it so easily. Many hydrographic offices belong to the military and produce classified information. We legally assure them that we are not going to share it with anybody and we are not going to make the actual data available to the public. The information in the Ocean Basemap isn't something users can query; it's simply a cached cartographic representation of the seabed to be used as a basemap. It's not vector data that they can use. At the same time, we want to enable potential users or actual users of this data to retrieve the source and perhaps contact them directly if they want to work with the actual data. In the end, the Ocean Basemap helps promote the services of hydrographic offices when users realize they might need to perform deeper analysis on actual datasets.

DeMeritt: How can people start using the Ocean Basemap?

Ponce: Anyone who wants to make maps using the Ocean Basemap can go to arcgis.com and call it up in the ArcGIS Online map viewer. It's in the Basemap Gallery along with the terrestrial backdrops.

DeMeritt: What future plans does Esri have for the Ocean Basemap?

Van Esch: For our next release, we plan to have 500k [500,000] down to 72k [72,000] to enhance what we already have available in US waters, and further in the large scales, off the west coast of the US. From there, depending on the timing of the contributors, we would like to incorporate more detailed ocean content in other parts of the world.

Student Finds a New Lease on Life

Seeing the community through Community Analyst

By Karen Richardson, Esri Writer



↑ Candace Tshirki

After living and working in the Midwest, 50-year-old Candace Tshirki moved to Florida to gain a new lease on life. As part of reinventing herself, Tshirki enrolled at the University of North Florida in Jacksonville.

A university student found Community Analyst the perfect tool for exploring food accessibility and many other topics.

After living and working in the Midwest, 50-year-

While there, she studied under Dr. Jeffrienne Wilder, an assistant professor of sociology. The department offers classes on racial and ethnic relations, colorism, sociology of black Americans, and qualitative methodology. In Wilder's class, Tshirki was introduced to a paper written by Dr. Shannon Zenk entitled "Fruit and Vegetable Intake in African Americans: Income and Store Characteristics" published in the *American Journal of Preventive Medicine*. This paper looked at food accessibility and contained a study of the spatial patterns inherent to food access in Detroit, Michigan.

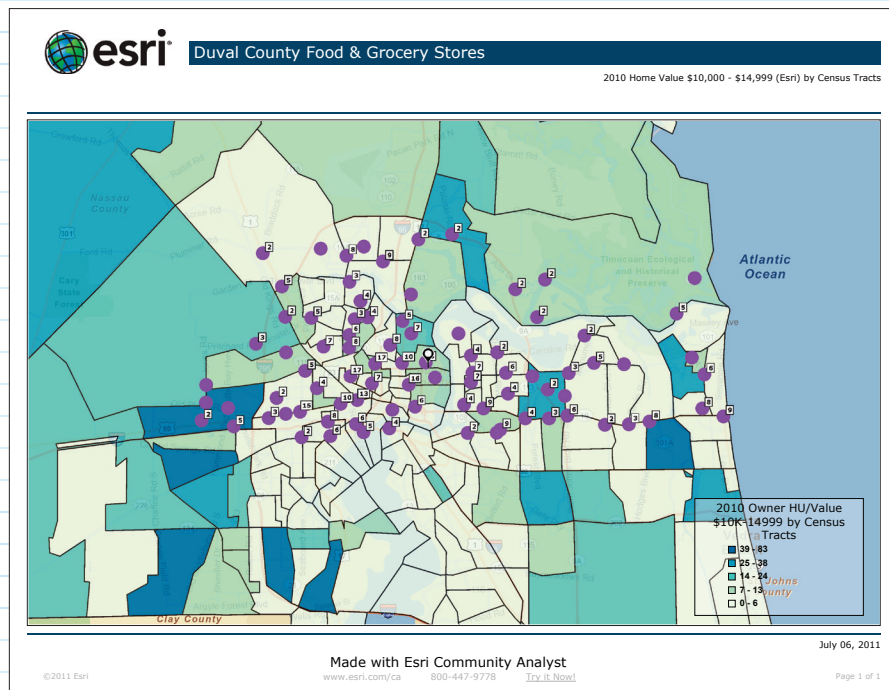
Tshirki had some experience with GIS before moving to Jacksonville. She had worked in the print-on-demand industry creating maps using ArcGIS. Knowing the capabilities of the software, Tshirki was fascinated by the idea of applying it to food accessibility issues in her newly adopted county. To learn more, she took an introductory GIS class from Dr. Chris Baynard, an assistant professor in the department of economics and geography.

Power to the People

"As part of taking the class, I got a subscription to *ArcUser* magazine," said Tshirki. "The issue looked at how place affects health, and I must have read it cover to cover in one sitting." Seeing these different applications helped Tshirki understand even more about the power of GIS. "It really opened my eyes to the many applications of GIS," she said. "Using it, you can help communities plan for all sorts of activities, including food accessibility. The possibilities are endless."

Tshirki's food study began the hard way: collecting the data needed to perform analyses. "Getting information was very tough," said Tshirki. "It wasn't in a central place. I ended up collecting data about restaurants and food stores from Internet searches, phone books, and restaurant licensure found through the county's website."

Everything had to be printed out, since it wasn't available in a format that could be imported readily. In the end, Tshirki entered almost 2,500 businesses, representing well over 100 hours of work. This did not include finding the census data and other information she needed to really look at the problem.



↑ One aspect of food accessibility is the availability of food and grocery stores. This map explores the location of stores in relation to home values.

Wanting to find an easier way to continue with the study, Tshirki turned to Community Analyst, a Software as a Service (SaaS) mapping solution hosted by Esri that provides GIS capabilities in a simple and easy-to-use framework. The university holds an Esri site license and participated in the beta program for the Community Analyst solution. When the solution went live, Tshirki logged on to Community Analyst and created a site that basically replicated the study done by the author of the academic article that had first caught her eye. In less than five hours, she had created a point layer of all the food access points in Duval County and began to view that information along with all the data that was available with the solution, such as up-to-date United States census information and Esri demographic data including vacancy rates and how far people must travel to work.

"I found out I didn't have to be a specialist to use it," said Tshirki. "GIS is powerful. With this solution, the power comes from where it should—instead of a really technical user, the power is in the information you can see and analyze and the ability to share that with others."

Opening up a Dialog

Many studies of food accessibility focus on the urban core, where most available food comes from local convenience stores. But Tshirki had a different vision. "The University of Florida is located by the beach, not the urban core of Jacksonville, but we face the same problem," said Tshirki.

The five-mile area surrounding the university is served by only two grocery stores. Transportation is key. It may be more convenient to walk five blocks to a fast-food location or a convenience store than to drive to a grocery chain store. Food accessibility did, in fact, seem to be a big issue.

With dots representing convenience stores populating the map, Tshirki was able to zoom in and out, looking at one dot and then comparing it to others to get a real perspective on food access in the county. "We were able to view an area and then delve a little deeper to see what was really in there," said Tshirki. "And we did this live, with real data, using it in a highly visible way."

Some areas of Tshirki's map lacked dots where many people thought there should be some. When this happened, she looked at the map and changed the variables being viewed. For example, when looking at a layer lacking grocery stores, she also looked at a layer describing the percentage of people who own cars in the area. "I was able to compare this different information on the fly and show the people who were asking about this very easily."

One particular area was a neighborhood located in a lower socioeconomic part of Jacksonville. For 40 blocks, there was no place to buy food. "We knew there wasn't food available in this area, but for 40 blocks?" said Tshirki. "To be able to map that is phenomenal. Using a map, this popped out at us right away. It opened a dialog about what this means and what can be done."

Boundless Applications

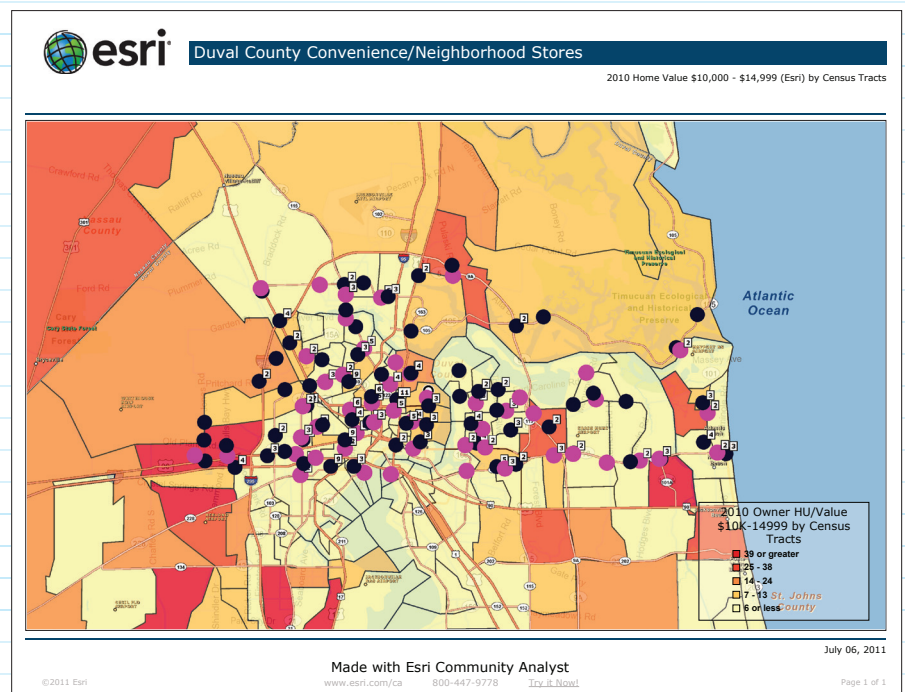
Tshirki sees applications for Community Analyst all around her. She is currently assisting the small Episcopal church she attends with long-range goal planning. "I thought it would be a good idea to look

at who our neighbors were," said Tshirki. "Looking at maps and traffic counts and creating one-, three-, and five-mile radiuses around the church, we found out a lot of information about ourselves."

What Tshirki found was that 10 percent of the population was Hispanic, many lived in apartment buildings, and most people in the area were in the lower income range. "We are less than a mile from the beach," said Tshirki. "We're not a poor church. Driving up and down the main arterial, we look a lot more affluent than we are."

By having this information readily available in an easy-to-discover solution, the church can now make plans to be an integral part of the community. "Instead of doing something because someone has a great idea, we can now create services that really reflect the community we are trying to serve," said Tshirki.

Tshirki is busy helping a friend back in Illinois generate the same types of reports she ran for her diocese and is also looking at other university projects that could benefit from Community Analyst. As Tshirki said, the possibilities are endless.



↑ Tshirki also looked at the location of convenience stores.

For the last 30 years, government, business, and academic organizations have been building a geospatial fabric that incorporates parcel, transportation, and other information. Although tremendous progress has been made in this endeavor, it is a fabric rent with gaping holes. These holes in the geospatial fabric represent building footprints, and they are cause for concern.

Urban areas constitute a man-made ecosystem that has a profound effect on the natural landscape surrounding it. Buildings are also where more of the population spends its time and where capital is most concentrated.

Why has geospatial information stopped at the building footprint level? In part, this was a by-product of how many organizations created basemaps. Many relied on aerial photography and/or GPS, which are data capture methods blind to building interiors.

However, understanding the urban ecosystem is becoming increasingly important. According to the United Nations Population Fund, in 2008—for the first time in history—more than half the world's population lived in towns and cities. The trend toward urbanization is accelerating, and in densely developed places like Manhattan, the extent of the floor space in its buildings far outstrips the land area encompassed by the borough's boundaries.

Facilities management (FM) is the interdisciplinary profession that integrates support for people, places, processes, and technology used to manage the built environment. *Facilities* is a broad term that covers airports, university campuses, military bases, and commercial campuses. By considering the interactions of all processes, FM allows building systems to be managed strategically. An abundance of data about buildings exists in CAD and building

information modeling (BIM) formats.

Increasingly, FM professionals are turning to GIS, with its tremendous capacity for integrating this detailed data from disparate sources. Instead of looking at facilities as a collection of parts, GIS lets managers see these subsystems holistically as parts of a whole, integrated based on commonality of location, which enables analyses. GIS is a complementary, not competitive, technology that brings data on the built and natural environments together and spans scales from the global to a building interior.

GIS can be used to follow a building through its entire life cycle from site selection, design, and construction to use, maintenance, and adaptation, through closing, repurposing, and reclamation. The challenge is managing each step of the process so a building's benefits are maximized and its short- and long-term impacts on the natural environment minimized.



The Next Great

The ability of GIS to assess the relationship between a building and the landscape that surrounds it can be analyzed with respect to effects on both the building and its environment. Through simulation, a building can be placed in specific environments to evaluate its performance and determine how location changes the structural requirements for that building. Aspects of design, such as energy efficiency or resistance to effects of climate change, can be incorporated into this simulation testing. By running the analysis from a geodesign perspective, the effect of the building on the landscape can be modeled, measured, and modified where necessary. By relating existing structures and systems on a campus or military base to the requirements for new infill, buildings can optimally sited.

The GIS tools available for these analyses are rapidly improving. With the recent acquisition of Procedural by Esri, the technology in its CityEngine 3D cities and buildings

modeling software will be integrated into ArcGIS, providing full 3D design in geographic space.

3D visualization is a vital aspect of GIS use for FM because it provides the multiple views at the level of detail needed not only to construct the building but also to identify possible conflicts before construction starts. In addition, some problems, such as line of site, collision detection, containment, skyline, and shadow analysis, can only be solved with 3D.

The ability to model virtual cities on scales down to the contents of individual rooms benefits not only design and construction but also facility and space management within buildings. GIS-based analysis at the building level supports decisions related to allocation and monitoring of fixed resources such as printers in an office or crash carts in a hospital. This same capability can address emergency preparedness issues such

as determining the best route for evacuating not only the building but the vicinity. By adding the fourth dimension, time, GIS can more effectively manage maintenance activities. Work orders can be consolidated based on both location and time frame.

The incorporation of GIS into FM continues to be driven by many factors. For many organizations, rising facility overhead (especially as related to energy costs) remains the largest operating cost item after personnel expense. Sustainability is becoming important to many organizations, particularly educational institutions. The need for a more effective method of addressing the vulnerabilities of public places to security threats remains pressing. Finally, in the current adverse economic climate, the need for buildings that are compliant, competitive, safe, and sustainable is greater than ever. Consequently, the urban landscape is the next great frontier for GIS.

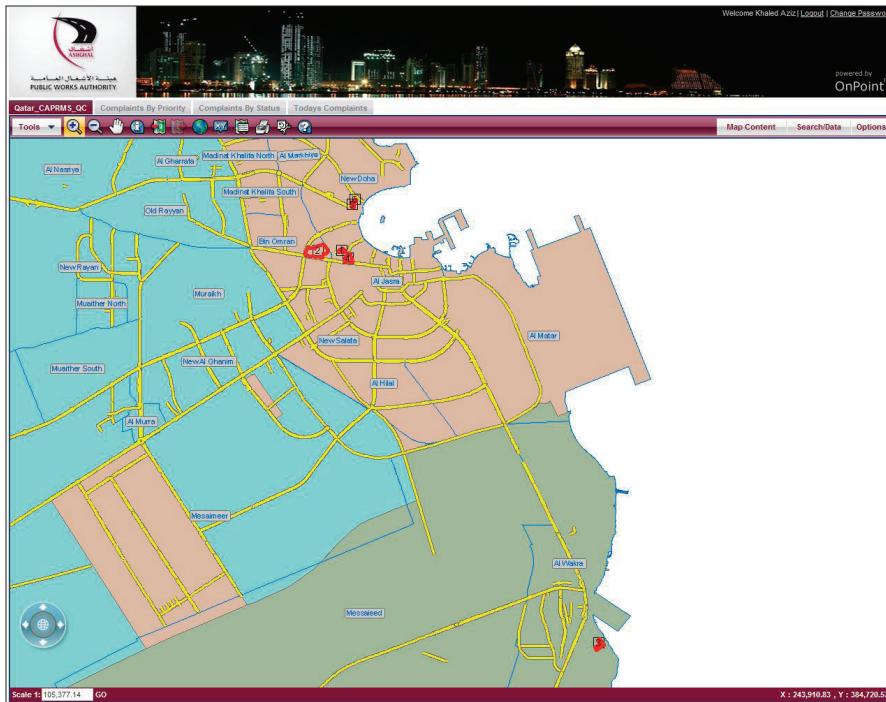
GIS Frontier

Simplifying the Project Approval Process

Geocentric approach to budgetary system

By Jim Baumann, Esri Writer

↓ High-level map view of multiple projects being proposed



Though Ashghal, the Qatar public works authority, is responsible for a significant amount of the country's infrastructure—including roads, wastewater systems, and public buildings—there are numerous other government organizations in charge of designing, building, and maintaining government facilities. Because all government infrastructure projects compete for public funding, Ashghal was given the responsibility for implementing a system to coordinate the annual capital project budget application process.

Traditional Workflow Led to Errors and Delays

Historically, the budget application process for major infrastructure projects was primarily paper based. This often led to incomplete or lost paperwork, resulting in protracted meetings between the ministries and Ashghal to resolve conflicts and miscommunications. It also led to late project submissions, frequent submission deadline

With its wealth of oil and natural gas reserves, resulting in an expansion in trade and investment, the small Middle Eastern nation of Qatar has seen its population more than triple to 1.7 million in fewer than 15 years. This population growth has sparked an unprecedented boom in construction and infrastructure development projects.

extensions, a complicated tracking method, and limited opportunities to collaborate on projects.

To automate this antiquated workflow, Ashghal's Engineering Business Services Department defined the requirements for a capital project request management system, called Moazanah (Arabic for *budget*). Moazanah would facilitate the country's budgetary review and approval, with the overarching aim to make sure that all capital project funding applications move forward smoothly, with greater clarity for the reviewing agencies and individuals. The Moazanah project was announced in 2009 and ultimately awarded to Rolta Middle East, an Esri partner, following competitive bidding.

↓ This Project Management view shows a high-level project estimate for a medical facility.

↓ This view displays a list of all projects so they can be reviewed by the project coordinator.

Agency Name	Project Name in English	Budget Code	Provision	Type	Year	Cost (QR)	Percent Complete	Project Status	Onhold Status	Project Manager	Project Coordinator	Last updated
Ministry of Urban Planning and Development	Supervision project for new school in West Bay area	BUD010	11	Design	2010	800,000.00	0	Approved	Conditionally	Mohsen Said	10/10/2010	
Ministry of Urban Planning and Development	Construction project for new school in West Bay area	BUD010	11	Design	2010	2,000,000.00	0	Approved	Conditionally	Mohsen Said	10/10/2010	
Ministry of Urban Planning and Development	Supervision project for new school for American Embassy	BUD010	11	Design	2010	2,000,000.00	0	Approved		Mohsen Said	10/10/2010	
Ministry of Urban Planning and Development	Supervision project for new office for the councilor	BUD010	11	Design	2010	900,000.00	0	Approved		Mohsen Said	10/10/2010	
Ministry of Urban Planning and Development	Construction project for new office for the councilor	BUD010	11	Design	2010	2,000,000.00	0	Approved		Mohsen Said	10/10/2010	
Ministry of Urban Planning and Development	Design project for extension of library near the upcoming Islamic Museum	BUD010	11	Design	2010	700,000.00	0	Budget	Approved	Mohsen Said	10/10/2010	
Ministry of Urban Planning and Development	Design project for new school in West Bay area	BUD010	11	Design	2010	500,000.00	0	Budget	Approved	Mohsen Said	10/10/2010	
Ministry of Urban Planning and Development	Design project for new office for the councilor	BUD010	11	Design	2010	40,000.00	0	Budget	Approved	Mohsen Said	10/10/2010	
Ministry of Urban Planning and Development	Construction project for new museum for Qatar Islamic Museum	BUD010	11	Design	2010	5,000,000.00	0	Approved	Conditionally	Mohsen Said	10/10/2010	
Ministry of Urban Planning and Development	Construction project for extension of library near the upcoming Islamic Museum	BUD010	11	Design	2010	900,000.00	0	Rejected		Mohsen Said	10/10/2010	
Ministry of Urban Planning and Development	Supervision project for extension of library near the upcoming Islamic Museum	BUD010	11	Design	2010	700,000.00	0	Rejected		Mohsen Said	10/10/2010	

GIS-Based System Resolves Budget Process Bottlenecks

On the surface, a capital budget review process—with its mix of estimates and textual details covering legalities, materials, construction services, and logistics—might seem lacking in geographic content.

However, georeferencing is central to Moazanah. Each project has a geographic extent, which highlights areas where nearby projects may overlap. Each overlap becomes an opportunity for coordination and cost savings. For example, it is obviously costly and inefficient to repeat construction work on the same stretch of roadway. However, in the past, projects were proposed, funded, and completed without considering other projects scheduled for the same area. A project might tear up the same stretch of road that had just been resurfaced. These repeated disruptions were costly for the government, unnecessarily impacted local business, and impeded traffic flow throughout the affected area. Using ArcGIS—a key component of Moazanah—to track project locations helps coordinate neighboring projects or associated work, which reduces construction costs and the disruption for local businesses and residents.

Nasser Ali Al Mawlawi, who is Ashghal's president and also an engineer, said, "Moazanah manages our government infrastructure projects from beginning to end. It has not only expedited the review and approval process, but we are already seeing a cost savings, which will undoubtedly result in a significant return on investment."

Central to the Moazanah solution is Rolta's OnPoint, a web-based GIS application; SharePoint Web Parts; and Microsoft SQL Server. The underlying engine is based on Esri's ArcGIS Server platform, which manages the spatial data for subsequent analysis and distribution. Moazanah is also integrated with Primavera's Project Portfolio Management (PPM) to organize and manage the proposed projects once the budget is approved.

Simplicity Is Key to System's Effectiveness

The system features a series of interconnected SharePoint forms. These forms are tailored to the role of the individual who logs in to

the system. Because the user experience was of utmost importance to the successful deployment of Moazanah, the user interface was deliberately kept clean and intuitive.

Shafik Jiwani, executive vice president of global business development at Rolta, explained, "We recognized early on that Ashghal had very ambitious plans for this system. With more than 23 agencies involved in the process, hundreds of users, and hundreds of complex projects, it was quite a challenge to present information in a way that felt intuitive to the user.

"As tempting as it was to build a sophisticated interface with lots of complex tools, the smart approach was to keep the interface clean and simple. It had to be easy to find the information needed to make informed assessments and immediate decisions."

Key performance indicators (KPI) are extracted from the data and displayed on a dashboard that is customized to reflect department heads' interests and responsibilities. Moazanah is used throughout the project assessment process to evaluate the suitability and impact of a proposed project on its specified location. During this process, various location-based government regulations must be considered. GIS is also used to drive other geospatially based analyses, such as the number of project requests submitted within a particular municipality and the status of those projects.

Increasing Efficiency and Collaboration

Moazanah has increased the efficiency of Qatar's budgetary process. Information is submitted digitally and can be examined by all stakeholders who evaluate and discuss the same information as it proceeds through the review procedures. It facilitates collaboration and coordination. With Moazanah, Qatar has an immediate status report for all proposed projects in the country.

Abdussamad Mohamed Al Makei, manager of Ashghal's Engineering Business Services Department, concluded, "Moazanah provides us with a forum to discuss and analyze the country's infrastructure project proposals so that we can confidently move forward with them, knowing they are properly managed and within budget."

Two F-16 Fighting Falcons taxi down the runway prior to takeoff from Hill AFB. Many operational and support missions are located in the base. (US Air Force photo/ Senior Airman Devin Doskey)



Innovative Strategy for Facility Upgrading

Hill AFB uses ArcGIS to manage thermal IR imagery

By Karen Richardson, Esri Writer

How do you check the soundness of the roofs and utility system for 1,300 buildings—spread over more than 10 acres—in a comprehensive and cost-effective manner?

Hill Air Force Base (AFB) used ArcGIS and thermal infrared radiation (IR) imagery to identify failing roofing and utilities. The base, part of the Air Force Materiel Command (AFMC), is located in northern Utah near the city of Ogden. Many operational and support missions are located here, including maintenance of the F-16 Fighting Falcon, the A-10 Thunderbolt II, and the C-130 Hercules aircraft.

The main base covers 10.2 square miles, and its buildings are used for aircraft maintenance and upgrades as well as technical and training facilities for flight staff on the base. This critical infrastructure houses personnel as well as assets and services worth hundreds of millions of dollars.

Many of the buildings on the base date back to the 1940s. As the result of normal

wear and tear, this infrastructure, which includes a maturing utility system, was deteriorating. Little reliable data had been kept on the condition of these facilities. Failing roofs were often discovered by the personnel directly affected by a leak or when the damage was extensive enough that it could be seen. Limited facilities information made identifying and fixing these issues expensive and time-consuming.

Historically, Hill AFB personnel inspected roofs, but the manpower and money required to conduct physical building-by-building roof inspections have made this impractical. Alternatively, the price tag for replacing all the roofs was prohibitive.

Discovering Roof Failure with Thermal IR Imagery

To find a solution that would help them work more intelligently and efficiently, Hill AFB personnel turned to ArcGIS. Most air bases are standardized on Esri GIS

technology. Hill AFB, a longtime user, had a site license for ArcGIS that allows use of the software throughout the base for everything from topographic mapping to flight charting.

Working with Esri partner Woolpert, Inc., based in Dayton, Ohio, members of the GIS department took existing topographic maps and overlaid them with aerial photographs of the buildings to map the facilities, including 12,000,000 square feet of roofing. Although this provided them with a visual representation of infrastructure location, the problem of cost-effectively finding failing roofs and pipes was still unresolved.

"We thought incorporating thermal infrared imagery into our facilities maintenance would be an efficient solution to identifying our failing infrastructure," said James Wright, GeoBase manager, 75 CEG/CEAO. *[The Air Force GeoBase program supports use of geospatial information technologies at Air Force installations]*

as corporate knowledge management resources.]

Thermal IR imagery shows heat and is often presented as a grayscale picture. Shades of gray indicate differences in temperature and emissivity (i.e., the ability to emit energy by radiation) of objects in the image. Typically, objects in a thermal IR image that look lighter are warmer and those that look darker are cooler. Thermographic imagery shows the unique heat signatures produced by different environmental conditions on physical materials. For example, by looking at thermal imagery, it is possible to see how buried chilled-water lines cool the surface above the line.

The wet areas of roof materials have distinctive thermal characteristics. Latent heat, caused by the sun shining on rooftops during the day, is trapped in the water mass of those areas. The heat in those areas is greater than the heat absorbed

require staff to access each roof level.

Woolpert staff flew the base with a fixed-wing aircraft and captured nadir images of the base. (Nadir images are taken by pointing the camera straight down toward earth.) Thermal IR is stored and used in the same manner as other types of raster data, so no special requirements were needed to view, analyze, and store this data in ArcGIS.

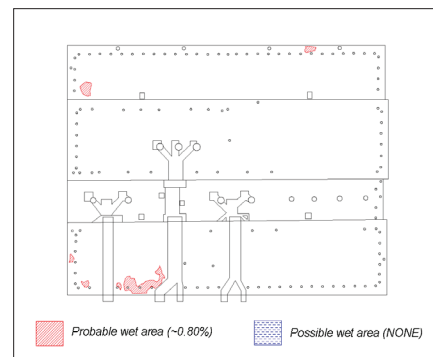
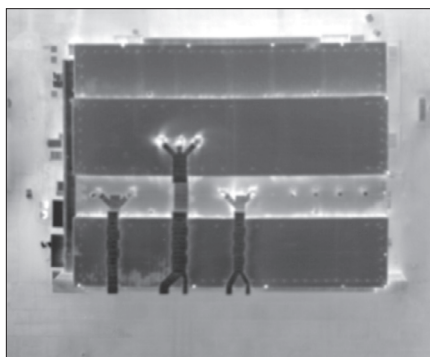
Once collected, the raster imagery is processed with ArcGIS and delivered in georeferenced vector and raster datasets that seamlessly integrate with existing GIS data used at the base. Staff can manage different image resources, such as thermal IR and aerial photos, in ArcGIS, which supports most existing raster and imagery formats. This simplifies image management and workflows.

