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The Magazine for Esri Software Users



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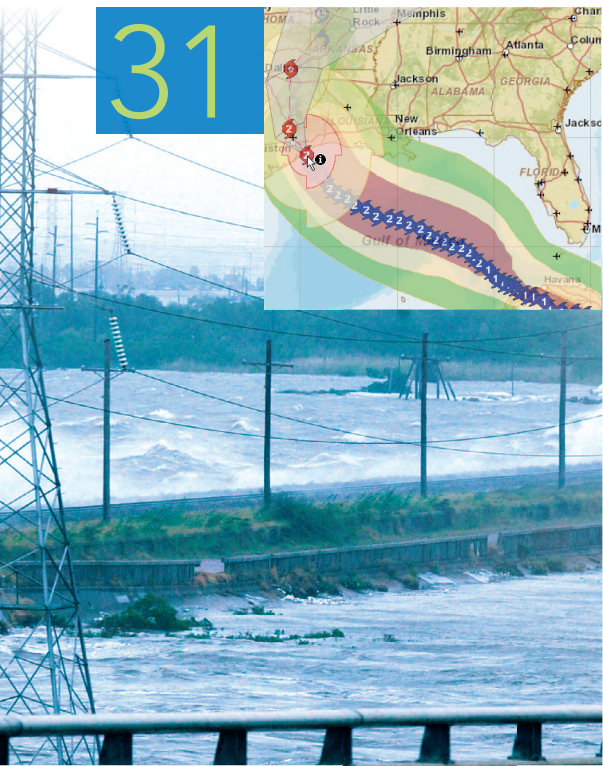
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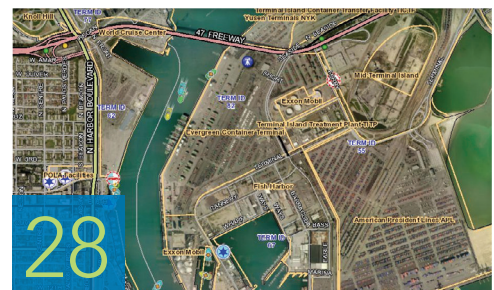
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A Place to Thrive

By examining problems in context and on multiple levels, geography provides a broader perspective. Instead of continuing to treat the symptoms, the underlying conditions can be addressed.

This issue focuses on the design of healthy communities. The healthy communities approach recognizes that the real goal of public health is not treating disease but promoting well-being. In the words of Seth Wiafe, one of the organizers of the Healthy Communities by Design Summit, "Once you start talking about health, you touch everything."

Healthy communities interpret "health" very broadly and focus on maintaining health through helping people make better choices in what they eat, where they live and work, how they get from one place to another, and how they interact with other people. Conceptualized in this fashion, health is concerned not just with disease and treatment outcomes, but also many aspects of community design: providing for transportation alternatives to driving, ensuring availability of fresh and nutritious food, and preserving air and water quality.

An initial impetus for the development of GIS was enabling a more holistic method of land-use planning. However, the ability to consider many interrelated factors has caused GIS to be adopted across numerous disciplines and in hundreds of organizations.

GeoDesign has emerged as the methodology for integrating GIS technology with the design of communities. As Michael Flaxman of MIT observed, "GeoDesign is a design and planning method which tightly couples the creation of design proposals with impact simulations informed by geographic contexts." Iteratively modeling the impacts of various scenarios helps avoid adopting solutions that have unintended and undesirable side effects.

Because GeoDesign is a visual approach to problem solving, it can be more easily communicated to a broader audience. This plays into the new collaborative spirit that is permeating society. From reporting graffiti to a local government agency to texting contributions to further Haiti relief efforts, technology is helping individuals engage with government and each other.

Web-based GIS, just one part of the pervasive geospatial platform that is emerging, enhances higher levels of collaboration and helps incorporate geographic knowledge into the decision-making process. Esri believes that geography is the key to shaping communities that are more livable, resilient, and sustainable.



Monica Pratt
ArcUser Editor

editor's page

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EDITORIAL

Editor
Monica Pratt

Contributors
Matthew DeMeritt
Keith Mann

Technical Advisors
Paul Dodd
Damian Spangrud

Copy Editing
Joyce Lawrence

DESIGN
Graphic Designer
Antoinette Zaragoza

Photography
Eric Laycock

Print Coordinator
Tim Polen

ADVISORY BOARD

Corporate
Linda Hecht

Corporate Alliances
Steve Trammell

Products
Dave Scheirer

International
Dean Angelides

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Industries
Lew Nelson

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Editorial Inquiries

Monica Pratt, *ArcUser* Editor
380 New York Street
Redlands, CA 92373-8100, USA
E-mail: arcuser_editor@esri.com
Visit the *ArcUser* Online Web pages (esri.com/arcuser) to read the article submission guidelines and copyright policy.

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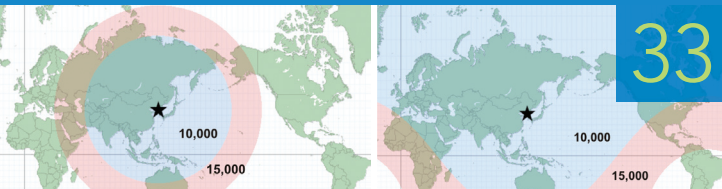
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It's Easier to Share Geographic Information

With new release of ArcGIS Explorer

New updates to ArcGIS Explorer, the free GIS viewer, help more closely integrate it with ArcGIS 10. It now provides direct support for image services, improved support for ArcGIS 10 layer packages and geodatabases, and more ways to leverage ArcGIS 10.

The new release supports greater interoperability with ArcGIS. Image services can be directly used and optimized. New tools and properties for image services include gamma, brightness, and contrast; compression and resample methods; and mosaic methods and operators. Image services can also be added as elevation layers.

With direct access to ArcGIS Online, ArcGIS Explorer users can easily find and add content and share geographic data and maps

through online communities. OpenStreetMap is now included in the ArcGIS Explorer basemap gallery. More data sources can be used in ArcGIS Explorer. In this new version, data from Excel spreadsheets can be added.

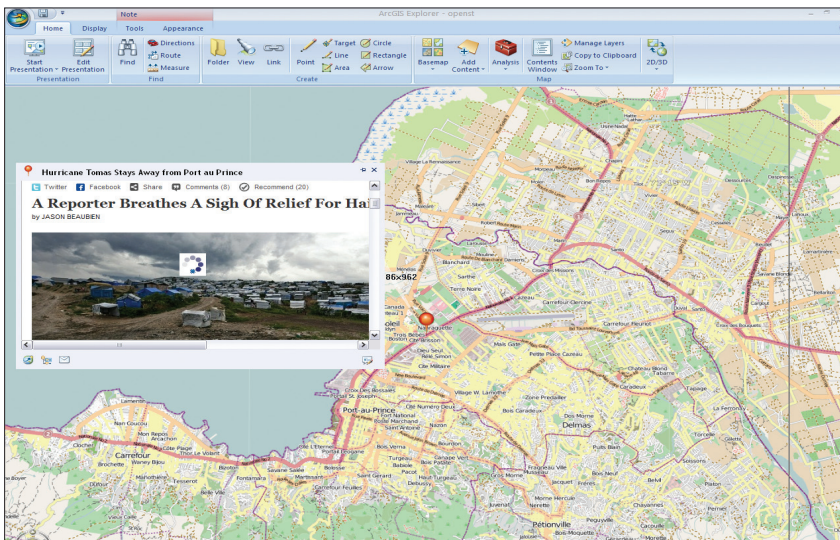
Enhanced features in ArcGIS Explorer make collaboration easier. Notes, a pop-up window associated with a shape drawn on the map, now displays a title as well as text. The presentation, pop-up, and Analysis Gallery features have new tools for sharing information. Shared layer packages, notes, and KML can be saved locally, added to ArcGIS Online, or e-mailed directly from ArcGIS Explorer.

Users can also share notes as Keyhole Markup Language (KML)

and convert KML to notes. KML handling has been improved in both the 2D and 3D modes, and regionated KML is now supported in 2D mode. (Regionated KML is a format that breaks an image file into tiles, or regions, that are easier to deliver than one large file.)

With the new query capability, users can create expressions to filter the data displayed. Symbology has been improved for both 2D and 3D modes.

In addition to the free download of ArcGIS Explorer, Esri offers a free ArcGIS Explorer software developer kit (SDK). This SDK has been updated to support Visual Studio 2010, including templates for the new add-in types and an updated add-in wizard. The reference and conceptual help have also been updated, and new/updated SDK samples are included. ArcGIS Explorer is supported in English, German, French, Spanish, Japanese, and simplified Chinese.



With the new release of ArcGIS Explorer, OpenStreetMap is included in the basemap gallery, and notes now have titles.

Efficient Enterprise Collaboration through Custom Web Applications

Esri Business Analyst Server 10 significantly speeds analysis tasks such as data summarization, benchmarking, and market ranking. These tasks can be done almost instantaneously—in less than a second in some cases.

This recent release improves collaboration and sharing of business models and analyses across the enterprise. Business Analyst Server combines GIS server technology with extensive business, updated demographic, and consumer spending data from Esri. Results of analyses can be shared through print-quality maps and reports that can be incorporated into market studies and distributed in ready-to-use, browser-based applications.

Business Analyst Server comes with out-of-the-box tools and services for rapidly publishing and sharing data, maps, analyses, and models. Software developer kits (SDKs) for Flex and Silverlight, in addition to REST and SOAP API services, are included. Application developers can quickly build easy-to-use Web applications that help end users solve site location problems, perform customer targeting, and do other types of analysis within a standard Web browser. End users don't have to be GIS experts.

To learn more about Business Analyst Server, visit esri.com/baserver. International customers should contact their local distributor for more information.

Esri Geoportal Server Helps Organizations Collaborate

Esri Geoportal Server, a free, open source product, helps organizations build and administer geoportals Web sites where data producers can register their geospatial resources for others to discover and consume.

Geoportals help maintain the quality, currentness, and availability of registered resources by providing tools for evaluating new entries, controlling access to metadata and resources, and integrating the geoportals with other enterprise systems.

This functionality means that geoportals can enhance collaboration and data sharing among government and private agencies. By connecting geospatial data and service producers with consumers, geoportals reduce data redundancy, which saves time and money. By improving sharing of the authoritative version of data throughout an organization, it helps maintain data integrity.

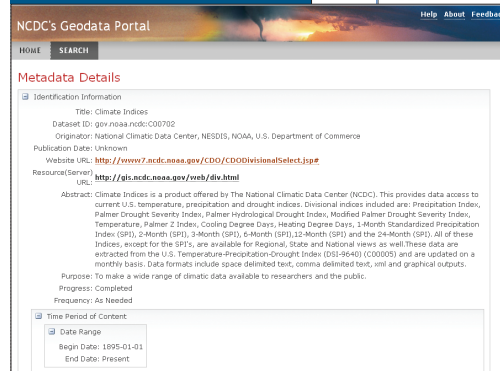
The geoportals server was released under the Apache 2.0 license, which allows developers to freely customize and redistribute the software. Esri is using SourceForge to host and distribute the software and source code. This familiar platform will make it easy to incorporate contributions to the product from the open source community.

The geoportals does not duplicate resources but stores and catalogs resource metadata as well as the information for accessing those resources. Esri Geoportal Server inventories all metadata for registered geospatial resources in an Open Geospatial Consortium, Inc. (OGC)-compliant Catalog Service for the Web (CSW) 2.0.2 geoportals catalog service. It supplies simple integration with external Web sites and applications through its support of REST, GeoRSS, KML, SOAP, and ATOM.

Geoportals support simple authentication or user authentication, with an external Lightweight Directory Access Protocol (LDAP), for access and security. Access to metadata can be designated as unrestricted, public-protected, or restricted at the record level. By automatically monitoring registered resources, the geoportals can synchronize any changes to the catalog service.

Data producers can publish their resources to the geoportals simply by registering the resource's metadata. Publishers can directly cre-

Free,
open source
product
now
available



▲ With the CSW clients for ArcGIS, geospatial data and services in a geoportals can be searched, accessed, and used directly in ArcMap and ArcGIS Explorer.

▲ Many organizations, such as the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC), are using Geoportal Server.

ate metadata in the Web application, upload existing metadata to the geoportals, or allow the geoportals to autogenerate metadata. Simple tools are provided for generating and registering metadata, and supported resources include datasets, analyses, tools, and Web services. In addition, the Publish Client that comes with the geoportals server lets data publishers register geospatial resources directly from ArcCatalog.

The geoportals supports and provides templates for several common metadata profiles—Federal Geographic Data Committee (FGDC), Dublin Core, and International Organization for Standardization (ISO) including support for the North American and Infrastructure for Spatial Information in Europe (INSPIRE) profiles.

The easy-to-use interface lets others discover and access resources registered with the geoportals for use in their projects by searching on keywords and by location. Smart matching—enhanced by the ontology service—and smart ranking quickly identify the most promising results. Searches can be made on

multiple types of search providers, including standards-based XSW systems, Web 2.0 (OpenSearch) systems, content management systems (CMS), and document management systems (DMS). With the CSW clients for ArcGIS, geospatial data and services in a geoportals can be searched, accessed, and used directly from ArcMap and ArcGIS Explorer.

Search results can be previewed using the geoportals's streamlined map previewer, or the geoportals can be integrated with an organization's existing map viewer. Geoportals provide direct access to live Web services for preview and use. Once located, data can be efficiently downloaded using the Clip-Zip-Ship task. The area of interest in the dataset is specified, and the geoportals extracts it, packages it into a ZIP file, and e-mails the data.

Many organizations around the world are using Geoportal Server. Visit bit.ly/bDIFG8 to view these sites. To learn more about Geoportal Server or download it, visit esri.com/geoportals.

Creating and Texturing

Learn basic techniques for creating 3D buildings

By Craig McCabe, Esri Mapping Center Team

The 3D virtual city is emerging as an essential GIS tool for visualization and analysis in the urban environment—from placing a proposed building construction in the context of its surroundings to conducting analyses in three dimensions such as line-of-sight or 3D volumetric shadows. The multipatch, Esri's native 3D feature type, is a key element whether working in ArcGlobe or ArcScene. ArcGIS 10 introduces a host of new 3D data management and analysis capabilities that enhance 3D analysis.

This exercise walks the reader through the process of creating and adding texture to a 3D multipatch feature. It uses a geometrically simple urban feature—a freeway overpass in downtown Philadelphia—and starts with a polygon and some high-resolution aerial imagery. The workflow outlined will familiarize the reader with tools in ArcGIS 10 for importing, exporting, and placing different types of 3D features.

It's assumed that the reader is familiar with ArcGIS Desktop applications and the ArcGIS 3D Analyst extension, including ArcGlobe. Some familiarity with Google SketchUp may also be helpful. To complete this exercise, the following software and data are required

- ArcGIS 10 with the 3D Analyst and Spatial Analyst extensions
- Google SketchUp 8 (free version available at sketchup.google.com/download/)
- Multipatch Overpass data .zip file on ArcGIS.com (bit.ly/ep5a2s)

The 16-step workflow is organized into four sections:

1. Extruding an overpass polygon and exporting it as a 3D multipatch feature from ArcGlobe
2. Extracting aerial imagery to use as a surface texture
3. Applying the extracted imagery to the overpass in SketchUp
4. Importing the newly textured overpass back into ArcGlobe

Supporting Data

Folder	Item	Description
Maps and GDBs	Overpass.3dd	The ArcGlobe document for viewing the overpass content in 3D
	Overpass.gdb	A geodatabase containing high-resolution imagery, polygon, and multipatch overpass features used in the workflow
3D Models	COLLADA (*.dae) models	A folder containing untextured (before) and textured (after) 3D overpass models in COLLADA format.

The folder and files in the Multipatch Overpass ZIP file. *Note: The Overpass.gdb in Maps and GDBs folder includes the overpass feature in various stages of the construction process, so more advanced users can skip some portions of the workflow if desired.*



Figure 1: This exercise shows how to correct this sampling error, commonly seen in high-resolution DEMs in urban environments.

Multipatch Features

Exercise Overview

This exercise starts with an overpass feature that has been poorly captured by the existing 1-meter (m) digital elevation model (DEM) for downtown Philadelphia as shown in Figure 1. This type sampling error is commonly seen in high-resolution DEMs in urban environments that show overlapping roadways and structures of different elevations. Lower-resolution DEMs, by comparison, just make features look flat. One approach to correcting this situation might be to edit the DEM or add a patch to raise that road and create a flat surface. Although this fixes the elevation of the overpass road, it creates an impenetrable wall in the underlying expressway.

Instead of editing the DEM, this tutorial will show how to create a simple but realistic-looking overpass as a 3D multipatch feature that spans the gap and has a void space underneath. This process requires a polygon file and a swatch of high-resolution imagery. SketchUp will be used to apply imagery to the top of the 3D overpass model.

Section 1: Create a 3D Multipatch from an Extruded Polygon

1. The first step is to create a polygon feature using ArcMap in universal transverse Mercator (UTM) Zone 18N. Later, this polygon will be extruded to create a 3D volume for the overpass. After adding the imagery file in the Overpass geodatabase to an ArcMap document, create a simple rectangular shape and ensure that there are small areas of overlap at each end of the overpass. (The completed polygon feature is `overpass_ply` and is included in `Overpass.gdb`.)

2. Close ArcMap and open the ArcGlobe Overpass.3dd file. Add the polygon feature just created. By default, the polygon will drape



Figure 2: Add the polygon feature created in ArcMap to Overpass.3dd.



Figure 3: By default, the polygon will drape over the globe surface like a blanket.

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Creating and Texturing Multipatch Features

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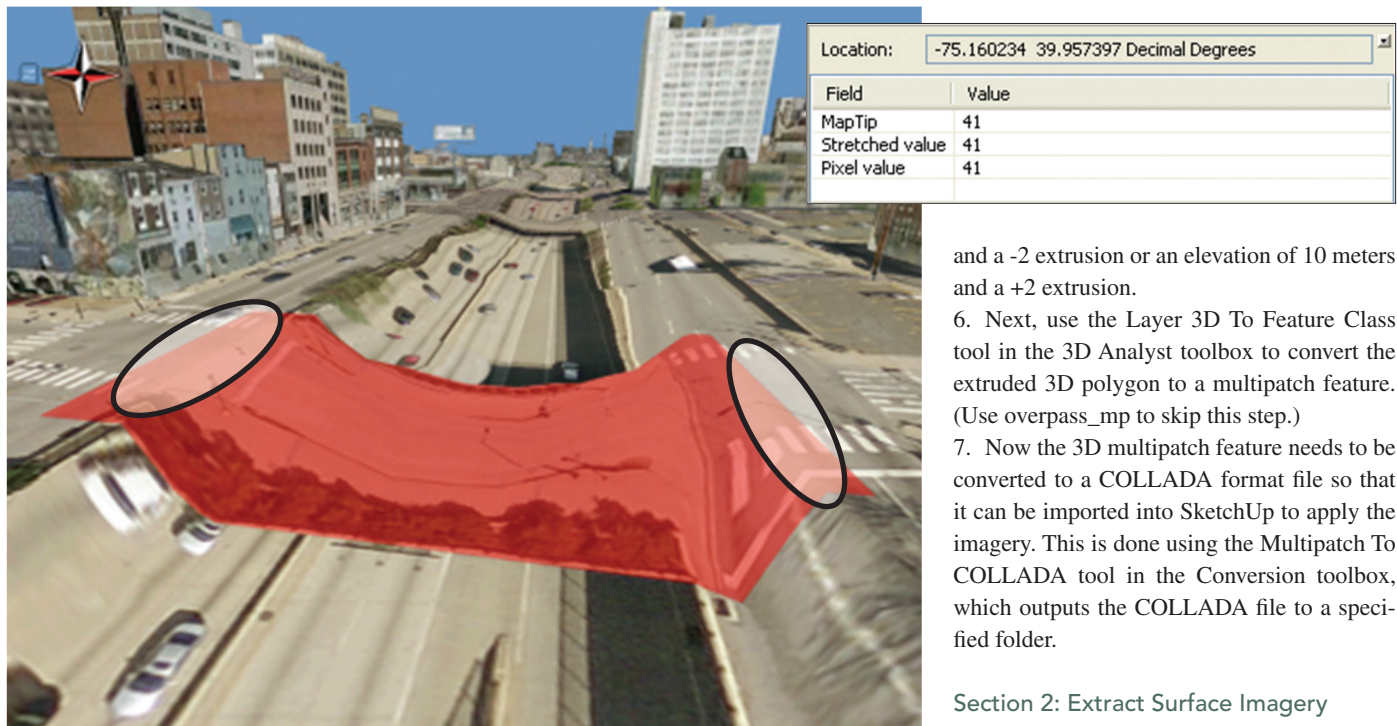


Figure 4: To determine the elevation of the overpass once it's extruded, sample the value of the DEM on each end of the roadway (as indicated by the ovals).

over the globe surface like a blanket. Ensure that the polygon completely spans the roadway below as well as part of the elevated road surface on each end so there are no gaps when the polygon is extruded to 3D.