Imagery is stored as mosaic datasets. Original datasets are referenced when

Data and reports generated from this analysis allowed staff to determine roofing needs and prioritize each building. Work orders were then created based on the analysis and entered into the work order system used throughout the Air Force's Automated Civil Engineer System (ACES).

Cost Savings and Discovery

Besides the deteriorating roofs, using the thermal IR found older areas of the base that have utility systems that are becoming increasingly volatile. Leaking steam lines are easily identified in the images as white lines. Because the raster is geospatially accurate, these utility locations can be identified, surveyed or digitized, and then loaded into ArcGIS. This eliminates the need for costly, ground-based detection to seek out malfunctioning lines. "Thermal IR roof inventory saved us money



↑ Comparison of standard RGB orthophotography (left) and thermographic imagery (center), which shows areas of water infiltration. Those areas are indicated on the sketch (right).

by dry insulation or roof substrate. As the rooftop cools after sunset, wet areas of roof insulation and other materials continue radiating heat. That heat can be detected and its signature captured with thermal equipment.

Efficient Image Processing

"Thermal IR promised significant potential cost savings, since it is much cheaper to fix a roof before it fails," explained Wright. One reason for this cost savings is manpower. Data for the entire installation can be collected in one night rather than the time needed to individually inspect 1,300 buildings. Also, information on buildings with rooflines on multiple levels can be collected easily using thermal IR, unlike ground-based survey methods that

imagery is accessed by the user, reducing storage requirements because multiple versions of the imagery aren't stored. This is an advantage when dealing with large files such as the thermal IR files, which were captured at an eight-inch resolution.

ArcGIS was used to analyze the thermal IR imagery for the probability of water infiltration or leakage and the amount of square footage affected. More than just a picture of roof damage, the imagery provided real data for analysis. "We like to use imagery because it isn't reinterpreted and so it retains all the original information, making it a perfect choice for analysis such as feature extraction, classification, suitability, and measurement," said Daniel Michalec, application specialist at Woolpert.

compared to traditional, manual roof assessment," stated Wright. For more information on how GIS is used in facilities management, visit esri.com/fm.



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Daunting Task Gets Easier

Geotagged photos aid real property inventory

By Kevin P. Corbley

An efficient and easy-to-use photo-mapping inventory process developed by the US Army Corps of Engineers (USACE) is being used to inventory real property assets and output ArcGIS feature layers that map geotagged photos and contain attributes.

The Chief Financial Officers Act of 1990 (CFO Act) sought to reduce government waste by improving the efficiency of financial management and accounting practices at US federal agencies. Among its many mandates, the act directs government departments to conduct regular inventories of their assets worldwide—this includes audits to assess and document real estate assets.

Under the act, real property audits apply to vacant parcels as well as improved properties. Audit guidelines require every government agency to inventory its properties and determine where they are located and assess how much they are worth. Documentation must include photographs of any buildings and structures and their geographic coordinates.

The inventory mandate was challenging for all federal agencies, but particularly daunting for the USACE, which owns, operates, and manages thousands of civilian and military properties located around the world. Primarily responsible for major civilian design, construction, and public works projects within the United States, the Corps also maintains land records for 250 military facilities on behalf of the US Army and US Air Force.

“[USACE] real property runs the gamut from a radio tower and building on a piece of land to a major dam complex with 1,200 individual items,” said Roger Miller, the real property administrator for the Corps’ Omaha (Nebraska) District.

The Corps is divided into 45 districts worldwide, delineated either by watershed (for civilian projects) or political boundaries (for military support activities). The Omaha District has more than 6,000 buildings or structures in management areas covering eight states. This district became the first to develop a highly efficient inventory process that

involves geotagging and photo mapping to create a real estate layer in ArcGIS.

Until recently, the Corps primarily used CAD for mapping projects. However, many divisions in the agency are now adopting ArcGIS for this purpose. The Corps’ Northwestern Division, which includes the Omaha District, is building a division-wide GIS containing layers for real property, engineering, operations, and project management. Once completed, this web application will make details of properties, facilities, and projects available to anyone in the Corps via a web browser.

Finding a Solution

Miller recalled the difficulties he encountered during his first assignment to perform an inventory of a project site. He was given a handheld GPS receiver and digital camera. At each feature, he snapped photos from one or more perspectives and then jotted down the latitude-longitude coordinates from the GPS screen.

“I came back from that not too happy with how long it took,” said Miller.

And if the time spent in the field seemed excessive, even more time was required back at the office to correctly correlate digital

PID & HRH : BEAR-70257 - HRH 25000
Structure Number : 6987
Original Cost : 0.00

Bear Creek Lake & Recreation Area
Location : 122 - Fox Hollow Golf Course
Cost Share : No

Privately Owned


US Army Corps
of Engineers
Omaha District



Title (Description) : Bridge (Pedestrian)
RealPropertyType&Use : 40 - 73
N 39° 39' 27.87" W 105° 07' 58.38"

150.8°M
5525 ft

Outgranted/Outleased : Yes
Contract Number : DAOW45-1-82-6091
Aug 31, 2009 4:48 PM

31 AUG 2009
150.8°M
N 39° 39' 27.87" W 105° 07' 58.38"

↑ Attributes, such as hand receipt number, location, and asset type, are embedded in the photo. Geotagged photos can be exported from the photo-mapping software as an ArcGIS map layer containing icons placed at the precise geographic locations of photographed features.

photos with property locations. Once the handwritten notes were correlated, it was a manually intensive process to rename and post the photos to their correct locations. To get an aerial view of a specific area required looking up each one using the resources available on the Internet.

Miller searched the web looking for an integrated system to streamline the asset inventory task. He eventually found Ricoh cameras (models 500SE and G700SE) with built-in GPS, compass, and attribute notation capabilities. He also discovered software that drastically reduced the correlation and mapping work back at the office. The Ricoh camera was offered as a bundled solution by Esri partner GeoSpatial Experts of Thornton, Colorado, developer of GPS-Photo Link photo-mapping software.

This software automatically correlates photos with their geographic coordinates and stamps the location and time, along with any other user-defined attribute data, as watermarks on each photo. GPS-Photo Link then outputs the photos to an annotated map layer in ArcGIS.

"It was all off-the-shelf technology that anybody could use," said Miller. "That's how I came up with the process that I'm currently using."

Putting Photo Mapping to Work

Typically, Miller travels around the project site by foot or car. Since all projects in the Omaha District have been inventoried at least once, he carries a printed list of items that must be visited and photographed as he looks for new assets that have been built since the previous visit. In the interests of accuracy and consistency, Miller has devised procedures for how each asset will be photographed. Large buildings, for example, are photographed from each side, while a small picnic table pad requires only one photo.

The Ricoh G700SE and 500SE were designed for use with GIS. Miller takes full advantage of their capabilities. As he photographs each item, the camera's GPS records the location. When positional accuracy is critical, he stands immediately next to the feature, holds a GPS lock button on the camera, and then moves away from the feature to snap the photo so the unit records the location of the item rather than the location of the camera when the photo was taken.

In some situations, such as a large dam structure, properties are not accessible by foot. In those cases, he links a TruPulse laser range finder to the camera via wireless Bluetooth connection. The laser determines the distance to the feature, and the software combines that distance information with the bearing and position information from the camera to calculate an offset position.

The Ricoh G700SE and 500SE act as data collection devices as well as cameras and GPS units. Each USACE asset is identified by a property identification (PID) number. While on-site, Miller selects values from the drop-down menus—created on a PC and transferred to the camera—to collect attributes for each item. These attributes are embedded in the photo. The attributes stored for each item are PID number, hand receipt number, location, asset type, structure

number, description, original cost (if available), outgranted/out-leased status, contract number, whether it is a cost share item, and the real property type and use codes.

Up to 100 notes or memos can be stored in the camera as attributes along with the GPS coordinates, which are linked permanently to each photo. Some assets have bar code stickers containing PID numbers that the Ricoh cameras can scan and automatically store with each picture.

Because thousands of photos may be taken for a single project during an inventory, Miller first organizes the pictures by location. He uses the basic editing software provided with the camera to add, delete, or update information. He then uploads the photos and attributes to the GPS-Photo Link software on a standard personal computer. The software can correlate hundreds of photos with GPS point locations and attributes in just a few minutes.

He then decides which attributes (e.g., coordinates, acquisition date, PID, assessed value) will be stamped with a watermark on each photo. Back in his Omaha office, Miller outputs the geotagged photos from the photo-mapping software as an ArcGIS map layer containing icons placed at the precise geographic locations of photographed features. Users click icons to view photos and related attribute information.

With photo-mapping software, Miller can output photos in a variety of other formats including PDFs, HTML reports, spreadsheets, or Microsoft Word documents.

Creating a Real Property GIS

By late 2011, Miller expects to have ArcGIS running on his laptop in the field. Although he can perform all photo and attribute editing in GPS-Photo Link, he currently has to wait until returning to his office to edit the GIS output layer in ArcGIS. Soon he will generate the ArcGIS layer in the field from his laptop and upload it to the division website.

The move away from CAD to GIS for storing information relating to real estate and other facilities will offer significant benefits across the Corps, according to Jesse Otterson, a cartographer in the Omaha District.

"It's a dataset that becomes helpful not just to our real estate division but also to people involved in operations and maintenance," he said. It helps people understand the buildings they maintain.

Miller's inventory process is so efficient and easy to use that he has been asked to teach it to other real estate specialists throughout the Corps and in other government agencies. The Corps is currently performing its real property inventories in three-year cycles. Because it was the first government agency to complete an audit under the CFO Act, the Corps' procedures are being emulated by other federal offices.

About the Author

Kevin Corbley is a communications consultant in the geospatial industry. He can be reached at www.corbleycommunications.com.



↑ Roger Miller, the real property administrator for the Corps' Omaha (Nebraska) District

Map Production Increased by 50%

With the same staff, using new system

By Michal Traurig, Land Survey Office of the Czech Republic

Beginning in 2001, new digital topographic maps were published based on a digital database created for the whole area of the former Czechoslovakia using ArcGIS. These new maps inaugurated a continuous updating process for maps.

Land Survey Office (LSO) administers the National Map Series of the Czech Republic. In recent years, LSO has developed the Information System of the National Map Series (IS NMS) in conjunction with the company T-MAPY spol s r.o. Basic and thematic maps at scales from 1:10,000 to 1:100,000 are processed in this system. The whole cartographic system is based on Esri products with the support of CPS eXpress, application software produced by Esri partner T-Kartor Sweden AB.

The National Map Series of the Czech Republic, created beginning in the 1970s, was the basis for the Fundamental Base of Geographic Data of the Czech Republic (ZABAGED) digital database. The previous map production methodology was developed in a MicroStation environment with MGE extensions. The production line for Basic Maps of the Czech Republic—very modern at that time—became out-of-date over the last 10 years, prompting the move to a new map production process based on Esri technologies.

From the beginning, many demands were made of the new system. The most significant requirements were

- Keeping linkage to the source databases—ZABAGED and the geographic names database (Geonames)
- Storing the data in a seamless database (This is one of the main differences between the old and new technologies. In the old system, data was stored in separate files. Each map sheet was a project containing many files.)



- Creating visualization with cartographic representations for basic maps at scales of 1:10,000 and 1:25,000 without changing the geometry of the data
- Detecting changes in the databases during the update process (In contrast, in previous systems, changes meant that the whole map sheet had to be remade.)
- Increasing map production by approximately 50 percent using the same number of employees
- Maintaining very high standards for printed outputs

Software Used

ArcGIS is used on the server and the desktop. ArcGIS Server Basic for Enterprise stores and manages spatial data in Oracle 11g. ArcGIS Desktop (ArcView, ArcEditor, and ArcInfo) is used for cartographic production. IS NMS also uses Maplex for better label placement, the ArcGIS Data Interoperability extension to import and export files in additional formats, and the ArcGIS 3D Analyst extension for creating 3D models of altimetry.

CPS eXpress is an extension designed for ArcGIS Desktop. With its help, a cartographer can create a whole map sheet, frame, and outer frame. Workflow Manager (WfM), a web application designed for the general management of IS NMS, is also used in the process.

The Data Structure

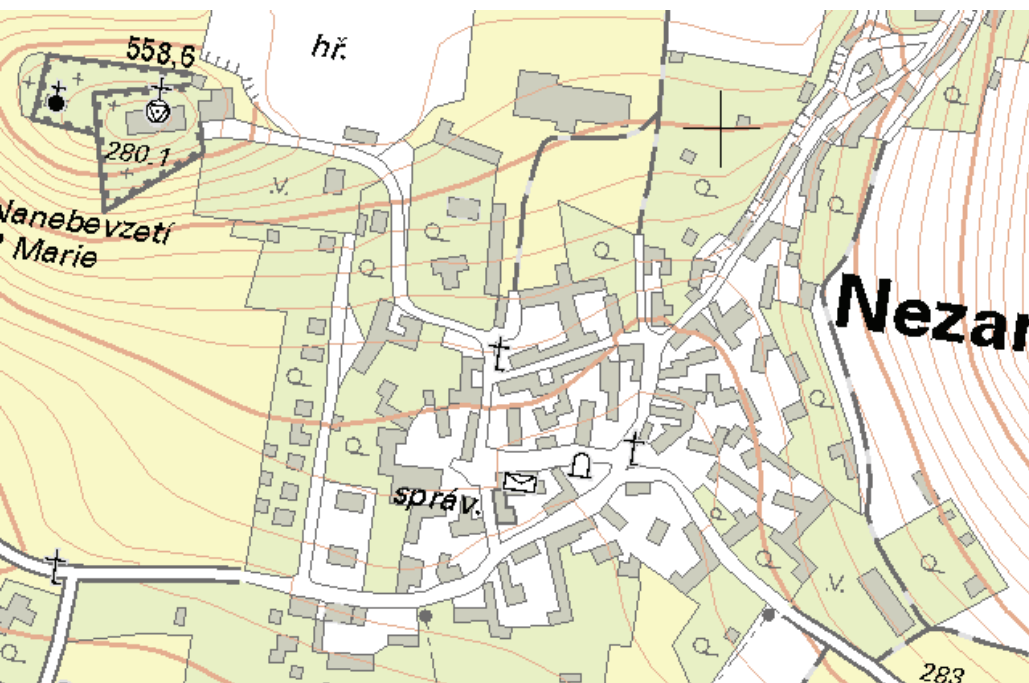
The data structure of IS NMS is divided into two parts: DATA 10 and DATA 50. DATA 10 is used for producing and updating ZM 10 and ZM 25 maps (basic maps at scales of 1:10,000 and 1:25,000). DATA 50 is used for producing and updating ZM 50 and ZM 100 maps (basic maps at scales of 1:50,000 and 1:100,000). Thematic alterations at relevant scales can be made in these two map groups. All maps use two main data sources: ZABAGED and Geonames. Thematic databases (internal or from external providers) are used to add thematic content to the maps.

System Architecture

IS NMS was designed using a three-layer architecture that provides optimal communication between data storage, the application layer, and the presentation layer. The system was designed to accommodate client stations located in two cities. Some stations are in LSO headquarters in Prague, but most are located with the servers 50 miles away in the city of Sedlčany. Communication between Prague and Sedlčany is provided by a wide area network (WAN) with a transmission capacity of 8 MB per second. The data, stored on a high-density disk array, is updated by regular replications.

The server part of the solution consists of two separate database servers, one for DATA 10 and the other for DATA 50. It is also the application server for all IS NMS server applications. The RDBMS is Oracle 11g with an Oracle Spatial extension used for data management. Communication with the database is provided via ArcGIS Server 9.3 Basic. The server portion of the workflow manager for production control is also installed on the application server.

↑ Output from the original system (left) and ArcGIS Desktop (right)



The client portion of the system consists of approximately 50 workstations, of which six are connected via WAN. LSO uses 45 floating ArcGIS Desktop 9.3 licenses. IS NMS uses Maplex to support correct text placement, the ArcGIS Data Interoperability extension for importing and exporting data in various formats, and the ArcGIS 3D Analyst extension for hypsometry work. CPS eXpress is also installed and used for creating map templates.

Map Production in DATA 10

In addition to DATA 10 map sheets produced at scales of 1:10,000 and 1:25,000, IS NMS can also process thematic maps according to a customer's request. Standard maps are output as printed maps using the map sheet division system or as digital raster maps. One of the main reasons for using a seamless database for production line work was the ability to offer map outputs (either standard or according to customer requests), which need not correspond to the uniform sheet line system.

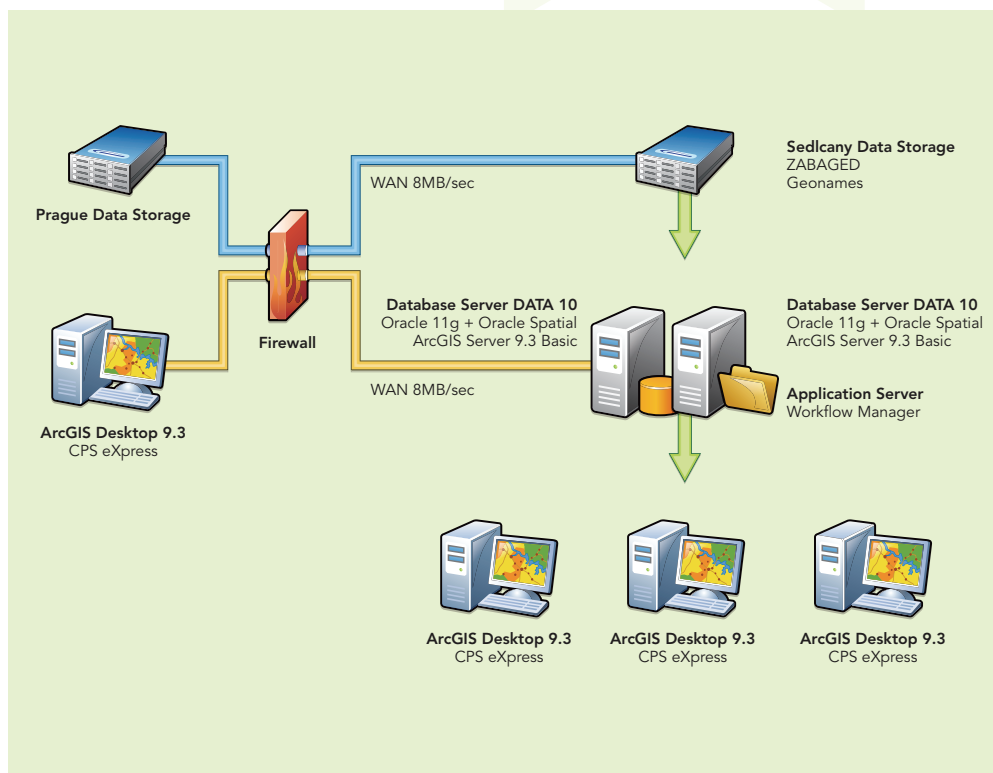
All cartographic edits are made in ArcMap. Cartographers work on a single map sheet in a map series. All map elements located in the envelope of an update procedure are included (i.e., all elements on the map sheet, in the outside buffer of 500 meters, and the inner and outer map frames). Above all, the work on a map sheet consists of solving map symbol conflicts. The cartographer has to correctly place labels and symbols that are close to the map framework. These are positioned in two ways depending on whether they will be displayed on a seamless map or a map using the map sheet divisions.

Map editing is carried out as a type of long transaction. Changes occur in the working version of a database and are posted to the production version of the database only when all work on the map sheet is completed.

ZM 25 map sheets are created after ZM 10 map sheets in an area are finished. Cartographic representations created for ZM 10 can be reused for ZM 25. This significantly reduces the time required for ZM 25 map sheets. Of course, any number of map sheets can be simultaneously processed.

The production manager chooses which areas will be updated, thereby minimizing possible conflicts that might occur between working versions if updates were running simultaneously on the same areas. Any conflicts are solved interactively. Executed changes are posted to the production version of the database only when all conflicts are resolved.

The indisputable benefit of the new technology is its decidedly friendlier user environment. The old technology worked with a wire model, which had its own symbol library. Reading maps on-screen required experience and lots of imagination. Thanks to Esri technology, cartographers now edit in a WYSIWYG environment that is more comfortable. Some features, like masks, are deliberately turned off to make redrawing smoother and faster.



↑ Schema of the Information System of the National Map Series

Updating DATA 10

The key to efficient map updating is changing only those elements that need to be changed. The old technology required making a completely new map. The new update process is based on a comparison of original and new features in the source databases. Older time frames can also be used. Changes are grouped together and—when there are a sufficient number of changes—the production manager assigns that map to a cartographer for updating.

There are three types of changes: deletions, insertions, and updates. Features to be deleted were in a previous version but are not in the current version. The system automatically deletes the cartographic representations of these features.

Features to be inserted were not in previous versions but are in the current version. The system automatically assigns a correct cartographic rule to these features. A cartographer can display both deleted and inserted features and check their relationship to surrounding features. Features to be updated have their cartographic representation adjusted by the cartographer.

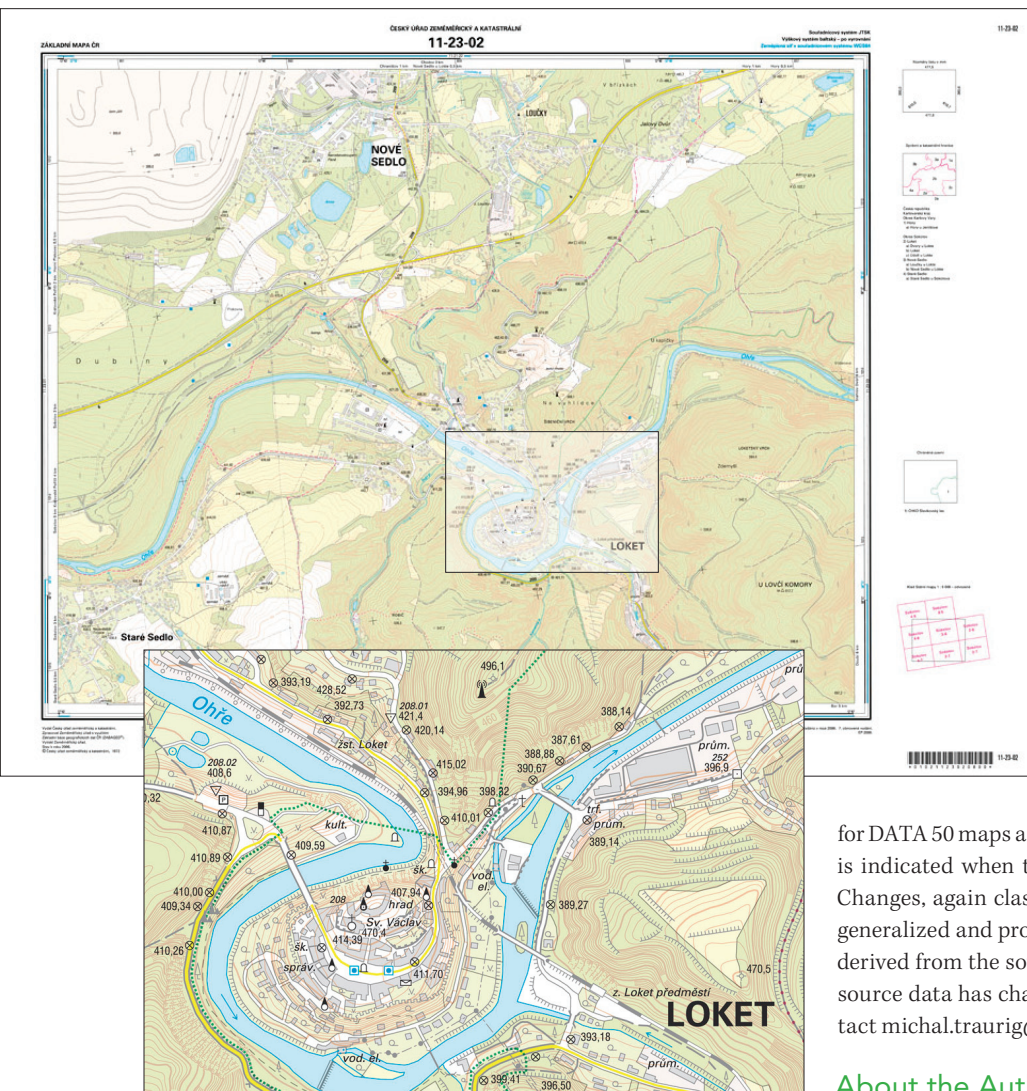
Map Production Using DATA 50

Maps using the database DATA 50 are produced at scales of 1:50,000 and 1:100,000. As with DATA 10, there are two standard map outputs—a printed map and a digital raster map. Though similar in principle to DATA 10 map production, the data for DATA 50 maps comes from former MGE projects and is handled differently. New maps are not derived directly from ZABAGED data. This workflow was chosen because of the substantial changes in DATA 50 caused by generalization, especially in layers containing built-up areas. New generalization of these features would take an unacceptable amount of time.

Like DATA 10 maps, all cartographic edits for DATA 50 maps are done in ArcMap as long transactions. Revision is indicated when the data is different from the source databases. Changes, again classified as deletions, insertions, and updates, are generalized and processed using the editing tools. Features directly derived from the source databases are automatically updated if the source data has changed. For more information about IS NMS, contact michal.traurig@cuzk.cz.

About the Author

Michal Traurig, who works in the Land Survey Office as head of the department of cartography and print making, is also the IS NMS project manager.



↑ Basic Maps of Czech Republic at 1:10,000 scale (map page and detail)



Making Connections

Modeling the relationship between food,
energy, and environmental impacts

By Todd J. Schuble, Esther E. Bowen, and Pamela A. Martin, University of Chicago

Researchers at the University of Chicago are employing geospatial analysis to quantify the resource potential for establishing foodsheds, increasing regional food production, and assessing impacts of that food production on health and the environment.



Feeding the City

Grouped under the heading Feeding the City, projects examine energy use and greenhouse gases associated with small-scale sustainable agriculture on both rural and urban farms and the potential for foodshed development in the upper Mississippi watershed, including the Chicago metropolitan region. The research team that worked on foodshed mapping included the authors of this article—Todd J. Schuble, Esther E. Bowen, and Pamela A. Martin—as well as Sabina Shaikh, Julia Govis, and Eugene Yan. Primary funding for the foodshed mapping project came from the University of Chicago's Energy Initiative.

Foodshed Mapping

Calculating a foodshed is a simple process. A foodshed is the amount of land necessary to support a population's food needs. A handful of variables are used to compute this model: the amount of food one person requires, the total number of people that need to be fed, and the amount of available land necessary to produce the food.