3. To correctly place the elevation of the overpass once it's extruded, sample the value of the DEM on each end of the roadway (as indicated by the ovals shown in Figure 4). Use the Identify tool to sample the elevation, with 1-m DEM specified as the Identify from layer. Both sides of the overpass will have an elevation value of about 41 feet.

4. To set the elevation of the overpass polygon, open the Layer Properties > Elevation tab and select the Floating without a surface option. Input a constant offset value for the desired elevation in the text box in the lower right side of the Layer Properties dialog box as shown in Figure 5. The DEM is 41 feet (this is pretty close to 12 meters), and this height bridges the gap well.

5. With the base elevation determined, an extrusion of 2 m is applied. To ensure that the top of the overpass matches the road surface on each side, use either an elevation of 12 meters

and a -2 extrusion or an elevation of 10 meters and a +2 extrusion.

6. Next, use the Layer 3D To Feature Class tool in the 3D Analyst toolbox to convert the extruded 3D polygon to a multipatch feature. (Use overpass_mp to skip this step.)

7. Now the 3D multipatch feature needs to be converted to a COLLADA format file so that it can be imported into SketchUp to apply the imagery. This is done using the Multipatch To COLLADA tool in the Conversion toolbox, which outputs the COLLADA file to a specified folder.

Section 2: Extract Surface Imagery

8. Use the Extract By Mask tool in the Spatial Analyst toolbox to extract imagery for the top of the overpass. The parameters for this tool

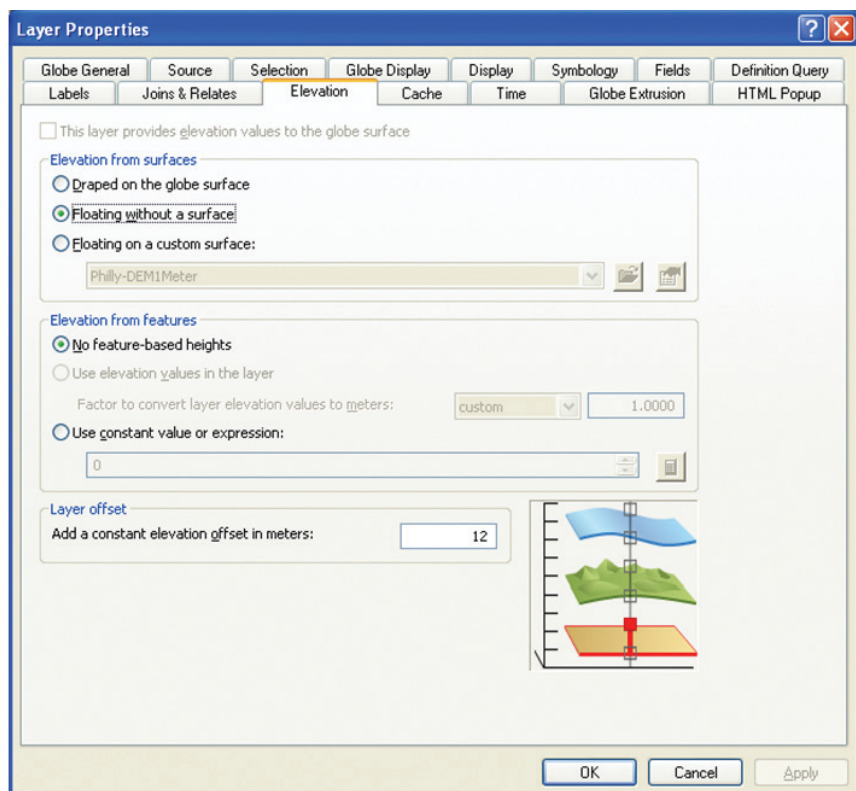


Figure 5: Set the elevation under Layer Properties.

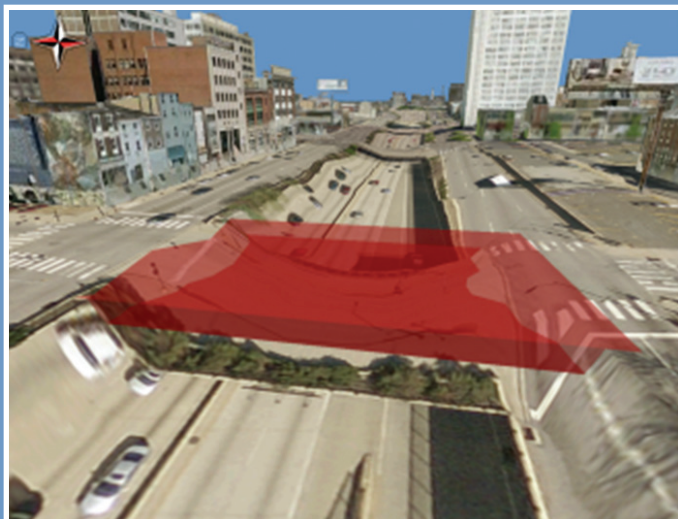


Figure 6: Use the Layer 3D To Feature Class tool to convert the extruded 3D polygon (left) to a multipatch feature (right).



Figure 7: Use the Extract By Mask tool in the Spatial Analyst toolbox to extract imagery for the top of the overpass.



include the imagery swatch as the input raster and the overpass polygon as the feature mask. (The imagery_extract file can be used to skip this step.)

9. Next, convert this extracted imagery to PNG format using the Copy Raster tool in the Data Management toolbox. The input raster is imagery_extract, the output raster is imagery is PNG and the pixel type is 8-bit unsigned.

Section 3: Apply Surface Imagery and Color to the 3D Overpass in SketchUp
10. Open SketchUp and use File > Import to import the COLLADA model (*.dae) saved in Step 7. Use the Select tool to select the model, then right-click and select the Explode option.
11. Activate just the top face of the overpass

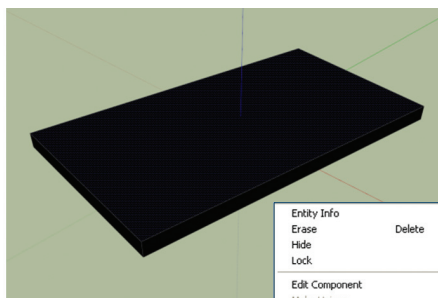


Figure 8: In SketchUp, use the Select tool to select the model, then right-click and select Explode.

with the Select tool. Use File > Import, select the *.png file type, then navigate to the PNG imagery exported in Step 9. With the Use as texture option enabled, roughly place the image on the top face (don't worry about the exact placement for now).

12. With the top face still selected, finely adjust the position of the imagery by choosing Edit > Face > Texture > Position. Four pins will appear at each corner of the image. Move each pin to the four edges of the overpass and stretch the imagery until it fits.

13. With the imagery in place, use the Paint Bucket tool to apply color to the sides and bottom of the overpass. (Color_C15 in the Materials palette roughly matches the color of the

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Creating and Texturing Multipatch Features

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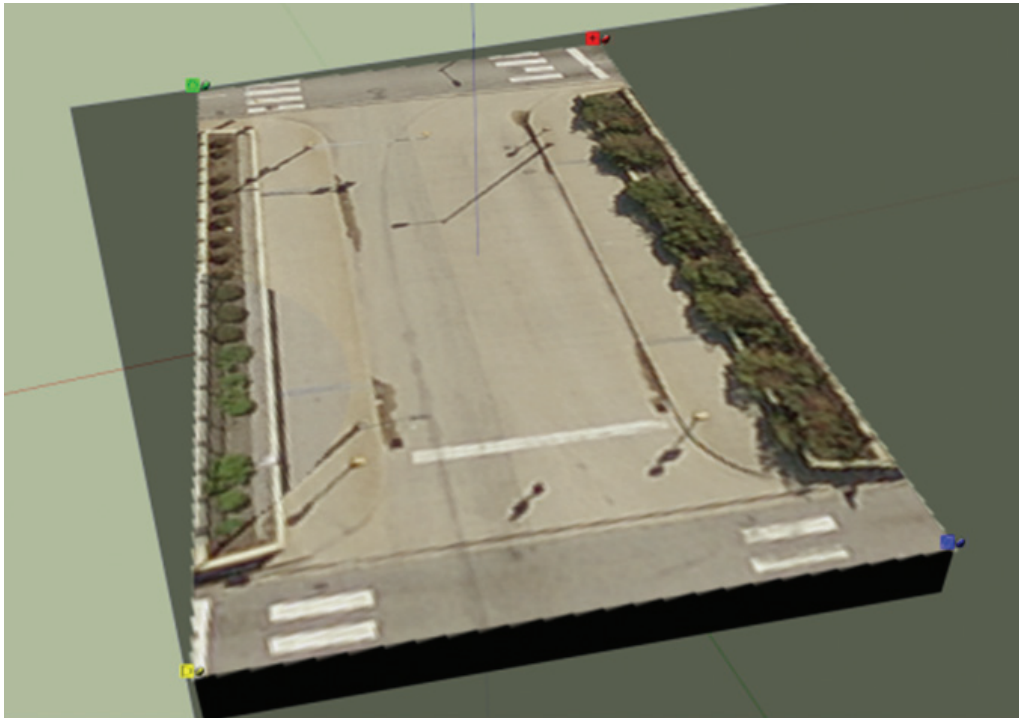


Figure 9: Move the four pins to the edges of the overpass and stretch the imagery to fit.

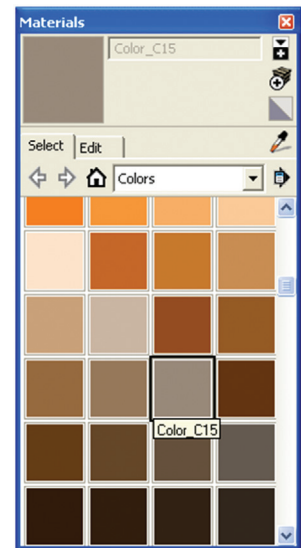


Figure 10: Use the Paint Bucket to color the sides and bottom of the overpass.

concrete.)

14. Once the imagery has been added and painted, export the model (File > Export > 3D Model) back to a COLLADA file, which will then be used to replace the untextured multipatch in the ArcGlobe document. *[Note: SketchUp version 6 format may be used in place of COLLADA for this step (File > Save As > SketchUp Version 6).]*

Section 4: Importing the Textured Overpass Back into ArcGlobe

15. In ArcGlobe, begin a 3D editing session. Use the Edit Placement tool on the 3D Editor toolbar to select the overpass. While the overpass is selected, use the Replace with Model function in the 3D Editor toolbar and navigate to the COLLADA(or SketchUp) file saved in Step 14. (A textured COLLADA file is also provided in the 3D Models directory in the ZIP file.) After the file is selected, save the edits. The newly textured overpass will appear in place of the untextured version (The textured multipatch supplied in the Overpass.gdb is overpass_mp feature.)

16. As a final touch, add shadow underneath the overpass to mask the duplicate imagery on the expressway below. A copy of the

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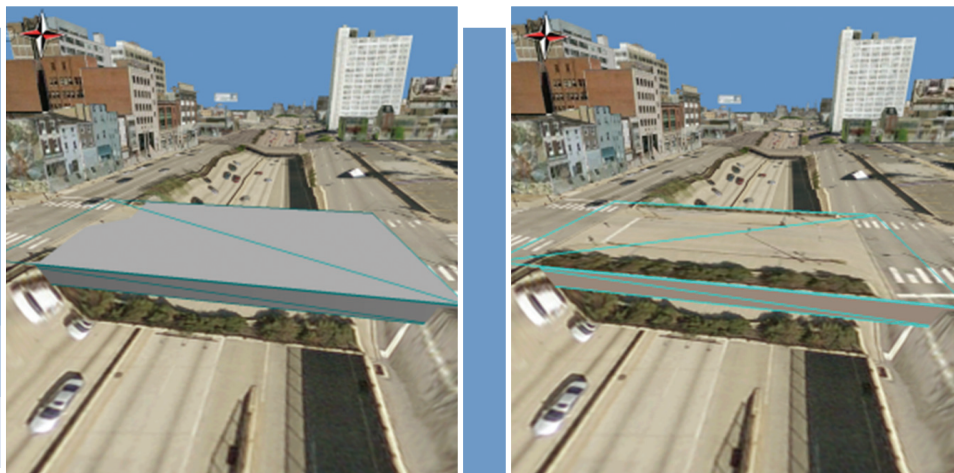


Figure 11: Use the Edit Placement tool and the Replace with Model function in the 3D Editor toolbar to add the COLLADA (or SketchUp) file.

original overpass polygon was adjusted to be slightly narrower on each side so that the shadow doesn't appear on the upper road surface edges. (Use shadow_ply in the Overpass geodatabase.) An 80 percent black fill is applied (CMYK=0,0,0,80) along with a 10 percent transparency. The finished product,

compared with the original image, is shown in Figure 12.

Conclusion

This exercise outlined the basic steps and tools needed to create a textured 3D multipatch feature in ArcGIS 10. The workflow is simple,

but the techniques for feature extrusion, multipatch creation, and texturing can be applied to create complicated 3D structures such as bridges, houses, or high-rises. If just 3D analysis is the goal, skip the texturing steps and see the ArcGIS Resource Center help topic "Obtaining elevation information for building footprints" to learn how to quickly create a city's worth of 3D multipatch buildings from footprint polygons with height attributes.

Visit the 3D GIS Resource Center (bit.ly/a0vnDp) and 3D GIS blog (bit.ly/g5J6xq) for tips on working with and analyzing 3D data in ArcGIS, and video demonstrations highlighting the different types of analysis possible in ArcGIS 10, such as volumetric shadow analysis over time, 3D feature extraction from LiDAR, and 3D viewshed analysis. Download additional 3D templates and workflows from the 3D Template Gallery. The 3D City: Philadelphia template is particularly useful for those new to virtual cities in ArcGlobe. It includes a collection of highly detailed 3D building models, vegetation, and street furniture for downtown Philadelphia, Pennsylvania.



Figure 12: Now compare the overpass in these before (left) and after (right) images.





Place and Health

Designing communities that promote well-being

By Monica Pratt, ArcUser Editor

“GIS is moving to a different stage,” Esri president Jack Dangermond said in his keynote address at the Healthy Communities by Design Summit held in November 2010. “We now want to create better communities from the start, not just fix communities that we have messed up. We need energy and thought about the kind of communities we want to live in.” (See the accompanying article, “Summit Promotes GeoDesign for Healthy Communities.”)

Researchers in health care, along with planning and environmental management, were early adopters of GIS. In health care, GIS has underpinned much of the work that has been done to understand and respond to pandemics and other types of disease outbreaks, optimize emergency health care response to natural and human-caused disasters, and manage hospitals and health care facilities more effectively.

As GIS has moved to the enterprise level in many organizations and expanded to new platforms (e.g., Web, mobile, cloud), public health officials and researchers began implementing an approach to promoting well-being called healthy communities. More preemptive, less reactive, this approach exploits new GIS capabilities and applications of GIS and a methodology called GeoDesign.

What Are Healthy Communities?

The idea behind healthy communities is not new. It was expressed in 1979 in the U.S. Department of Health and Human Services’ Healthy

People Initiative. It is a deceptively simple idea: “Increase the quality of life for all Americans and eliminate disparities in health status.”

Health is more than the absence of disease and infirmity—it is well-being. Healthy Community Design, a program of the Centers for Disease Control and Prevention (CDC), stresses the importance of community design to increase physical activity and access to healthy food; decrease or minimize injuries, mental health stresses, and the effects of climate change; and improve air and water quality and the strength of social connections.

The CDC, World Health Organization (WHO), and other organizations that promote health advocate designing new or redesigning existing communities in ways that

- Integrate different kinds of housing choices with access to government and commercial uses.
- Promote transportation alternatives to driving such as bicycling, walking, and using mass transit.
- Preserve open spaces such as parks, forests, and wildlife corridors.
- Encourage brownfields cleanup and development and the practice of infilling sites rather than continually developing at urban boundaries.

The places where you live (and have lived) affect how healthy you are and how likely you are to die in any given year. *The Grim Reaper’s Road Map: An Atlas of Mortality*, published in Britain in 2008, is a collection of maps that reveal the geographic patterns of mortality for specific



causes of death.

For example, people living in southern Scotland are more likely to die from brain cancer, while those in northern England are more likely to succumb to cervical cancer.

In his TED talk, Esri's health and human services industry manager Bill Davenhall asked, "Can geographic information make you happy?" After suffering a heart attack in 2001, he examined the places that he had lived and discovered that—quite unintentionally—he had lived in some of the most polluted places in the United States. "By design, if I'd wanted to have a heart attack, I've been in the right places," he said. Relevant information on the quality of the air, water, ground, food, and other factors about the places where Davenhall lived was never considered in his medical treatment at any stage of his life.

However, this is easily accomplished using GIS. Esri has created My Place History, a free, simple-to-use app for the iPhone, iPad, and iPod touch that demonstrates how GIS can provide insights into the effects of personal geography on individual health. Nations spend great sums of money collecting data on areas with adverse environmental conditions. In the United States, much of the data about these environmental conditions is readily available. After inputting the addresses and time periods where the user has lived, My Place History queries data from the Dartmouth Atlas of Health Care, the Toxic Release Inventory of the United States Environmental Protection Agency, and the Haz-Map of the U.S. National Library of Medicine to identify potentially adverse conditions near each address and creates a personal place history for an individual.

Just as GIS can be used to assess the factors that could have contributed to Davenhall's heart attack, its ability to place data and information in context to discover relationships is a powerful tool for moving from diagnosis to prevention and from the individual to the community.

Unintended but Not Inconsequential Consequences

Poorly designed communities can significantly contribute to poor health outcomes for their residents. The tremendous impact of community design can be appreciated by looking at the causes and effects of obesity, just one aspect of health that is linked to design.