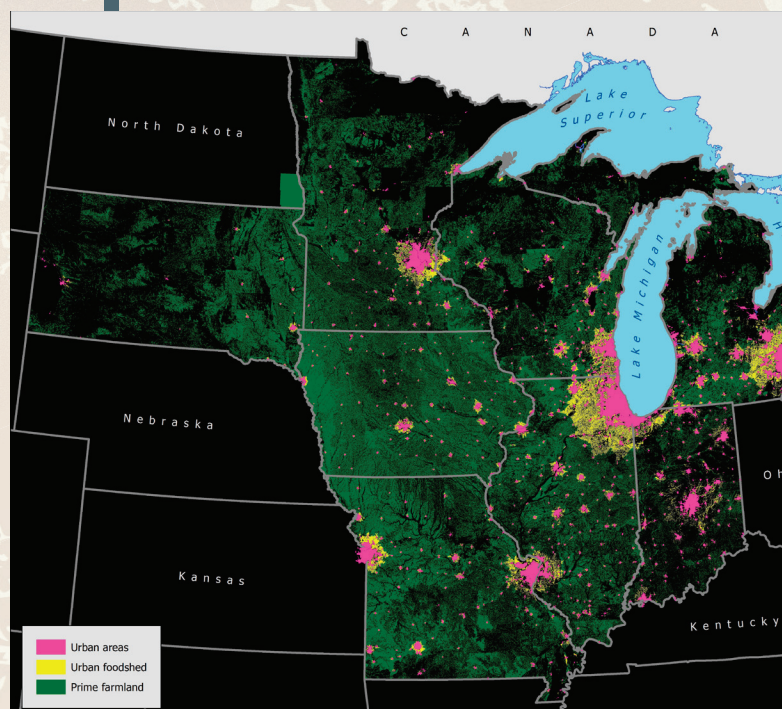
The United States Department of Agriculture (USDA) provides two major inputs for the foodshed calculation. The first input is the average caloric intake of an adult resident of the United States. The second input—more important to spatial analysis—is data about soil from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database. This data includes vector polygon boundaries for different soil types along with soil and land-use attributes for nearly every county in the United States.

Python scripting was used extensively in the project to modify and prepare the SSURGO data for analysis. For each county in each state, SSURGO provides an individual file. The county file contains two directories for spatial and tabular data in addition to the meta-data files. The spatial directory contains point, line, and polygon shapefiles delineating areas of contiguous soil types. In the tabular directory, attributes for the soil features are stored as text files.

The attributes in each text file are joined to the corresponding soil features using a unique identifying code. The text file naming convention that was implemented gives each file a unique name so processing can be automated. For example, `_il001` was added to the `mapunit.txt` file for Adams County, Illinois, which results in a unique file name of `mapunit_il001.txt`. Attribute text files do not include headers, so before joining them to the soil features, headers are added to text files of interest according to NRCS metadata standards. Of the 24 attribute columns in each `mapunit` file, the `farmland` and `mukey` columns were retained and joined to the soil layer using the `mukey` field.

The US Census Bureau provides two more pieces of data for the equation: individual urban area boundaries and total population for urban areas represented as vector polygons as delineated by the US Census Bureau 2008 TIGER/Line files for US states (US Department of Commerce 2008).

Finally, transportation must be accounted for. In this model, only road transportation data was used. Esri's StreetMap Premium for the United States and Canada included vector line data for every street in the study area as well as posted speed limits for each street segment. This information is crucial to determine travel times from urban area centers to the individual soil polygons where food is produced. Other versions of the model include rail and water transportation modes as well.



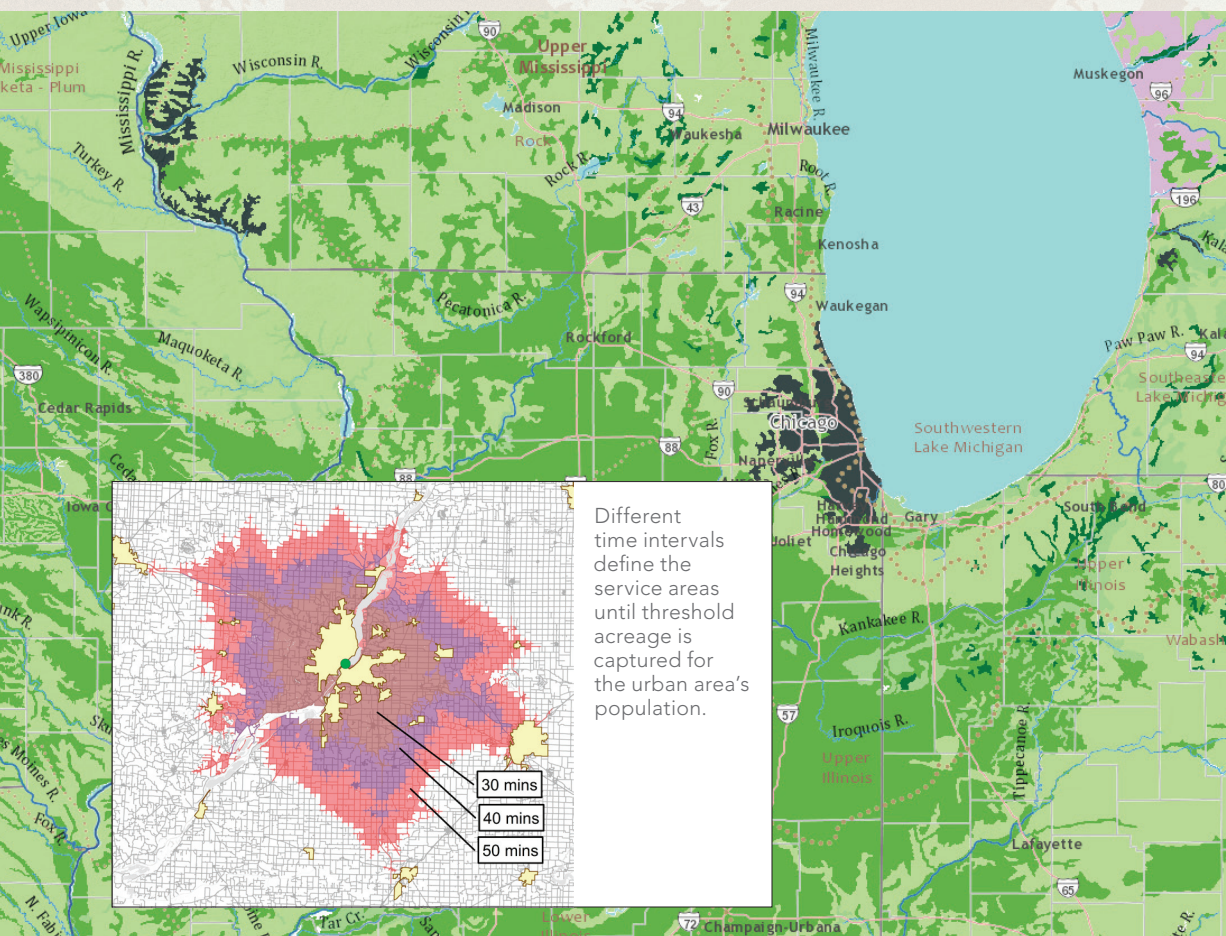
↑ The foodshed mapping project explores the potential for foodshed development in the upper Mississippi watershed, including the Chicago metropolitan region.

Foodshed Model

Beyond the spatial data necessary to calculate the foodshed, these four assumptions are included in the foodshed model calculations:

1. All persons in the study area eat the same daily average number of calories as calculated by the USDA. According to the *Agriculture Fact Book 2001–2002*, the aggregate food supply in 2000 provided 3,800 calories per person per day with about 1,100 calories being lost to spoilage, waste, or other losses. The caloric intake of individuals is, of course, very different. However, using 3,800 calories as a base simplifies model calculation.
2. The NRCS classifies soil in different ways. Some examples: prime farmland, prime farmland if drained, and prime farmland if irrigated. The model only includes soil classified as prime farmland or farmland of statewide importance in the analysis. The model assumes these selected soil types would produce the same yield regardless of location despite the fact that different soil types obviously produce different yields depending on meteorological factors along with human intervention such as fertilization or irrigation. However, for this model, all yields remain equal regardless of farmland type designation.
3. The model's population base consumes only two types of foodstuffs: grains and vegetables. Different food types and groups provide different calorie amounts. In this model, all grains and vegetables have the same caloric output. In subsequent variations of the model, calorie amounts vary by crop type, and animal-based products (dairy, meat) enter a population's food pyramid. These additions expand an urban area's foodshed, because growing varied crops or animal feed requires more land.





↑ The United States Department of Agriculture Natural Resources Conservation Service Soil Survey Geographic (SSURGO) data, available from ArcGIS Online as a map and a map service, was used in the project.

4. As previously stated, all soil types in the model produce the same yield regardless of crop type. Therefore, every acre of land produces the same number of calories. This standard produces the foodshed person-to-acre ratio. Consequently, the acreage necessary to fulfill a population's caloric need is calculated through simple multiplication.

Since the threshold acreage to feed an urban area's population is known, the remaining unknown is the time buffer that will define the boundaries of the foodshed. The time buffer is the minimum amount of travel time necessary to capture the threshold acreage for an urban area.

ArcGIS Network Analyst creates the time buffer. A service area layer (or time buffer) is defined using the StreetMap Premium data and a predetermined default break value for the service area. In this model, the service area's starting default break value is two minutes. Measuring along the street network for two minutes in all directions from the centroid of an urban area creates the initial service area layer. Next, a simple Select by Location function executes to determine if the necessary number of acres (soil polygons) for the urban area exists within the service area layer boundary.

If the threshold acreage is not met, the routine deletes the layers and continues to loop, doubling the default break value (or time

restriction) with each iteration until the acreage summation within the service area is greater than the threshold acreage. Once the model goes beyond the threshold, the last default break value used is divided by two.

The model then multiplies the last default break value by 1.5 (instead of 2) until the acreage summation within the service area is again greater than the threshold acreage. If the total acreage is too much, the last default break value is divided by 1.5, and the product is then multiplied by 1.25. This process continues overshooting and dialing back the default break value at lower and lower rates (e.g., 1.25, 1.125) until the minimum default break value captures the smallest number of acres necessary to meet the threshold acreage of the urban area.

Once the optimal acreage that meets the threshold value is achieved, the selected soil polygons are tagged with the urban area's name in the attribute table. This prevents

other urban areas from including those polygons for its foodshed. The model then begins the entire foodshed definition process again by moving on to the next urban area in the region.

Urban areas that are in close proximity may have overlapping foodsheds. However, in this model, no two urban areas can share the same land in their individual foodsheds. To address this issue, a network accessibility index is calculated for urban areas within the region. The less accessible an urban area is, the more priority it receives in choosing land within its proximity. Two variables define the accessibility index: the number of connections that intersect an urban area and the capacity or speed of those connections. Through this process, foodsheds for very large urban areas may surround smaller, previously designated foodsheds but will not share the same land.

The complexity of the foodshed model increases with the size of the region being analyzed. Since all SSURGO soil vectors from each county are merged into one seamless vector dataset, the number of records being processed for a foodshed becomes staggering. The largest model run to date includes soil and urban area data from 12 states in the Midwest. This model encompasses 827 urban areas and approximately 15 million soil polygons.

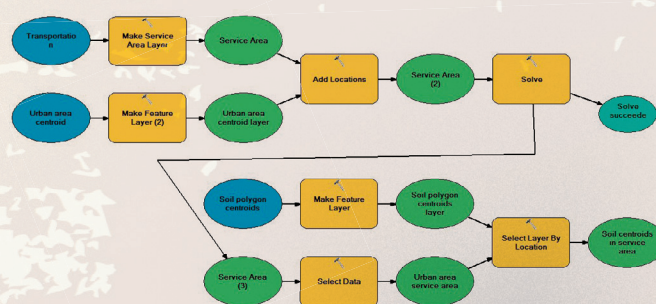
Models and datasets of this size have been processed in the past using grid computing. However, this model proves that large-scale vector data processing is not only feasible but also relatively easy. This model produces output at an extremely high resolution with pinpoint accuracy. Moreover, processing is comparatively quick.

This foodshed model processes all data using a simple Python script embedded with ArcGIS functions for the spatial queries. The back-end infrastructure for the process model includes a robust relational database and database server. The data is stored in a PostgreSQL database with ArcSDE 10. The database server specifications are relatively powerful but not extravagant: the server is running on a Red Hat Linux 64-bit platform with dual quad core 2.66 GHz Intel Xeon processors and 12 GB of RAM. With these specifications, the 12-state model ran in just under 60 hours. There is still plenty of room for this model to improve in terms of speed, agility, and complexity.

A Strong Start

The foodshed model as described here is incomplete but provides a very strong working base. Many of the omitted variables mentioned previously, such as different transportation modes, crop variation, yield variation, and meteorological factors, are currently being integrated. The model continues to be improved with the addition of better processing infrastructure and more variables.

The goal is to build a foodshed model that can emulate the environmental and economic conditions as closely as possible, not only for the United States but also for other countries around the world. Ultimately, project researchers hope that quantification of the impacts from changes in land use and food production can inform regional planning and lead to environmental mitigation strategies while, at the same time, developing a more robust food system. For more information, please contact Todd Schuble at tschuble@uchicago.edu.



↑ The functional flow model serves as the basis for calculating the foodshed.

About the Authors

Todd J. Schuble has been the GIS specialist for Social Sciences Computing Services and a senior lecturer in the University of Chicago's Committee on Geographical Studies for more than 10 years. He has undergraduate and graduate degrees in applied/urban geography and GIS. He collaborates with notable scientists and researchers from all disciplines from departments across the university on subjects ranging from economics to agriculture and archaeology to medicine. Schuble's personal research revolves around transportation, real estate, and job markets. Prior to his current position, he worked with local governments and corporations, helping them maximize their potential through GIS.

Esther E. Bowen, who received her bachelor's degree in environmental studies from the University of Chicago, wrote her thesis on the energy and emissions impact of local versus organic food production. She also has field experience in sustainable agriculture and food production through her work with three sustainable farming systems. Currently, she is in the master's program in the department of geophysical sciences at the University of Chicago. Her interdisciplinary research spans environmental science, economics, and policy. Bowen is the cochair of the University of Chicago's Sustainability Council, is active in community education, and coordinates farm interns for the Feeding the City project.

Pamela A. Martin is an assistant professor in the department of geology at Indiana University-Purdue University, Indianapolis (IUPUI). Prior to her appointment at IUPUI, she was an assistant professor in the department of geophysical sciences at the University of Chicago. She conducts research in two areas of environmental science: paleoclimatology (the study of past climate change) and the impact of food production on the environment. In 2006, she coauthored a study that looked at the importance of different dietary choices on per-capita greenhouse gas emissions. In the course of the study, she realized there was a gap in the data available to quantify the environmental, social, and economic impacts of sustainable, regional-based agriculture.

Feeding Chicago

Accessing the potential for locally grown food

Just as a watershed traces the course of water over the landscape, a foodshed traces the path food follows as it travels from its source to consumers. While the global community can be thought of as one massive foodshed, breaking down foodsheds to the neighborhood level is interesting to local leaders addressing issues such as energy, environmental sustainability, and quality of life within their own communities.

Buying local food can benefit communities by supporting local farmers, keeping money circulating within a community, and making growing and raising animals profitable so land will remain productive agricultural land rather than being sold for development. Local food is fresher and tastes better because it doesn't have to travel as far. This also reduces carbon dioxide emissions and packing materials. Also, knowing where food was grown helps consumers take control of what they eat by allowing them to know if chemicals, pesticides, hormones, or antibiotics were used and whether crops were grown from genetically modified seed.

"Foodsheds are an incredibly interdisciplinary problem," said Esther Bowen, a graduate student at the department of the geophysical sciences at the University of Chicago. "We found that GIS was the thread that connected all these disciplines."

"Caring about the environment is sometimes hard to impress upon people, but when you start to talk about the environment through food, it becomes a more interesting social problem," said Pamela

Martin, assistant professor of geophysical sciences at the University of Chicago. Martin focuses on the environmental implications associated with dietary choices, like buying and eating only locally sourced food. To address this question quantitatively, she enlisted Todd Schuble, a GIS specialist for the social sciences division at the University of Chicago and a senior lecturer in the university's committee on geographic studies.

Martin, Schuble, and a group of professors and graduate students decided to try to map the potential capacity of a foodshed at a local community level, starting with Chicago.

Using ArcGIS and a few datasets, they set out to answer two simple questions: Can enough food be grown locally to sustain Chicago? and What changes to the local farming system would be needed to accomplish this? They used ArcGIS to process data and provide a holistic way to view all the information.

Finding and collecting the massive amount of data needed to analyze this problem was the most difficult challenge. Information on drainage, the chemical makeup of the soil, and land classification by land plat are just a few of the important data types available by county for the entire United States from the United States Department of Agriculture (USDA). Add to that information on water quality and watersheds for the whole United States and it's easy to see how one can start to drown in the vast amount of data. "Making it usable for us to do analysis was

a challenge," said Schuble. "We had to figure out how to organize this amount of data in order to model what we wanted."

The model is not new. In the past, raster datasets were used at low resolution. Keeping the data at a high resolution was important to the team so that the data could be used by a wide range of people from local to national levels. Creating this model using vector data at the plat level was extremely valuable. "Using data at this level, we can visit a small rural area and say, 'Here is what your foodshed should look like,'" said Schuble.

The team developed Python scripts to download, clean, and compress data to learn where farmland with the highest yields exists in certain areas. Scripts scrubbed millions of data records. "Using ArcGIS with Python scripting to handle the mundane tasks of finding files, extracting the data, joining it to other files to make a new one, and then creating a data layer was a lifesaver," said Schuble.

Rather than finding the closest land, Schuble's team built a routine to find the appropriate spaces. Using a radial pattern to reach out from the urban center, the team measured the area to find how much suitable land was available to feed Chicago's three million people.

For this model, the team could only consider crop yield for grains and vegetables. Further foodshed analysis will be based on realistic yields collected from a

"Using ArcGIS with Python scripting to handle the mundane tasks of finding files, extracting the data, joining it to other files to make a new one, and then creating a data layer was a lifesaver."

research project. In this project, students have collected data from local farmers for the past two years. This allowed them to not only build into the model yield data from conventional agriculture but also take into account smaller, highly diverse, sustainable local farms that have a much smaller growing area and offer more diverse varieties of foods.

What they found was surprising. The foodshed wasn't really that large. An 80-mile buffer around Chicago encompassed sufficient land to adequately feed the city's inhabitants. Many areas designated as high-yield farmland were already being farmed. "We weren't looking at having to plow under tracts of homes in order to feed people," said Schuble. "We were using already cultivated land for our model."

Recently, this foodshed analysis has expanded to 12 states, and the team is ramping up capacity to look at the entire United States. All the while, Schuble is refining his model to take into consideration factors such as choice. In a free market, economics plays a significant role. Crops are usually chosen based on profitability. With government subsidies and incentives, farmers can sometimes make more money from growing corn for ethanol rather than lettuce for salads. Schuble is looking forward to incorporating a

transportation model into the GIS foodshed model. He is also looking at measuring proximity from the urban core in terms of time rather than distance. "If you have a corn field off the interstate, it is easier to get to and costs less than having to travel a gravel road," said Schuble.

He noted, "From local farmers to the USDA to city officials, there are a lot of people who are starting to get more interested, especially as topics such as energy efficiency and environmental impacts gain in popularity." Using GIS as an envisioning and planning tool, the team has been able to ask powerful questions and create a base model for learning about what exists today and what can be achieved tomorrow. "This is a project about hope," said Schuble. "We are looking at what is possible."



Making Sure Wastewater Isn't Wasted

GIS aids in managing the application of biosolids

By Kara Klinger, GIS Analyst, Hampton Roads Sanitation District

Ever wonder what happens to all the wastewater sent to treatment plants?

↑ A typical corn field found in the Hampton Roads area of Virginia

Farmers in Chesapeake and Virginia Beach, Virginia, use a product created from wastewater called biosolids. By applying biosolids to farmland, a natural resource that preserves healthy soils and benefits crops is recycled back into the environment rather than wastefully disposed of in landfills.

GIS helps ensure that all biosolids created and applied to farmland by the Hampton Roads Sanitation District (HRSD) of Virginia Beach comply with federal, state, and local regulations and has simplified the process of keeping field maps and records current.

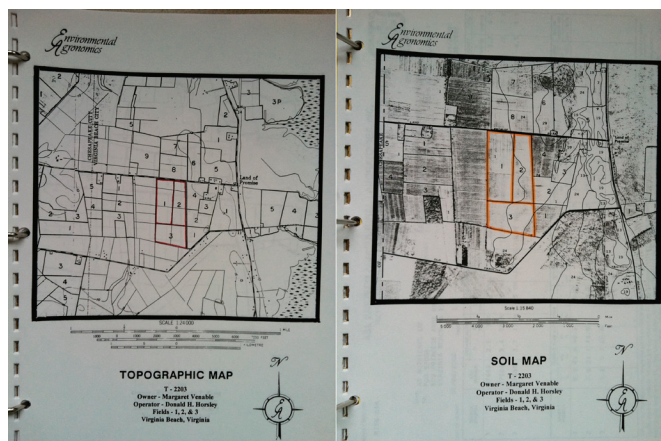
Nutri-Green Biosolids, a brand of biosolids sold by HRSD, is produced from wastewater cleaned by separating the solids from the liquid portions through the natural biological, chemical, and physical treatment of wastewater. The separated solids contain nutrient-rich organic material consisting of sand, plant nutrients, microorganisms, and trace amounts of metals. The biosolids product is characterized by a moist to dry soil material with a naturally mild organic odor that dissipates once applied to farmland. The nutrients from biosolids are in an organic form and act as a slow-release fertilizer

and soil conditioner. They improve the soil properties, counteracting the effects of wind and water erosion, increasing plant productivity, and reducing dependence on chemical fertilizers.

Biosolids may be applied once every three years. The US Environmental Protection Agency and the Virginia Department of Environmental Quality have established regulations that require monitoring the quality and contents of biosolids and employing best management practices for controlling the specific application sites.

HRSD has been recycling Nutri-Green Biosolids to agricultural land application sites since 1981. Currently more than 1,500 acres of farmland in Chesapeake and Virginia Beach use biosolids each year on fields growing corn, soybeans, pasture, and hay crops.

HRSD's Treatment Department maintains biosolid land application sites. With help from a hired consultant, HRSD developed Field Site books that contain correspondence and maps pertaining to the physical and soil properties of the crop fields. The books are part of HRSD's Atlantic Plant Virginia Pollutant Discharge Elimination System (VPDES) permit and contain required



↑ An example of a topographic and soil map found in HRSD's Field Site book

regulatory information. Currently, more than 180 Field Site books have been created. However, over time, biosolids site information can change: property boundaries move, new farmers or landowners are added, and new buffer guidelines must be enforced. These and other changes require remapping and updating Field Site books.

Migrating to ArcGIS

During 2008, the Treatment Department consulted with Planning and Analysis' GIS Group to determine if this project could be migrated to ArcGIS so maps and Field Site books could be more easily kept up to date. The process adopted can be summarized in seven steps:

1. Create Permitted Biosolid points.
2. Create Permitted Biosolid fields.
3. Add soil data from the National Resources Conservation Service, United States Department of Agriculture.
4. Perform calculations on acreage and percentage of soil type for each biosolid field.
5. Collect buffered features based on Virginia Department of Environmental Quality (DEQ) requirements with a Trimble GeoXT unit.
6. Modify existing biosolid layers to accommodate buffered results.
7. Maintain the Biosolid Land Application Project database in ArcGIS.

The first step was identifying biosolid fields by physical location. Fortunately, a hired consultant who was familiar with the project had already collected the x,y coordinates for most of the biosolid fields in Virginia Beach and Chesapeake. The coordinates, which provided a general point location for these fields, were stored in Microsoft Excel. Unfortunately, the x,y coordinates were in different map units. Safe Software's FME software was used to transform the map units for all points to decimal degrees.

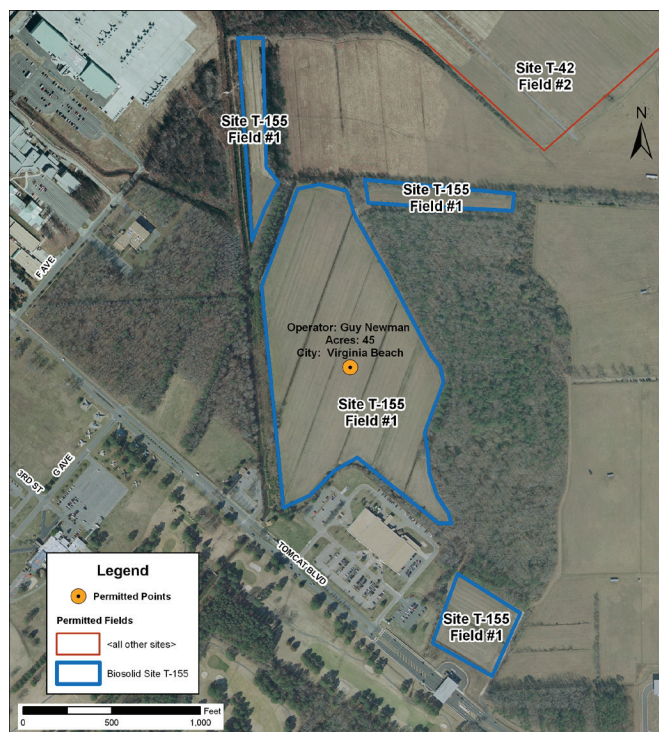
A personal geodatabase called pGDB_Permitted_Sites.mdb was created in ArcGIS for storing the feature classes used in the Biosolid Land Application Project. The x,y coordinates stored in Excel were used to create a point feature class called Permitted Points. A table containing fields for site names and paths to contract locations was created and joined to the Permitted_Points attribute table so each biosolid site could be hyperlinked to its landowner agreement contract for on-the-fly access by users.

The next step was correlating the Permitted_Points table with biosolid field outlines. The Permitted_Fields layer was created based on the parcel layers for Virginia Beach and Chesapeake. The exact parcel outline was copied or modified based on the Field Site book and project orthoimagery. Orthoimagery for the project was captured in 2007 at six-inch and one-foot horizontal resolution.

Biosolid site locations contain many fields associated with one site. Some sites share the same crop field number but must be represented as multiple polygon shapes because barrier structures—such as roads, bodies of water, wooded areas, and residential and commercial properties—break up biosolid farm sites. Other sites are associated with various, and at times recurring, field numbers in multiple locations, which could be challenging, especially for new users.

Obtaining and Creating Soil Attribute Data

Additional attributes, such as its identifying site name, field number, operator, landowner, city, location, and acreage, were added to the Permitted_Points and Permitted_Fields layers. Attribute data was obtained from the Field Site books or by performing queries in ArcGIS on the data. The application of Nutri-Green Biosolids is based on existing soil conditions, so obtaining the soil data for Virginia Beach and Chesapeake was important. Rhonda Bowen, who is in charge of the Nutri-Green Biosolids Recycling Land Application Program, obtained current soil data from the United States Department of Agriculture Natural Resources Conservation Service Soil Data Mart website (datagateway.nrcs.usda.gov). The soil data was imported into the personal geodatabase so the PermittedSites_Soils layer could be manipulated.



↑ This biosolid site is represented by the same field number in various locations. Site T-155 shares the same field number but is represented by four polygon shapes because barrier structures, such as wooded areas and commercial properties, are present.



↑ This biosolid site is represented by uniquely identified field numbers in various locations. Site T-439 is represented by nine polygons. Wooded areas act as a barricade structure that separates field #9 from the rest of the fields.

Because the soil type key field is not universal across the United States, matching the soil type key field with its soil description for Virginia Beach and Chesapeake was tricky. After downloading and adding the soil data to an ArcMap document, it was clipped against the Permitted_Fields layer to create individual soil areas for each field in each site. Dividing the size of individual soil areas by the entire site size produced the percentage of each soil type in each field. The percentage of each soil type was correlated with its field number (if it had the same field number); otherwise, the soil percentage value was broken down for each field number. This value was recorded in the Soil_Percent field of the attribute table for the Permitted_Fields layer.

Obtaining DEQ Buffer Restriction Data

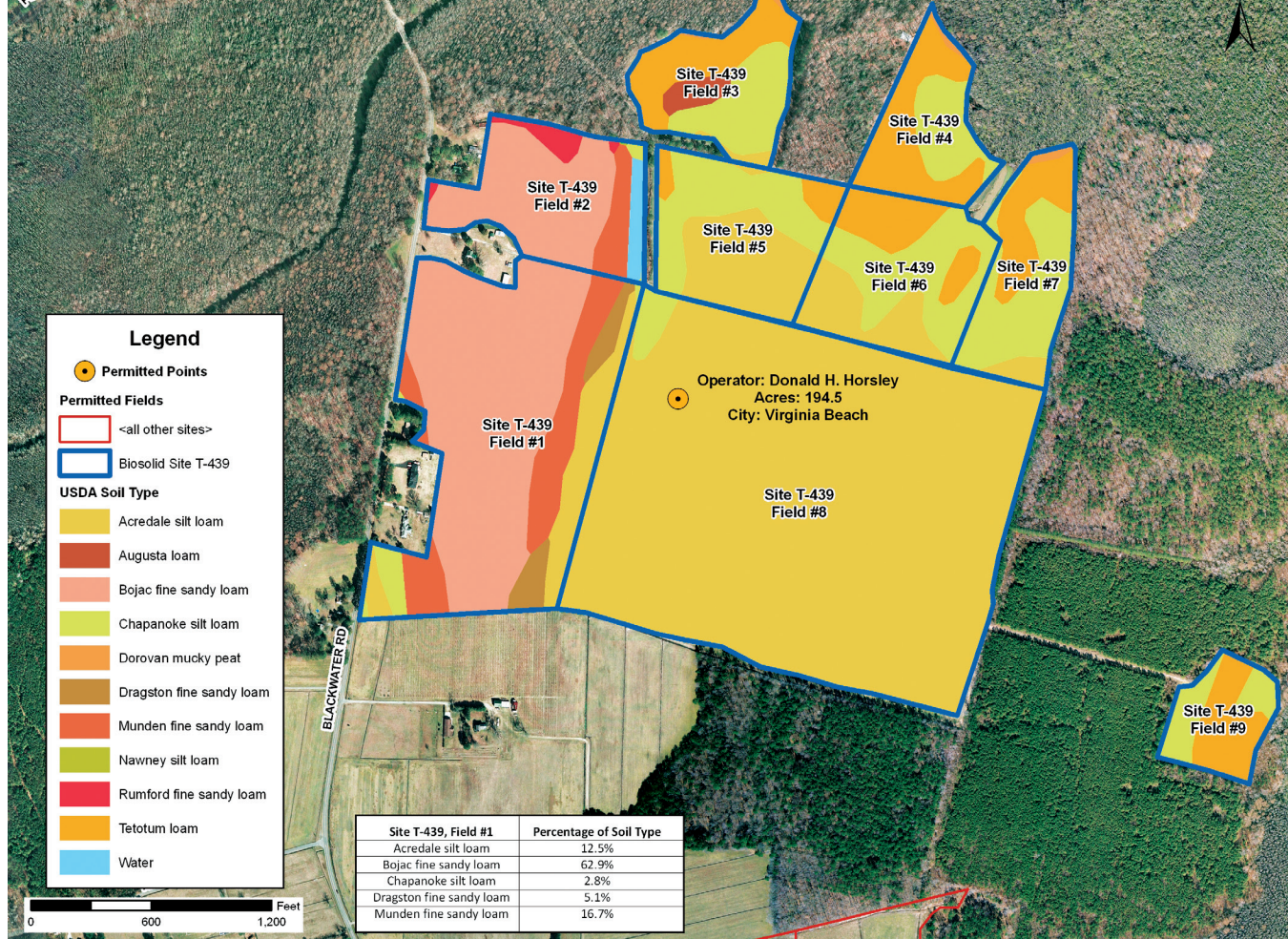
Because the Virginia DEQ does not allow the application of biosolids to agricultural land within specified distances of occupied dwellings, property lines, water supply wells or springs, perennial and intermittent streams, surface waters, drainage ditches, and other features, buffers had to be created around these features. Unfortunately, none of the features that required buffering had been captured, nor could they easily be seen on orthoimagery. This necessitated on-site field visits to capture the coordinates for these features. In the spring, the Treatment Department purchased a Trimble GeoXT GPS unit to collect the features to be buffered before the Nutri-Green biosolids were applied to the farmland sites.

Two feature classes, BufferFeatures and BufferApplication, were

Adjacent Features	Surface Application	Incorporation	Winter Application*
Occupied dwellings	200	200	200
Property lines, water supply wells, or springs	100	100	100
Perennial streams, other surface waters except intermittent streams	50	35	100
Intermittent streams/Drainage ditches	25	25	50
All improved roadways	10	5	10
Agricultural drainage ditches slopes < 2 percent	10	5	10

↑ Table 1: Virginia Department of Environmental Quality buffer requirements (All distances are shown in feet.)

* Application on slopes > 7 percent between November 16 and March 15



↑ The soil types within each field are shown for Site T-439, a biosolid site. The soil percentage was broken down for each individual field, as shown by field #1.

created in the personal geodatabase to hold the data collected by a consultant hired for the Biosolid Land Application Project. These feature classes, enhanced with domains for easier, valid data collection, were converted to ArcPad shapefiles. The BufferFeatures layer is a line feature class that captures the edge of the buffered feature to allow new buffered distances to be applied to the same feature to accommodate any change in buffer requirements. The BufferApplication layer is a polygon feature class created based on the BufferFeatures layer that contains DEQ buffer application distance requirements for different feature types. These buffers are used to create a more accurate representation for each BufferApplication shape.

Challenges Involved with the Project

Buffer creation and the need to collect the locations of buffered features on-site were challenging facets of this project. Another challenging aspect was introducing both internal and external personnel to ArcGIS and Microsoft Access. However, with documentation describing how to create ArcGIS layers and maintain databases and through using the ArcGIS help, this challenge was resolved in a reasonable time frame.

The Future

The migration of the Biosolid Land Application Project to ArcGIS has been ongoing for more than three years now. Though the project is not yet completed, it has successfully met its goals. For instance, the ability to generate soil percentages for each field site and have all

DEQ buffered features shown for analysis purposes is groundbreaking. The project's progress from just having Field Site books to using x,y coordinates for the Permitted_Site locations and having a database created for biosolid sites is pretty spectacular.

In addition, HRSD can share the shapefiles for all permitted farm fields with the cities of Virginia Beach and Chesapeake, so they can also track the biosolid land application program. Bowen is working on the creation of even more substantial data for the biosolid layers. Eventually, the biosolid sites and data will be maintained solely in ArcGIS, and the Map Book series will be used to easily produce maps.

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About the Author

Kara Klinger, a GIS analyst with the Hampton Roads Sanitation District, worked with GIS applications for utilities for more than 10 years and has been involved with building GIS systems from the ground up. She holds a bachelor of science degree in geology with an emphasis in GIS from Old Dominion University, Norfolk, Virginia.

Small Scripts,

Big ROI

ArcGIS resources dramatically speed property reappraisal

By Matthew DeMeritt, Esri Writer



↑ The extension allowed the appraisers to load photos into the ArcPhoto window and drag and drop the photos over their corresponding parcel polygons in ArcGIS, geotagging the image by populating the GPS coordinate fields in the EXIF metadata.

In 2009, Guilford County's tax department could not process large numbers of street-level photos for a property reappraisal project and had no budget to pay for a solution.

In a flagging economy, shrinking government budgets can sometimes force managers to investigate existing available resources, creating solutions with what they already have or what can be obtained for free. In this environment, GIS managers can tap into no-cost online resources such as free extensions and scripts, many designed to solve specific workflow problems.

Project supervisors in Guilford County discovered free ArcGIS applications that helped the tax department create a photo geotagging system that dramatically exceeded the North Carolina county's objectives.

Sync Problem

To ensure fair implementation of the new tax system, all Guilford County properties had to be photographically reappraised. Using simple point-and-shoot digital cameras the county already had, tax department staff took photographs of single-family residential structures

to assess their current value. It wasn't long before they realized the department's system of processing the photos wouldn't meet the project's deadline. A key step in this process was manually renaming the photos. At a minimum, the system should automatically title each photo with its parcel ID and populate the image file's metadata.

Ideally, these photos could then be dragged and dropped into parcel polygons on the map, providing an augmented visualization by linking the parcel with its photograph.

The tax department went to the Guilford County GIS Department. Both departments agreed the new system should automatically associate each photograph with its parcel record stored in the computer-aided mass appraisal (CAMA) system. Initially, everyone thought that GPS might be the answer.

"The county already had a few GPS units," said Stephen Dew, GIS manager at Guilford County. "We thought we could automate the process by syncing the camera's internal clock with the GPS unit's internal timing." GPS units collect a data point every second and store it in a track file, which can be displayed as a series of points outlining the route taken by the GPS user. This method could give each photo a spatial location that could be mapped and matched to a digital parcel number in the county's GIS. There was only one problem: the cameras' clocks could not be reliably synchronized with the GPS receivers' clocks.

Way to Geotag

While Dew and his staff pondered another solution, appraisers resorted to manually locating their photos using the free ArcPhoto software extension to ArcGIS found at Esri's ArcGIS Resource Center (resources.arcgis.com). Developed by Esri programmer Thomas Emge, ArcPhoto tools enable the quick import of digital photographs into ArcGIS by working directly off the EXchangeable Image File (EXIF) format metadata encoded into standard digital imagery. In professional-grade cameras or photos taken with ArcPad 7, imagery can hold GPS location information.

The extension allowed the appraisers to load photos into the ArcPhoto window, then drag and drop the photos over their corresponding parcel polygons in ArcGIS, geotagging the image by populating the GPS coordinate fields in the EXIF metadata. The ArcPhoto extension can directly read the EXIF metadata and allows streamlined integration of photos in maps. Using this method to geolocate the parcel images increased productivity from 50 to approximately 200 images per day—a significant

improvement but, unfortunately, not on target with the looming deadline.

After automating the process somewhat, Eric Funderburk, GIS analyst and lead researcher for the project, downloaded an ArcScript for ArcPad from the ArcGIS Resource Center. The script created a data entry form in ArcPad that allows the user to enter the number of the first digital image taken. Clicking the Register Picture button writes the complete image file name to the attribute table of the shapefile. After entering the first image, the script sequentially auto numbers the next digital image in the attribute table. This method allowed field crews to quickly take the photo and concurrently assign a point to a digital map before photographing the next house.

Automating with Python

When the appraisers returned from collecting photos, they copied the images to Guilford County's local network. Funderburk simplified this process using Python. "After inserting the camera's SD card into the desktop USB reader, a Python script executes from

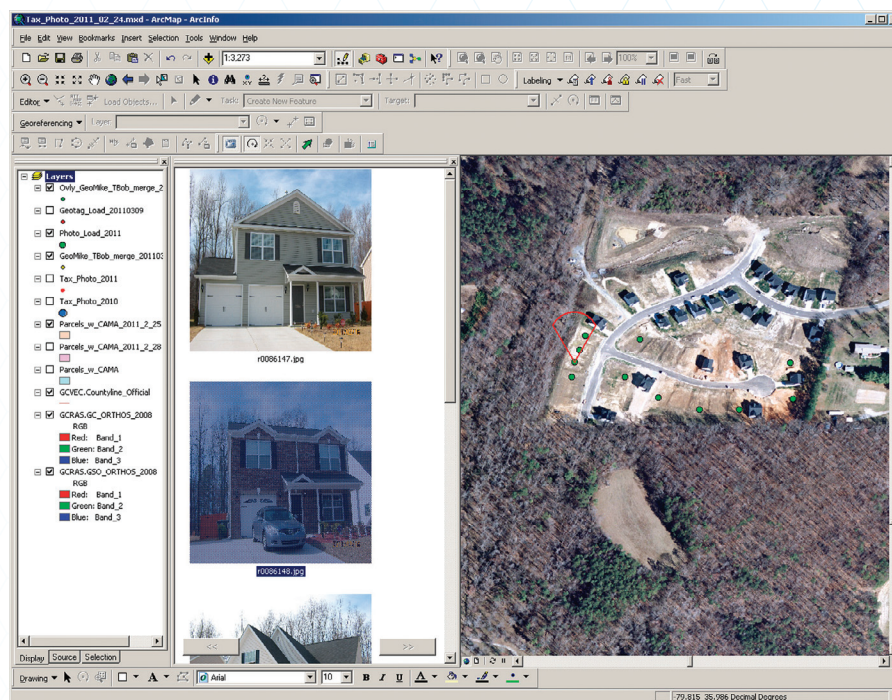
the user's desktop that reads the SD card in the card reader, including the time and date each digital image was taken," says Funderburk. "This creates a secure directory on the server and copies the images by date to their corresponding directories."

Next, they had to figure out a way to automatically rename each photo (e.g., IMG 001, IMG 002) with its associated parcel ID number (e.g., 334). With the help of Esri technical support analyst James Unger, Dew and Funderburk used another Python script that renamed photos using the point feature class that held the parcel number and the original image file name. The Python script searches the directory where the photos are stored, loops through the records in the point feature class to find a matching image file name, and uses the Parcel_Number field in the feature class to rename the original image with its parcel ID.

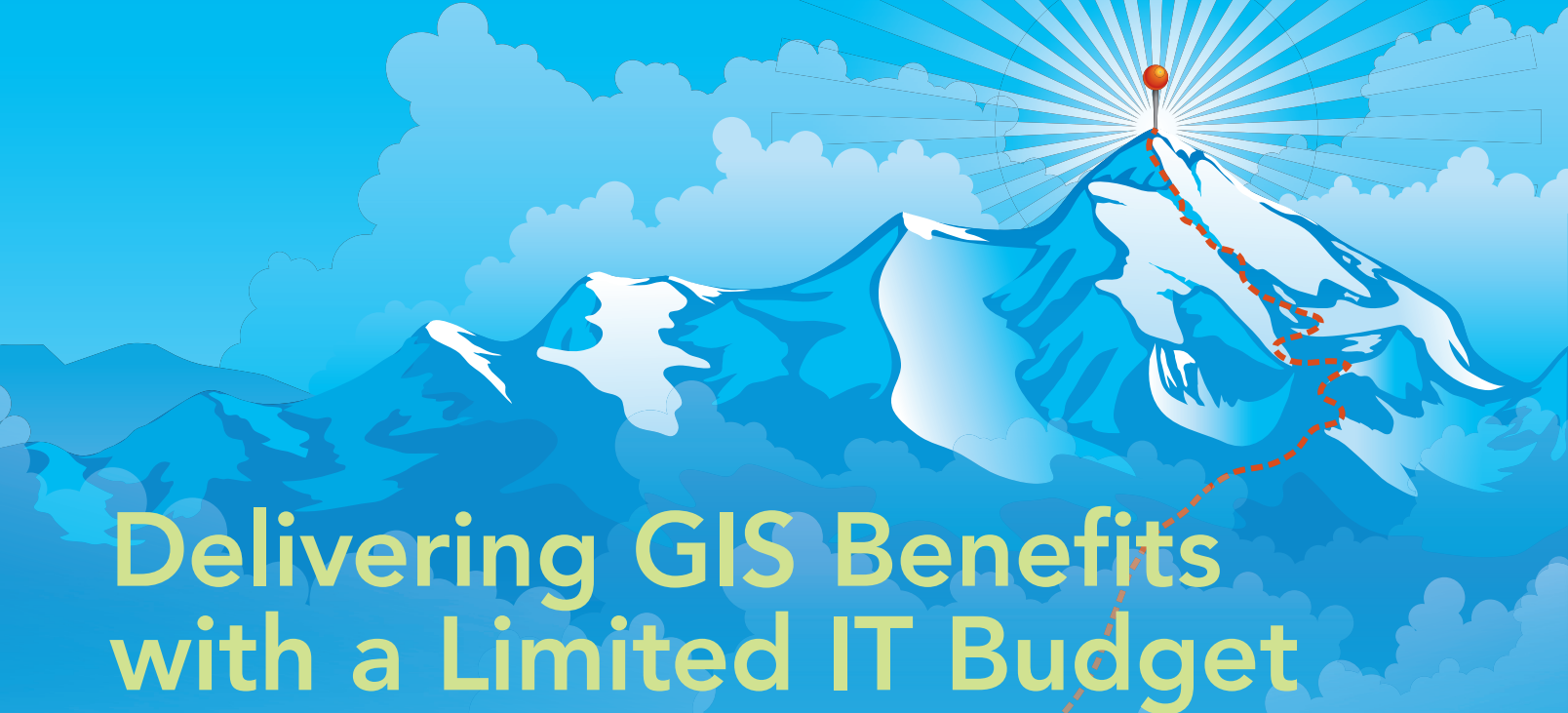
Projected Output Exceeded

Reappraisal productivity at Guilford County increased immediately and dramatically. At its peak, crews collected and named more than 750 images per day using the new methods—an increase of 1,500 percent from the initial output. With just two crews in the field, almost 4,000 images were collected and georeferenced in three days. Before adopting this workflow, the tax department had hoped to have a few thousand photographs ready for the new tax system. By the February 2010 cutoff date, it had delivered more than 40,000 images.

Although Guilford County had no money to fund its reappraisal project, using in-house equipment and existing expertise, the tax and GIS departments collaborated and improved the daily output associated with this project. The increase in productivity boosted the morale of the entire appraisal staff and made the project viable. For more information, contact Stephen Dew, GIS manager for Guilford County, at sdew@co.guilford.nc.us. Download ArcPhoto tools at arcscripts.esri.com/details.asp?dbid=14856.



↑ The ArcPhoto window allows Guilford GIS staff to view photos within ArcMap. ArcPhoto writes the coordinates in the EXIF header of the JPEG and geotags the image.



Delivering GIS Benefits with a Limited IT Budget

Effective project management is the key

When access to GIS data, maps, and applications is broadly available throughout an organization, we call it an enterprise GIS. Organizations intrigued by the idea of deploying GIS enterprise-wide often have concerns about the work (and costs) involved. Is there a particular way to go about it? Where do you start? What if you can't afford a consultant?

For answers to these questions and more, Suzanne Boden of Esri Training Services turned to Dave Peters, manager of systems integration at Esri. Peters spent most of the 1980s with the US Air Force, working on aerospace systems integration projects. In former lives, he was a physicist, pilot, and engineer. During his 20-year tenure at Esri, Peters has worked on system design projects with numerous clients and has become the acknowledged expert on system architecture design for enterprise GIS operations. In this interview, Boden asked Peters about different aspects of implementing an enterprise GIS.

Boden: Is enterprise GIS cost prohibitive for organizations with limited IT budgets?

Peters: I would think not. We implement enterprise GIS to improve business efficiency and effectiveness. The benefits of implementing GIS throughout the enterprise far outweigh the cost. These benefits have been demonstrated over and over again by organizations both big and small.

If you have a limited budget, you can take smaller steps forward; over time, you will see the same benefits accrue. Today, hardware and software costs are significantly reduced, driven by the increase in processing capacity and performance for both servers and networks. This opens a variety of opportunities for small business automation.

Proper planning is the key to success. Understanding the technology and getting it right at the beginning reduces cost and improves the effectiveness of any IT deployment. Effective project management can deliver GIS benefits within a limited IT budget.

Boden: An organization has decided to implement an enterprise GIS. How much time should it plan to invest in the system design process?

Peters: I feel strongly that the system design process should be an integral part of GIS planning—and too many times it is not. Dr. Roger Tomlinson's book *Thinking About GIS* (4th edition, Esri Press, 2011) addresses the importance of GIS planning and estimates about 5 to 7 percent of the first year's overall GIS budget as a typical planning investment.

Most of this planning focuses on clearly understanding your business needs—what information products and data resources make your business work, what your business workflows are, what GIS information products should be developed for your user community, and when. The organization's GIS and IT staff need to take the time to understand the environment and appreciate how GIS can make a difference in their business.

Boden: Your recipe for a successful enterprise GIS deployment includes four key ingredients: communication, planning, project management, and performance milestones. What do organizations risk if they don't follow the recipe?

Peters: If organizations don't follow lessons learned by those who have gone before, the risks can be high. Good communication between the GIS user community and the IT support staff is critical and not always easy to establish. There are clear relationships between user business needs, system processing loads, and required hardware specifications—and these relationships are important to understand.

Planning is where you put these relationships together. Getting it right before you start spending money on the solution reduces implementation risk and overall cost.

Good project management is needed to implement the plan and manage changes to the plan that impact cost, budget, performance, and the ability of the final solution to satisfy business requirements.

Performance should be an integral part of your project plan, with milestones identified to validate compliance throughout the implementation process. The Capacity Planning Tool [CPT] is designed to help project managers understand performance constraints and implement GIS operations that satisfy user productivity needs.

Boden: In the foreword to your book, *Building a GIS* [Esri Press, 2008], Esri president Jack Dangermond calls you a “teacher and an inventor of creative solutions.” Can you give an example of a creative solution you engineered?

Peters: My focus is to help Esri customers build successful GIS operations—to make a difference where it counts (at the bottom line). To be successful, customers need to understand how to build systems that make their users more productive—understand their user needs, the GIS software technology that can make a positive difference, and the IT infrastructure required to make it happen.

Over the years at Esri, I’ve worked on a number of projects to get the information out to organizations through system architecture design consulting services: the *System Design Strategies* technical reference document, the *System Design Strategies* training course (an Esri instructor-led course), the *System Architecture Design for GIS* seminar presented each year at the Esri International User Conference, the Esri Press book *Building a GIS*, and the CPT.

The CPT is a set of tools shared as an Excel workbook that automates the system architecture design analysis that would normally require a skilled system design consultant. The CPT helps answer many system performance questions such as

- What are the steps to selecting the right platform solution?
- What system do I need to support my peak user loads with this workflow?
- What network capacity do I need?
- How does my existing infrastructure impact remote site user productivity?
- How can I understand my existing GIS operational system performance capacity?
- How can I model and manage system performance for my enterprise GIS operations?

The CPT identifies user input requirements and shows the information we need to answer your design questions. It also provides the final IT hardware and network solution—this makes the CPT something you can use to better understand your environment. It is updated regularly and available on the Building a GIS online resource center. We use the CPT to model our understanding of the technology. You can use the tool to manage enterprise GIS operations.

With all the solutions listed above, our purpose has always been the same: to share with customers real solutions that help them build successful GIS operations.

Boden: You are, in fact, a teacher. You developed the *System Design Strategies* training course and regularly present it to Esri customers. Where does training fit into the system design process?

Peters: Understanding the technology is the first step to building a successful enterprise GIS. The training class teaches a communication framework for GIS business users and their IT support staff counterparts. They learn how to represent their specific user productivity needs and clearly identify the IT hardware systems required to meet them.

When building a GIS, the GIS/IT systems integration management team needs to understand how they can all contribute to system performance and scalability—how to get the most of their GIS investment. This is what the training course is all about.

GIS managers need to understand how to reduce system deployment risk, improve user productivity, and spend their development dollars wisely, and many times they are asked to show their management how this can be done.

IT managers need to understand how GIS is making a difference—what the software technology does, how it performs, system configuration best practices, data administration strategies, network and hardware performance constraints, and platform configuration and sizing requirements that make GIS work within their organization.

GIS programmers need to understand how to build applications and services that satisfy user productivity needs.

Data administrators need to understand how to manage the variety of GIS data resources and deployment formats for optimum performance and scalability.

The CPT is fully integrated with the course; it is used throughout the course to teach how to build and manage successful enterprise GIS operations.

Resources for Building an Enterprise GIS

System Design Strategies Wiki

The latest place to learn about Peters’ system design methodology
wiki.gis.com/wiki/index.php/System_Design_Strategies

Enterprise GIS Resource Center

A rich source of technical information for IT professionals on system architecture, security, and performance
resources.arcgis.com/content/enterprise/10.0/about

Technology Topics: Enterprise GIS

A good resource for managers and others looking for an overview of how enterprise GIS can help achieve business objectives
esri.com/technology-topics/enterprise-gis/index.html

Instructor-Led Training Courses

esri.com/training

App Supplies Bus Locations and Schedules

Creating the Yakima Transit iBus widget

By Tom Sellsted, City of Yakima, Washington

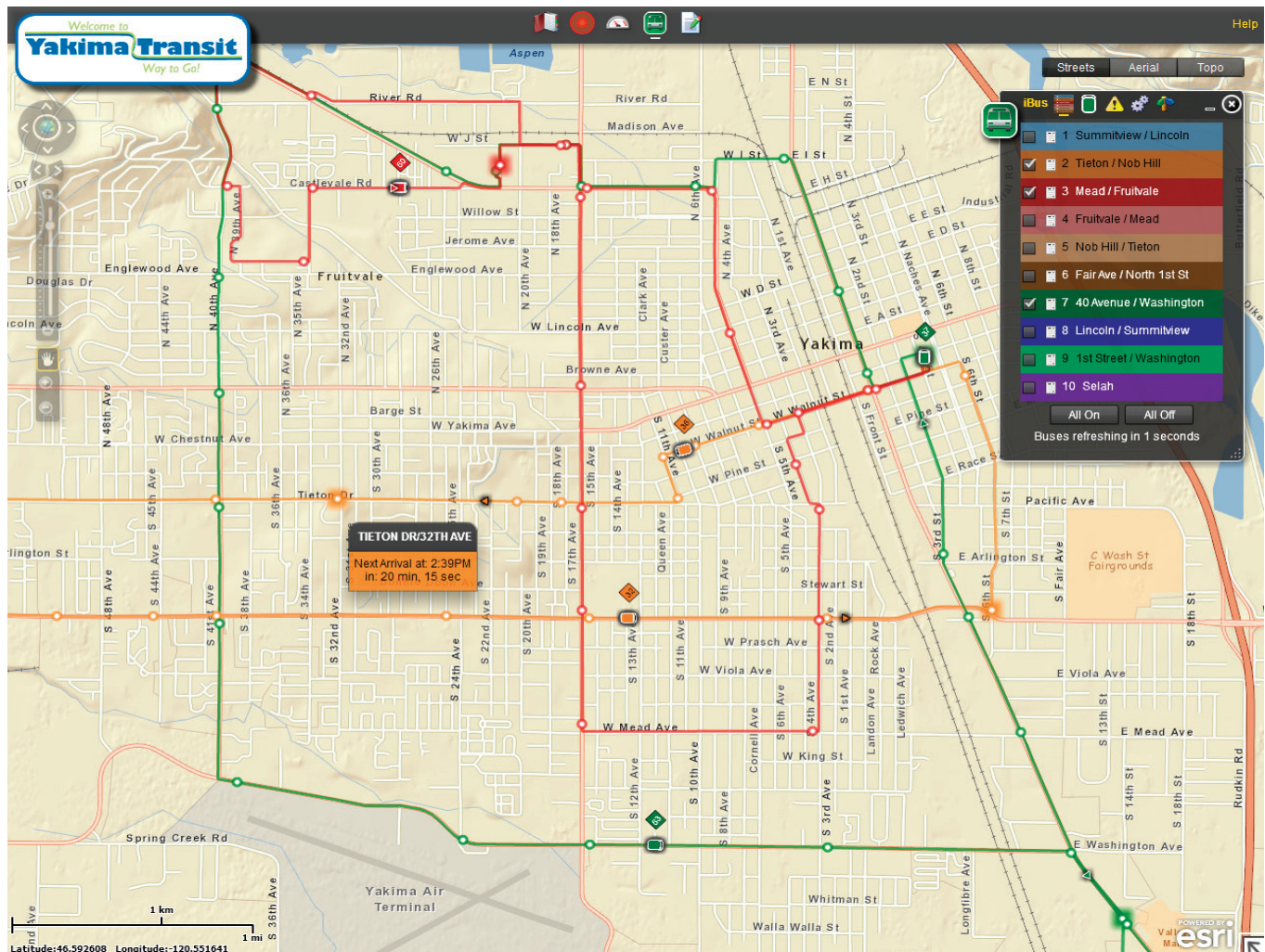
Yakima residents now know when their bus will arrive, thanks to the iBus widget. Created for Yakima Transit, it provides more schedule information than previous applications and lets citizens and transit staff monitor bus locations and consult schedules from the Yakima website.