Many problems plaguing communities, like obesity, have been quite literally built into them. The classic 1950s vision of suburban development separated where people worked from where they lived and where they shopped. As Dangermond has observed, this type of development is the product of "cheap energy and single-sector thinking. We can do

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Summit Promotes GeoDesign for Healthy Communities

More than 130 public health professionals gathered for the inaugural Healthy Communities by Design Summit to share their work in creating places that promote healthy minds and bodies in a sustainable environment.

The summit was held November 15–18, 2010, at Esri's Redlands, California, headquarters and at the Loma Linda University (LLU) campus in Loma Linda, California. Esri and LLU cohosted the event.

"Designing and building healthy communities improves quality of life for all and creates an environment in which every person is free to age in place and remain all their lives in a community that reflects their changing lifestyles and changing physical capabilities," said Jack Dangermond, Esri president and one of the event's keynote speakers.

Healthy community design provides a framework for creating communities that improve the quality of life for residents while respecting the natural environment.

At this invitation-only event, researchers, program directors, physicians, nurses, and students from government public health agencies, universities, nonprofits, and businesses met to discuss the environmental factors that affect health and how geospatial analysis can be incorporated into community planning practices.

The program, which spanned two and a half days, included presentations, moderated panel discussions by leaders in the community planning and design, environmental health, health policies and research, and built environment disciplines. The topics discussed include not only research and policy development but also strategies for educating and engaging communities.

"We exceeded our expectations," said Bill Davenhall in his closing remarks. Davenhall, one of the event's organizers and Esri's health and human services industry manager, said his goal for the conference was to make sure that healthy communities was well represented in the discussion of GeoDesign. He observed that people in the healthy communities movement are doing important work but are struggling. An important goal going forward is finding better ways to share often limited resources. GIS tools are useful to this end but are not broadly, or in some cases, intelligently used. "Results matter. This issue needs to be in your face. Instant gratification is required to get people to change. They have to see change and need community feedback," said Davenhall.



Place and Health

Continued from page 15

much better by looking beyond economic considerations into social, environmental, and other factors.”

Separating where people live from where they work means hours spent commuting. This really means hours of sitting, often in congested traffic, while driving to and fro, which adds to the stress of a long day.

In highly auto-dependent communities, stores, schools, and other common destinations, as well as employment centers, can't be reached except by car. These communities typically lack an infrastructure that promotes exercise and often have limited ready access to fresh, healthy food choices. Consequently, they also have many individuals who are overweight and obese.

Many chronic, life-threatening diseases—diabetes mellitus (Type 2 diabetes), cardiovascular disease, stroke, hypertension, and some cancers—are associated with obesity. Taken together, these diseases impose a great economic burden on health care systems and contribute to morbidity, mortality, and disability and detract from the quality of life for afflicted persons and their families.

Diabetes, just one of these lifestyle-related diseases, exacts a staggering price from society. The American Diabetes Association estimated that in 2007, diabetes in the United States cost \$174 billion. Diabetes treatment accounted for \$1 in every \$10 spent on health care. Other indirect costs of diabetes include absenteeism, reduced productivity, and lost productivity (caused by early death).

Making Problems Visual

The development of GIS-based tools for GeoDesign provides a way to significantly improve how communities are designed or redesigned to encourage lifestyles that help residents maintain a healthy weight.

What is GeoDesign? Michael Flaxman, assistant professor of urban technologies at the Massachusetts Institute of Technology, defined GeoDesign as “a design and planning method that tightly couples the creation of design proposals with impact simulations informed by geographic contexts.” It is a methodology for balancing social and biological aspects with economic considerations when planning communities. With GIS, the hidden costs of decisions can be teased out and quickly assessed.

“One of the powers of GeoDesign is it makes these problems visual,” said Thomas Fisher, dean of the College of Design at the University of Minnesota. He sees GeoDesign as a powerful approach because it makes problems visual. “They [problems] are easier to ignore when they are abstractions. Because we have been designing the world without data-rich knowledge of consequences, we’ve created a situation where we’ve made ourselves vulnerable as a species, which to me gives urgency to GeoDesign. This is something we don’t have a lot of time to develop.”

Suburban development in the United States over the past 60 years illustrates the unintended consequences of designing without “data-rich



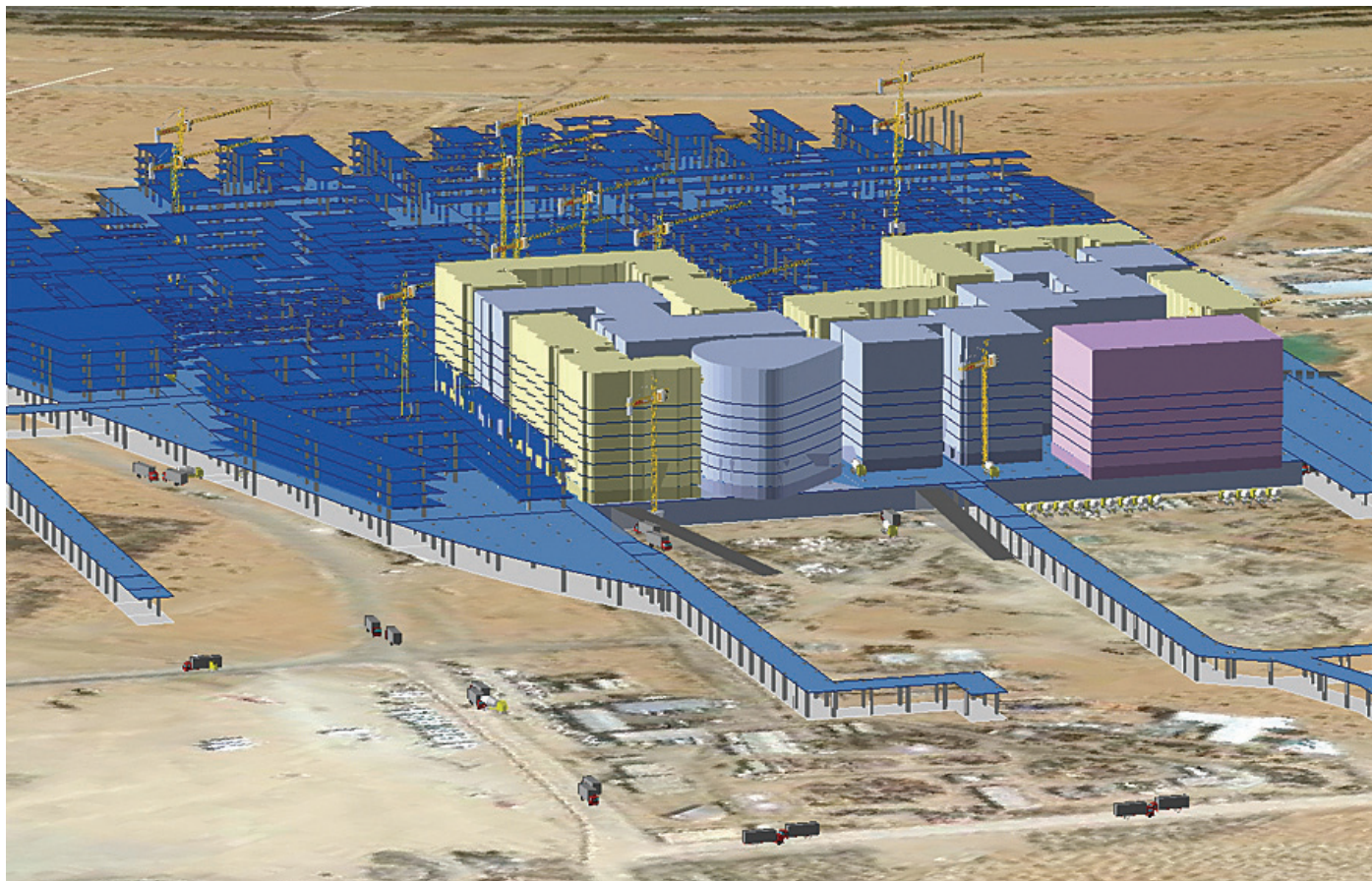
▲ My Place History, a free, simple-to-use app developed by Esri for the iPhone, iPad, and iPod Touch, demonstrates how GIS can provide insights into the effects personal geography on individual health.

knowledge” and context. To meet the housing needs of veterans returning from World War II, a planning model was actively pursued that separated where people worked from where they lived and where they shopped. The argument for this type of suburban development was that the relatively low cost of housing (at least during the initial development phase) made it more affordable.

However, an important question wasn't asked: What does a daily commute really cost? According to the U.S. Census, getting to work means driving alone for 77 percent of American workers. The gasoline required for the trip is an obvious cost, but the expense of purchasing, maintaining, and insuring a car and the cost of building and maintaining the streets, highway, and freeways needed by all those suburban commuters should be included in the tally.

Highway fatalities are a less obvious cost of commuting. In 2009, nearly 34,000 people died in auto and motorcycle accidents according to the National Highway Traffic Safety Administration. Air pollution, a factor strongly correlated with many potentially fatal conditions, such as asthma and heart disease, is also a by-product of commuting that affects not only commuters but anyone living in the region, especially those in proximity to freeways and highways.

Even less apparent is a cost in quality of life. Commuters strapped in car seats for hours each day, often stressed by traffic congestion, are deprived of time with family and friends and have more limited opportunities to exercise or follow other pursuits.



▲ The geodatabase made data about the Masdar City project available as maps, data, and analytic services via ArcGIS Server to the more than 100 organizations involved.



▲ Masdar City will be the world's first carbon-neutral, zero-waste city powered by renewable energy sources.

A more comprehensive accounting of the costs associated with the decision to separate work and home can be accomplished and the resulting information visualized with GeoDesign. Placed in a larger context, that house in suburbia no longer seems as affordable.

A New Kind of Community

GeoDesign is the process and GIS the technology that enable a quick and penetrating design. While this Imagine > Visualize > Assess > Repeat approach is not new, the technology to realize it more effectively is. Esri is evolving ArcGIS to provide platforms, tools, models, and workflows that can drill down into contextual information and also be rapidly iterative.

The vision of a community designed to be both healthy and sustainable is becoming a reality in the southeastern Arabian Peninsula. Located in Abu Dhabi in the United Arab Emirates (UAE), Masdar City is heralded as the world's first carbon-neutral, zero-waste city powered by renewable energy sources.

The information needed to design, build, and operate Masdar City is managed in GIS. CH2M HILL, an Esri business partner, was chosen as a leading partner on this project. CH2M HILL used GIS to integrate data on the geography of the area with a range of the design strategies of traditional Arabic architecture and regional urban planning practices with advanced renewable energy and clean technologies.

"Building a city like this has never been done before, and GIS is

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proving to be an absolutely critical tool,” said Shannon McElvaney, who was an information solutions consultant for CH2M HILL on the project. (McElvaney is now the Esri GeoDesign project manager.) Information from the geodatabase containing data on environment, infrastructure, elevation, vegetation, imagery, buildings, costs, schedule, and carbon tracking was made available as maps, data, and analytic services via ArcGIS Server to the more than 100 organizations involved in the project.

The Time Has Come for Healthy Communities

Creating healthy communities is an old idea that has been reborn at a time when the tools are available to realize this goal. Historically, planning processes have cast social values and environmental values as competing with economic considerations. GeoDesign takes into account the impact of decisions. By quantifying the cost of adverse effects to society and the environment, these hidden economic impacts can be assessed. When considered in context, social, environmental, and economic factors are not in conflict but in harmony.

“We are on a threshold. Now we have the technology to change things,” said Dangermond at the Healthy Communities by Design Summit. “We can bring this down to individual decisions and make those decisions consistent with sustainable practices. This process uses the Web, is inclusive, and uses the language of visualization. It will use a process that will let us look at alternatives and their consequences and evaluate them *quickly* to determine whether an action and its consequences are appropriate for sustainable communities.”

Tools for Building Healthier Communities

Nonprofit organizations are leaders in efforts to create healthy communities. To effectively perform this important work, they need the same tools and capabilities as governments and commercial enterprises. A new program sponsored by Esri makes ArcGIS software and support resources available to qualifying nonprofit organizations that are working on environmental or humanitarian initiatives.

GIS has long been used by nonprofits and other organizations to promote healthy communities. It is being used in support of healthy communities on scales from local to global. According to the United Nations Environment Programme (UNEP), one child under the age of five dies every 20 seconds from water-related diseases. Cutting in half the number of people who lack access to improved drinking water and sanitation is one of the United Nations-sponsored Millennium Development Goals (MDG).

This goal is being realized through a project that helps improve access to clean drinking water in Mayange and other communities across sub-Saharan Africa. Two professors from the University of Redlands in California, Max Baber and Katherine Noble-Goodman, and a group of students mapped water sources and collected water use data using GIS and GPS. This information will improve the health of communities in this area.

Esri was originally founded as a nonprofit. Although Esri later became a private company because the commercial model provided a better way for developing professional GIS tools, a passion for helping society and the environment remain core company values. Through a variety of grant programs, Esri has donated many millions of dollars to nonprofit organizations, many of them nongovernmental organizations (NGOs), in the form of software, training, consulting, and project support.

“We have always provided our software to NGOs around the world,” said Jack Dangermond, president of Esri. “We want geospatial technology to be available to NGOs of all types so they can build their own data, use government data, and be more active participants in maintaining the health of our planet.”

The program, which includes ArcGIS Desktop, ArcGIS Server, and enterprise license agreement options, provides single-seat licenses of ArcGIS Desktop, ArcGIS Desktop extensions, ArcGIS Server, ArcGIS Server extensions, and community and self-help support to eligible organizations. Visit esri.com/nonprofit for additional information.



Turning Red Zones Blue

How GIS can help create healthy communities

By Monica Pratt, ArcUser Editor



“How can we turn red zones into Blue Zones?”

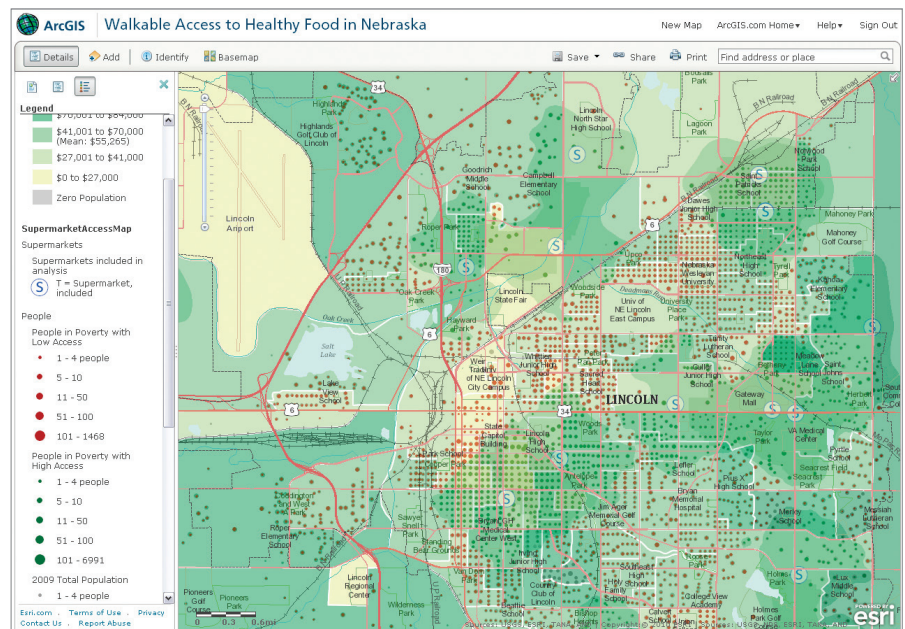
Seth Wiawe asked this question of the attendees of the Healthy Communities by Design Summit, cosponsored by Esri and Loma Linda University in November 2010.

The summit, cosponsored by Esri and Loma Linda University, explored the ways that GIS can be used to design communities that foster lifestyles that improve the well-being of their residents. (For more information on this event, see the accompanying article, “Summit Promotes GeoDesign for Healthy Communities.”)

Blue Zones is the name given by explorer, educator, and author Dan Buettner to places where people live long lives—often past the age of 100. Buettner found that people living in Sardinia, Italy; Okinawa, Japan; Loma Linda, California; Nicoya Peninsula, Costa Rica; and Icaria, Greece, lived not only long but also active lives.

Interest in determining the factors that contribute to a long, healthy, and active life has grown as health care systems in the United States and elsewhere have become more burdened by the substantial increase in chronic diseases and conditions, such as diabetes, heart disease, and high blood pressure, that are associated with lifestyle choices.

The healthy communities movement began in the mid-1980s as a response to the rise of chronic conditions rooted in lifestyle and environmental factors. This movement adopted a very broad definition of health and a very different approach to fostering it. In contrast



Environment influences food choice and physical activity. This map on ArcGIS.com shows where residents can walk to sources of healthy food.

to traditional health care, which concentrates efforts on identifying and treating disease in individuals, healthy communities work on strategies for improving the health of populations.

Creating a Blue Zone

Joel Spoonheim, director of Health Initia-

tives for Blue Zones, Healthways, described to Healthy Communities by Design Summit attendees how a prototype project made substantial improvements to the health of a Minnesota community in just 10 months. The project's goal was to transform this city into a Blue Zone by modifying the behavior of its

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Turning Red Zones Blue

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residents.

The AARP/Blue Zones Vitality Project, based on Buettner's research, was sponsored with a \$750,000 grant from UnitedHealth Foundation. It implemented a holistic approach to the well-being of the entire community—not just individuals. The focus was on well-being rather than health, because this broader term covers more than just physical health. Organizers wanted to find ways to make it easy for people to not only eat healthier food but also become more physically active, develop supportive relationships, and acquire a greater sense of purpose in their lives. They believe that changing environment is the key to changing lifestyles.

Albert Lea, a city of 18,000 located approximately 90 miles south of Minneapolis, was chosen for the project. The program began in January 2009 with a host of programs that encouraged these lifestyle changes in innovative and fun ways. Parents and volunteers walked children to elementary schools as part of the Walking School Bus Program. The project also organized adults into walking teams that promoted friendship and regular exercise. Grocery stores were urged to stock food that promotes longevity. Restaurants offered healthy side options and smaller portions. Space was made available for community gardens. Noted transportation expert Dan Burden did a walkability audit of Albert Lea. As a result, the town added sections of sidewalk that now connect previously existing routes.

Some changes were more subtle. Some simple modifications to home and workplace had a big impact.



A project in Albert Lea, Minnesota applied a holistic approach to improving the well-being of an entire community.

Using smaller plates, placing healthy foods at eye level, decorating lunchrooms so they were more enjoyable places to eat, holding standing or walking meetings, and changing vending machine selections were all quickly and inexpensively effected, making it easier for residents to add wholesome food and moderate exercise to their daily routines.

When the project officially ended in October 2009, the program's active participants had, on average, added 3.1 years to their projected longevity. They lost an average of two pounds, consumed more vegetables, engaged in more physical activities, and reported they felt less sadness. The City of Albert Lea has continued supporting the programs that were started during the project.

Spoonheim observed that successful programs are run by people who know the community and make recommendations that are specific and appropriate. Just applying a set prescription is not effective. GIS supplies the context for the community. Using an environmental approach, Spoonheim believes that communities can be transformed to improve the quality of life, not just its duration.

Empowering Local Change

Erika Lewis-Huntly, who works in the city manager's office in Rancho Cucamonga, California, another presenter at the Healthy Communities by Design Summit, described how

GIS has empowered Healthy RC, the city's successful and ambitious program for promoting a more vibrant community that has incorporated many of the techniques that were also used in Albert Lea.