Yakima, located in central Washington State, covers 28 square miles and has more than 91,000 residents. The city offers a full complement of services: police, fire, water, sewer, refuse, and transit. All city departments need location-based applications and analysis, so there are many opportunities for supplying GIS services. The analyst

and technician, who comprise the city's GIS staff, also provide services unrelated to GIS. Limited staffing resources have motivated the city to become efficient and take advantage of new technologies to enhance city services.

Yakima Transit operates 10 fixed routes that cover the communities of Yakima and Selah. A complete trip of each route is made each half-hour on the routes with larger riderships and hourly for all other routes. Transit service is available seven days a week and most holidays, with full service on weekdays and abbreviated service on weekends and holidays.

↓ The Yakima Transit iBus widget supplies bus speeds and directions as well as transit bus routes.



Transit Application History

Starting in 2000, GIS applications for bus locations and routes were developed for Yakima Transit using MapObjects and Visual Basic 6. These applications included a server, client, and Google mashup for public viewing. The server application received position updates from buses equipped with GPS cellular modems and relay position information to logged-in clients. The position information was written to Microsoft Access database tables so transit dispatchers and management staff could view the real-time positions of all GPS-equipped buses.

The main problem with this approach was that the data for routes had to be distributed with each update. Route updates generally happen quarterly. Edits were made and exported to shapefiles that were distributed to each desktop. In addition, route changes for extended road closures also required editing and the distribution of shapefiles.

While these applications were functional, they could not access newer feature classes in the geodatabase. Application and data distribution became more difficult with limited time and budget dollars. After MapObjects was retired in 2004 and Visual Basic 6 gave way to .NET, it was time to look for a new way to provide applications and information to city departments and Yakima Transit.

Utilizing a geodatabase provided an opportunity to streamline data handling. Esri's ArcGIS API for Flex, ArcGIS Viewer for Flex, and REST services offered an excellent solution to these problems. Edits made in the geodatabase are immediately available to everyone, and no duplicate data distribution is required. ArcGIS Viewer for Flex supplied a great foundation for the iBus widget. All the tools needed for a web mapping application were already in place and very configurable. When the widget was ready for use, it was posted in the ArcGIS Viewer framework and made available to anyone with a web browser and the required version of Flash player.

Schedule + New Real-Time Bus Locations

A primary goal of the iBus widget was inclusion of the actual bus stop schedule information for each route to complement near real-time bus position updates. The position of the schedule in relation to the actual bus position lets the viewer know whether the bus is on time or late.

The previous mashup provided only bus location information for the routes they were assigned. Schedule information for most route segments, supplied from the Yakima Transit bus book, was available via an associated PDF link. However, though there are about 25 segments for each route, only 10 segments would have schedule information.

Bus stop scheduled times were not available for each route segment. For segments not containing a time schedule, a calculation was made using each segment's sequence of travel and the number of seconds it took to travel the segment. These calculations are made as the route feature class is loaded into the widget.

Because each route segment now has a set of scheduled departure times for every day, a timer can be used to determine which route segments are active at any specific moment. Subtracting the assigned travel time for the segment from the next available departure time will equal the start time for that segment. If the current time falls between the start time and stop time, it is an active segment. To indicate that a segment is active, its endpoint is made to glow.

Consequently, it is important that the clock on the client computer is accurate. Most computers perform a time sync with an accurate Internet clock. It is also necessary for the client's time to be in the same time zone.

The active segments are used to model the scheduled location (where the bus should be if it is on time) of the route. Each active segment is a simple polyline composed of a single path with at least two points. Since starting, stopping, and current times are known, a percentage of each segment's completion can be calculated. This percentage can also be applied to the segment's geometry to find between which two segment points the scheduled point should fall. A program loop that evaluates the length of the summed points and compares it to the total length of the segment makes this determination. The loop also compares the summed distance of the points to the percentage along the route to determine which two points will be used to calculate the angle of the marker arrow. A trigonometric function is used to determine the position of the marker. The position for the percentage along the route is used for the schedule point geometry. By default, this is updated every five seconds and can be adjusted by the user.

GPS in Near Real Time

In addition to the scheduled points, the widget shows near real-time bus location information supplied by GPS. Most buses have a Sierra Wireless MP595W modem that is configured to send its location to a designated server. For this project, a Python script has been set up as a service and is used to receive these User Datagram Protocol (UDP) position reports and write them to a vehicle table and a historical positions table in the automated vehicle locator (AVL) geodatabase. The Python script is 150 lines of code that listens on a designated port. As a position report is received, the message is parsed to the appropriate fields and geometry is created from the latitude and longitude. An ArcPy update cursor is used to modify the vehicle table using the vehicle modem's IP address as the key. An ArcPy insert cursor is used to add a record to the historical positions table. Using Python made this a very efficient and simple way to obtain vehicle information.

Another timer is used to query a REST service for the latest position of each vehicle. Only vehicles that have been assigned to a route are part of this query. A back-office widget allows the transit dispatchers to assign buses to the appropriate routes for the day. The returned vehicles are drawn on the map as color-coded graphics and rotated to represent their current heading.

Back-Office Widgets

Additional widgets were added for transit dispatchers and management staff to make bus assignments to fixed routes and display historical bus positions. The bus assignment widget queries the vehicle REST service for all buses. A drop-down box is displayed next to each bus and allows the user to select the route. Once all the assignments have been made, clicking a button updates the geodatabase. The city vehicles widget is used to display historical vehicle positions so management can ensure that vehicles are traveling on time, using the correct route, and not exceeding the speed limit while driving the route.



Problems Encountered

While the Flash player is supposed to be browser independent, small idiosyncrasies were found when using Internet Explorer. Custom MapTips would not display properly. However, a simple change to the way the tip was initialized fixed this problem, although it was difficult to diagnose. In addition, when a vehicle position query was made in Internet Explorer, the previously cached query result was used. Logic was added to make each query unique so when the timer expired and a new query was made, a fresh result was returned.

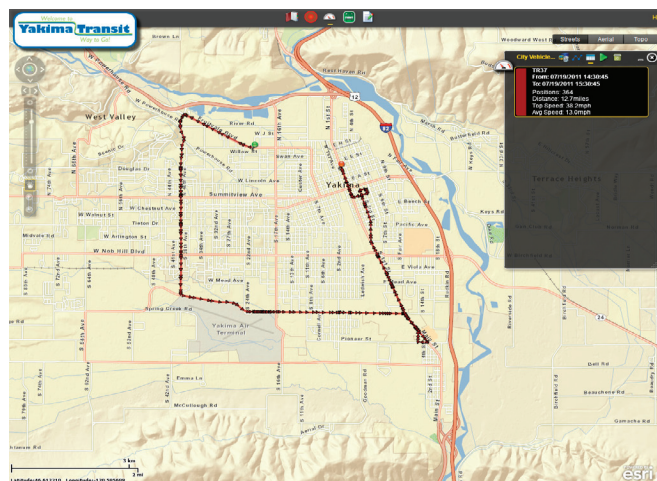
Assigning buses to routes is critical to make the buses appear properly on the map or calculate whether the bus is on time or behind schedule. Buses actually on a route but not assigned to a route won't display at all. Buses assigned to the wrong route are displayed with the wrong color.

Future Enhancements

Additional logic will be added to calculate the estimated arrival time for buses along routes so riders can know how long they will have to wait for buses at their favorite stops. Similar logic will allow the widget to determine whether the bus is on time or late.

Adding an advertising widget to the system is being considered. This widget would be configurable to display an icon for each location of interested businesses. A timer would be used to rotate each interested advertiser and display its information. While this could be a new source of income, it might also detract from the application's appeal to riders.

↓ The City Vehicles AVL widget supplies status information.



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Thanks to Robert Scheitlin for his custom splash screen for the iBus widget and his many great examples of Flex. Thanks to Jill Ballard, GIS technician at the City of Yakima, for her editing skills and work on the datasets in this project. This project would not be possible without that data.

About the Author

Tom Sellsted, employed by the City of Yakima since 1985, has worked on GIS activities since 1988. He is a supervising senior GIS analyst for the city. He graduated from Central Washington University with a bachelor's degree in management science.

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Maintaining High Performance with Big Datasets *and* Interactivity

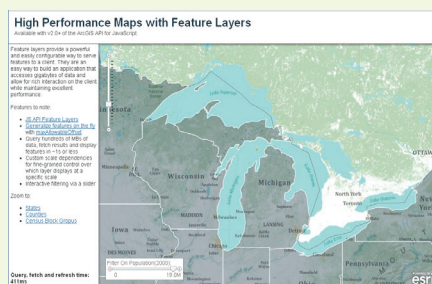
By Derek Swingley, ArcGIS API for JavaScript Development Team

Dealing with big datasets is a frequent topic of discussion among web mapping app developers. The prevalence of huge, crowdsourced datasets ensures that big data will continue to be a common point of discussion when you get more than two web mapping geeks in the same room. The traditional approaches of generating a raster tile cache or using a dynamic map service work, but if you want any interactivity with the underlying data, it requires a server round trip. This article will discuss some of the key concepts behind building a web app that provides an extensive interactive experience while maintaining responsiveness and performance.

What makes big data tricky is that browsers cannot elegantly handle upwards of a few thousand features. Send more than a few thousand points or a few hundred polygons to a browser and you can watch it grind to a halt, especially if you're running a legacy version of Internet Explorer. This is a problem, because slow performance is a death knell for web apps. If someone using your web app has to wait 10 seconds, 20 seconds, or longer for five megs of JSON data to be retrieved and displayed, there's a good chance they'll just give up and move on. What good is a web app that no one uses?

At some point, you cross a threshold where it's not practical to send all your data across the wire and let the client sort it out. While that threshold is an ambiguous one, you know when you hit it. If you're a JavaScript developer, how should you deal with big data? The answer: feature layers.

I've put together an application, High Performance Maps with Feature Layers (servicesbeta.esri.com/demos/high-perf-feature-layers), that demonstrates how to use feature layers to set up custom scale dependencies and follow best practices to ensure that performance does not suffer when querying, retrieving, and displaying large datasets in an ArcGIS API for JavaScript application.



the browser with features. This app makes sure that only the states appear at the small scales, counties at the medium scales, and census block groups at the large scales. This ensures that a manageable number of features are always being transferred and displayed.

The app is simple, but the concepts can be applied to just about any web mapping app that has to deal with big data. The total size of the data used by the app is around a couple of hundred megabytes.

The goal was to display appropriate US boundaries (states, counties, or census block groups) for the current map scale. For example, trying to display census block groups for the whole United States would overwhelm

This is accomplished through custom scale dependencies. This is as simple as creating a few feature layers, listening for their onLoad event, and setting their minScale and maxScale properties. Listing 1 is a simple code sample that shows how this is done:

```
var fl = new esri.layers.FeatureLayer(url, options);
dojo.connect(fl, 'onLoad', function() {
    fl.minScale = minScale;
    fl.maxScale = maxScale;
});
```

↑ Listing 1: Custom scale dependencies

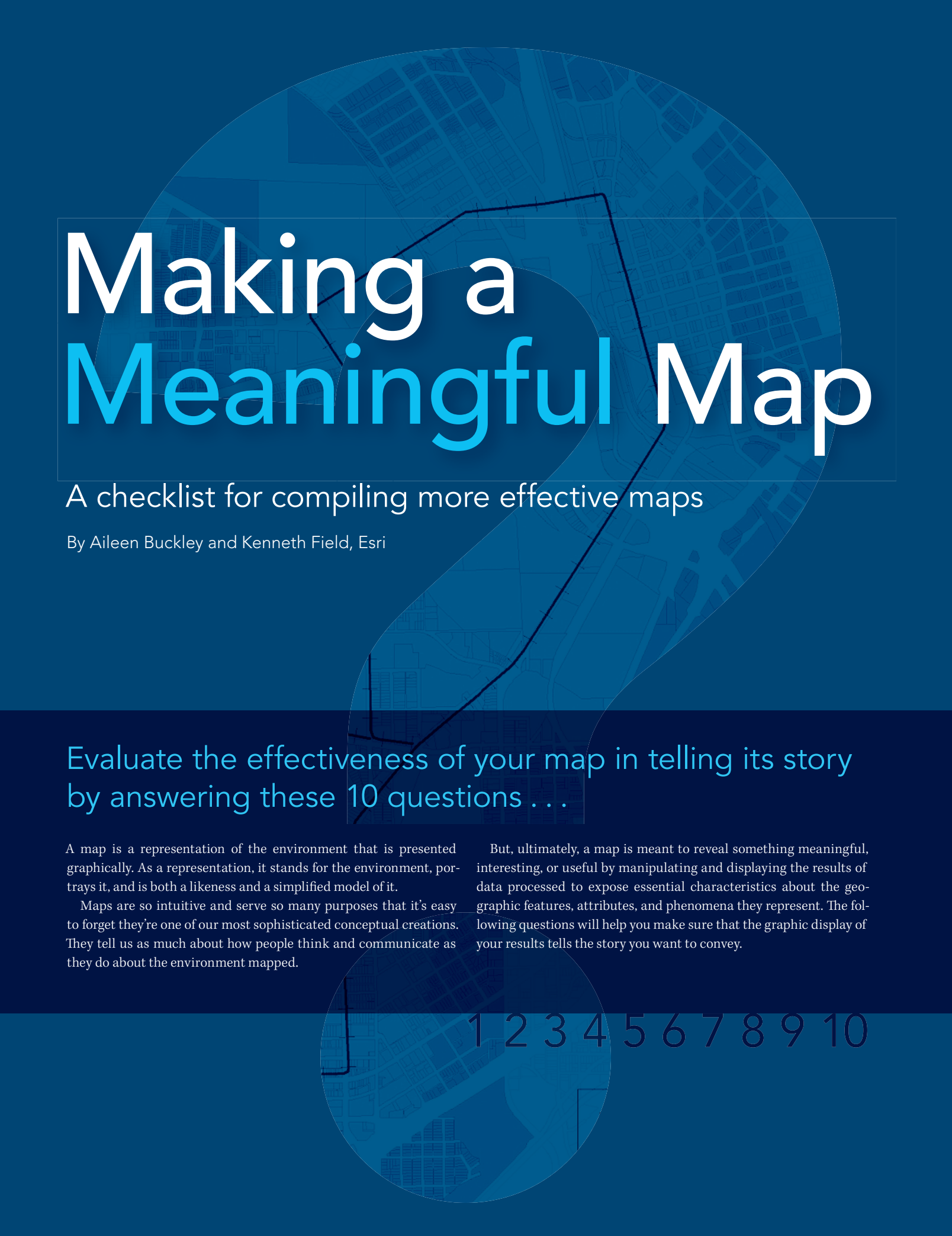
The app includes a couple of other bells and whistles that demonstrate some tools that are available when you have your features on the client side. The first is a rich pop-up that displays feature attributes, as well as an option to zoom to the feature when you touch a graphic. The second is the ability to filter features based on population using a slider. Neither tool would perform nearly as well if features weren't available client side.

The final point is that the app's performance is kept snappy because only the required data is being sent to the client. For attributes, only the fields required by the pop-up are sent across the wire. For geometries, that means using maxAllowableOffset to generalize geometries on the server before they're sent to the client.

When you create a feature layer, one of the options is maxAllowableOffset. You might recognize this parameter name from the ArcGIS for Desktop generalization tools, where it's been used for years. If this is new terminology, see the ArcGIS for Desktop Help for the Generalize tool. A bonus: FeatureLayer comes with a setter method, setMaxAllowableOffset, that you can use to simplify features on the fly. Since the web APIs fire an event when the map's extent/zoom level changes, you can listen for this event and use setMaxAllowableOffset to indicate an appropriate value.

Now all you have to do is figure out a value for maxAllowableOffset. Let me suggest a method: A feature's geometry should not display more than one vertex per pixel. After all, a pixel is the smallest unit for our displays, so displaying more than one vertex per pixel is wasted effort. To display no more than one vertex per pixel, we can take the map's width in coordinate space divided by the map's width in pixels, and we have a reasonable value for maxAllowableOffset. With this method, you are telling your feature layer to make sure simplified features do not differ from the original by more than the width of a pixel.

Finally, one caveat. You can't specify maxAllowableOffset on layers that you allow users to edit. If you're editing a feature, you need to see the true representation of that feature, including all its participating vertices. Editing a generalized feature and then sending it back to the server could wipe out detailed information that was meticulously created and maintained, so you can't specify maxAllowableOffset on feature layers that are editable.



Making a Meaningful Map

A checklist for compiling more effective maps

By Aileen Buckley and Kenneth Field, Esri

Evaluate the effectiveness of your map in telling its story by answering these 10 questions . . .

A map is a representation of the environment that is presented graphically. As a representation, it stands for the environment, portrays it, and is both a likeness and a simplified model of it.

Maps are so intuitive and serve so many purposes that it's easy to forget they're one of our most sophisticated conceptual creations. They tell us as much about how people think and communicate as they do about the environment mapped.

But, ultimately, a map is meant to reveal something meaningful, interesting, or useful by manipulating and displaying the results of data processed to expose essential characteristics about the geographic features, attributes, and phenomena they represent. The following questions will help you make sure that the graphic display of your results tells the story you want to convey.

1 2 3 4 5 6 7 8 9 10

1. Do I know what my map's story is?

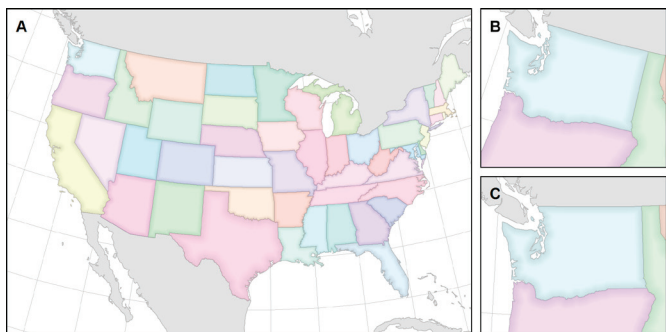
Before you start making a map, think about its meaning. Figure out the story you want to tell, the audience you want to tell it to, and the media you will tell it through (e.g., paper, a projected image on a computer screen). Try writing down what it is that you think the map shows and describe what you are mapping (the data); what the data tells you (the distribution); and any special things to note, such as outliers, high or low values, or missing values.

If you discover there is no story or that it cannot be told by a map, don't make the map! Some topics are just not good candidates for mapping. Knowing this at the outset will save you a lot of time and effort that could be used making a map that *does* tell a story.

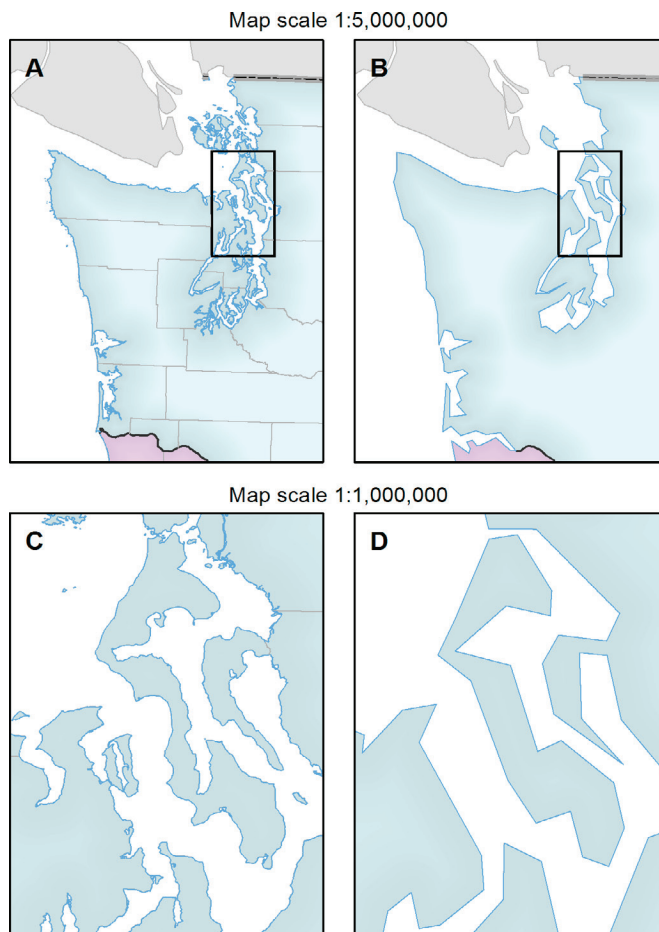
2. Am I using the right map projection?

Map projections are designed for particular purposes and have certain properties, so choosing the right one is important. Often, this is a moot point because the projection has been decided for you by mapping standards, precedence set in prior use cases, or client requirements. When you do have to choose a map projection, there are two aspects that people often consider. The first is considering the geometric distortion properties relating to the distance, shape, direction, and area of specific map projections. The second is understanding how the surface used to construct the projection results in the pattern of spatial distortion over the map surface. The online documentation can help you make this decision. You should not only choose the right projection but also make any necessary modifications to the projection to make it serve the purpose of the map.

A good example is repositioning the central meridian (the origin of the longitudinal x-coordinates of the map projection) to the center of the mapped area. A telltale sign that the mapmaker did not do this is that the map is tilted in the center so that north is not up (Figure 1). Simply modifying the projection to position the central meridian at or near the center of the mapped area will take care of this problem.



↑ Figure 1: When using the Lambert conformal conic map projection for the US (A), which is centered on 96 degrees west longitude, a map of Washington (B) will appear tilted. Changing the central meridian of the map projection to -120 (the approximate east-west center of the state) will fix the problem (C).



↑ Figure 2: Curvilinear lines can help you determine if the data is too detailed for the map (A) or too general for the map (D). Examples (B) and (C) are the better solutions.

3. Am I using data at the right level of generalization?

Another thing to check is the level of generalization of the data. This relates to the map scale. Small-scale maps (that cover a larger area) look better when the data is more generalized. Large-scale maps (that show a smaller area) require more detailed data.

Generalization also relates to the symbology you use. Thinner lines reveal more about the true geometry of the features. Thicker lines can mask jagged edges and areas where features don't line up exactly (which is a trick cartographers use to fix some problems).

Two clues that will help you tell if your data is at the right level of generalization can be found when you examine a curvilinear line, like a river or a boundary that follows a natural feature (e.g., a mountain ridge). Is it drawn with what will likely be the final symbology? Does that line collapse in on itself, causing portions to appear as polygons instead of lines (Figure 2A)? This apparent increase in feature dimensionality (from 2D lines to 3D polygons) is a good indicator that the data is too detailed for the selected map scale and symbology. Conversely, map lines that have sharp angles where they should appear smooth (Figure 2D) indicates the data is too general. Solutions for both problems include replacing the data with a more appropriate dataset, geoprocessing data to bring it more in line with the map requirements, and using some cartographic tricks to mask the problem (like modifying symbology).



4. Is my symbology clear?

Symbology is critical. If your map readers cannot tell what a symbol is or what it means, your map is potentially misleading or even useless. Three things will help make your symbology more easily understood by map readers: familiar symbols, intuitive symbols, or good explanations for symbols that are not familiar or intuitive. From their previous map use experience, many map readers will already be familiar with some symbols, such as a blue line for a river or a green polygon for a patch of vegetation. When possible, use these familiar symbols. For features that do not have a familiar representation, try picking a symbol that your readers will intuitively understand such as a picture of a person walking with a stick to symbolize a trail. For symbols that are not familiar or intuitive, provide a good explanation in a legend or through explanatory text.

To also improve clarity, when you have a number of features that will overlap, try using a cased symbol (one with an outline). This will let readers distinguish all the features, even when they overlap one another.

5. Do my symbols match my data?

To choose the right symbol, first determine if the data is qualitative (signifying difference in type) or quantitative (signifying a difference in magnitude). The visual variables (i.e., the properties of symbols that you can alter to change their appearance) you use depend on whether you're mapping qualitative or quantitative data. For qualitative data, color hue (e.g., red, green, blue) and shape (e.g., points, lines) will be your best choices (Figure 3).

For quantitative data, size or color lightness and/or saturation (i.e., the intensity of the hue) are your best choices (Figure 4). The eye will intuitively see larger or darker symbols as more.

Feature Type	Visual Variable		
	Shape	Orientation	Color Hue
Point	 Spring	 Live Tree	 Live Tree
	 House	 Dead Tree	 Dead Tree
	 Tower		
Line	 National Border	 Asphalt Road	 National Border
	 Trail	 Concrete Road	 State Border
	 Section Line		
Area	 Gravel	 Orchard	 Land
	 Sand	 Field Crop	 Water

↑ Figure 3: Color hue and shape, and to a lesser extent orientation, naturally evoke qualitative differences among features. (Image courtesy of *Map Use*, Sixth Edition)

Feature Type	Visual Variable			
	Size	Pattern Texture	Color Lightness	Color Saturation
Point	Small ↓ Large	Coarse ↓ Fine	Light ↓ Dark	Pale ↓ Intense
	  	  	  	  
	Low ↓ High	Low ↓ High	Low ↓ High	Low ↓ High
Line	Medium ↓ Low	Medium ↓ Low	Medium ↓ Low	Medium ↓ Low
	  	  	  	  
	High ↓ Low	High ↓ Low	High ↓ Low	High ↓ Low
Area	High ↓ Low	High ↓ Low	High ↓ Low	High ↓ Low
	  	  	  	  
	High ↓ Low	High ↓ Low	High ↓ Low	High ↓ Low

↑ Figure 4: Shape and color value and/or saturation naturally evoke quantitative differences among features. (Image courtesy of *Map Use*, Sixth Edition)

6. Have I used the right text symbols?

Text is also a symbol on the map, and the rules for symbolizing features also apply to text. Color hue helps distinguish different types of features (blue river labels, brown contour values, and black anthropogenic feature text). Larger text is used to label features that have more of something (e.g., people in a city, traffic on a road, or area in a polygon). Text on the map can also be used to reduce or eliminate ambiguity of your feature symbols. Try creating an explicit visual association between a feature and its label using placement (e.g., near the feature) and visual variables (e.g., the same color hue as the feature); the label can help the map reader interpret the symbol meaning. Too many maps have too few labels, so a common mistake is to make labels too large in order to fill up the empty space. If you have only one feature of a specific type on the map, try to label it so you won't have to include it in the legend.

7. Does my map have figure-ground organization?

Figure-ground organization is the spontaneous separation of the map into a figure that draws the eye and an amorphous background. This helps your map readers know what part of the map or page to focus on.

You can achieve figure-ground organization by

- Adding more content (or detail) than in the background
- Mapping familiar places that are recognized immediately as the figure
- Mapping closed forms (i.e., areas enclosed by boundaries or water)
- Using a whitewash to lighten the outside area
- Using a drop shadow to lift the figure off the page
- Fading the map out to the background (i.e., feathering, shown in Figure 5D)

8. Does my map have good visual hierarchy?

Visual hierarchy is the separation of the map layers into planes of information. This is the basis for distinguishing features and perceiving their relative importance. Think about the hierarchy within and among the layers on the map. Within layers, remember that symbology is meant to convey differences in types of features and the amount of something associated with features. Doing this correctly helps map readers see hierarchy within a layer. Sometimes there is a nested hierarchy of features within a layer. For example, county lines nest within state lines, which nest within national boundary lines. By varying the width of the lines or the dashes in the lines so that wider lines or more widely spaced dashes relate to the higher levels in the hierarchy, readers will have visual clues about how these features are related.