The city's enterprise-wide GIS, Rancho Enterprise Geographic Information System (REGIS), is integrated into the daily operations of city staff members. It supplies maps, helps optimize operations, and makes support available to all city departments. Specific GIS applications have been developed by many departments including code enforcement, engineering, police, fire, emergency operations, community services, planning, special districts, and the city clerk's office.

A public-facing Web site, MyNeighborhood, hosts applications that give residents easy access to information on trash pickup, street sweeping, the general plan, zoning, city facilities, school districts, parks, utilities, and many other services. In recognition of REGIS' outstanding work, it received a Special Achievement in GIS Award in 2010.

In 2008, the City of Rancho Cucamonga launched Healthy RC, an initiative that encourages a lifestyle that promotes the well-being of its 180,000 residents and sustainability for the community. This approach comprehensively works to build a better community not only through programs and events but also by addressing changes in policy and infrastructure.

Because GIS is used extensively in creating the general plan, Healthy RC was able to use GIS to weave elements into the plan that promote healthy lifestyles. The GIS division has supported successful grant requests including a Robert Wood Johnson Foundation Healthy Kids, Healthy Communities program grant. The city was one of 40 in the United States chosen to participate in the four-year effort to improve food choices and increase physical activity for children and families, particularly those at highest risk for obesity.

As part of Healthy RC, REGIS was also used to locate city areas in need. Esri and city data was combined and used to identify areas of the city that had few green spaces, had limited access to grocery stores, or lacked infrastructure that let residents safely walk. GIS also helped the city find places for community gardens and farmers markets. After identifying community needs, the city held forums where residents identified good and bad features of their neighborhoods on maps.

The Healthy RC Challenge Online tool encourages healthier choices by giving residents an easy way to track exercise, diet, and even hydration. The Activity Tracker on the site lets program participants input steps from a pedometer or convert the time spent on many physical activities into equivalent measurements in steps. With an interactive map of the city, participants can measure walking or running routes by drawing them on the map. The site has routes for exploring the city, or participants can create and save multiple walking, running, or biking routes and share them with others. The site also helps people find other people to exercise with and promotes friendly competition through challenges.

The Time Is Now

Healthy RC exemplifies how a local government and its citizens can use geographic knowledge to redesign communities as places where people live long and active lives. Declining levels of well-being and rising costs—both economic and societal—attributed to lifestyle diseases and conditions are challenging communities to become Blue Zones.

This new era of citizen engagement and GIS has become an ecosystem on the Web that provides the framework for understanding communities. Many forces—technologi-

cal, social, and economic—have converged to make this possible. ArcGIS supports a pervasive geospatial platform that encompasses desktop, mobile, server, and Web. The Community Maps Program and other programs like it are making high quality maps widely available.

As Jack Dangermond, Esri's president observed in his keynote address at the Healthy

Communities by Design Summit, "Now we can measure and interact with everything and exert ourselves to say what we feel and think through a map." With the advances in GIS technology across all platforms and the development of the GeoDesign, which incorporates outcomes into decision making, there are greater opportunities to create the kind of communities in which people thrive.

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Making the Results of Analysis Accessible

ArcGIS Explorer plug-in aids natural resources management

By Yi-Chen E. Yang and Yu-Feng F. Lin, University of Illinois, Urbana-Champaign

Editor's note: A free plug-in for ArcGIS Explorer provides an accessible GIS-based decision support toolkit developed by the authors that encourages community participation.

Environmental resources management is a critical issue. Population growth means that more resources are required to sustain society and the natural environment. Yet data from the complex modeling studies that are frequently employed to quantify environmental trends are commonly either inaccessible or poorly understood by the decision makers who develop management policies and guidelines for natural resources management.

GIS is a powerful tool for evaluation and analysis of natural resources management problems. A GIS-based decision support system (DSS) can allow nontechnical individuals to visualize data and facilitate informed participation in decision-making processes. The combination of community participation and GIS-based DSS can bridge the gap between technical modeling results and social considerations for sustainable resource management.

The WebGIS Analysis Toolkit for Extensive Resources (uWATER), described in this article, is a plug-in for ArcGIS Explorer. uWATER is based on ArcGIS Explorer (build 1200) and is compatible with the more recent build 1500 of ArcGIS Explorer. It was developed using ArcGIS Explorer software development kit (SDK) with Microsoft Visual Basic 2008.

The system requirements for uWATER are the same as those for ArcGIS Explorer.

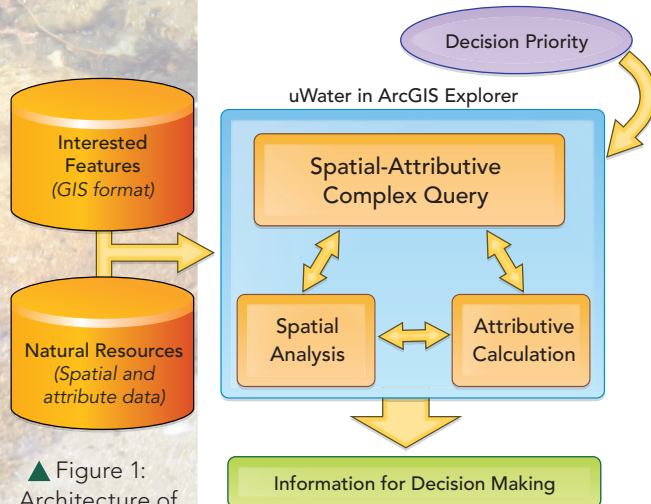
In the spirit of "GIS for Everyone," this ArcGIS Explorer Web GIS application gives decision and policy makers access to technical modeling results using customized interfaces and functions provided by developers. Analysis functions such as tabular attribute calculation and spatial and attribute queries allow decision makers to systematically examine natural resource availability and the impacts of development. The input data, supplied in shapefile format, required by uWATER includes data depicting features that could have an impact on natural resources (e.g., groundwater draw-down or population distribution) and data on natural resources that could be impacted (e.g., fish habitats or river flow rates).

Interface and Methodology

Installation of uWATER is simple. It does not require installing a conventional executable file (e.g., .exe or .dll) on the destination computer. Instead, uWATER uses an ArcGIS Explorer application configuration file (.ncfg) that installs automatically on any computer on which ArcGIS Explorer is properly installed. Obtain uWATER by downloading the uWATER toolkit from isws.illinois.edu/gws/sware/uwater/.

Double-clicking the uWATER1.0.ncfg icon opens ArcGIS Explorer and adds a customized tab, uWATER1.0, to the default ArcGIS Explorer interface. The uWATER1.0 tab contains a single control button that launches uWATER. The interface is designed as a dockable window in ArcGIS Explorer. uWATER has two major functions: attribute calculation and complex query.

The Attribute Calculation tab allows users to add a shapefile from the local computer to the ArcGIS Explorer display and perform simple attribute calculations using the shapefile's attribute table. The program permits addition, subtraction, multiplication, and division of any two numeric attributes. Calculation results



▲ Figure 1:
Architecture of
uWATER

are added to the ArcGIS Explorer table of contents and map display as notes, an ArcGIS Explorer data format denoted by a file folder symbol in the table of contents. All results of uWATER procedures are stored as notes and grouped in folders. The notes folder contains a single note for each feature in the shapefile. Each note generated by an attribute calculation is assigned a name that begins with the string CalNote. The remainder of the name is specified by the user and may include the FID (the feature ID that exists for every shapefile), the calculation result, or both. Notes have the same spatial domain as the original shapefile.

The Complex Query tab allows combined spatial and attribute queries of user-imported shapefiles. The shapefile name is entered in a window in the Add Shapefile for Query box as shown in Figure 2. An additional shapefile and notes can be used as criteria. If additional shapefile data will be included in the query, the Adding external shapefile radio button is selected. If notes calculated during the same ArcGIS Explorer session will be employed in the query, select the Using the previous calculated Notes radio button. Selection of either radio button activates a group box that allows the user to specify a range of data using minimum and maximum values from the chosen data source.

The user selects the desired spatial relationship for the spatial query from the options in Table 1. Clicking the Identify features button executes the query. Two folders of notes are created. The identified feature notes folder contains a note for each feature identified using the specified minimum and maximum values. Each note is (by default) assigned a name beginning with the string IdfNote (if the features are stored as notes) or EXTNote (if the features are stored in a shapefile). The spatial query notes folder contains one note for each feature identified through the spatial query. By default, the names assigned to these notes begin with the string SQNote.

A Real-World Application

Data from a real-world water resources management project in McHenry County, Illinois, is included with the uWATER application and can be used to demonstrate uWATER functions. The water supplies for McHenry County, located in northeast Illinois, are derived entire-

Figure 2: The uWATER interface showing the Attribute Calculation and Complex Query tabs

water discharge to rivers or wetlands. This could cause the decline of base flow or stream stage, resulting in serious ecological issues such as water quality degradation and fish habitat losses. Therefore, excessive groundwater drawdown should be evaluated in the areas where water supplies are heavily dependent on groundwater.

ly from groundwater. Consequently, groundwater is a vital resource for residents and the county's economy (Meyer 1998). With rapid population growth, groundwater withdrawals are expected to increase and may result in the degradation of the natural environment. Groundwater is found within underground aquifers in the saturated zone where water fills all the pore spaces in the subsurface materials. The water table (groundwater level) is located at the top of the saturated zone.

The Illinois State Water Survey used a groundwater model (Meyer et al., in preparation) to simulate the water table under different future climate and water use scenarios. The results are stored in shapefile format and displayed as model cells covering the entire spatial domain of McHenry County. The attribute table contains the elevation (in feet above mean sea level) of the groundwater level for each cell under different pumping scenarios. These are used as the input for uWATER.

First, uWATER can be used to compute the groundwater drawdown in each cell. When groundwater is withdrawn from a well, a cone of depression is formed. In this example, groundwater drawdown means the difference in a water table between natural (i.e., predevelopment) conditions and the water table after a cone of depression develops at the same location.

Groundwater drawdown might cause several environmental problems. Drawdown may dry nearby wells and result in an insufficient water supply; it may also decrease the ground-

water function in uWATER can easily compute drawdown using the water table from two different periods. For example, if one wishes to know drawdown in 2025 compared with predevelopment conditions, uWATER can compute the drawdown and show the results as notes in ArcGIS Explorer (shown in Figure 3).

If one wishes to evaluate the impact of groundwater drawdown on other natural resources, a uWATER complex query can be used. Natural resources, such as fish (represented by collection sites), rivers, and wetlands, may be depicted in three different spatial formats: points, lines, and polygons. An analyst may wish to identify natural resources that intersect cells that will have drawdowns greater than 5 feet in 2025.

uWATER first identifies the cells with drawdown greater than 5 feet using the groundwater modeling result shapefile. Figures 4 to 6 show the results of these queries. The blue cell is the groundwater modeling result shapefile, and the green cells are the cells with drawdown greater than 5 feet calculated by uWATER. Overlapped with the basemap underlying the groundwater modeling result, areas with larger drawdown values (green cells) are all located near large municipalities such as Crystal Lake, Woodstock, and Algonquin. After identification of these cells, uWATER conducts a spatial query on the fish sample sites (purple points in Figure 4), rivers (purple lines in Figure 5), and wetlands (purple polygons in Figure 6). Various natural resource features that might

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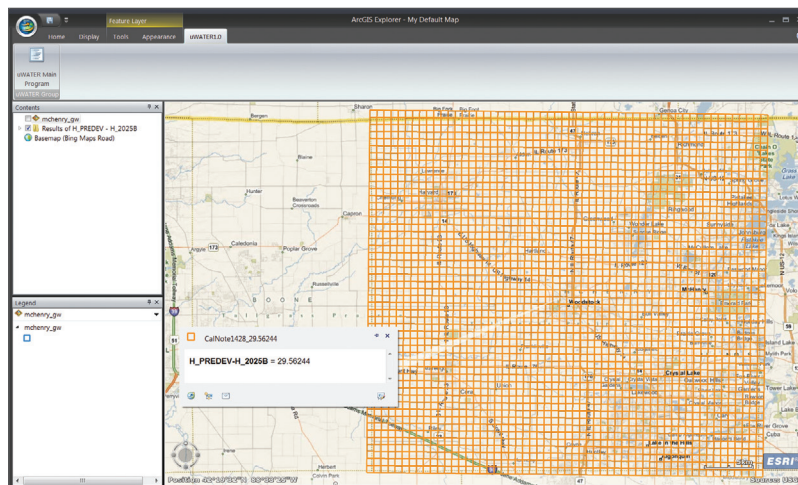
Making the Results of Analysis Accessible

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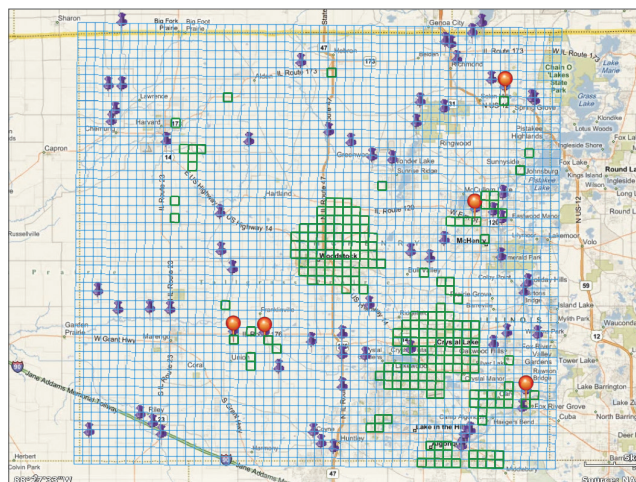
be affected by groundwater withdrawal can be easily identified (red-colored features shown in Figures 4, 5, and 6) based on the special distribution of green cells. In these examples, decision makers could choose to focus on these red-colored features.

Conclusion

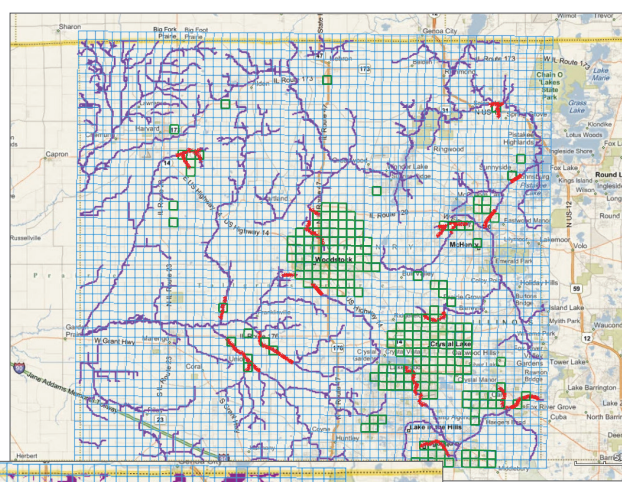
With this free GIS-based DSS, nonspecialists can consider the results of technical modeling, along with societal values, when making decisions that affect sustainable resource management. The uWATER package (main program, test data, and manual) can be downloaded for free at isws.illinois.edu/gws/sware/uwater/. The download package includes the plug-in program, user's manual, and example files.



▲ Figure 3: An attribute calculation in uWATER determining the level of the water table at two times (i.e., groundwater drawdown)

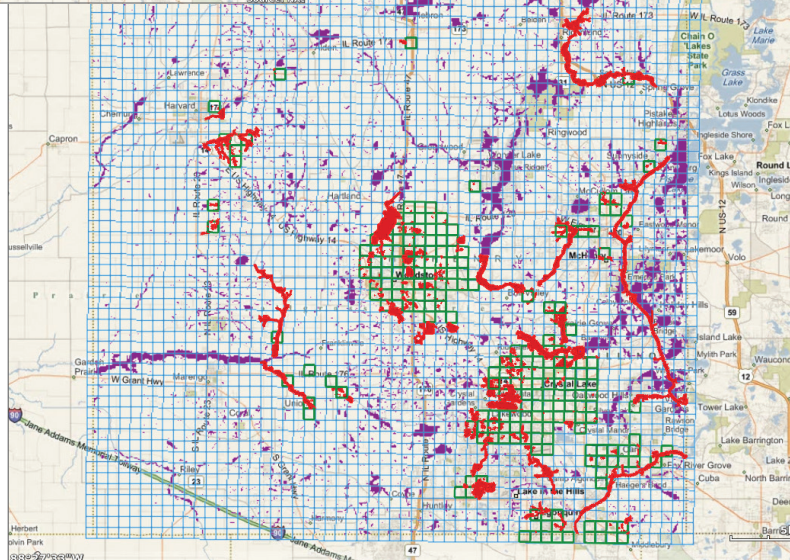


▲ Figure 4: A complex query in uWATER intersects query points for fish sample sites with polygons representing groundwater drawdown greater than 5 feet



▲ Figure 5: A complex query in uWATER intersecting query lines for rivers with polygons representing groundwater drawdown greater than 5 feet

► Figure 6: A complex query in uWATER intersecting polygons for wetlands with polygons representing groundwater drawdown greater than 5 feet



For more information, contact Yi-Chen E. Yang (yang24@illinois.edu) and Yu-Feng F. Lin (yflin@illinois.edu), Illinois State Water Survey, Esri–GIS Development Center, Institute of Natural Resource Sustainability, University of Illinois at Urbana-Champaign, 2204 Griffith Drive, Champaign, Illinois 61820.

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About the Authors

Yi-Chen Ethan Yang was awarded an Esri–GIS Development Center Scholarship at the University of Illinois in March 2010. Since receiving his doctorate in civil and environmental engineering from the University of Illinois, he has been employed at the Illinois State Water Survey and as an instructor at the Esri–GIS Development Center, which are both part of the Institute of Natural Resource Sustainabil-

ity at the University of Illinois. His research interests are coupled natural-human systems, agent-based modeling, and hydroecology.

Yu-Feng Forrest Lin is the founding director of the Esri–GIS Development Center at the University of Illinois and a hydrogeologist at the Illinois State Water Survey. His current research involves environmental impact associated with geologic carbon (CO₂) sequestration, GIS applications in natural resource management, and water resources investigations in the Great Lakes region.

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Method	Description
Contains	Searches for occurrences where the input geometry completely contains any of the geometries stored in the table. Valid for all shape type combinations.
Crosses	Searches for occurrences where the input geometry intersects any of the geometries stored in the table but only shares points in common, at least one of which is not an endpoint. A polyline and a polygon cross if they share a polyline in common on the interior of the polygon that is not equivalent to the entire polyline. Valid for polyline/polyline, polyline/polygon, and polygon/polyline shape type combinations.
Intersects	Searches for any type of spatial relationship between the input geometry and the geometries stored in the table. Valid for all shape type combinations.
Overlaps	Searches for occurrences where the input geometry intersects any of the geometries stored in the table but also where the region of their intersection is of the same dimension as the geometries involved and is not equivalent to either of the geometries (i.e., the shapes cannot be completely on top of each other). Applies to polygon/polygon, polyline/polyline, and multipoint/multipoint shape type combinations.
Touches	Searches for occurrences where the input geometry shares a common boundary with any of the geometries stored in the table but also where the intersection of the interiors of the searched shapes is empty. In the point/polyline case, the point may touch an endpoint only of the line. Applies to all combinations except point/point.
Within	Searches for occurrences where the input geometry is completely within any of the geometries stored in the table. Valid for all shape type combinations.

Table 1: Spatial query methods in uWATER (adapted from ArcGIS Explorer SDK Developer Help)

Simplifying Citizen Reporting

Smartphone 311 app enhances government responsiveness

By Matthew DeMeritt, Esri Writer

An application developed for all major smartphone operating systems enables citizens to more effectively and directly participate in local government by registering their concerns and forwarding those concerns to government work order management systems. Called CitySourced, the application was developed in summer 2009 by the company of the same name.