To promote hierarchy among layers, use drawing order and symbol choices. You want features with greater importance to appear higher on the map. For example, you might place terrain, hydrography, and other layers that relate to the natural environment on the bottom level. Anthropogenic basemap layers, such as boundaries and land areas, would be the next visual level. The thematic symbology that tells the main story of the map will be at the highest visual level.

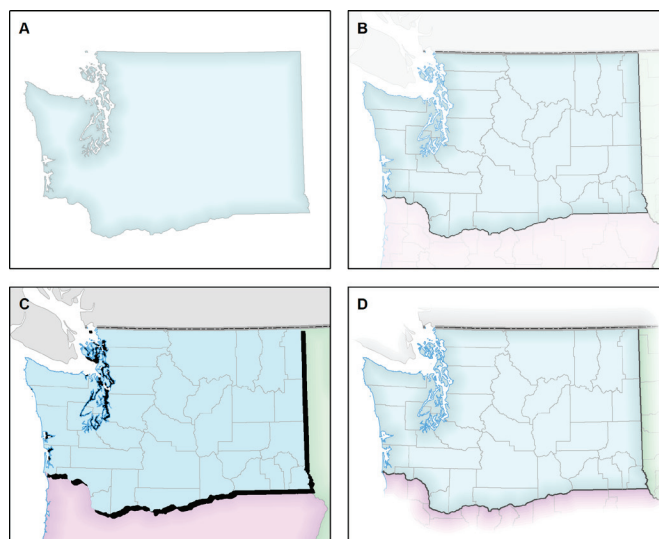
9. Do I need to add anything else to my map?

Check your map for missing information. One thing often left off maps is text for features that are not generally in a geodatabase such as labels for marine water bodies or physiographic features. You can either add these labels using a geodatabase with these features or add text as a dumb graphic aligned as you would like it to appear on the map. (The Esri Mapping Center has both marine water body and physiographic feature datasets for small-scale maps. Instructions for adding dumb text so that its geographic position will be constant even when the map is panned or zoomed are also available at the Mapping Center.)

Finally, decide if you need to add any map elements such as a title, legend, scale bar, or north arrow. Before adding any additional elements, consider a guiding cartographic principle: only add map elements if they are absolutely necessary.

10. Have I asked for a critique?

A good last step is to ask a colleague to review your map. A new set of eyes can often find small errors—or even glaring ones—that may have become invisible to you during the mapmaking process. Ask your colleagues to tell you what story they see in the map. This will help you know if you met your goal of making a meaningful map. Also, if the map is ambiguous, confusing, or visually unappealing, a good friend will tell you that. It's much better to get this feedback before the map is published rather than after.



↑ Figure 5: Techniques for promoting figure-ground separation include mapping a closed form (A), using a whitewash (B), adding a drop shadow (C), and using feathering (D).

Using this checklist and these tips will help you more easily meet the goal of having a map that tells the story you want it to. For more information about mapmaking, ArcGIS, and the techniques mentioned in this article, visit the Esri Mapping Center website (mappingcenter.esri.com).

About the Authors

Aileen Buckley is the lead of the Esri Mapping Center (mappingcenter.esri.com), an Esri website dedicated to helping users make professional-quality maps with ArcGIS. She has more than 25 years of experience in cartography and holds a doctorate in geography from Oregon State University. She has written and presented widely on cartography and GIS and is one of the authors of *Map Use*, Sixth Edition, published by Esri Press.

Kenneth Field has more than 20 years of experience in cartography and GIS and holds a doctorate from Leicester University, UK. Prior to joining the Mapping Center, he was the course director of GIS at Kingston University. He has published and presented widely on cartographic design and is currently the editor of *The Cartographic Journal*.

Use ArcGIS Online to Manage Your Own Custom Map Gallery

By Keith Mann, Esri

↑ Start customizing the template by changing the graphics and the web page title.

Wouldn't it be great if you could create a dynamic gallery of maps and layers for your website and yet maintain all the geospatial content for it in a cloud-based geocontent management system?

The following tutorial teaches you to do just that using a free map gallery template and ArcGIS Online. You'll learn how to customize the look of this gallery and, more important, how to connect it to your ArcGIS Online content so that you can dynamically manage the maps and layers that it contains. All it will take is making a few edits to some of the template files and copying and pasting a couple of files. No special skills are required.

What You Will Need

- An Internet connection
- An Esri Global Account (free)
- A simple text editor (such as Notepad++)
- Template downloaded from *ArcUser* website

Getting Started

Before you begin, take a look at the gallery template by going to the Public Maps Gallery template description page on ArcGIS Online: esri.com/publicmapstemplate. Either click the thumbnail image or click the Open button and then click Open Application to launch the gallery template. The Public Maps Gallery is an all-in-one template that you can customize to match your personal style or your organization's branding. It has many features that make it easy to navigate and use.

To get started, download the gallery template and make sure it's working for you. Go to the *ArcUser* website and download the template archive for this tutorial. Extract the contents of the ZIP file to a new working folder (e.g., c:\gallery). This will create a subfolder named public-maps-gallery. Open the public-maps-gallery folder and test the gallery template by double-clicking the index.html file. This is the same gallery you looked at earlier, except this one is on your machine. Leave the browser window open.

Change the Gallery Banner

The first thing you'll do is make changes to the banner for this gallery. The title, Public Maps Gallery, is actually two images. To change it, you'll need new images. For this tutorial, two new images are provided in the download.

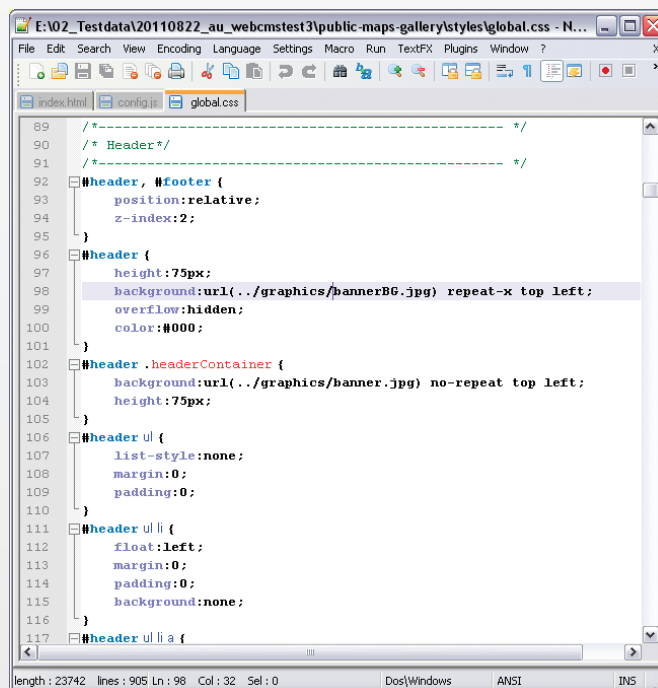
1. Open public-maps-gallery and click index.html to open a local version of the template. Go to the public-maps-gallery\new-graphics folder and copy the home.gif and home.png files. Open the public-maps-gallery\graphics folder and paste the files in it. This will replace the existing files of the same name. To see the changes, refresh your browser by pressing the F5 key. Note: If you want to create your own custom title, you can edit the Photoshop file named home.psd provided in the resources folder, save the changed file as home.gif and home.png, and replace the home.gif and home.png files in the graphics folder.
2. Next, change the banner for the gallery by editing the global.css file and referencing two new banner graphics that are included with the download. Open the public-maps-gallery\styles\global.css file in a text editor (I like Notepad++ because it makes it easy to edit HTML and it's free). Search for the word *Header*. The global.css file will contain one reference for each graphic.
3. Under that section, locate bannerBG.jpg and change bannerBG.jpg to newbannerBG.jpg. Next, locate banner.jpg and change banner.jpg to newbanner.jpg. The new graphics have been created for you and are already stored in the graphics folder. (Of course, you can create your own banner graphics. If you do, make sure to store them in the graphics folder.)

4. Now search for the <title> tag and change the title for the page from Public Maps Gallery to My Maps Gallery.
5. The Index 2 and Index 3 links in the banner point to different gallery types: a carousel-style gallery and a gallery for mobile apps, respectively. However, you won't need them for this tutorial, so open the public-maps-gallery/index.html file in the text editor, search for the word *Header*, and delete the two lines of code shown in Listing 1.

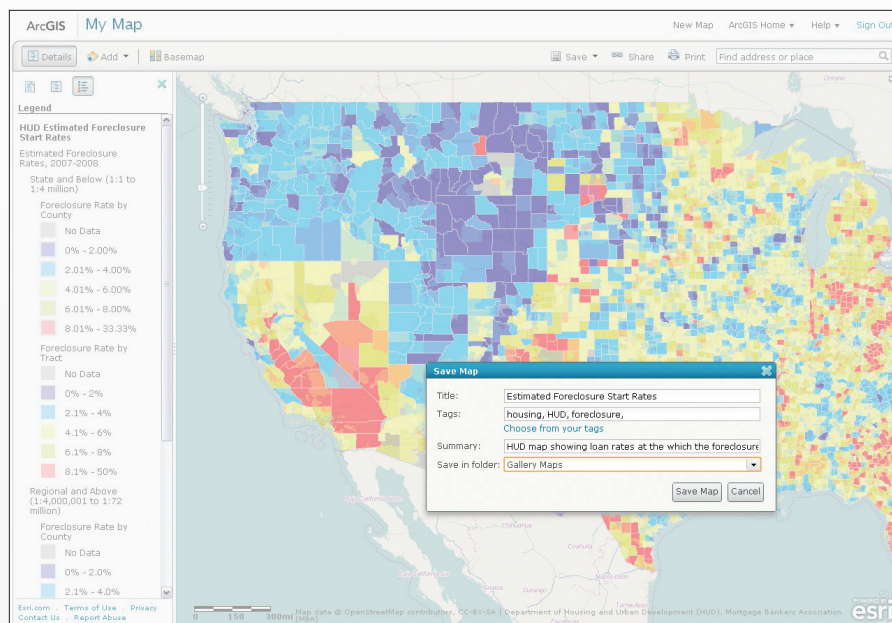
```
<li><a href="index2.html">Index 2</a></li>
<li><a href="index3.html">Index 3</a></li>
```

↑ Listing 1: Lines to delete from index.html

6. Save your changes (and leave the text editor open). Refresh your browser. You can change other elements of the template by editing the files stored in the public-maps-gallery folder. ➔



↑ Use a simple text editor, such as Notepad++, to change the index.html and global.css files.



← You can add web maps you have already created, ones that have been created by others and shared on ArcGIS Online, or web maps you create in ArcGIS Online and save. Save maps to the Gallery Maps folder you created on My Content.

Create a New Group and Content Folder

Next, you'll learn how to add your maps to the gallery using ArcGIS Online to manage your content. First, you need to create a new group and content folder in ArcGIS Online. Note: While creating new groups and folders isn't absolutely necessary, it is a good practice, especially if you plan to create more than one gallery.

1. Go to ArcGIS Online (arcgis.com) and sign in. You will need an Esri Global Account. Create one if you don't already have one.
2. Click Groups, create a new group, and give it a unique name such as Joe's Map Gallery. Fill out the metadata for the Details page. For now, use the text in Figure 1. You can always go back and edit it later. For Status, make sure Public is selected, but uncheck the box that allows the user to apply to join group.

Item	Description
Summary	This is a group for my web maps.
Description	This is a group for my web maps.
Tags	web, map

↑ Figure 1: Metadata for Details page of Gallery Maps group

3. Make sure you add an image next to the group name. The image must be in JPEG, PNG, or GIF format. Click Save.
4. Now, click the My Content tab. Under the top folder (the one with your user name), create a new folder called Gallery Maps.

Adding Existing Maps to the Gallery

Next, you'll prepare content for the web map portion of the gallery. If you already have web maps saved in your My Content items, you can check the box next to a map in My Content, click the Share button, and check the boxes to share it with Everyone and the Gallery Maps group that you just created. You can also search ArcGIS Online for web maps created by others and save them to the <your name> Maps Gallery group. Note: Because you are not the owner of those maps, you cannot edit the Details page.

Creating and Adding New Maps

Alternatively (or in addition), you can create new maps that you can manage with the <your name> Maps Gallery group.

1. Click the Map tab or the Create Map button on the My Content page. If you want to change the default basemap, click the Basemap button and choose another map.

2. Search for a layer to add to the basemap by entering a keyword (e.g., fire) in the Find box. You can search for layers on ArcGIS Online, the web, or a known GIS server. In this case, search ArcGIS Online.
3. Before adding the layer to your map, click the map title in the list of results to invoke the map summary card. Click Item Details. The Details page displays the metadata provided by the author. Pay particular attention to the Access and Use Constraints section to note any restrictions on using the map or required attributions.
4. Under the thumbnail image of the map, click the Open button and click Open in ArcGIS.com Viewer. Now zoom in to a portion of the map so that the layer information you just added fills the map display.
5. Click the Save drop-down and click Save As. In the Save Map dialog box, enter a title, a few tags, and a brief summary.
6. From the Save in drop-down, select Gallery Maps (the folder you created earlier). Click Save Map.
7. Now click the ArcGIS Home drop-down and click My Content. Click the <your name> Maps Gallery group and click the title of the item you just saved. Notice that the thumbnail image is the map you composed before saving it. Clicking the Edit button will allow you to edit elements such as the title, summary, description, access and use constraints, and tags. Add a description if you want.
8. Click the Share button and check the boxes for Everyone (public) and the <your name> Maps Gallery group. Click OK.
9. Click the Groups tab and then click the <your name> Maps Gallery group in the list to verify that your map has been shared with this group. Leave this page open.

Syncing the Gallery with My Content

Now that you have at least one item in your group, you can sync the group with the gallery. To do this, you'll need to capture the group ID. This template includes a handy tool called Group ID Finder, located in the banner.

1. In ArcGIS Online, make sure you're on the <your name> Maps Gallery group page, and copy the URL for that page.
2. In the Public Maps Gallery (now called

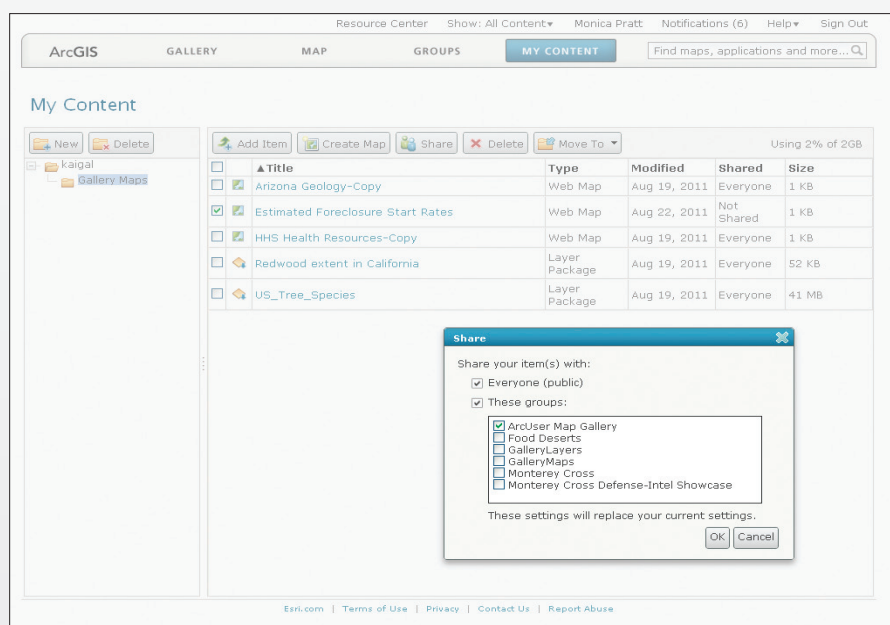
My Maps Gallery), click the Group ID Finder link, paste the group URL into the info box, and click Submit.

3. Now copy the group ID that is returned. In the text editor, open the config.js file located in the public-maps-gallery\scripts folder. In the GLOBAL VARIABLES section, you'll see a variable named mapsGroupID. Highlight the group ID and paste the <your name> Maps Gallery group ID to replace it. Save your changes (leave the text editor open), return to the browser, and click the banner.

Only the maps you have in your group will show up in the gallery. Now that you've synced the gallery with the group, when you add web map items to the Gallery Maps folder and share those items with the <your name> Maps Gallery group, these new items will appear after you refresh your browser when your gallery is displayed. Because the template includes pagination, a new page will automatically be added to the gallery if you share more than nine web maps with the <your name> Maps Gallery group.

Adding Layer Packages to the Gallery

The right side of the gallery can display a list of layer packages, which are also pulled from an ArcGIS Online group. Unlike web maps, which can be opened and used within a browser, layer packages ➔

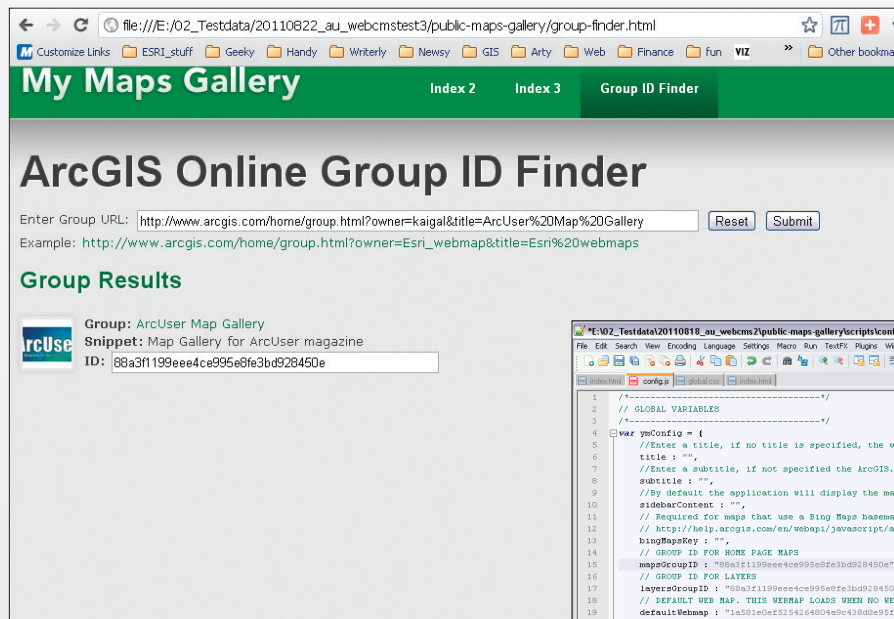


↑ Once you have saved a map, share it with Everyone and with the <your name> Map Gallery you created.

are downloaded and opened in ArcGIS for Desktop. In addition to layer packages you have, you can borrow layer packages, contributed to ArcGIS Online by other users, for your gallery.

You will use the same steps for adding web maps to your gallery to add layer package links to your gallery. You can save layer packages to the Gallery Maps folder or to another folder you create on your My Content page. Share these layers with the <your name> Maps Gallery group or with a new group. You can put web maps and layers in the <your name> Maps Gallery group because the template parses the web maps and layers and puts them in the right place in the gallery. If you store your layers in a new group (e.g., <your name> Layers Gallery), use the Group ID Finder tool and replace the group ID for the layersGroupID variable in the config.js file. *[You'll need ArcGIS for Desktop to create your own layer packages.]*

1. Make sure you're signed in to ArcGIS Online, click the Gallery tab, and search for a topic (e.g., trees).
2. Filter your search to limit results to map layers. Open the Details page for any layer you want to use and make sure the access and use constraints listed will allow its use.



↑ Use the utility in the template to find the Group ID and insert it as the mapsGroupID variable in the config.js file to sync your My Content maps with the <your name> Maps Gallery.

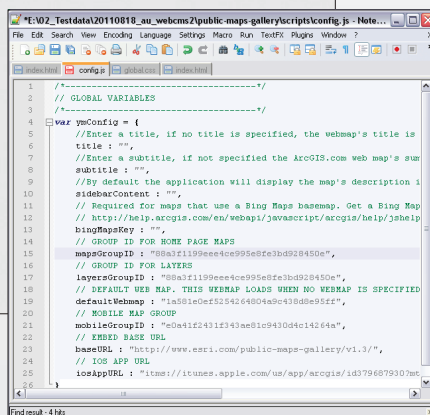
3. Click the Open button and click Download. Save the layer package to your computer.
4. Now click the My Content tab, select the Gallery Maps folder, and click the Add Item button.
5. In the Add Item dialog box, make sure On My Computer is selected. Click the Choose File button and navigate to the location where you downloaded the package, select it, and click Open.
6. Enter a new title and tags for the item. It's a good idea to acknowledge the source of a borrowed layer. Click Add Item. Click the new item to open the Details page. Make any necessary edits. Click the Share button and share it with Everyone and the <your name> Maps Gallery group or your new Layers group. Click OK.

Syncing Layer Packages with the Gallery

1. Click the Groups tab, open the Maps Gallery group that contains your layers, and again copy the URL for that page.
2. On the My Maps Gallery page, click the Group ID Finder link, paste the group URL into the info box, and click Submit. Copy the group ID that is returned.

3. In the text editor, open the config.js file located in the public-maps-gallery\scripts folder. In the GLOBAL VARIABLES section, you'll see a variable named layersGroupID. Highlight the group ID and paste the <your name> Maps Gallery group ID to replace it. Save your changes (leave the text editor open), return to the browser, and click the banner.

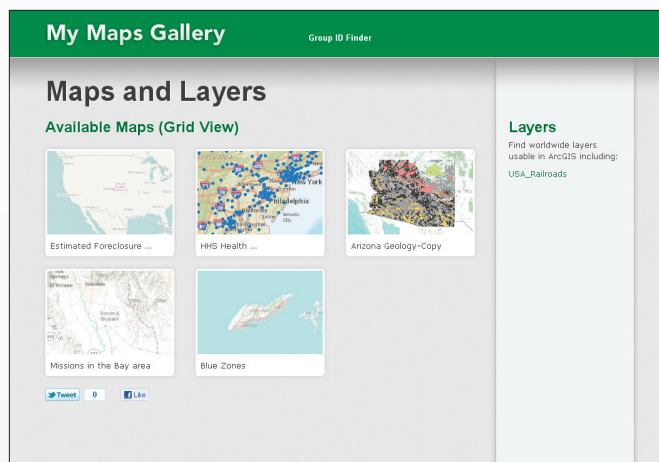
Now that you've synced the gallery with the group, or groups containing your content, just add and share items to this group, and any new items will show after refreshing the browser. To remove items from the gallery, simply stop sharing them. The template includes pagination, so a new page will automatically be added to the bottom of the gallery if your list of maps and layers exceeds the space available.



Deploying the Gallery

If you want to deploy your gallery so others can interact with it, just copy the public-maps-gallery folder to your web host. This may require assistance from your IT staff. Usually, this is done by using an FTP client to transfer the folder and its content to your remote web host. Once the files are transferred, your website is ready for viewing. No further customization is necessary for the gallery application to run. Just point a web browser to the index.html file at the location you copied the yourmaps files, and the application will work.

For more information, contact Keith Mann at kmann@esri.com.



↑ Layer package links can also be added to the <your name> Maps Gallery and synced. Now whenever new maps or layer packages are added to My Content, they will automatically appear in the <your name> Maps Gallery.

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SHARE AND DOCUMENT MAPS WITH MAP PACKAGES

By Monica Pratt, *ArcUser* Editor



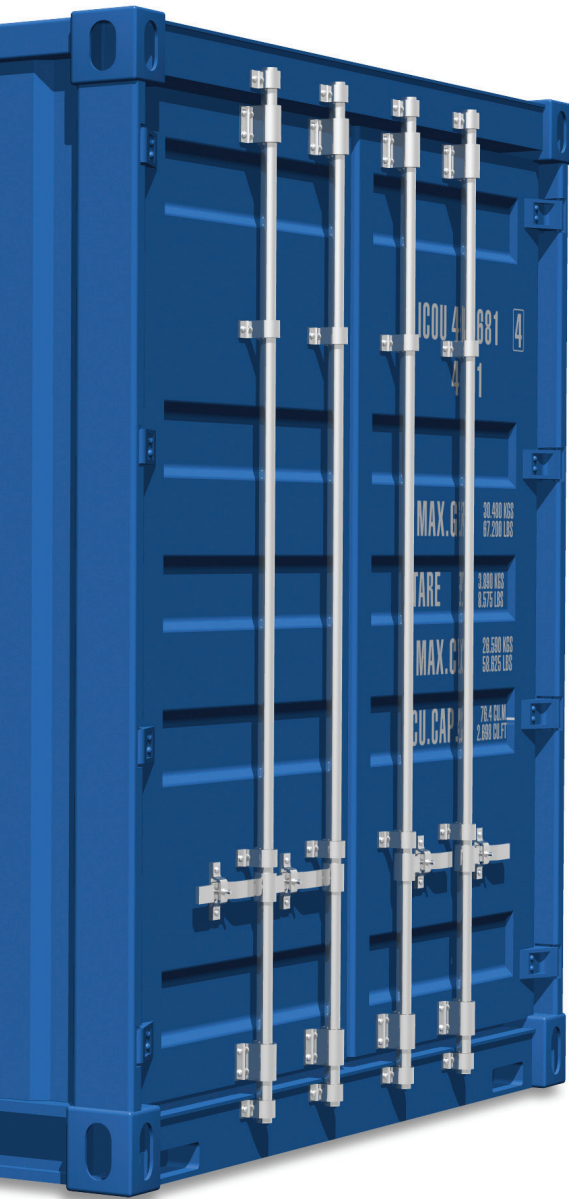
Since ArcGIS 9.3.1 was released, you have been able to package a layer in a map as a layer package (.lpx) and easily share it via e-mail or upload it to ArcGIS Online. With ArcGIS 10, *complete map documents* can be shared using map packages (MPK).

Map packages include a map document (.mxd) and the data referenced by the map layers packaged into one portable file. Like layer packages, map packages make it easy to share maps that include the symbology of the source map by uploading the MPK file directly to ArcGIS Online or saving it locally and e-mailing it or making it available on a file share. Another valuable use for map packages is documenting your work, because a map package is a snapshot of the map and the current state of its data.

Packaging Data

Map packages can be created interactively through the ArcMap interface or by using the geoprocessing tools in the Package toolset. When using either method, ArcGIS prepares and validates the data that will be included in the map package along with the map document. Different data types are handled in different ways during this packaging process:

- If a layer references data in a personal geodatabase, the reference will be included, but the layer will be converted



participate in a relationship class will be consolidated into the map package. Likewise, when datasets that reference other datasets (e.g., geometric networks, topology, locators), those participating datasets will also be packaged.

- Raster data is included in map packages. Uncompressed rasters will be clipped based on the extent parameter specified in the Data Frame properties. Compressed rasters will not be clipped even if an extent has been specified.

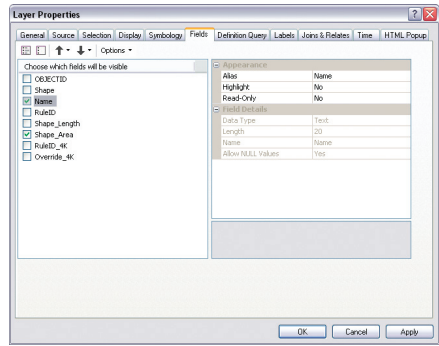
What You Can't Include in a Map Package

Currently, ArcGlobe and ArcScene documents cannot be shared in map packages. Unsupported layer types, such as Tool layers and Schematic layers, also cannot be included in map packages.

Preparing Your Data for Sharing

The actual process of generating a map package in ArcGIS 10 using the Package tool is simple and straightforward. However, the map and its data must be carefully prepared so they will be meaningful to others and can be intelligently and readily used by them.

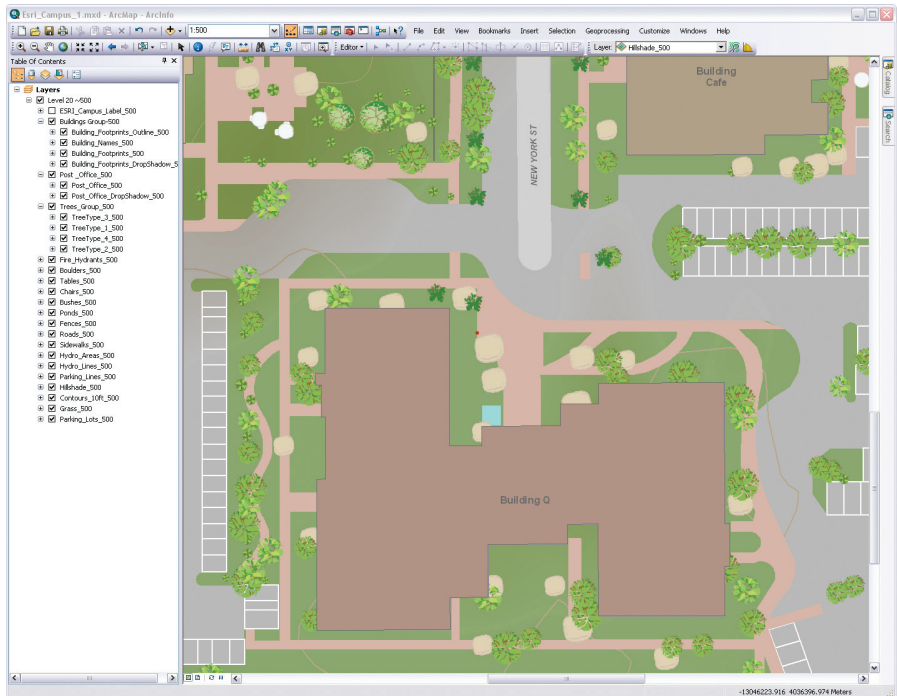
Simplify and minimize the data required for the map. Use an online basemap, such as imagery, to provide context for your



↑ When preparing the data in the map for sharing, turn off any unnecessary fields in the attribute table and create meaningful field aliases for the fields that will be displayed.

data. If the map uses data from a dataset larger than the area of interest, clip the data to the extent of the area of interest. For each layer that will be shared with the map, open Layer Properties and turn off any unnecessary fields in the attribute table. Create meaningful field aliases for the fields that will be displayed.

Specify a useful primary display field or use a display expression. The primary display field is used in MapTips, the Identify dialog box, and the Attributes window. With ArcGIS 10, a display expression can be used instead of a primary display field.



↑ Map packages let you share complete maps that include the symbology and data of the source map.

- to a file geodatabase.
- By default, data in an ArcSDE geodatabase will be referenced rather than included. Consequently, anyone using the map package that uses data from an ArcSDE geodatabase will need to have access to that geodatabase. Alternatively, you can include the data sourced from an ArcSDE geodatabase in the map package by checking the Include ArcSDE geodatabase data check box when using the Package tool.
- The data in layers that contain a join or

A display expression is a custom string that can include values from multiple fields in the same way that label expressions can be created. To create a display expression, click the Display tab on the Layer Properties or Table Properties dialog box and click the Expression button. You can use Visual Basic Script or JScript to add logic or text processing capabilities to the expression.

Add documentation in the ArcMap document by choosing File > Map Document Properties and entering the map title, description, author, credits, and tags. Make sure the check box for Store relative pathnames to data sources is checked. In the map layout, add your agency's name and logo, if appropriate.

Guide map users to the important information in your map. Symbolize layers to highlight important attributes or classes of features. Change the default full extent (which is the extent of the largest layer) to a custom extent that encompasses the area of interest. Specify appropriate display units and units for the x,y readout on the status bar. Make the map easier to use by turning on MapTips and HTML pop-ups for the key operational layers and creating bookmarks at useful extents in the map.

The Schema Only parameter can be used to consolidate the schema of an input

data source to incorporate the schema—but not the data—for layers or records in a map package. Data sources that do not support the Schema Only parameter will not be consolidated or packaged.

Creating Map Packages with the Package Tool

1. To create a map package, choose File > Create Map Package from the ArcMap Standard toolbar.
2. On the dialog box, specify whether the map package will be uploaded to ArcGIS Online or saved locally.
3. Click Validate. Validation checks your data for errors or issues that might impede performance or usability (for example, layers that do not have HTML pop-ups enabled). Any issues discovered are listed in a window. Right-click each item in the list to address these issues.
4. Click the Share button (which becomes enabled after validation is complete).
5. If you are uploading the map package to ArcGIS Online, you'll be prompted to sign in to arcgis.com using your Esri Global Account.
6. The Package Details dialog box appears. If uploading the map package to ArcGIS Online, fill in the fields specifying if you are sharing it with everyone or with specific groups. Click OK.

↑ If uploading the map package to ArcGIS Online, specify who will be allowed to access the map package.

Package Toolset

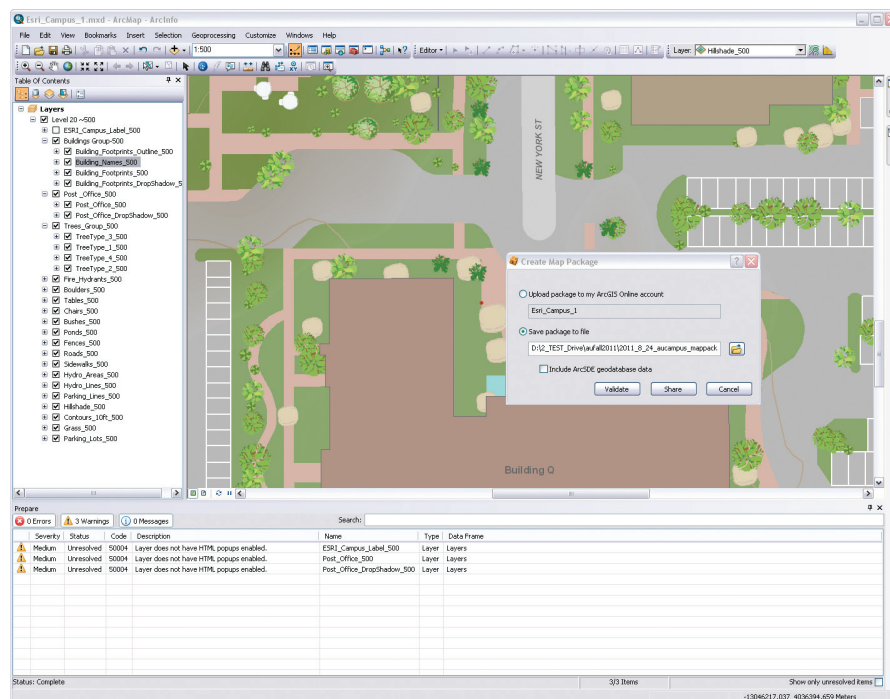
Alternatively, you can use the geoprocessing tools in the Package toolset (located in the Data Management toolbox) with Python and ModelBuilder to automate map sharing. These tools consolidate, package, and share map documents (and layers, too). See the help topics for usage, syntax, and code samples for individual tools. Table 1 lists descriptions of the tools in the Package toolset.

Managing Packages Uploaded to ArcGIS Online

Manage map packages created and uploaded by going to ArcGIS Online. Make sure the Show option at the top of the page is set to All Content (not Web Content only) so your content will not be filtered out. Packages uploaded to ArcGIS Online cannot be added to ArcGIS Online web maps. To make map packages available for web mapping applications and clients such as ArcGIS Explorer Online and ArcGIS for iOS, you need to publish your data as map services using ArcGIS Server.

Conclusion

Map packages can streamline workflows in several ways. They can standardize the cartography and data representation used by an organization through supplying the schemas and symbolization. Data collection tasks can be more quickly and



↑ Validation checks the data for errors and usability issues and returns a list of issues.

Tool	Description
Consolidate Layer	Consolidates one or more layers by copying all data and referenced data sources into a single folder.
Consolidate Map	Consolidates a map document and all referenced data sources to a specified output folder.
Package Layer	Packages one or more layers and all referenced data sources to create a single compressed .lpx file.
Package Map	Packages a map document and all referenced data sources to create a single compressed .mpk file.
Extract Package	Extracts the contents of a layer or map package to a specified folder. The contents of the output folder are updated with the contents of the input package.
Share Package	Shares a layer or map package by publishing to ArcGIS Online.

↑ Table 1: The Package toolset

correctly accomplished by supplying staff or contractors with map packages. Map packages can be used to provide clients with deliverables as a fully functional digital version of the map that they can interact with and better understand. Finally, map packages are an efficient method for digitally archiving maps locally.

Maps are phenomenally efficient in presenting a great deal of information in a manner that is easily comprehended. Because GIS maps are interactive, they can be used to tell stories and let us interact with the results of analysis, understand the relationships in systems like water

utilities, or understand the operational status of emergency response situations.

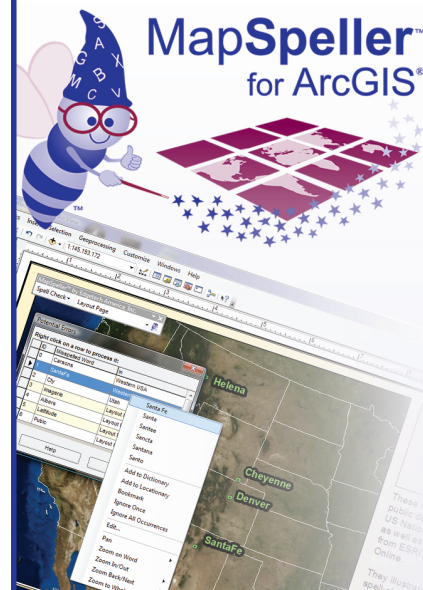
At ArcGIS 10, ArcGIS has been transformed from a suite of software to a network that makes your information accessible from the desktop, web browser, or mobile device. Map packages are another step in this evolution—moving beyond collecting, integrating, and managing data to communicating complex information through maps. By sharing maps, not just data, geospatial intelligence becomes more widely accessible to knowledge workers or policy makers without requiring that they possess GIS expertise.

The screenshot shows the ArcGIS Online web interface. At the top, there's a navigation bar with 'ArcGIS', 'GALLERY', 'MAP', 'GROUPS', and 'MY CONTENT'. Below this, a search bar says 'Find maps, applications and more...'. The main content area displays a map package titled 'Esri_Campus_1'. It includes a thumbnail image of a campus map, a description 'Esri campus basemap at 500 meter scale. Map Package by kaigal (last modified: August 26, 2011)', and social media links for Facebook and Twitter. Below the map, there are buttons for 'Open', 'Share', 'Edit', 'Delete', 'Move To', and 'Update'. A 'Description' section states 'Map created using the Campus Basemap template downloaded from the ArcGIS Resources center.' There's also an 'Access and Use Constraints' section indicating 'No access and use constraints'. A 'Shared with' section lists 'ArcUser Map Gallery'. 'Tags' include 'ArcUser, California, infrastructure, package, trees, facilities management'. 'Credits' are listed. 'Size' is 565 KB. 'Extent' is shown with coordinates: Left: -117.22, Right: -117.19, Top: 34.07, Bottom: 34.05. A 'Comments (0)' section is visible on the right, and an 'Add a Comment' button is at the bottom.

↑ The uploaded map package will be available from your My Content tab on ArcGIS Online.

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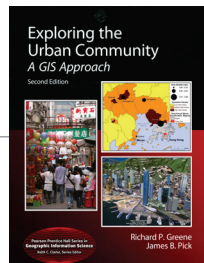
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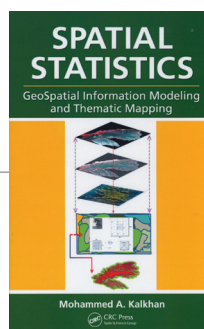
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By Richard P. Greene and James B. Pick

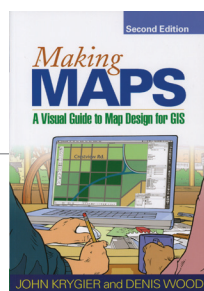
The first edition of this text was published in 2005. Like that edition, this second edition of *Exploring the Urban Community: A GIS Approach* uses GIS as a tool for understanding urban geography and how it changes over time. Lavishly illustrated with photographs, maps, and diagrams, topics covered in this edition reflect developments in the study of urban geography and incorporate current events, such as the oil spill in the Gulf of Mexico in 2010 and the crisis in US housing. More international coverage is supplied, with examples from China, Japan, India, and Africa. Exercises, updated for ArcGIS 10, and other companion study materials are available online by subscription. Prentice Hall, 2011, 432 pp., ISBN-13: 978-0321751591



Spatial Statistics: Geospatial Information Modeling and Thematic Mapping

By Mohammed A. Kalkhan

Based on a workshop the author conducted on the integration of geospatial information and spatial statistics, *Spatial Statistics: Geospatial Information Modeling and Thematic Mapping* does not require advanced knowledge of geospatial information sciences or quantitative methods. After providing a brief review of the types of data supplied by remote sensing, GIS, and GPS, the book explores recognizing and understanding spatial patterns and correlation statistics. It also covers geospatial analysis and modeling. The methods covered include step-wise regression, ordinary least squares (OLS), variogram, kriging, spatial auto-regression, binary classification trees, and cokriging. Finally, *Spatial Statistics* explains how to use R statistical software for statistical analyses, case studies, and geospatial statistical model development. The book includes practical examples and laboratory exercises using ArcGIS and other popular software for geospatial modeling. The author has more than 20 years in research and teaching at Colorado State University in Fort Collins, Colorado, where he is a member of the Natural Resource Ecology Laboratory (NREL). His main interests are in the integration of field data, remote sensing, and GIS with geospatial statistics. CRC Press, 2011, 184 pp., ISBN-13: 978-1420069761

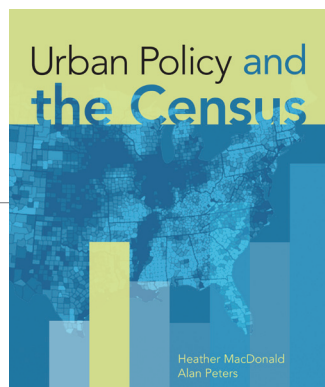


Making Maps: A Visual Guide to Map Design for GIS, Second Edition

By John Krygier and Denis Wood

This book has two basic premises: mapmaking is all about communicating a message, and it is challenging. This conceptual discussion of mapmaking starts with a basic question that is often omitted: Do you really need a map? The authors explore various aspects of mapmaking using a series of questions: Is a map the best solution? Should you, could you, map this topic? What will be the map medium? Has your map been reviewed by experts? Successful mapmaking also requires an understanding of the data and an appreciation of its reliability, accuracy, and ownership. Projections of frogs and nudes are among the illustrations used to demonstrate the difficulties associated with map projections. For those new to mapmaking, this book provides a good introduction to the topic. For those familiar with mapmaking, it can inspire them to improve their maps. The Guilford Press, 2011, 256 pp., ISBN-13: 978-1609181666

Making Sense of Census Data



With the release of the 2010 census data and the ongoing American Community Survey (ACS), the amount of demographic, housing, economic, and transportation data avail-

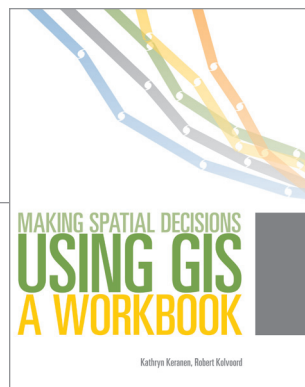
able describing the United States and its citizenry is vast. However, transforming this census data into meaningful information that can form the basis of good decisions is an increasingly challenging task for government policy makers.

Urban Policy and the Census supplies both background and practical advice on using census data. It also addresses the special challenges inherent in spatial data and the characteristics of specific census datasets. Some data, previously collected using the familiar decennial Census of Population and Housing, is now gathered on a more frequent basis using ACS. Rather than a snapshot of the data on a specific date, ACS data represents a rolling average, providing improved timeliness at a cost in precision. This trade-off is most acutely felt when census data is used at the local level. To use ACS and other census data intelligently requires a greater understanding of how the data was produced and its limitations.

While the audience for this book extends from researchers and policy makers to college students and academics, it can benefit anyone who would like a better understanding of this important part of the nation's information infrastructure. This book provides a solid introduction to the data, insights into how it can be correctly interpreted, and methods for effectively communicating the information derived from it. Study design examples also demonstrate how to incorporate administrative data with census data.

The authors, Heather MacDonald and Alan Peters, previously collaborated on *Unlocking the Census with GIS*, released in 2004. MacDonald, a former associate professor in the urban and regional planning program at the University of Iowa, is a senior lecturer and course director of planning in the School of the Built Environment at the University of Technology in Sydney, Australia. Peters is a professor of the built environment at the University of New South Wales. Peters previously held the positions of professor and chair of urban and regional planning at both the University of Sydney and the University of Iowa. Esri Press, 2011, 240 pp., ISBN-13: 978-1589482227

Learning Skills to Solve Challenging Problems



The lessons in the second edition of *Making Spatial Decisions Using GIS: A Workbook* reflect the work performed by GIS professionals because they focus on using a workflow that revolves around the

problem-solving process. Unlike other GIS books that include exercises, this book explains not only how to use GIS but also how to accomplish useful work with GIS. Its focus on identifying the problem to be solved, working systematically, documenting processes, and evaluating the work produced makes it more valuable than many other tutorial books.

The exercises are grouped around the use of GIS for local decision making relating to emergencies, understanding demographics, law enforcement analysis and planning, hurricane response, and urban planning. In each section, two projects are supplied by the authors, and the third will be supplied by the student. Each section can stand on its own, so modules can be assigned or worked in any order.

This book assumes a basic understanding of ArcGIS 10. A DVD containing data for the exercises and instructor resources is included. A 180-day trial of ArcGIS 10 for Desktop can be downloaded to work the exercises.

The first edition of this book, part of the Our World GIS Education series published by Esri Press, won the 2008 Geographic Excellence in Media award from the National Council for Geographic Education.

The authors, Kathryn Keranen and Robert Kolvoord, have extensive experience teaching this topic. Keranen, a retired teacher who was instrumental in introducing GPS, GIS, and remote sensing into the geosystems curriculum in Fairfax County, Virginia, schools, is currently a private consultant, an authorized K-12 Esri instructor, and adjunct professor at James Madison University in Harrisonburg, Virginia. Kolvoord is a professor of integrated science and technology at James Madison University. At the University of Arizona, he was a founder of the nonprofit Center for Image Processing in Education. He has given workshops and presentations around the world on using data visualization technology in education. Esri Press, 2011, 172 pp., ISBN-13: 978-1589482807



Coming Together to Create Understanding



On July 11, 2011, more than 14,000 people from 126 countries, who use GIS to address the world's problems, gathered in San Diego for the Esri International User Conference.

As he has since 1981, Esri president Jack Dangermond welcomed attendees at the start of the Plenary Session. "I meet with hundreds of GIS professionals over the course of the year and am continually amazed at the creativity they display in using GIS to solve complex problems and support critical decisions. The User Conference is like magnifying this 100 times and condensing it all into one short week."

That short week was crammed with opportunities to learn about new

developments in technology at workshops and demonstrations and the work of GIS professionals around the world through hundreds of paper presentations. Throughout the week—between presentations, over lunch and dinner, and at social events—thousands of users met and shared experiences and expertise.

The theme for this year's conference, GIS—Understanding Our World, was built on an observation by last year's keynote speaker, Richard Saul Wurman, who noted that "understanding precedes action."

GIS provides a locational context that allows a deeper understanding of many problems by bringing to light relationships and dependencies so that practical action can be taken.

It is coevolving along with other information technologies to deal with the ever-increasing quantities of data from sources such as sensor networks, crowdsourcing, models, and the digitization of historic records. It provides a systematic framework for gaining a collective understanding of the complex and interdependent nature



transforms terabytes of data into information that guides policy makers in these countries. In addition, online content from ArcGIS feeds more than 80 maps and apps that enable integration of authoritative, citizen scientist, and crowdsourced data that can be contributed and shared in 32 languages.

Eye on Earth, one of the apps available from the EEA website, is a platform for two-way communication. It uses crowdsourcing to validate readings from monitoring stations on the quality of air and swimming sites. Over the next five years, feedback from ordinary citizens will be used to improve the quality of biodiversity, coastal erosion, and other types of environmental data using this app.

During the Plenary Session, Dangermond provided an overview of the outstanding work being done by users as hundreds of maps, representing almost every imaginable discipline, were projected on the screen behind him. Later in the week, 140 organizations were recognized with Special Achievement in GIS (SAG) Awards for their exceptional and innovative work with GIS.

Dangermond also presented special awards to specific organizations and

individuals at the Plenary Session. The President's Award was given to the Federal Service of State Registration Cadastre and Mapping of Russia for building a national cadastral system for the entire country. There were two recipients of the Making a Difference Award: professor Haruo Hayashi of the Research Center for Disaster Reduction Systems, Kyoto, and Geneva International Centre for Humanitarian Demining (GICHD). Hayashi was honored for his work with a team of students who provided maps of the area surrounding the location of Japan's 2011 Tōhoku earthquake, the ensuing tsunami, and subsequent fallout disasters. The award to GICHD, accepted by director Daniel Ericksson, was made in recognition of the integration of GIS in the Information Management System for Mine Action (IMSMA), which supports demining, explosive ordnance disposal, and disarmament.

In addition to recognizing the work of users, each year, the Esri UC provides an opportunity for Esri to share its vision for software development in both the short and long term. ArcGIS Online continues to mature as a platform that makes GIS available to anyone, anywhere—on a desktop, browser, smartphone, or tablet—and

← EEA executive director Jacqueline McGlade explained how the agency uses GIS to monitor environmental data quality.

of the world. New patterns for sharing the information gleaned from this glut of data use web apps and lightweight viewers to make this information widely available.

This new GIS pattern is exemplified by the work of the European Environment Agency (EEA). In her conference keynote address, One Degree Matters, EEA executive director Jacqueline McGlade described how the agency uses GIS to meet the challenge of monitoring the quality of data about the condition of the environment of states in the European Union. EEA

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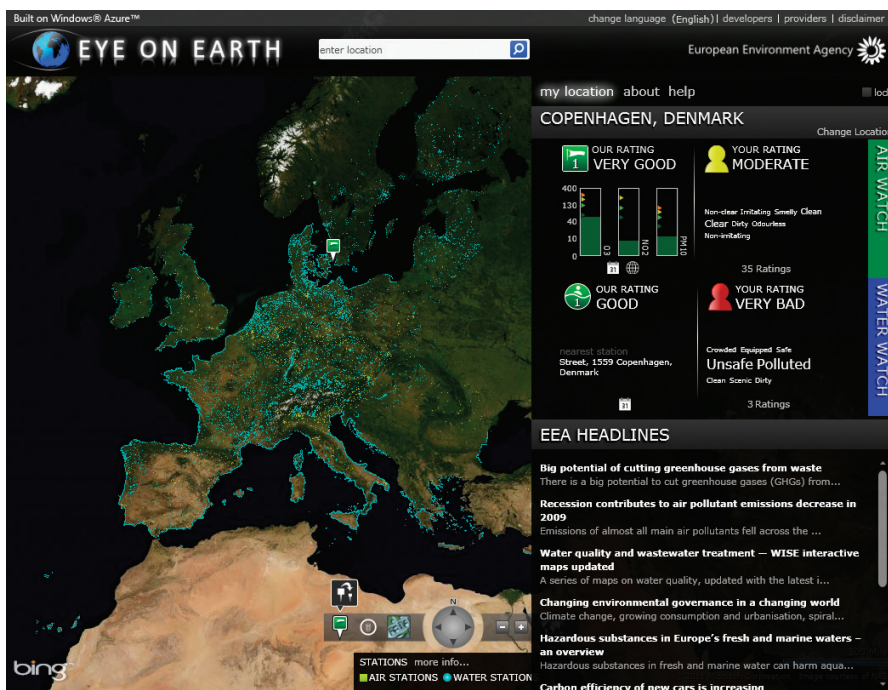
provides access to a growing collection of more than 100,000 maps and apps. Esri's new GIS cloud service, Community Analyst, allows users to perform analysis with more than 6,000 variables without requiring any local software installation.

Among many important enhancements, the next release of ArcGIS will continue supplying tools and enabling workflows that simplify work with imagery. ArcGIS 10.1 makes lidar data in LAS format more accessible with quick viewing, update and analysis, classification, data management, and sharing capabilities.

The introduction of the ArcGIS Runtime at 10.1 was one of the most dramatic conference announcements. The software development kits (SDKs) are used for building custom native 64-bit solutions for ArcGIS for Windows Mobile, iOS, Android, Windows, and Linux. These applications have a small footprint, deliver high performance, and are easy to deploy.

The acquisition of the Swiss company Procedural and its flagship product CityEngine was also revealed at this year's conference. "Many GIS problems can only be solved in 3D, particularly in the area of urban development," said Dangermond. "Procedural's unique capabilities for generating high-quality 3D data, using the same GIS data our users already have, makes them a perfect match for Esri."

Urban planners, architects, video game developers, and movie studios around the world use CityEngine to create stunning 3D urban environments from typical 2D



↑ Eye on Earth, EEA app, uses crowdsourcing to validate readings from monitoring stations.

data. With the acquisition of Procedural, 3D content visualization will become part of GIS—not a separate technology—simplifying the process of visualizing, understanding, and designing urban environments. Procedural's offices in Zurich will be a leading-edge R&D center for urban design and 3D content creation.

As its capabilities have evolved to handle ever-increasing amounts of data about our world, transform it to information, and make it more comprehensible

through 3D visualization, GIS is becoming a new language for understanding and responding to these problems.

With enhanced visualization capabilities and the shift to web services used with lightweight viewers, GIS is more accessible to more people, and the goal of making GIS for everyone is closer to reality than ever before. The growing GIS community is creating a better world by addressing problems on scales from the global to personal using a science-based GIS approach.



↑ More than 14,000 people from 126 countries traveled to San Diego, California, for the 2011 Esri UC.

Be part of the world's largest GIS conference. Save the date for the 2012 Esri International User Conference in San Diego, California, July 23–27.

My Top 10 from the 2011 EdUC and Esri UC

By Joseph Kerski, Esri Education Manager

It has become a tradition at the last several Esri User Conferences for some of the plenary presenters to give their top 10 favorite enhancements to ArcGIS software and its extensions. As I await my flight departing San Diego from this year's Esri Education User Conference (EdUC) and Esri International User Conference (Esri UC), I would like to offer my top 10.



- 1 The ability to drag and drop files in text, comma-separated values, Microsoft Excel, and Esri shapefile format from your computer to ArcGIS Online is incredibly easy and powerful.
- 2 A close second is the new ability to thematically map data in ArcGIS Online using a graduated symbol or graduated color.
- 3 I enjoyed and learned from my colleagues who participated in the EdUC plenary. I used ArcGIS Online's presentation capabilities to give my section of the EdUC plenary keynote. It worked very well, and it is a wonderful educational tool.
- 4 We had an excellent discussion at the curriculum development Special Interest Group meeting on Sunday. Innovative projects were shared by many in attendance. We also had a number of math educators this year. We discussed the Spatial Math library on ArcLessons and discussed what else needs to be developed for math educators.
- 5 Once again I absolutely loved meeting and hearing about the projects from the 4-H students. They are an inspiration, and many of them were only freshmen in high school. Think of what they will be doing by the time they graduate!
- 6 The Esri UC plenary was once again my favorite day, seeing on the big stage and screen the new capabilities of the software, including the use of lidar and Landsat data; the vision shared by Jack Dangermond and others, and the inspiring work done by the Rwanda coffee project leaders, the European Environment Agency, and the student and teacher from Clark Magnet High School.
- 7 I love the fact that the plenary videos are online. Please consider attending Esri UC and EdUC in 2012. It truly is a life-changing experience.
- 8 My colleagues and I had wonderful, deep discussions with people who stopped at our Education Island in the exhibit hall. I wish everyone on the planet who wonders how geography and GIS are applicable to our world could spend time in the exhibit hall and Map Gallery. Within five minutes, they will understand!
- 9 The Academic Program Fair on Monday night was a terrific time of networking and learning, and even included a high school this year, Piner High School in Santa Rosa.
- 10 As I reflect on the energy, expertise, and vision of the 14,000 who gathered this week, I am greatly encouraged. People using GIS are truly changing the world in positive ways! Will you make plans to attend the 2012 EdUC and Esri UC?