Many cities use GIS-enabled work order management systems to process citizen-reported infrastructure repair requests. These systems put repair incidents into prioritized queues and assign incidents to work crews. While this process is effective, a discrepancy typically exists between the number of incidents that need service and the number of reports about those incidents received. CitySourced realized that smartphones and GIS could be used to crowdsource these reports in a way that was both easier for residents and more efficient for governments.

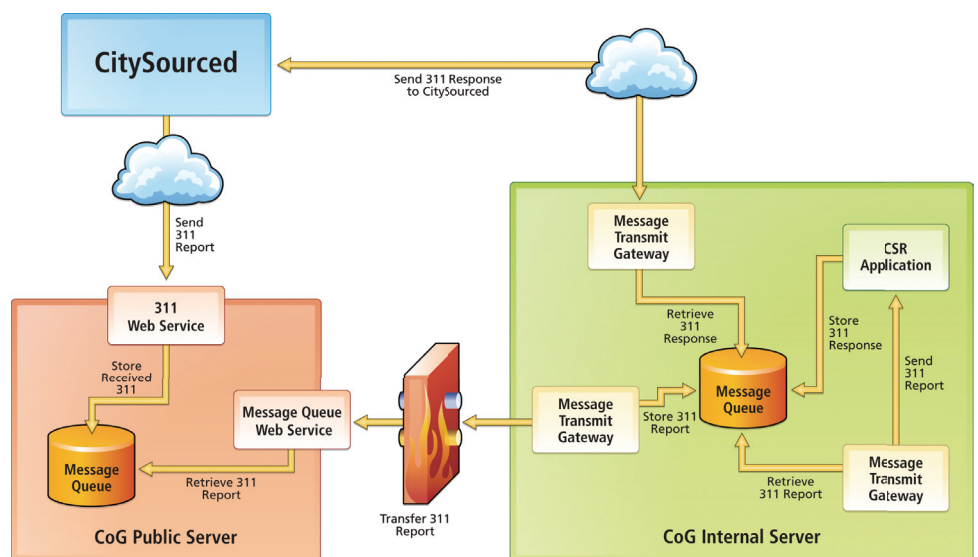
Adding Mobile VGI to Local Government

Many geospatially enabled applications and Web sites allow laypeople to record observations that appear immediately on a map or are processed and subsequently incorporated into a feature layer. Self-described as “a real-time mobile civic engagement company,” CitySourced is the latest expression of this type of crowdsourced or volunteered geographic information (VGI).

To report a local problem using CitySourced, a citizen simply takes a picture of it using the smartphone’s camera, categorizes the problem using the application’s pull-down menus, then submits the incident to the city’s work order queue. Because GPS-enabled smartphones geotag the photos, work crews can locate the problem without requiring a citizen to enter address information—the application can automatically return a map showing the location of the incident.

The application expands the responsiveness of local government enormously. In an average city, the number of staff members in the field is fairly limited, but the number of smartphone-carrying citizens is much greater. The CitySourced app essentially turns the average citizen with a smartphone into a sensor for a city.

“That’s important, because the labor bud-



▲ How messages are routed to CitySourced, then to the client

get of most cities is somewhere between 70 and 80 percent of the city’s total expenditure,” said Kurt Daradics, CitySourced cofounder and director of business development. “Anything that a city can do to make labor more efficient will positively impact its budget.”

CitySourced also gives city executives additional insights into their jurisdictions by revealing patterns not evident in tabular work order lists. By entering data into ArcGIS Server as a transaction, cities can perform analyses on the server and identify hot spots, find trends, and see changes over time.

Daradics uses the example of a map that CitySourced recently generated for Los Angeles city council president Eric Garcetti. A simple feature layer on a map of the city showed that 80 percent of graffiti incidents were concentrated within one mile of the freeway. “That’s the kind of information that will be very useful in response planning,” added Daradics.

Currently, cities can avail themselves of CitySourced services using a generic application that is available for major smartphone platforms. CitySourced has one of the largest geodatabases in the United States. Service requests issued from the generic app in unsubscribed cities go straight to CitySourced’s ArcGIS 10 and Microsoft Azure servers. Each service request is turned into a report and

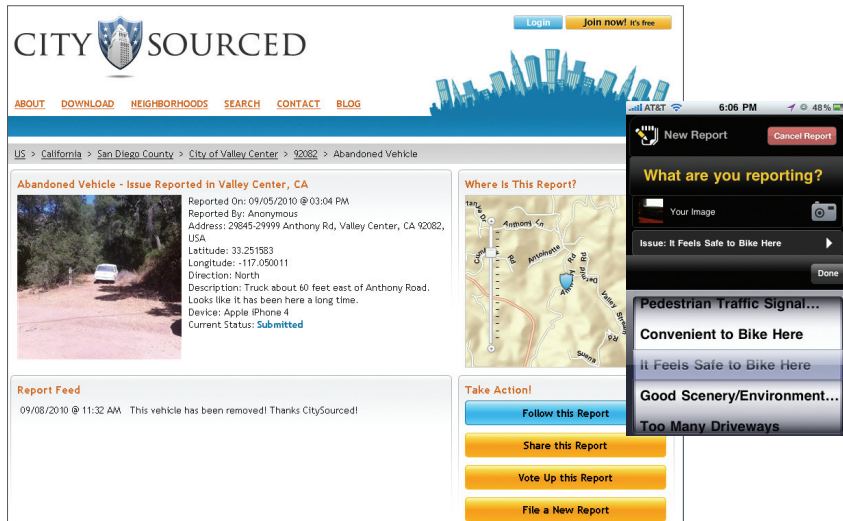
e-mailed to the appropriate city.

All reports are delivered in Esri formats that can be easily integrated with existing GIS implementations. CitySourced developed a REST application programming interface (API) composed of REST calls utilizing POST methods. Data is returned as either XML or JSON. Cities that subscribe to CitySourced receive a customized app that directly connects citizen service requests to existing work order systems, making e-mail reports unnecessary.

A Collaborative Platform with Many Uses

To monitor and improve its bike path infrastructure, the City of Reno, Nevada, recently drafted a master plan and hired CitySourced to create a custom app that would encourage bikers and pedestrians to record the condition of the path as issues arose. The city uses the data to update its inventory and provide maps that can be used to prioritize areas in need of response.

The University of California at Davis (UC Davis) is using the app to document its compliance with the university’s Stormwater Management Plan (SWMP), mandated by the U.S. Environmental Protection Agency (EPA) and California’s State Water Board. Campus maintenance teams use the app to acquire geotagged



▲ CitySourced Web site visitors can see service request reports for individual cities. This Valley Center, California, request includes the photo and status of an abandoned truck report. A variety of report types make reporting problems easy and specific. A comment field is also included for more precise reporting.



◀ Service requests issued from the generic app in unsubscribed cities go straight to CitySourced's ArcGIS 10 and Microsoft Azure servers, where those requests are turned into reports and e-mailed to the appropriate city.

Templates Aid Adoption of Citizen Service Request Services

With the release of ArcGIS 10, Esri created a series of templates to help government agencies implement ArcGIS. Distributed for free to users on the Local Government Resource Center, the templates are organized around local government workflows. One template, the Citizen Service Request template, was built to enable citizen service reports. The template can be used to configure ArcGIS to take service requests online. In addition to the JavaScript application citizens can use to submit service requests, it also includes a local government geodatabase with sample data from the City of Naperville, Illinois; local government basemap templates; and a service request map. Esri has also published a Local Government Service Request layer package that can be used to author an ArcGIS 10 feature service.

CitySourced's presentation during the Plenary Session at the 2010 Esri International User Conference generated great interest in mobile VGI. The company will continue working on different ways of encouraging the adoption of GIS to support the CitySourced platform. "Our mission is to transform civic engagement," said Daradics. "Transformation happens from the inside out, so we're committed to finding new ways to help our clients connect broken workflows, deliver transparency, and create more efficient feedback loops."

About the Author

Matthew DeMeritt is a writer in Esri's Marketing Communications Department. He focuses on GIS technology and the mining industry.

photographs with date/time stamps, and other data for potential storm drain violations. This has helped facilities staff mitigate potential violations, which could cause the university to incur fines up to \$27,500 a day.

The Future

CitySourced hopes to extend ArcGIS to deliver more value to its clients. Daradics is

currently working on functionality for querying the operational asset layer and delivering the asset ID (e.g., streetlight #1201) into the Object field of a work order. "That way, we can ID the asset number based on a decision tree," said Daradics. "This will help automate and prioritize service requests even more efficiently by answering the question Who's in charge here? geospatially."



Nearly 190 million metric tons of cargo come through the Port of Los Angeles annually. (Photo courtesy of Port of Los Angeles.)

Tracking a Dynamic Environment

System integrates information access for Port of Los Angeles

By Matthew DeMeritt, Esri Writer

The Port of Los Angeles' enterprise GIS system provides operational awareness and integrates both static and dynamic data at one of the world's busiest ports.

In terms of shipping container volume and cargo value, the Port of Los Angeles is the leading seaport in North America according to the American Association of Port Authorities (AAPA). It encompasses 7,500 acres with 43 miles of waterfront and 27 cargo terminals.

Ports have larger and more complicated infrastructures than most gateways of commerce. The physical structure can change over time as roads and railroads move, new docks are built, and infilling with rocks and gravel creates additional shoreline.

In 2009, the port hired Esri and GIS consultant NorthSouth GIS LLC to create a system that would aggregate, serve, and share port data throughout all its divisions.

The Main Driver: Unified Operations

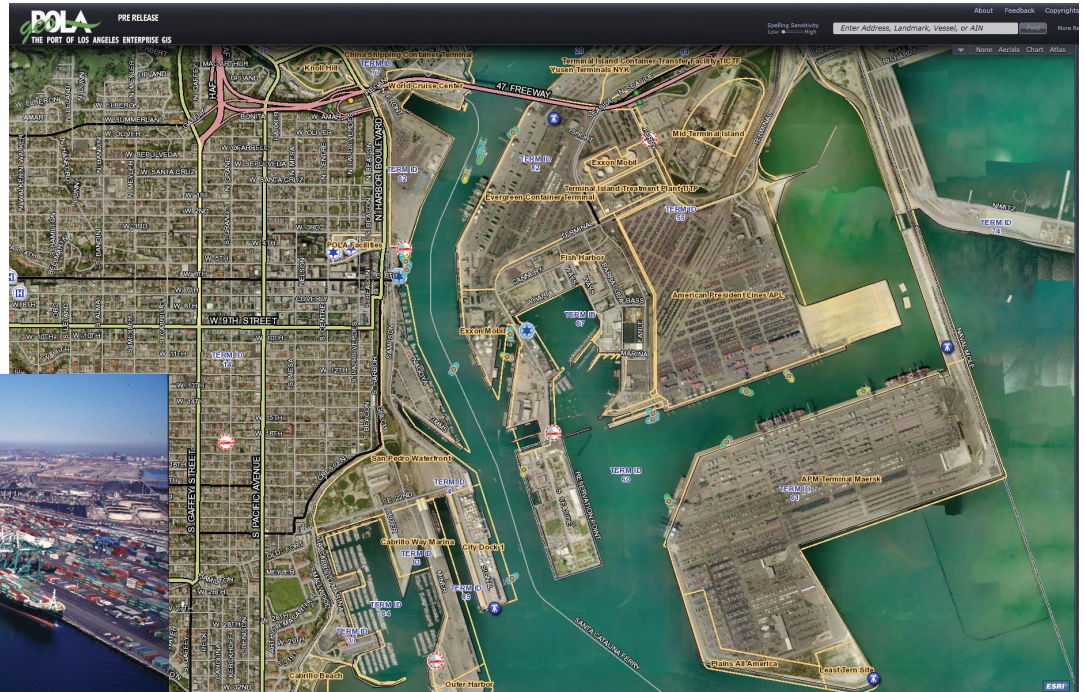
The port's 27 cargo terminals include dry and liquid bulk, container, breakbulk, automobile, and omni facilities. The volume of goods going through the port, combined with national security concerns, prompted

a focus on giving operations, including the Port Police, access to every kilobyte of data related to the port.

"The initiative to improve data sharing began with the police," said Christine Thome, enterprise GIS manager at the Port of L.A. "Port Police needed complete situation awareness, and that couldn't be had without a framework to access other divisions' data." Most of the data was locked up in GIS silos within the department, with no system in place to efficiently serve and share the information throughout the enterprise. The IT division knew that a simple data portal would allow police to mine whatever data they needed at any time.

"Optimizing the way our Port Police division dispatched officers to certain locations was a top goal," said Thome. "We know that a system of servers would provide a foundation for a robust Blue Force Tracking system that shows where all officers, vehicles, and vessels are at any given time." The success of the project convinced management—and the rest of the divisions that actively shared their data with Port Police—that an enterprise GIS implementation would work for all port operations.

▼ The main channel of the Port of Los Angeles, the leading seaport in North America in terms of shipping container volume and cargo value (Photo courtesy of Port of Los Angeles.)



▲ Port staff view data exclusively through geoPOLA, a viewer created with the ArcGIS API for Microsoft Silverlight.

Operational Awareness and Permissions

Because Port Police handle sensitive data that only security personnel can manage and view, data permissions for each department was an issue that needed to be addressed first. Every division that owns and maintains data for the Port of Los Angeles has permissions for updating and making changes to its datasets, but the security rights given to each layer depend on who has permissions to view and update that data.

“We formed a technical advisory committee to determine each division’s permissions to govern its own data,” said Daniel Elroi, president of NorthSouth GIS, LLC. “The division that ‘owns’ that data is the only division that can change it, though most port employees can view almost all the layers.”

The Enterprise Viewer: geoPOLA

In addition to a tremendous amount of static GIS data, the Port of Los Angeles also needed to integrate and display its dynamic data on an enterprise viewer. Information about ship schedules, weather, and movable assets is constantly updated and just as crucial to operations. Without access to that information, complete maritime domain awareness (nautical speak for “common operating picture”) wasn’t possible.

“A viewer was created with the Silverlight API that would display all enterprise data, including the dynamic data,” said Elroi. “Port data changes frequently in location, status, or both. The key to delivering optimal awareness across the board was to write software that combined static and dynamic awareness in one area for everyone to view.”

Port of Los Angeles staff view data exclusively through the browser-based Silverlight viewer called geoPOLA. The port’s GIS editors, who use AutoCAD and ArcGIS, have praised the viewer for its outstanding performance. In particular, they enjoy its ability to consume many different map services that can be used when working with GIS data.

Feeds and Metadata

One of the most important aspects of a modern GIS implementation is the integration of data from disparate sources. “We needed to carefully research which feeds we would connect to the enterprise viewer,” said Thome. “We knew there were good feeds out there but also ones that wouldn’t deliver the kind of information we needed.”

That process involved the creation of a Dynamic Data Focus Group that met and determined what type of dynamic data was needed. This group and NorthSouth GIS researched different sources of data to see if they had anything that the port could consume as a feed.

After three months of research, they finally chose the feeds that delivered the information the port could use on vessels, radar, automatic vehicle location (AVL), weather, traffic, and California Highway Patrol alerts. The system is also designed so that new dynamic feeds can easily be added through the GeoRSS broker.

Almost as important as dynamic data integration is the creation of metadata standards and procedures. For that, a metadata program was customized that simplified the creation, tracking, and management of the port’s finer-grained data. “That program was invaluable in helping us set up our standards and procedures for capturing metadata,” said Thome. “Without it, creating these standards manually would have taken forever.”

The Port of Los Angeles needed to integrate its internal operations to remain efficient and profitable. Today, more than 1,200 computer users at the port can access and update GIS data that provides a complete maritime domain awareness for the port. In 2010, the Port of Los Angeles received an award for excellence in technology from the AAPA for its enterprise GIS.

About the Author

Matthew DeMeritt is a writer in Esri’s Marketing Communications Department. He focuses on GIS technology and the mining industry.

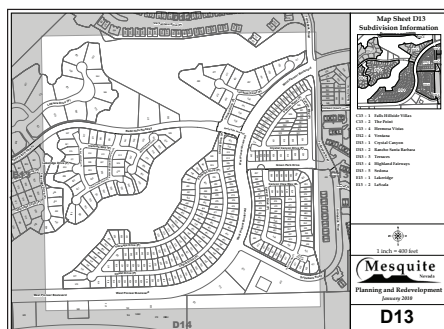
Big Benefits for Small Organizations

Automating map production saves time and money

By Shree Rajagopalan, Esri Production Mapping, Business Development, and Karen Richardson, Esri Writer

Adopting workflows that standardize and automate the creation of cartographic outputs from a GIS benefit not only large enterprises that create thousands of map products but also smaller organizations that regularly create map books, atlases, or other cartographic products for both internal and external customers.

Mesquite, Nevada, a city with a population of slightly more than 21,000, found cost savings by implementing ArcGIS and Esri Production Mapping. The city first published its *Address Map Book* in 1996 in CAD format. Although the *Address Map Book* was appreciated by end users, producing it was extremely labor intensive. Each year, the map book took three weeks or more to complete. Because it had become the standard reference guide for local utilities, land developers, real estate professionals, and outdoor enthusiasts, the city wanted to produce the book more quickly and easily.

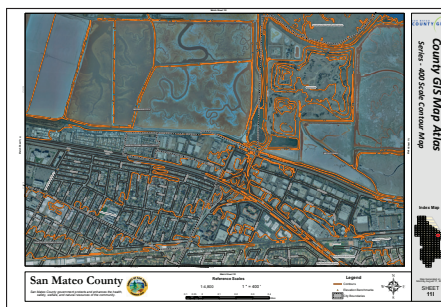


GIS staff in Mesquite, Nevada, now create a sophisticated map series product in two days instead of three (or more) weeks.

The city has been using Esri GIS since 1995. Mesquite began using Esri Production Mapping in 2008 to create the *Address Map Book* because it offered the cartographic functionality not available in CAD. This included selecting features in the area of interest for each map page, dynamically placing text on the map page, and producing dynamic inset maps for each page. Using Production Mapping, the city could create the three-section *Address Map Book* illustrated with basic reference graphics and tables for each city grid tile and detailed graphics for the city's 145 subdivisions.

The *Address Map Book*, a sophisticated

map series product, is now created by the GIS staff in two days instead of three or more weeks using the city's GIS. There is no need for duplicate CAD or other legacy files, so these files can now be archived and removed from the server, which promotes more efficient server management and file organization structure.



Instead of visiting the county offices of San Mateo, residents can download county maps as PDFs from the Web site.

With Production Mapping, map book templates can be easily modified to serve the specific needs of the police, fire, and public works departments. The city has been able to partially offset its annual software maintenance costs by charging a modest fee for printed or digital deliverables. Nearly 300 printed copies of the *Address Map Book* were requested during 2009, and the city made digital copies available in 2010. Delivering quality products is increasing the recognition for the GIS program. Using Esri Production Mapping has resulted in significant time savings for Mesquite.

When creating map products is a central service provided to an organization, it is important that the software used to create those map products fits in with the information technology department. Esri's ArcGIS platform with Production Mapping is based on accepted standards which ensures a high level of interoperability across platforms, databases, development languages, and applications.

The county of San Mateo, California's Information Services Department (ISD) assists approximately 20 departments within the county. San Mateo County GIS, a group in ISD, maintains accurate geographic data that is used by county employees.