Warner De Gooijer, strategic analyst and project manager for global supply chain operations at Cisco Systems, Inc., was one of the speakers at the Esri Business Summit plenary session.

Transforming Business with Geographic Knowledge

By Karen Richardson, Esri Writer



Patrick O'Hagan, Starbucks Coffee Company's manager of global market planning for the world's largest retail coffee chain, served some great advice to executives at the 2011 Esri Business Summit: **Don't put the buggy before the horse.**

Starbucks first began using GIS technology and data in the late 1990s. To make vital business decisions about company stores, employees needed to understand store trade areas. The company's GIS staff flooded its staff members with data, especially those working with real estate.

O'Hagan's team created an Esri ArcReader application that allowed staff members to access all the geodemographic and topographic data that was available for use in the company. While it was important to allow staff to have access to the data they requested, this approach didn't quite catch on.

"We held pretty true to the putting the buggy before the horse allegory, but in a futuristic sense," O'Hagan said, speaking in San Diego, California, to a group of 200 business executives from all over the world. While Starbucks staff had access to massive amounts of data, they had no way to easily analyze it. Today, instead of a flood of data, O'Hagan's team provides analytics and business support to its real estate section. The team uses ArcGIS for Server to create data-rich applications that staff members can access from desktops, the Internet, and mobile devices in the field.

O'Hagan pointed out during a panel discussion why this was a successful approach: "Our people don't want to know what GIS means or what it can do. They care about functionality, speed, and convenience. ArcGIS allows us to create replicable consumer applications that are exactly what they need."

Communicating through Maps

Other Business Summit speakers included Matt Mikula, a principal at Edward Jones, an investment company that serves nearly seven million investors. Edward Jones has licensed Business Analyst software and business datasets to assist in opening new branches. It is looking forward to using the technology to better understand customers' financial needs, whether they are saving for a child's college education or getting ready for retirement.

Nigel Davis, director of product development at Willis Re, a re-insurance adviser headquartered in London, England, also spoke on the importance of using geographic data to help his customers—in this case, insurance brokers—understand information to make better business decisions. Willis Re created eCOMPASS, a

cloud-based application based on ArcGIS, for its customers. It supplies data covering major perils worldwide, from flood zones in Latin America to earthquakes in New Zealand.

When the magnitude 9.0 earthquake rocked Japan on March 11, 2011, and set off a tsunami, Willis Re staff were able to quickly gather critical information, including policy locations, hazards, and other related spatial data, for its insurance clients to view and analyze. In keeping with the Business Summit theme, Davis reiterated the need to keep things simple so people can really understand the information that is being transmitted. Davis agreed with O'Hagan. He explained that "interactive maps help in communication, but you have to be careful. Part of the challenge is not to overload people with information."

Preparing for the Worst

Willis Re began working on this innovative platform last year when the company anticipated that a large number of hurricanes would make landfall in many countries. It wanted to make impact assessments before tropical storms began. By knowing where client exposures were and what they had at risk and viewing this information with a digital rendering of a live storm track, it was able to better estimate total exposure for its clients.

This was done quickly by physically locating all policies contained within the footprint of a storm and representing them by geocoded points on a map. Willis Re's clients logged on and selected their policies inside the storm area to access all the descriptive information associated with these policies for further analysis and action. Using this data, loss adjusting activities could be contemplated and policyholders could be contacted, ensuring that service would be swift and accurate.

When the earthquake and subsequent tsunami hit Japan, Willis Re staff derived a bespoke tsunami zone, a digital elevation model (DEM), and ground observations to create an estimated representation. The DEM was derived from data supplied by Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) sensors. ASTER provides remotely sensed terrain data at a resolution of 30 meters that is easy to access and provides wide coverage. Elevation and slope of the land were derived to analyze where inundation from water would take place. This tsunami dataset was loaded to eCOMPASS Online soon after the event for analysis purposes. Willis Re staff also provided earthquake ShakeMaps from USGS and displayed this data on top of a world topographic map from Esri.

"One of the powerful analytic functions of the solution is the tsunami impact footprint," said Davis. "Using a mapcentric view of risks in a portfolio makes it much easier to identify risks that are impacted by the tsunami. Using GIS, risks that are in the tsunami's path can be found without guessing, extracted, and exported for an offline loss estimation."

Streamlining Business Processes

Warner De Gooijer, strategic analyst and project manager for global supply chain operations at Cisco Systems, Inc., also spoke at the summit, explaining how his company uses GIS. Cisco, worldwide leader in networking, offers products and services that help companies share data and information securely anywhere in the world. Cisco is adopting Esri GIS technology and data to streamline its global

"Seeing data through a mapping context greatly increases the possibility of deeper analysis and better decision making."

Allan Pym
APOS Systems

supply chain and continue providing high levels of customer service.

"Leveraging GIS technology advances our analysis capabilities and introduces new methodologies for business analytics," said De Gooijer. "We realized that this important service could be enhanced with spatial analysis."

ArcGIS will be used to create web maps and analysis services that help position the company's service depots to provide customers with the best service quickly. The business requirements and factors that determine the response times vary worldwide, so finding a solution that worked across the company and could be adapted to each country was important.

Becoming a Believer

Using geography as an information filter transformed the companies that presented during the Plenary Session. Matthew Felton, director of GIS and research at MacKenzie Commercial Real Estate Services, explained that once his company got past the problem of not knowing what it was missing, the company was sold on using GIS to visualize and analyze its data.

"GIS is like a smartphone: if you use it, you are a believer," Felton said. "Those that don't have one don't really get it. But like how an iPhone seems to transform the people who use it, this is how our company feels about GIS."

Felton introduced his company to Business Analyst and Business Analyst Online. "For the first time, I think members of my company really saw their real estate," Felton said. "We had a lot of fun with the data, viewing and exploring information in a way they hadn't experienced before. The more they saw in the maps, the more questions they would ask."



"GIS is like a smartphone:
if you use it, you are a
believer."

Matthew Felton
MacKenzie Commercial Real Estate
Services

Targeting the Audience

The afternoon session included breakout sessions and an invitation-only media summit for publishers, editors, and journalists using or interested in using GIS in telling news stories. The media session began with Lightning Talks from leaders in higher education and the industry, including Matt Carmichael, director of information projects with *Advertising Age* in Chicago. Carmichael describes himself as the publisher's resident stats geek, covering demographics, consumer trends, and analytics for the publisher. *Advertising Age* is a weekly publication focused on advertising and has been using Esri's GIS technology and data to better understand where people that buy certain things are located.

A recent story, entitled "Pain at the Pump: Running on Empty, Americans Cut Spending," used Esri data to analyze income and spending data and determine where the people who will be most impacted by gas price increases live. Esri's consumer spending data augments other data from the government and private industry that helps Carmichael look in depth at certain aspects of popular trends. "We regularly use many different sources for our data in order to classify thousands of human behaviors that consumer products companies can track at the brand level," said Carmichael. "Synthesizing the information based on geography makes sense because many times, we are where we live."



Left to right: Matt Mikula, a principal at the investment company Edward Jones; Matthew Felton, director of GIS and research at MacKenzie Commercial Real Estate Services; and Patrick O'Hagan, manager of global market planning for Starbucks Coffee, all spoke at the Plenary Session.

If I Only Had a Whole Brain

This sentiment also held true in another afternoon session entitled Location Intelligence—The Power of Where. Presenters, including Allan Pym, chief operating officer for APOS Systems, discussed the need for understanding business data through a geographic context. The company provides integration between SAP BusinessObjects and ArcGIS so information analysts can see, understand, and communicate business intelligence and geospatial data more quickly and more completely.

Pym grabbed the attention of his audience as he asked them, “How many of your business decisions have you really made with only half a brain?”

He explained that business intelligence is traditionally handled by the left side of the brain, which is oriented more toward linear reasoning and language. By also engaging the right side of the brain, which can more easily engage with and interpret patterns, shapes, and colors, decision makers can up their cognition and comprehend with better understanding all that their data has to offer them. “Dashboards, pie charts, and bar graphs are really just window dressing that can’t hide the fact that the left brain is in control,” said Pym. “Seeing data through a mapping context greatly increases the possibility of deeper analysis and better decision making.”

Pym went on to explain that using maps and location intelligence

will improve the efficiency of analysis, reporting, and communication in any industry. “If your marketing, planning, asset management, resource tracking, or service management are based even partly on geography, then location intelligence will have a noticeable impact on your organization,” said Pym.

The biggest effect will be found wherever business intelligence is highly geospatial in nature. For example, retail chains, whether expanding or contracting, need the best possible intelligence about store locations. Using GIS can help retail chains channel products to the appropriate markets, understand local and regional requirements, and maintain optimal inventory levels at stores and distribution centers. By displaying the purchasing history of stores on maps, retail chains can plan effectively for seasonal marketing campaigns. By displaying demographics on maps, planners can forecast future selling patterns.

Don’t miss next year’s Esri Business Summit. Learn more at esri.com/bizsummit.

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Learning Every Day

Developer thrives
on fast pace

Leslie Roundy, Esri Writer

A technology-related career was a natural choice for Elitsa Baklova, a software development programmer at Esri. Her whole family comes from a GIS background.

Baklova, who has been at Esri for about two years, was introduced to technology and GIS at a young age. Her father, mother, and brother have postgraduate degrees in geodesy and civil engineering. While Baklova was a young girl growing up in Bulgaria, her mother was an infrastructure engineer designing roads and bridges, and her father worked as an urban surveyor. He took both children on field projects in different cities throughout Bulgaria. That's how Baklova first became interested in surveying and GIS in general.

Math was her strongest academic area, so when it came time to choose a career, her brother convinced her that computing would be interesting and she would

never get bored. That led her to pursue a career in software development.

She had been using Esri products while obtaining her master's degree in computer science from the University of Oxford. After working as a developer at a media distribution company in the United Kingdom for about a year, she joined the .NET team at Esri.

Since coming to Esri, Baklova has been involved in a variety of projects: working on functionality enhancements to the Web ADF Manager for .NET and implementing the ArcGIS Map Web Part and ArcGIS Geocode Workflow as components of Esri's ArcGIS for SharePoint product, used to integrate maps and GIS content into SharePoint.

Currently, she is working on the ArcGIS Viewer/Builder for Microsoft Silverlight. Unlike her previous job, where a single product's release cycle took up to two years, at Esri she works on many different products and research projects. "We try to release software updates more frequently so that we can take into account functionality requests we get from our users during beta programs and software previews," said Baklova. "And we are encouraged to come up with interesting ideas that can be converted into a product. All this keeps it exciting."

"Software quality is of extreme importance to Esri," she continued. "As a software development programmer, I work closely with the product engineers in



"There is a sort of pride and satisfaction of seeing so many different industries utilizing the products each of us works on. GIS is everywhere. That's what makes it so powerful."

product development to make sure the bar is set high. Every day we have scrums to review the status of what we've been working on. The product engineer will propose user interface workflows as well as ensure that our code changes meet the quality requirements. There are frequent discussions between developers and product engineers to discuss new features. Each brings different things to the table. Sometimes it's amazing how many diverse opinions there can be when discussing functionality, but at the end of the day, it's through different eyes that we get best practices, so that's important."

The technology is always changing, so a developer's job is to learn every day.

Baklova observed that "once you stop learning, it means you're not a good programmer anymore. Development changes so fast that if you don't keep up with the pace, you're kind of out-of-date." She and other developers go to conferences to stay current on technology, attend on-campus technology courses, and are encouraged to learn on their own. At the Esri Developer Summit and Esri International User Conference, developers interact with customers to see how products are being used. Development teams from Esri partner organizations also present their latest technologies.

When asked why she chose GIS, Baklova said, "Unlike developers at a

lot of companies that often work on systems for internal use only or websites that serve a specific need, here at Esri we're not simply providing a solution for a limited number of users. We have the privilege of working on products that enable others." Many Esri users will take the web APIs or out-of-the-box solutions and use them to create something that serves their needs, whether that is a complex proprietary system for tracking marketing trends; a fast-response emergency application; or just a simple, beautiful map. "There is a sort of pride and satisfaction of seeing so many different industries utilizing the products each of us works on. GIS is everywhere. That's what makes it so powerful."

Esri Technical Certification

Building a community of highly skilled GIS professionals

Why does Esri Technical Certification matter?

Jim Tochterman—GISP, vice president of research and development at Bradshaw Consulting Services, Inc. (BCS), and an Esri Certified Enterprise Associate—offers some insights on this question from his perspective. He explains how the new Esri Technical Certification program will help build a community of highly skilled professionals who can develop, sell, service, support, and use Esri solutions.

Question: Why does your company feel that certification is important?

Tochterman: At Bradshaw Consulting Services, Inc., we believe the Esri Technical Certification program is important because it validates that not only do people who pass one of the certifications know and understand a set of products, but that they also understand the technology and GIS principles behind those products.

Question: How will you leverage certification for your business?

Tochterman: We will leverage the new certification program to ensure that staff skills and knowledge are leading edge, which in turn will help us gain a competitive advantage by differentiating ourselves and reassuring our customers that our staff are up-to-date in using Esri best practices.

Question: What does your company value most about certification?

Tochterman: After having taken the certification exams, we see value that it is in fact a true certification program. “True” in that not everyone will pass by just studying materials. To take and pass any of the exams, the person will need to have the knowledge and skills in the exam they are taking.

Question: How do you feel certification will help your customers?

Tochterman: The Esri Technical Certification program will provide customers a way to validate the knowledge, quality, and competency of a consultant—whether they are simply implementing new software or designing new solutions.

Question: How do you think customer trust will differ for vendors/partners who have staff that are certified versus ones that do not?

Tochterman: Typically, customers looking for trustworthy or experienced vendors/partners have had to rely on word of mouth, previous project experience, and interviews when selecting someone to contract with. This process is very time-consuming and quite often still does not help in obtaining trustworthy vendors/partners. Now, with the certification program, a potential customer can immediately know if a vendor/partner truly has the experienced staff necessary for a successful project or software implementation.

Question: How many of your staff members have earned certifications so far, and which certifications did they earn?

Tochterman: Presently, four of our staff members have taken and passed Esri Technical Certification exams. Those certifications include Enterprise Administration Associate, Enterprise Geodatabase Management Associate, ArcGIS Desktop Professional, and ArcGIS Desktop Associate. As new certification exams become available (such as mobile), we will have more staff members taking those exams as well.

Question: Will your company consider certification during the hiring process? If so, to what extent?

Tochterman: We most definitely will consider a candidate's certifications. Today, there are many more qualified people in the GIS job market than there have been in years past. Having to evaluate a person's competency at interview time can be time-consuming and laborious. If they have obtained one or more certifications, we will know they already have a certain level of knowledge, and we can move on to a more in-depth evaluation of that candidate.

Question: What is the number-one reason why people should consider getting certified?

Tochterman: Recognized proficiency. There are lots of people who truly have substantial ArcGIS knowledge and experience. There are also an even larger number of people who simply claim to have substantial ArcGIS knowledge and experience. How would you tell these people apart? The quickest and easiest way a potential employer or customer is going to be able to tell the difference is through certification.

Esri Welcomes "Deepsea Dawn" Aboard

Quick Facts about Esri Technical Certification

- Esri Technical Certifications recognize expertise in desktop, developer, and enterprise use of Esri technology.
- Exams are offered worldwide at 5,000 Pearson VUE (Esri's global testing partner) locations in 165 countries.
- Seven certification exams are now available: ArcGIS Desktop Associate, ArcGIS Desktop Professional, ArcGIS Desktop Developer Associate, Web Application Developer Associate, Enterprise Geodatabase Management Associate, Enterprise System Design Associate, and Enterprise Administration Associate. Six more certifications will be added to the program later in 2011 and in 2012.
- Esri certifications do not expire. Once you are certified for a specified version, you always hold that certification.

For More Information

Esri Technical Certification Website
esri.com/certification

Exam Registration
pearsonvue.com/esri

Desktop Certification Skills Review Classes
esri.com/skillsreview

About BCS

BCS is an Esri Gold Tier partner that provides total GIS solutions to business, industry, and government clients throughout the United States. From design and implementation to full application development, BCS creates turnkey solutions for clients ranging from small businesses to Fortune 500 companies.



Jim Tochterman, vice president of research and development at BCS

Ocean scientist, geographer, and notable authority in geographic information science, Dawn J. Wright, aka Deepsea Dawn, joins Esri as its chief scientist.

"In her capacity as chief scientist, she will interface with government, business, industry, and the public and collaborate with them to understand and find solutions for our planet," said Esri president Jack Dangermond. In this position, Wright will help formulate and advance the intellectual agenda for the environmental, conservation, climate, and ocean science aspects of Esri's work and represent Esri in the national/international scientific community.

For the past 16 years, Wright has combined her expertise as a geographer and GIS user to map the seafloor, design geospatial solutions for coastal mapping and charting, and advise organizations on oceanography and fisheries. Wright has teamed with scientists worldwide in using GIS to map and analyze terrains, ecosystems, and habitat and worked with the GIS community in developing data models and creating solutions for analyzing the ocean. She serves on the National Academy of Sciences Ocean Studies Board.

Wright, currently a professor of geography and oceanography at Oregon State University, will continue to be affiliated with the university. Her research interests include geographic information science; ocean informatics and cyberinfrastructure; benthic terrain and habitat characterization; and the processing and interpretation of high-resolution bathymetry, video, and underwater photographic images.

Named US Professor of the Year for the state of Oregon by the Carnegie Foundation for the Advancement of Teaching and the Council for the Advancement and Support of Education in 2007, she is also a fellow of the American Association for the Advancement of Science and a new fellow of the Stanford University Aldo Leopold Leadership Program in science communication.

Wright received a doctorate in physical geography and marine geology from the University of California, Santa Barbara; a master's degree in oceanography from Texas A&M; and a bachelor's degree with honors from Wheaton College in Illinois. She is also certified by the GIS Certification Institute as a GIS professional (GISP).

Transparent Communication Keeps Contributions Coming

By Karen Richardson, Esri Writer

GIS web apps keep donations coming into Direct Relief International (DRI) by constantly apprising donors of how their contributions are being spent.

Nonprofit organizations like Santa Barbara, California-based DRI rely on the charity of individuals, businesses, and foundations to operate. DRI collects and distributes medical supplies and pharmaceuticals to 72 countries, including the United States. The organization provides medicines and medical supplies for those who otherwise can't afford them because they are low-income and don't have health insurance or live in developing countries that lack the infrastructure to provide basic health services. In addition to partnering with licensed health care providers to deliver reliable medical services throughout the world, DRI also responds to crises such as the 2010 Haiti earthquake.

The earthquake in Haiti killed or injured hundreds of thousands of people and displaced more than a million. DRI relied on generous donations from individuals and corporations to reach out to help those suffering. "Unlike some nonprofits, DRI does not use US

government funding or grants for the services we provide. We rely solely on charitable contributions," explained Andrew Schroeder, director of research and analysis for DRI.

Current and prospective donors can visit an interactive map (www.directrelief.org/Flash/Haiti_Aid_Distribution/Index.html) of Haiti to ensure that contributions are being put to good use. The map, located on DRI's website, allows anyone to explore details about DRI's shipments to the country based on the location and type of medical supplies required. Pie charts provide a visual breakdown of the composition of medical donations (e.g., prescription drugs, instruments) matched with their associated costs.

As new donations arrive in Haiti, DRI's website tracks supplies, needs, and working partners. "It's important that our donors and others, such as the public and news media, see that we are able to deliver essential supplies in the right amounts, forms, strengths, and dosages to the facilities that need them," said Schroeder. "If they see their money is being well spent, we have a better chance of retaining donors and attracting new ones."

In the six months following the Haiti quake, DRI provided more than 400 tons of emergency medical assistance worth approximately \$57 million to 53 Haitian health care facilities, international medical teams, mobile medical clinics, tent-based hospitals, and medical units at camps for displaced people across the country. The ability to raise the substantial funding needed for these medical supplies is substantially aided by what Schroeder described as "transparency and communication."

DRI provides a similar map for contributions at work in the United States (www.directrelief.org/Flash/USAmapi/index.html). It contains information on the amounts and types of donations provided to more than 1,100 nonprofit clinics throughout the 50 states. The map of clinic locations can display donations nationwide or by state or individual clinic. Icon size indicates the amount of medical aid a clinic receives. Users can view individual states by choosing from a drop-down and seeing aggregated statewide aid totals, zooming in to a specific area, or typing in an address.



↑ Anyone visiting the DRI website can explore details about shipments to Haiti.



Fund-raising is a tough nut to crack.

Schroeder and his team use ArcGIS for Server to manage the geo-spatial aspects of US and international inventory that is tracked by the organization in SAP. Microsoft SQL Server is a bridge to inventory files that are exported from SAP in Microsoft Excel and DBF format files and imported into ArcGIS for Server applications via a multiuser geodatabase. Multiple mapping applications created with ArcGIS API for Flex are available to the general public (like the Haiti and United States clinic maps), and others are used internally at DRI. These solutions were built with the assistance of researchers in the Department of Geography at the University of California, Santa Barbara.

In addition to showing donors where their money is being spent, DRI must constantly find new donors. Fund-raising is a necessary part of DRI's operations. The organization received more than \$341 million in total public support, including cash and in-kind donations. DRI spent less than one-half of 1 percent of this total on its fund-raising efforts. DRI's efficiency and expense ratings are consistently among the best in the United States, and it was rated as 100 percent efficient in fund-raising for the eighth time in 2010 by *Forbes* magazine. *[Fund-raising efficiency is based on charitable commitment, and donor dependency.]* Maintaining this efficiency is important to the organization, and it is always looking for better ways of finding donors to bring necessary medical supplies to the people who need them around the world. "As a lean nonprofit, we can't spend a lot of money on a market research firm to help us find donors," said Schroeder, "so we need much better tools and intelligence internal to our organization."

DRI is looking forward to implementing Esri's Software as a Service (SaaS) product Community Analyst as a cost-efficient solution to help target potential donors in the United States. "Fund-raising is a tough nut to crack," said Schroeder. "By understanding our existing donors and finding more like them, we can attract a substantial and sustainable significant donor base. We'll be more able to think strategically about how to raise resources."

Community Analyst will allow staff at DRI to look at profiles of donors at smaller scales of geography, such as census block groups, and find out more specifically where new donors might be located. This helps target marketing and outreach campaigns, ensure that less money is spent on fund-raising, and allow more money to go toward serving the needs of vulnerable populations.

This solution may help DRI as it provides aid to people affected by other crisis situations such as the drought and resultant famine spreading across the Horn of Africa. Coordinating with a group of Kenya-based nongovernmental organizations and the Kenyan Red Cross, DRI is working to fill the gap in essential medical supplies for



↑ DRI collects and distributes medical supplies and pharmaceuticals to 72 countries and partners with licensed health care providers to deliver reliable medical services throughout the world. (Photos courtesy of DRI)

people in northern and eastern Kenya, including tens of thousands of famished Somalis who have been pouring across the border in search of food. While the amount of food aid being brought into the area is increasing rapidly, there is a persistent gap in essential medical services that DRI is working to fill.

There is also a significant gap in financial contributions for this crisis, so DRI is allocating an initial \$50,000 from reserve funds to obtain and distribute essential medications and supplies in response to specific needs identified in the camps and settlements in and around Turkana, in northwestern Kenya near the Ethiopian border. With a little luck, and the right map, DRI may find the people needed to bring medical supplies to this desperate community.

DRI works hard to bring health to vulnerable populations around the world. Being healthy is the first building block of breaking the cycle of poverty. If children are sick, they don't attend school and can't learn skills. If adults are sick, they can't work for a living and provide for their families. While eradicating poverty is an extremely complex challenge, better access to reliable health services is necessary to create a positive change and increase livelihoods and enhance economic development.

DRI continues to look at the next generation of information technology to bring better understanding of information in the organization. Creating a community for providers, donors, and the public through mapping applications is one powerful way it has found to bring assistance to those who need it.

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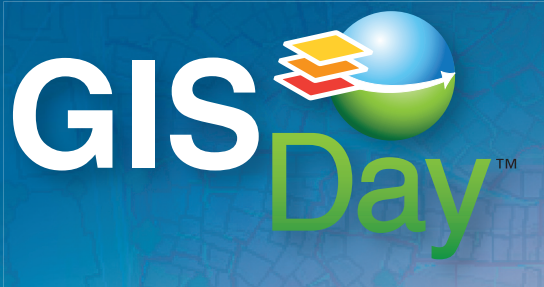
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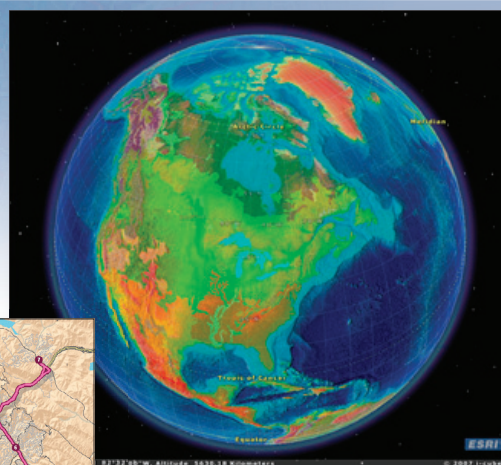
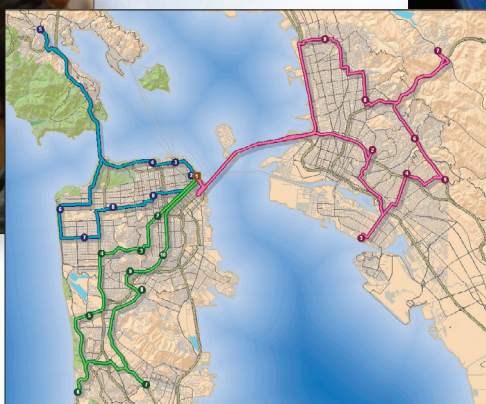
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November 16, 2011



As a GIS user, you have no doubt met people who are unfamiliar with GIS technology. GIS Day™ is an opportunity to share your passion for your work with colleagues and your community—allowing others to see and experience GIS firsthand.

About GIS Day

Since 1999, more than 10,000 organizations have participated in GIS Day by hosting events such as open houses, hands-on workshops, community expos, career fairs, schoolwide assemblies, and mapping projects.

GIS Day's success is due to the hard work and dedication of GIS users around the world who see the importance in sharing their GIS knowledge with others.

"The city's GIS Day event helped show citizens and employees that GIS is all around you, and it can be as fun and interesting as it is useful!"

Sylvia Wood
City of Denton, Texas

Why Should I Participate?

- Promote your organization's use of GIS.
- Showcase real-world applications.
- Establish mentor relationships with local youth.
- Introduce GIS to potential clients.
- Point students toward a career in GIS.

How Do I Get Started?

Visit the GIS Day Web site to

- Register your event.
- Search for events near you.
- Download free materials.
- Read success stories for inspiration.
- View photos from last year's events.
- Gather ideas for a future event.



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