County GIS produces map atlases that

have two predefined scales based on a grid system. Each map atlas contains between 40 and 160 map sheets. The map products include 1:800-scale basemaps, 1:400-scale aerial maps, and 1:400-scale contour maps. Until the 1990s, these map products were created using non-GIS technology purchased at the county office. Although the county adopted enterprise GIS in the early 2000s, large-scale map atlas production was not standardized and remained a cumbersome process that required staff to build and maintain several workspaces for each map product.

The county decided to move to a Web-based system but wanted to have a standardized map product first. County GIS engineers evaluated Production Line Tool Set (now known as Esri Production Mapping). The user interface for generating map atlases was more intuitive than the map plotting utilities previously used. With Esri Production Mapping, map products were standardized and their production streamlined. The county now builds a workspace for one map product and reuses the information for the others. A single layout can be used as a template to batch generate multiple maps rather than manually creating individual layouts—a significant time savings.

County GIS now provides its map products over its Web site, www.co.sanmateo.ca.us/portal/site/gis. The products are updated on a semiannual basis. Instead of visiting a county office, people who want county maps can download PDFs from the Web site and print them.

Esri Production Mapping helps organizations of any size create map products ranging from producing map books to advanced high-end cartography in a shared work environment that improves the quality and value of both geospatial data and cartographic products. Database-driven cartographic production—automating maps and charts based on the information stored in the GIS—makes Production Mapping a powerful tool for achieving cost savings by managing and publishing accurate data and cartographic products more efficiently. For more information, visit esri.com/productionmapping or e-mail productionmapping@esri.com.

Eye to the Sky

Transition from ArcIMS to ArcGIS Server makes state-of-the-art weather warnings a reality

By Matthew DeMeritt, Esri Writer

Current weather observations, lightning strike events, and storm reports—tens of thousands of new data elements used in predicting weather patterns can potentially become available each hour. AccuWeather, Inc., the leading global weather information provider, interprets this vast volume of data and issues weather bulletins to hundreds of millions of people each day via the Internet, mobile devices, print, and other media.

Businesses and consumers often require more precise weather warnings than government weather tracking systems provide. To meet that need, the more than 100 AccuWeather meteorologists use GIS to achieve the situational awareness needed to issue accurate, comprehensive severe weather alerts that help protect lives and property.

Meeting Client Demands

In 2002, AccuWeather began hosting custom Web sites for its clients using ArcIMS. Recently, the company adopted ArcGIS Server to enhance the weather content it served to customers.

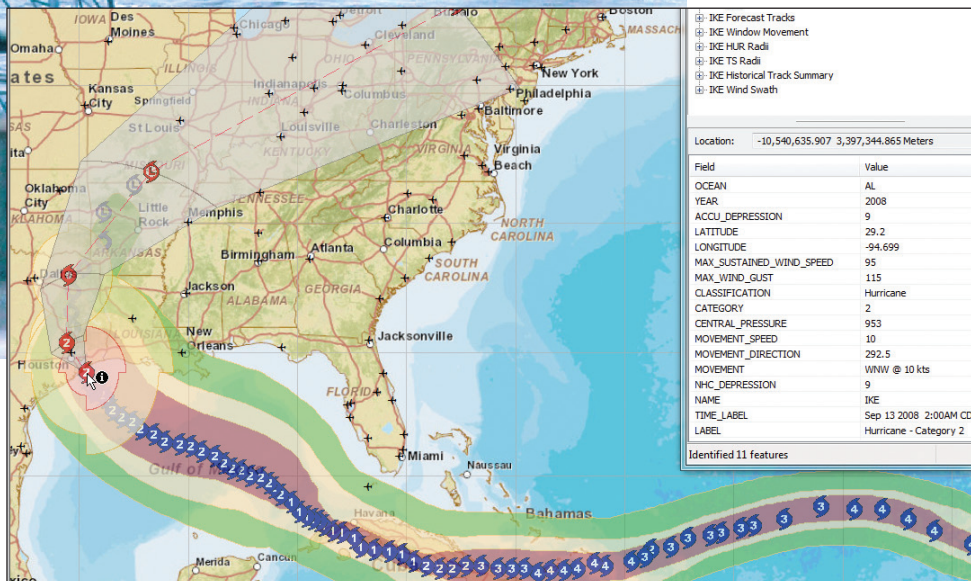
Initially, AccuWeather used ArcIMS to serve basic weather information. Later, the company relayed weather content and created specific products for clients with ArcIMS. According to Ethan Knocke, GIS technical coordinator for AccuWeather, that quickly paid dividends by attracting a diverse and demanding clientele who ended up pushing them harder.

“Clients saw our work and came to us with more challenging demands,” said Knocke, who is also a meteorologist. “We did a lot of cutting-edge configuration of our enterprise geodatabases and their associated connectors into ArcIMS Web mapping and data services to meet these needs.” AccuWeather’s work with one such client earned a Special Achievement in GIS Award at the 2005

Esri International User Conference.

For years, ArcIMS performed extremely well for the weather services provider. Its GIS team developed unique techniques for converting extensive global weather datasets into GIS formats that could be loaded into ArcSDE in real time. Integrating AccuWeather’s enterprise

Continued on page 32



▲ Users can easily embed SkyGuard Warnings, tropical impact forecasts, and other relevant current weather content into ArcGIS Desktop for visualization and analysis with their assets using SkyGuard data services. This map shows layers of the SkyGuard Tropical Impact Forecast Product Suite for Hurricane Ike loaded in ArcMap as a REST map service.

Eye to the Sky

Continued from page 31

data systems with Esri geodatabases created a seamless pipeline of weather content for clients. Users could view warning information as live layers and other rapidly changing data elements within seconds of their acquisition in a raw format by AccuWeather.

However, the meteorological team knew GIS server technology had evolved and could take AccuWeather products to the next level. “ArcIMS served us very well, but ArcGIS Server was doing things with geodatabase management, such as open Web services, interactive Adobe Flex client-side Web mapping, and mobile application development, that we really wanted to leverage in our continuing efforts to create a comprehensive, real-time weather portal,” said Knocke.

Pinpointing Threats

The U.S. government issues severe weather warnings for hazardous weather conditions such as tornadoes, thunderstorms, and flash floods. Affected areas are identified by political boundaries and issued for fixed thresholds. Consequently, an organization’s assets may fall within an area identified by a government warning but may not actually be in harm’s way.

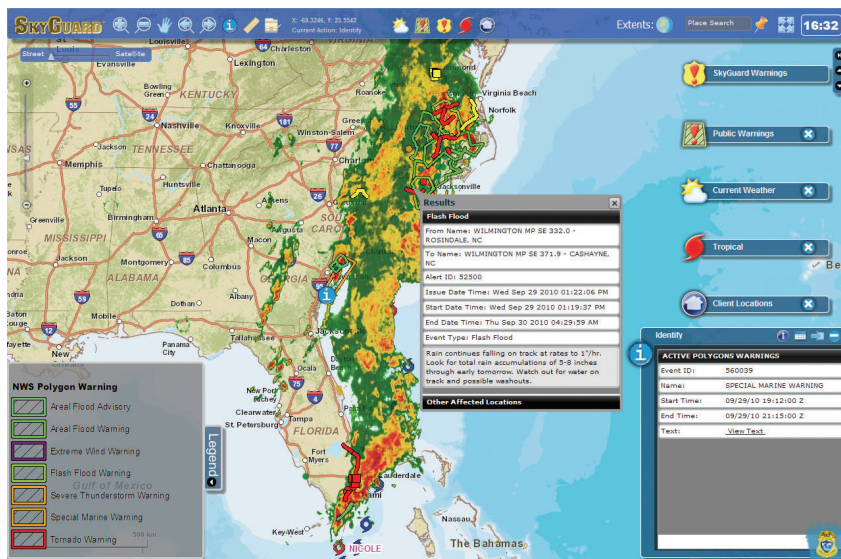
“Shutting down business when there is no actual risk from a weather situation can cost just as much as ignoring a legitimate warning and incurring weather-related damage,” said Jonathan Porter, AccuWeather’s manager of meteorological data. “That’s why there’s such demand for a pinpoint warning service like SkyGuard Warnings.”

Warnings delivered through AccuWeather’s SkyGuard Warnings service are based on specific criteria determined by the client and issued only when assets are in danger. SkyGuard warnings consist of point warnings applicable to locations such as schools, manufacturing plants, or corporate offices; segment warnings that relate to portions of a railroad or trucking routes; or areal warnings that cover energy grids, amusement parks, or other similar facilities.

Online Weather Portal

To generate such specific warnings, SkyGuard meteorologists closely monitor the geospatial relationship between a client’s assets and pending weather threats. Warnings must get to clients quickly as a comprehensive real-time view. ArcGIS Server enabled AccuWeather to create a highly available Web-based solution for its flagship SkyGuard product called SkyGuard Online.

The online weather portal, created using the ArcGIS API for Flex, displays SkyGuard warnings, tropical impact forecasts, and other relevant information on current conditions. AccuWeather’s team of meteorologists enters the data into the geodatabase, which appears in an all-in-one map viewer. Subscribers receive a secure Web portal customized to their location that supplies selected services. Customers may also upload their own data into their SkyGuard Online portal to create a centralized mashup of their assets and AccuWeather’s live weather information.



▲ SkyGuard Online, a real-time situational awareness Web application, leverages ArcGIS Server 10 and ArcGIS API for Flex to create a dynamic, interactive, and visually appealing weather portal. This image shows SkyGuard warnings in North Carolina and Florida related to Tropical Storm Nicole.

“It’s a real-time situational awareness tool,” said Knocke. “There would have been no way to configure ArcIMS to pull all of our time-sensitive warnings and weather information into one dynamic and visually appealing interface.”

Data Services: Open Data Models

ArcGIS Server also brought another level of efficiency to AccuWeather in the form of SOAP and REST services. “ArcGIS Server opened up the floodgates by providing much more flexibility with open data models,” said Knocke. “Many of our clients already have deployed full GIS infrastructures and just need the missing piece—the weather content—exposed as data layers via REST and SOAP Web services.”

Today, the GIS team can provide live Web services to its clients, who then integrate these services into their enterprise systems for visualization and modeling. “The geodatabase connectors in ArcGIS Server really opened the door for us,” said Porter. “They enabled us to easily integrate a vast array of weather data stored in back-end relational databases into the Esri product suite.”

As its visibility in the GIS space has grown, AccuWeather realized that it had to go beyond ArcIMS to meet and exceed the expectations of its client base. The SkyGuard Online weather warning portal builds on the benefits unique to the ArcGIS Server platform. Plans are currently under way for AccuWeather to enter the mobile GIS space with smartphone versions of SkyGuard Online.

About the Author

Matthew DeMeritt is a writer in Esri’s Marketing Communications Department. He focuses on GIS technology and the mining industry.

Understanding Geodesic Buffering

Correctly use the Buffer tool in ArcGIS

By Drew Flater, Esri Geoprocessing Development Team

Several years ago, a major newsmagazine published a map (similar to the one in Figure 1) that showed 10,000- and 15,000-kilometer (km) ranges for missiles launched from North Korea. If you lived in Europe, the Americas, or most of Africa and were not familiar with earth's dimensions, this map might have been comforting because it appears that those areas are outside the reach of even the longest-range missiles launched from North Korea. However, if you *are* familiar with earth's dimensions, you might have noticed something wasn't quite right with this map.

Earth's circumference is approximately 40,000 km. A 15,000 km buffer would result in a circle with a diameter of 30,000 km. Yet the buffer shown on this map covers far less than three-quarters of earth's 40,000 km circumference. Something was definitely off.

► Figure 1: The original map showing 10,000 and 15,000 km buffers around North Korea

▼ Figure 2: The corrected map showing 10,000 and 15,000 km buffers around North Korea

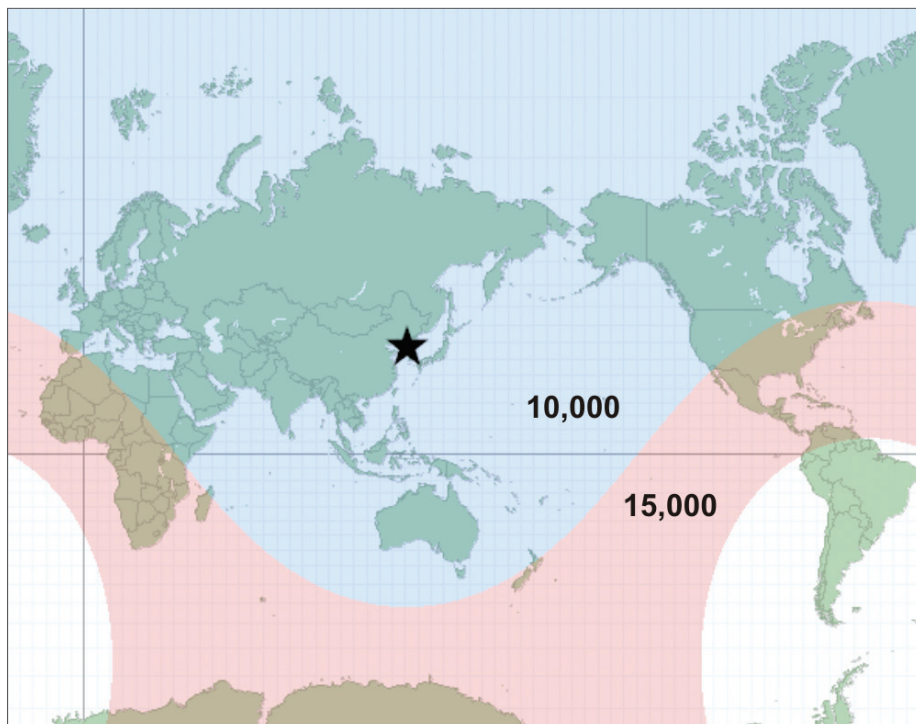
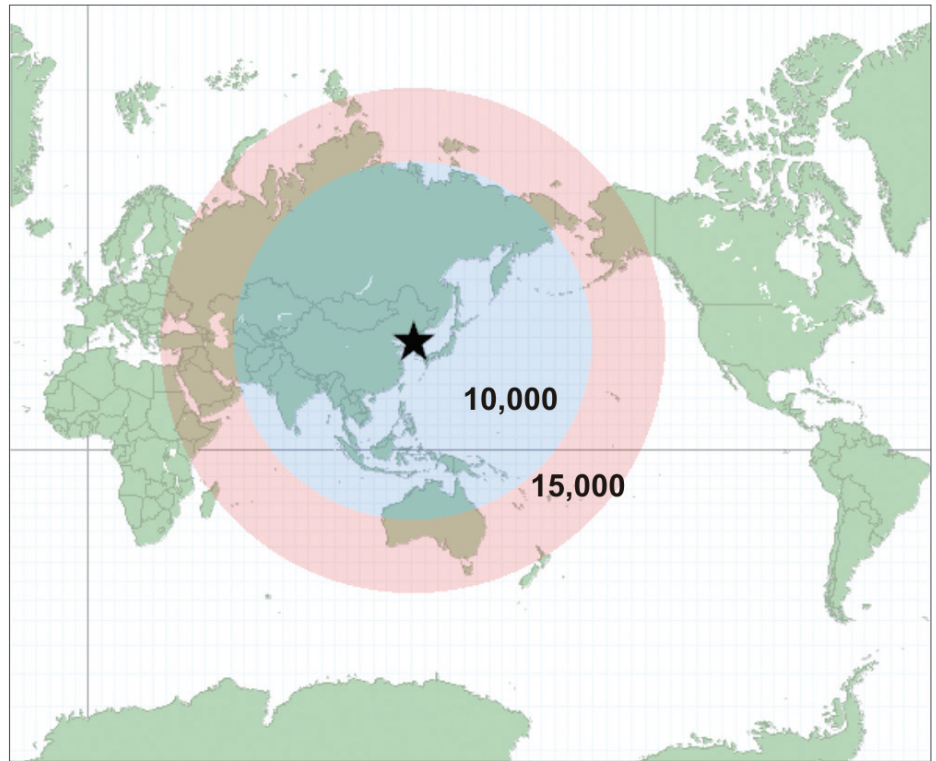


Figure 2 shows a corrected map that was published by the magazine two weeks later. In the corrected map, all of Europe, Asia, and most of North America are within the 10,000 km range, and only South America is outside the 15,000 km range. What went wrong with those original buffers? Could the analyst have entered the wrong buffer distances? The answer is not quite that simple.

Understanding Buffering

The Buffer tool, a geoprocessing tool in the Analysis toolbox in ArcToolbox, generates buffer polygons, or offsets, around input features at a specified distance. Buffers show the area that is within some distance of the input features. The tool is popular because the concept of buffering is easy to understand and buffering plays an important role in many geoprocessing workflows involving proximity or distance analysis (i.e., How far away are

Continued on page 34

Understanding Geodesic Buffering

Continued from page 33

these things? or What features are within a distance of other features?). Because the Buffer tool is important in performing proximity tasks, a key goal for developers working on this tool has been to ensure that buffers accurately depict distances around features.

The Buffer tool is used when analyzing data from many sources—from national forest inventories to local street centerlines. However, a better understanding of how this tool works is necessary to ensure that analysis results are reliable.

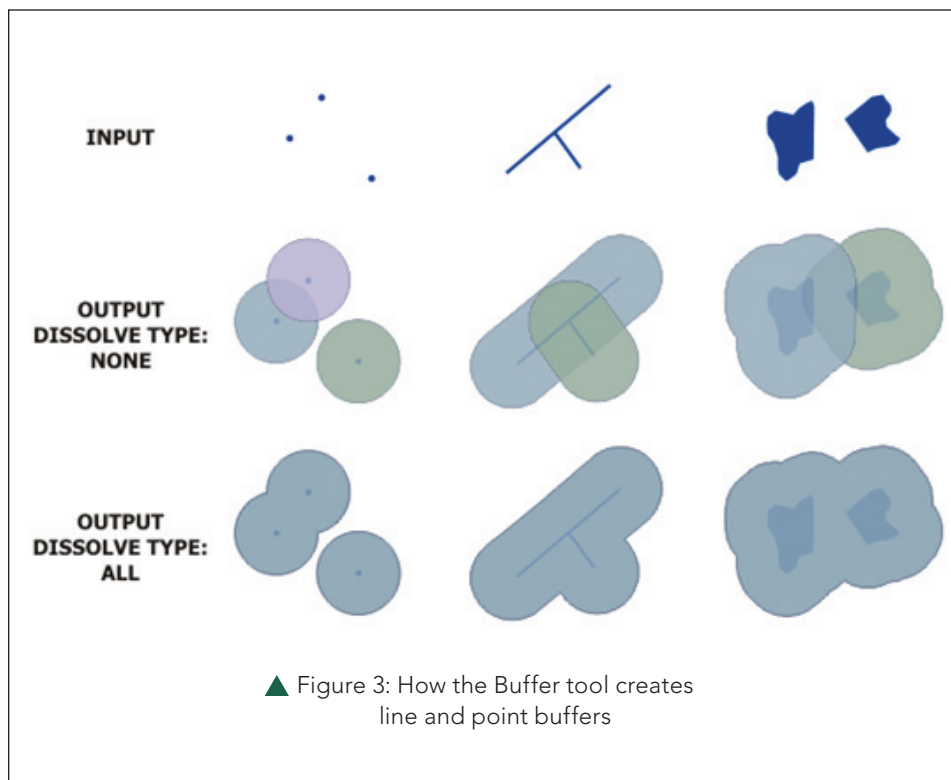
Euclidean and Geodesic Buffering

The ability to generate geodesic buffers is an important feature of the Buffer tool that can help prevent the kind of mistake made by the analyst mapping those missile ranges. Geodesic buffers account for the earth's actual shape in the calculation of the buffers. The earth is an ellipsoid (or, more properly, a geoid), and when the Buffer tool generates geodesic buffers, distances are measured between two points on a globe.

Euclidean buffers—another kind of buffer—measure distance on a two-dimensional Cartesian plane. With Euclidean buffers, straight-line distances are calculated between two points on a plane. Euclidean buffers appear as perfect circles when drawn on a projected flat map, while geodesic buffers appear as perfect circles only on a globe. On two-dimensional maps, geodesic buffers often appear as irregular ellipses.

Euclidean buffers are more common. They work well when analyzing distances around features that are concentrated in a relatively small area in a projected coordinate system (e.g., when all features are contained in one universal transverse Mercator [UTM] zone). Geodesic buffers are less common but provide more accurate buffer offsets for features that are more dispersed (i.e., cover multiple UTM zones, large regions, or even the whole globe).

In some situations, performing a Euclidean buffer will produce results that are not technically correct. In the missile range mapping example, the first map used Euclidean buffers, while the second map used geodesic buffers. The major danger when performing a Euclidean buffer on features stored in a projected



▲ Figure 3: How the Buffer tool creates line and point buffers

coordinate system stems from the distortion of distances, areas, and the shapes of features caused by projected coordinate systems.

For example, when using UTM (a projected coordinate system), features become more distorted the farther they are from the origin of the projection (i.e., the center of the UTM zone). When using a dataset that is not contained in a single UTM zone or when the buffer distance used is large enough to create offsets outside that zone, Euclidean buffers will yield incorrect results.

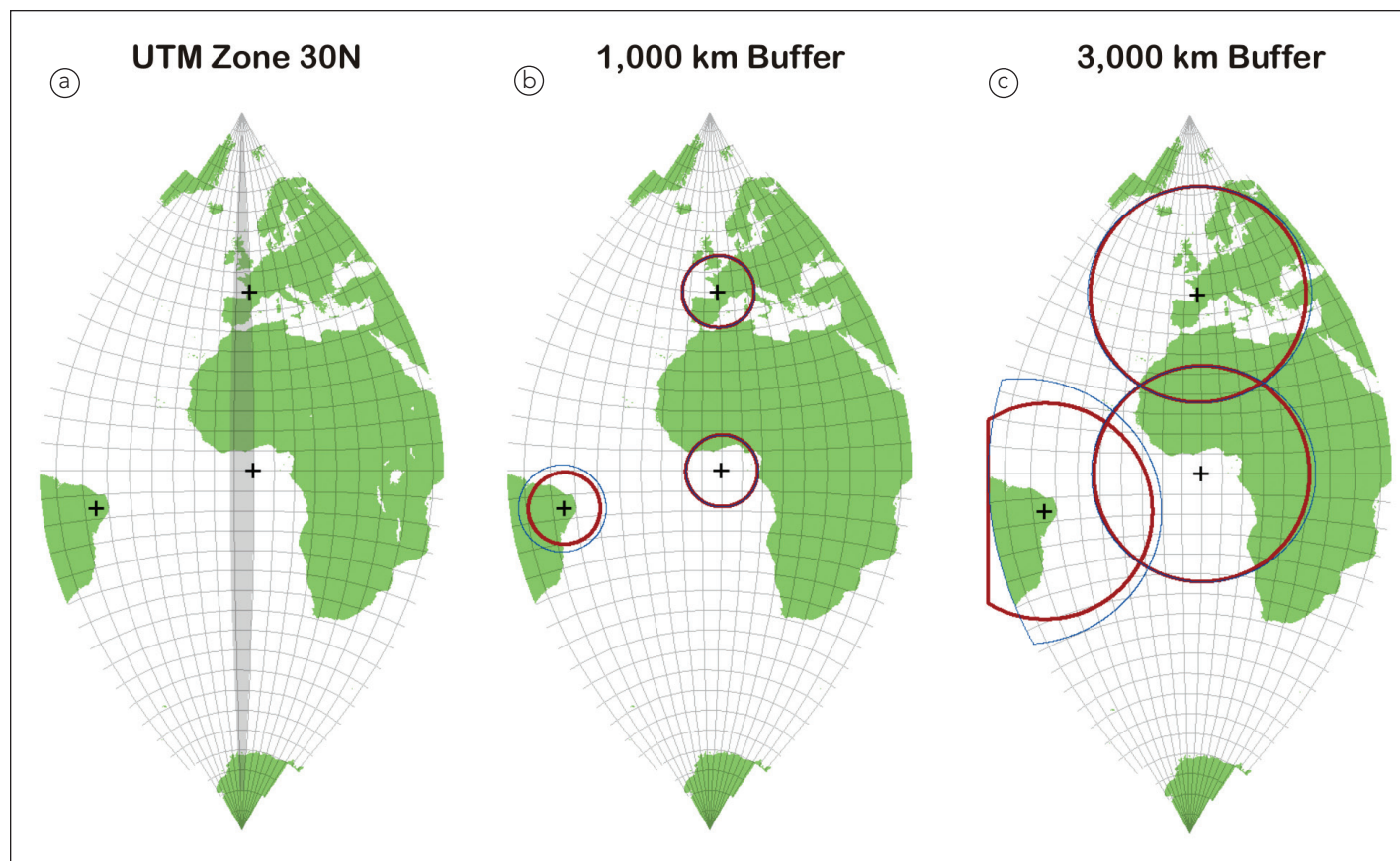
Similarly, if a world projected coordinate system is used, distortion is often minimal in one area but significant in another. For instance, distortion in the Mercator World projection is minimal near the equator but significant near the poles. For a dataset that has features in both low- and high-distortion areas, Euclidean buffers will be more accurate in the low-distortion areas and less accurate in the high-distortion areas. Geodesic buffers will be accurate in all areas.

Performing Geodesic Buffering

At ArcGIS 9.3, the Buffer tool included the functionality to produce geodesic buffers. To perform geodesic buffering with the Buffer tool, these criteria must be met:

- The input feature class must be a point or multipoint dataset.
- The input feature class must have a geographic coordinate system.
- The buffer distance must be specified as a linear unit such as kilometers, miles, or feet.

To perform geodesic buffering on an input feature class that is a polygon or polyline dataset, first use the Feature To Point tool (located in the Data Management toolbox in ArcToolbox). If the input feature class has a projected coordinate system, use the Project tool (also found in the Data Management toolbox) to make a copy of the feature class in a geographic coordinate system. Enhancements to the Buffer tool being explored for future releases of ArcGIS will allow geodesic buffers to be generated from line and polygon inputs.



▲ Figure 4: (a) UTM Zone 30N projected coordinate system with a 10 x 10 degree grid, (b) 1,000 km buffers, and (c) 3,000 km buffers. The Euclidean buffers are shown in red, and geodesic buffers are shown in blue.

Looking at Some Examples

In each of these examples, Euclidean and geodesic buffers are compared with various point datasets in different coordinate systems. Two sets of each point feature class were used to accomplish this effect for each example: a point feature class in a projected coordinate system that was used to generate Euclidean buffers and a copy of that point feature class in a geographic coordinate system that was used to generate geodesic buffers. The buffer distance used for both the Euclidean and geodesic buffers was held constant. In each example, Euclidean buffers are shown as thicker red rings, and geodesic buffers are shown as blue rings.

UTM Projection (UTM Zone 30N; WGS 1984 Datum)

In Figure 4, 1,000 and 3,000 km buffers are shown on a map in a projected coordinate system, UTM Zone 30N with a 10 x 10 degree

grid for reference. Zone 30 is shaded in the first map. UTM zones are roughly 6-degree-wide bands that run north and south between the poles. UTM Zone 30 is the zone immediately adjacent to the prime meridian.

In the 1,000 km buffer graphic, the two points within Zone 30 have Euclidean and geodesic buffers that are coincident. This shows that for points within the zone, the UTM projection does a good job minimizing distance distortion, regardless of latitude. The third point to the west of these two points (on the horn of Brazil) has geodesic and Euclidean buffers that are significantly different.

Outside Zone 30, distance distortions cause the Euclidean buffer to be considerably undersized compared to the geodesic buffer, although that buffer is exactly the same size as the two other Euclidean buffers. This occurs because the Euclidean buffer assumes that map units are the same everywhere in the projection (i.e., 1 km on the horn of Brazil is

the same as 1 km in the Atlantic Ocean south of Africa). This is not true, because outside UTM Zone 30, the distance becomes more and more distorted with this projection.

Different-sized geodesic buffers illustrate how the map projection is distorted. Each buffer would be identical in size on a globe. Because all these geodesic buffers have the same area but the geodesic buffer in Brazil looks larger than the others, it can be assumed that the projection is causing features to be stretched out or enlarged in this area.

In the 3,000 km buffer graphic, the Euclidean and geodesic buffers for points inside Zone 30 are beginning to diverge. Although the features are within Zone 30, the buffers extend far outside the zone and cause the Euclidean buffers to be slightly distorted.

Because the dataset includes features outside the target zone and a buffer distance is used that causes the offsets to extend well outside the target zone, geodesic buffers should

Continued on page 36

Understanding Geodesic Buffering

Continued from page 35

be used because they more accurately portray the buffered area.

World Projection (World Mercator; WGS 1984 Datum)

When working with a dataset in one of the common projected coordinate systems for the whole world, such as Mercator, projection distortion may be minimal near the equator but significant near the poles. Figure 5 shows 1,000 and 3,000 km buffers on a map with the projected coordinate system Mercator (World).

In the 1,000 km buffer graphic, the points near the equator have geodesic and Euclidean buffers that are coincident. For points near the equator, the Mercator projection does a good job minimizing distance distortion.

Points far from the equator show the most distance distortion. The Euclidean buffers for those points are considerably smaller than the geodesic buffers. This occurs with the Mercator projection because, at the poles, areas are stretched. Land masses close to the poles, such as Greenland and Antarctica, appear to have enormous areas compared with land masses that are actually similar in size but located close to the equator. All 1,000 km Euclidean buffers are the same size because the Euclidean buffer assumes that map units are the same everywhere in the projection (1 km in Brazil is the same as 1 km in central Russia). This is not true, because as locations move away from the equator, the distances become more and more distorted with this projection.

The variation in size of geodesic buffers shows how the map projection is distorted, because each buffer would appear identical in size on a globe. The same results, though exaggerated, are shown in the 3,000 km buffer graphic. With any type of analysis of distance on a global scale, geodesic buffers should be used because (again) they more accurately portray the buffered area.

Conclusion

When performing a buffer operation with a dataset that has features covering a large region or when using a very large buffer distance, it is important to remember that projection distortion can have a serious effect on the results. In both cases, Euclidean buffering performed on

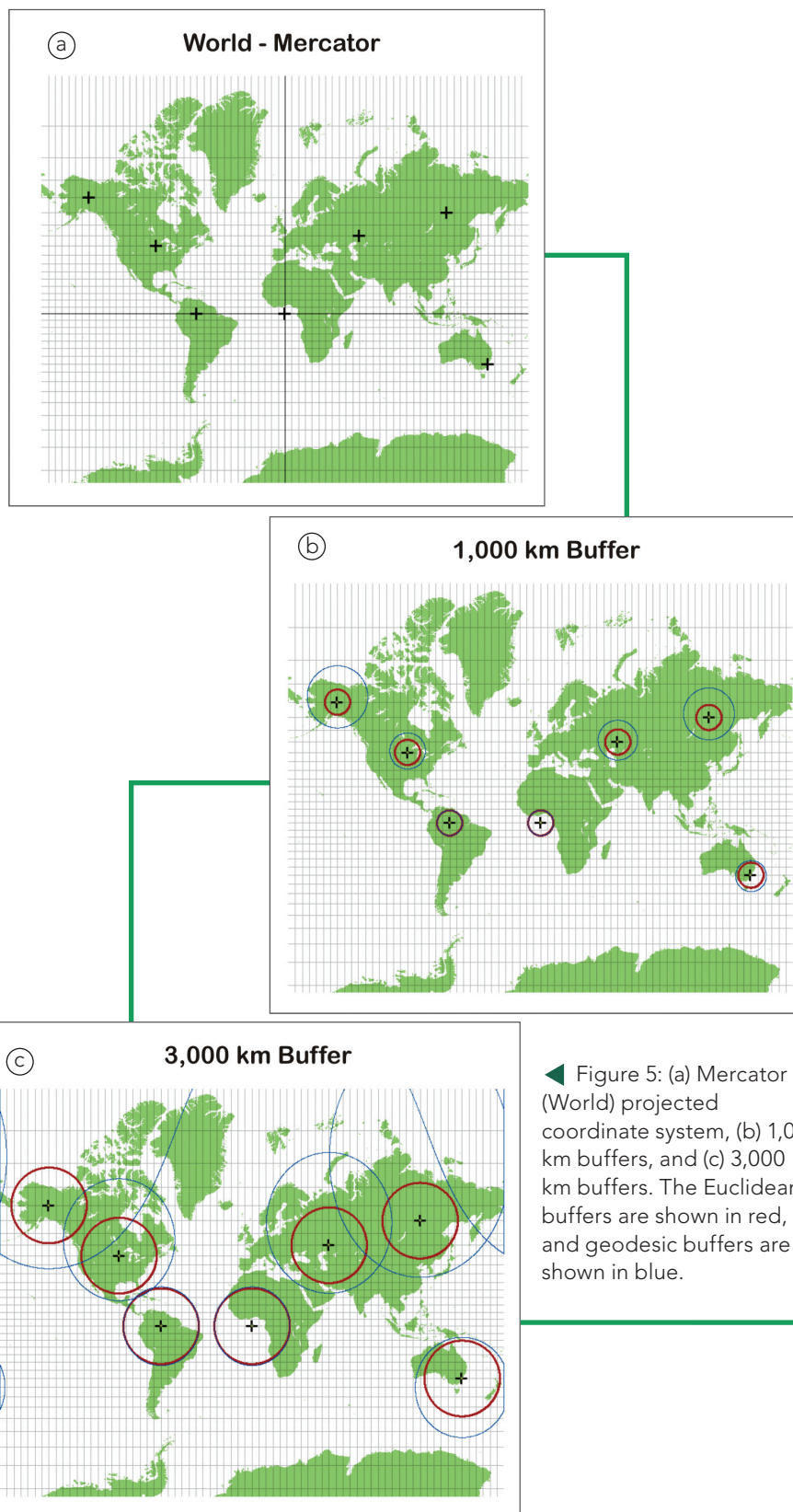
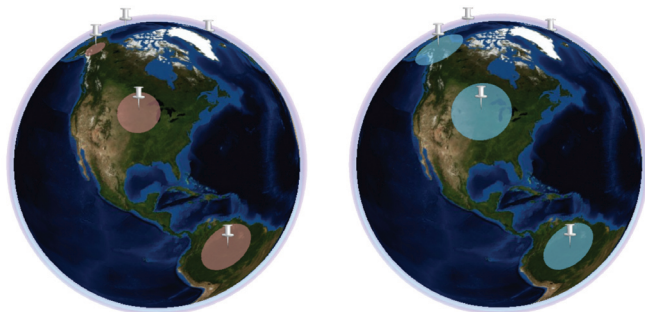


Figure 5: (a) Mercator (World) projected coordinate system, (b) 1,000 km buffers, and (c) 3,000 km buffers. The Euclidean buffers are shown in red, and geodesic buffers are shown in blue.

1,000 km Buffer



◀ Figure 6:
Euclidean (shown in red) and geodesic buffers (shown in blue) in ArcGlobe

buffer in Brazil.) Again, this occurs because these Euclidean buffers are created based on the false assumption that distances on the map remain constant across the map. In contrast, each of the geodesic buffers is a correct, uniform size when displayed on the globe. The geodesic buffers are correct because they were not influenced by distortion from a projected coordinate system.

For more information, contact Drew Flater at dflater@esri.com.

projected feature classes can produce misleading and technically incorrect buffers. However, geodesic buffering will always produce results that are geographically accurate because geodesic buffers are not affected by the distortions introduced by projected coordinate systems.

Displaying buffers in ArcGlobe or ArcGIS Explorer can help visualize the problems that occur when buffering projected data because

these applications can display geographic data on a three-dimensional globe. Figure 6 shows the same 1,000 km Euclidean and geodesic buffers shown in Figure 4, displayed in ArcGIS Explorer. When displayed on a globe, these Euclidean buffers are different sizes, even though the same buffer distance was used for each Euclidean buffer. (Note that the buffer in Alaska appears considerably smaller than the

About the Author

Drew Flater is a product engineer on the Esri geoprocessing development team. Before joining Esri in 2008, he earned a bachelor's degree in geography from the University of Wisconsin, Eau Claire, and a master's degree in geographic information science from the University of Akron, Ohio.

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STRENGTHENING CONNECTIONS

Dev Meet Ups foster developer communities

Is once a year enough? Perhaps for birthdays and holidays it is, but meeting once a year is not often enough for the growing community of geospatial developers. Consequently, Esri suggested to GIS developers that meet ups could be a way to bring the community together more often than the annual Esri Developer Summit.

Meet ups are events facilitated by a Web-based social networking site with a twist: it uses online connections to foster offline interaction based on a shared interest and a shared geography. “Do something. Learn something. Share something. Change something.”—Meetup.com’s motto has been bringing people together since 2001. The groups created through Meetup.com vary wildly (Las Vegas Hiking with Dogs, Raw & Organic Mamas, The Riverside Robotic Society Monthly Meetup), but members seem passionately interested in their chosen topics.

The response to the Dev Meet Ups organized

by the Esri Developer Network (EDN) team has been similarly exuberant. From the first Dev Meet Up, held June 24 of this year in New York City, these events have spread across the United States. Meet ups in Los Angeles, California; Decatur, Illinois (aka “Soybean Capital of the World”); and Washington, D.C., quickly followed. As of November 2010, a dozen have been held, and 15 more are currently planned through May 2011.

All developers are welcome at these free events, from GIS professionals with years in the industry to those new to geospatial development. At meet ups, developers can demonstrate an application or framework, present an interesting concept or idea, share experiences, and connect with others in the field.

The Dev Meet Up format is simple and informal: one or more presentations followed by four lightning talks. Lightning talks are short (10-minute) presentations on something the presenter is working on, has done, or has learned that might be of interest to the group.

For example, at

the Dev Meet Up in Fort Collins, Colorado, Brian Sullivan of the City of Greeley gave a lightning talk called What Would Dieter Do? that identified the characteristics of good de-

City	Date	Time	Register now	Join the group
FL Tampa	Thurs., December 2, 2010		Register now	Join the group
TX Houston	Tues., December 7, 2010		Register now	Join the group
WA Seattle	Tues., December 7, 2010		Register now	Join the group
MA Boston	Wed., December 8, 2010		Register now	Join the group
OR Portland	Thurs., December 9, 2010		Register now	Join the group
CA Sacramento	January 2011	Coming soon		
CA San Francisco	January 2011	Coming soon		
GA Atlanta	February 2011	Coming soon		
FL Ft. Lauderdale	February 2011	Coming soon		
AZ Phoenix	February 2011	Coming soon		
MD Baltimore	April 2011	Coming soon		
KS Kansas City	April 2011	Coming soon		
MO St. Louis	April 2011	Coming soon		
IL Chicago	May 2011	Coming soon		
MN Minneapolis	May 2011	Coming soon		

City	Date	Who attended	Join the group
NY New York	June 24, 2010	Who attended	
CA Los Angeles	September 15, 2010	Who attended	
IL Decatur	September 16, 2010	Who attended	
Washington, DC	September 28, 2010	Who attended	
PA Philadelphia	September 30, 2010	Who attended	
TX Austin	October 13, 2010	Who attended	Join the group
TX Dallas	October 14, 2010	Who attended	Join the group
NC Charlotte	October 19, 2010	Who attended	Join the group
ID Boise	October 20, 2010	Who attended	Join the group
CO Ft. Collins	October 20, 2010	Who attended	Join the group
CO Denver	October 21, 2010	Who attended	Join the group
NC Raleigh	October 21, 2010	Who attended	Join the group
UT Salt Lake City	November 9, 2010	Who attended	Join the group

Register for upcoming Dev Meet Ups at esri.com/events/dev-meetup/index.html.

sign in a way that was both entertaining and visually appealing. Following events, presenters will often share their presentation slides through the group's Meet Up site.

The rest of the evening is devoted to free-ranging discussions that cover hot topics, geospatial technologies, complementary third-party tools, development platforms (e.g., Silverlight, Java, Flex, JavaScript), programming challenges, and tips and tricks. This format is flexible and provides lots of time to enjoy good food and make new friends.

Andy Gup, Esri technology lead, observed that these events “have tapped into existing energy in this community.” He noted that in some places, communities already existed, so Dev Meet Ups have provided the impetus for “these folks to get together more often.” In other places, meet ups have brought people together and created new communities interested in developing with geospatial technology. In either case, the developers participating in Dev Meet Ups work in various settings—private companies, local government, the military, and academic institutions.

Visit esri.com/events/dev-meetup/index.html to join a group; find out if there is a Dev Meet Up scheduled near you; or join the online community via Facebook, Twitter, or LinkedIn.



Todd Buchanan, GIS analyst with Ada County Highway District, gave the keynote presentation on regional GIS development at the Dev Meet Up in Boise, Idaho.

Meetup



Defining Success in the Geospatial Industry

Competency model can aid staff hiring, retention, and development

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

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

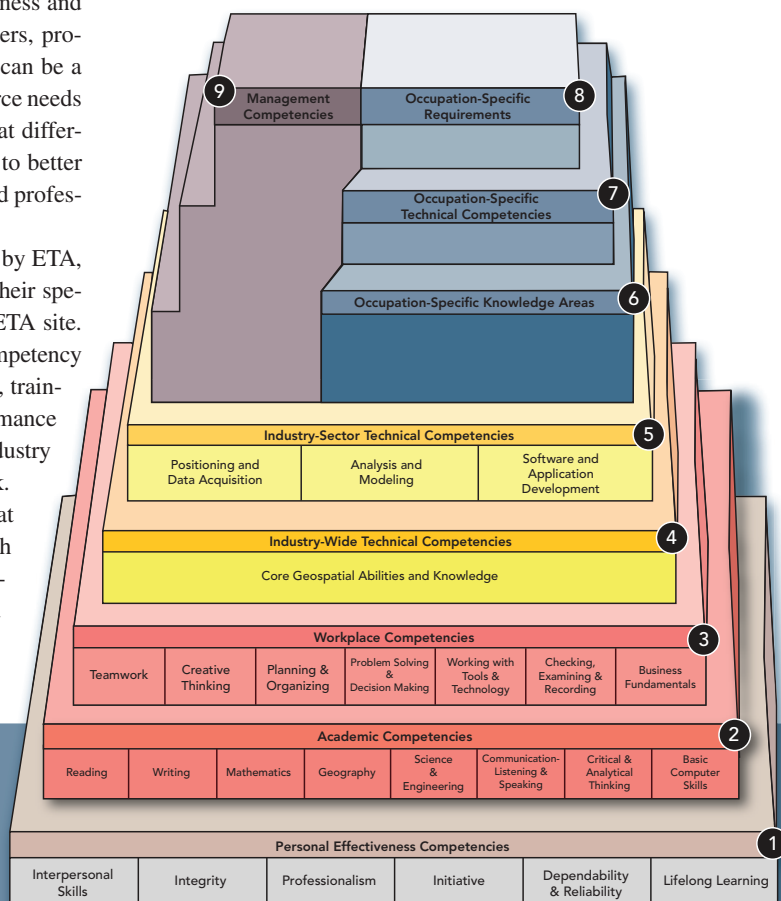
While competency models can benefit many groups—business and industry, economic developers, educators and training providers, professional organizations, and students and their parents—they can be a valuable resource for managers because they articulate workforce needs and define the requirements for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

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

The recently published model had been in development at ETA since 2005. In that year, the geospatial industry, along with biotechnology and nanotechnology, was recognized as a high-growth industry. Not only were these sectors expected to add a substantial number of jobs, but they were also identified as having the greatest potential impact on the economy. In ad-

dition to being characterized as having a bright future generally, many specific occupations in the geospatial industry are also characterized as “green”—occupations likely to change as a result of the growth of green economy activities. This model is designed to evolve along with changing requirements of this field.

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

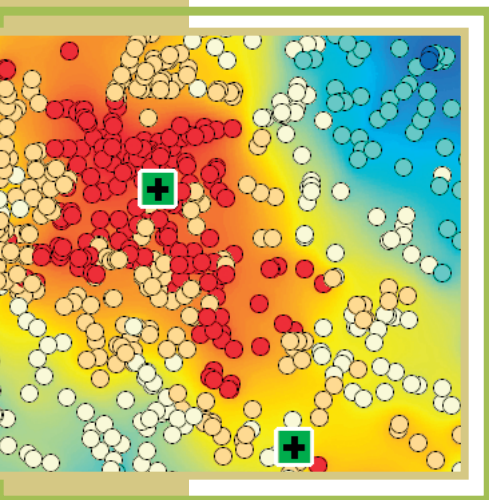


Competency models define successful performance in specific jobs, job groups, organizations, occupations, or industries and are the foundation for recruitment and hiring, training and development, and performance management.

Finding a Meaningful Model

This checklist will help you evaluate regression models

By Lauren Rosenshein, Lauren Scott, and Monica Pratt, Esri



The spatial statistics tools in ArcGIS let you address *why* questions using regression analysis. Regression models help answer questions like

- Why are there places in the United States with test scores consistently above the national average?
- Why are there areas of the city with such high rates of residential burglary?

Regression analysis is used to understand, model, predict, and/or explain complex phenomena. Because the spatial statistics tools used for regression analysis are part of the ArcGIS geoprocessing framework, they are well documented and accessed in a standard fashion.

However, coming up with a properly specified regression model to answer a specific *why* question can be challenging. What is a properly specified model? It is a model we can trust—one that is unbiased (i.e., predicts well in all parts of the study area) and includes all the key variables that explain the phenomenon you are examining. This article will step you through a process for evaluating regression models using a list of six checks and the Ordinary Least Squares (OLS) and Geographically Weighted Regression (GWR) tools in the ArcGIS Spatial Statistics toolbox.

Applying Regression Analysis

Regression analysis is all about explaining a phenomenon, such as childhood obesity, using a set of related variables, such as income, education, or access to healthy food. Typically, regression analysis helps answer *why* questions so you can do something about them. For example, by using regression analysis, you might discover that childhood obesity is lower in schools that serve fresh fruits and vegetables at lunch. That information can influence decisions about school lunch programs. Likewise, knowing the variables that explain high crime rates can help you make predictions about future crime so that prevention resources can be allocated more effectively. [For more infor-

mation on regression analysis, see “Answering Why Questions: An introduction to using regression analysis with spatial data” in the Spring 2009 issue of ArcUser.]

Unfortunately, it isn’t always easy to find a set of explanatory variables that will allow you to model your question or explain the phenomena you’re interested in. However, OLS regression, the best-known regression technique, includes information that can tell you when you’ve found a good model. The documentation for this tool also includes a guide that alerts you to the six tests your model should pass before you can feel confident you have a properly specified model.

This article examines these six checks and the techniques you can use to solve some of the most common regression analysis problems. Finding a properly specified model is often an iterative process, and these resources will make your work easier.

Choosing Appropriate Variables

Choosing the variable that you want to understand, predict, or model is the first task. This variable is known as the dependent variable. Test scores, crime, and childhood obesity were the dependent variables being modeled in the examples previously described.

Next, decide which factors might help explain the dependent variable. These variables are known as the explanatory variables. In the childhood obesity example, the explanatory variables might be things such as income, education, or access to healthy food. Identifying all the explanatory variables that might be important will require research. You’ll want to consult theory and existing literature and talk to experts. Always rely on your common sense. Conducting preliminary research increases your chances of finding a good model.

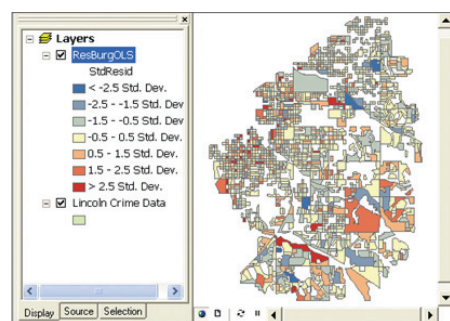
With the dependent variable and the candidate explanatory variables chosen, running your analysis is the next step. The regression tools in ArcGIS are found in the Spatial Statistics toolbox in the Modeling Spatial Relation-



Answer the **WHY** questions

ships toolset. Always start with OLS regression, because it provides important diagnostic tests that let you know if you've found a good model or if you still have some work to do.

The OLS tool generates several outputs including a map of the regression residuals and a summary report. The regression residuals map shows the over- and underpredictions from



▲ Figure 1: Mapping regression residuals from the model. Analyzing the residuals is an important step in finding a good model.

your model. Analyzing it is an important step in finding a good model. The largely numeric OLS summary report includes diagnostics you will use when going through the six checks discussed throughout the rest of this article.

✓ 1: Are these explanatory variables helping my model?

After consulting theory and existing research, you will have identified a set of candidate explanatory variables. You'll have good reasons for including each one in your model. However, after running your model, some explanatory variables will be statistically significant, and some will not.

How will you know which are significant? The OLS tool calculates a coefficient for each explanatory variable in the model and performs a statistical test to determine whether that variable is helping your model explain the phenomenon. The statistical test computes the probability that the coefficient is actually zero. If a coefficient is zero (or very near zero), the associated explanatory variable has very little impact on your model. In other words, that variable is not helping.

The smaller the probability is, the smaller the likelihood that the coefficient is zero. When the probability is smaller than 0.05, an asterisk next to the probability on the OLS summary report indicates that the associated explanatory variable is helping your model (i.e., its coefficient is statistically significant at the 95 percent confidence level). So when looking for explanatory variables associated with statistically significant probabilities, look for ones with asterisks.

The OLS tool computes both the probability and the robust probability for each explanatory variable.

(Robust probabilities are accurate even when the relationships being modeled aren't stationary.) With spatial data, it is not unusual for the relationships you are modeling to vary across the study area. These relationships are characterized as nonstationary. When the relationships are nonstationary, you can only trust robust probabilities to tell you if an explanatory variable is statistically significant or not.

How will you know if the relationships in your model are nonstationary? The Koenker test for nonstationarity is another diagnostic reported by OLS. The Koenker p-value reflects how likely it is that the relationships being modeled are consistent across the entire study area. If the Koenker p-value is small and statistically significant (as indicated by an asterisk), the relationships do vary across the study area and are therefore nonstationary. Be sure to consult the robust probabilities.

While finding a model with explanatory variables that have statistically significant coefficients, you will likely try a variety of

Summary of OLS Results

Variable	Coefficient	StdError	t-Statistic	Probability	Robust_SE	Robust_t	Robust_Pr	VIF [1]
Intercept	15.768546	3.693802	4.268920	0.000055*	3.537938	4.456988	0.000028*	
POP	0.005495	0.001468	3.742836	0.000341*	0.001716	3.202300	0.001946*	

OLS Diagnostics

Number of Observations:	87	Number of Variables:	5
Degrees of Freedom:	82	Akaike's Information Criterion (AIC) [2]:	680.420629
Multiple R-Squared [2]:	0.838936	Adjusted R-Squared [2]:	0.831080
Joint F-Statistic [3]:	106.778882	Prob(>F), (4,82) degrees of freedom:	0.000000*
Joint Wald Statistic [4]:	224.669428	Prob(>chi-squared), (4) degrees of freedom:	0.000000*
Koenker (BP) Statistic [5]:	15.873747	Prob(>chi-squared), (4) degrees of freedom:	0.003193*
Jarque-Bera Statistic [6]:	0.342521	Prob(>chi-squared), (2) degrees of freedom:	0.842602

Figure 2: A portion of the diagnostics generated by OLS

Continued on page 42

Finding a Meaningful Model

Continued from page 41

OLS regression models. These coefficients (and their statistical significance) can change radically depending on the combination of variables in your model. Typically, you will remove explanatory variables from your model if they are not statistically significant. However, if theory indicates that a variable is very important, or if a particular variable is the focus of your analysis, you might retain it even if it's not statistically significant.

✓ 2: Are the relationships what I expected?

It is important to not only determine whether an explanatory variable is actually helping your model but also think about its relationship to the dependent variable.

The coefficient associated with each explanatory variable is either a negative or positive number. Suppose you were modeling crime and one of your statistically significant explanatory variables is neighborhood in-

come. If the coefficient associated with the income variable is negative, it means that crime goes up as neighborhood incomes go down (a negative relationship). If you were modeling childhood obesity and access to fast food was an explanatory variable with a statistically significant positive coefficient, this would indicate that childhood obesity increases when the number of fast food opportunities also increases (a positive relationship).

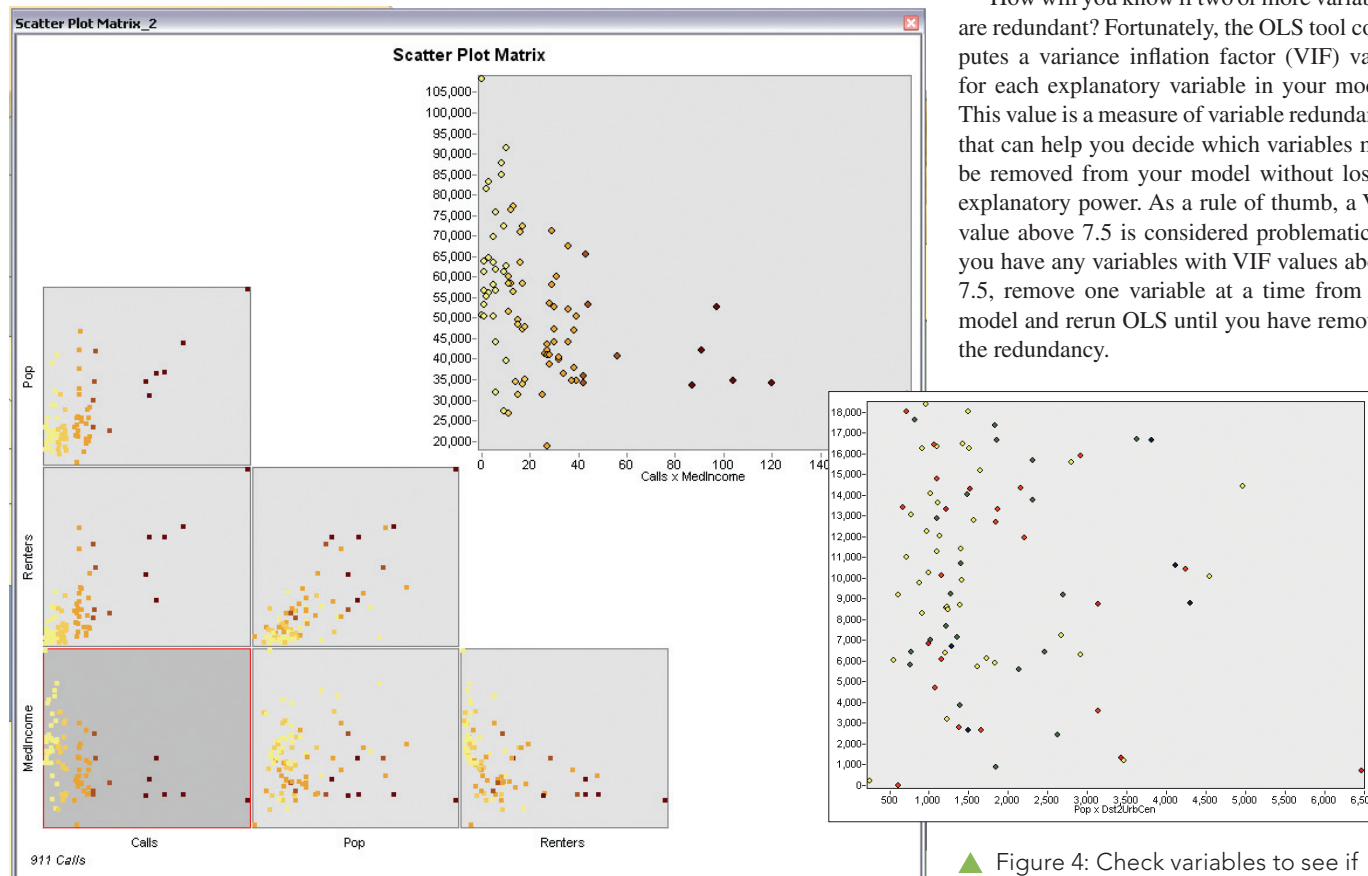
When you create a list of candidate explanatory variables, you should include the relationship (positive or negative) you expect for each variable. It would be difficult to trust a model that tells you the opposite of what theory and/or common sense dictate. For example, if a regression model for predicting forest fire frequency returned a positive coefficient for the precipitation variable, that would indicate forest fires increase in locations with lots of rain—not an outcome you would expect.

Unexpected coefficient signs usually indicate other problems with your model that will surface as you continue through the six checks. You can only trust the sign and strength of your explanatory variable coefficients if your model passes all these checks.

✓ 3: Are there redundant explanatory variables?

When choosing explanatory variables, look for ones that address different aspects of the phenomenon you are trying to model. Avoid redundant variables. For example, if you were trying to model home values, you probably wouldn't include explanatory variables for both home square footage and the number of bedrooms because both variables are related to home size. Including both could make your model unstable. Ultimately, you cannot trust your model if you have multiple variables that tell the same story.

How will you know if two or more variables are redundant? Fortunately, the OLS tool computes a variance inflation factor (VIF) value for each explanatory variable in your model. This value is a measure of variable redundancy that can help you decide which variables may be removed from your model without losing explanatory power. As a rule of thumb, a VIF value above 7.5 is considered problematic. If you have any variables with VIF values above 7.5, remove one variable at a time from the model and rerun OLS until you have removed the redundancy.

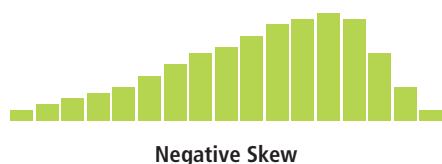
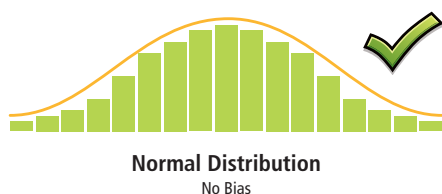
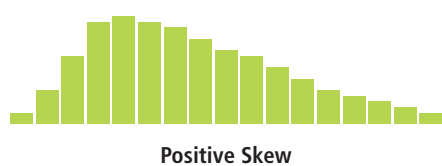


▲ Figure 3: The scatterplot matrix can be used to evaluate all the relationships between the variables in your data. It is a graphic that displays two types of numeric data for each variable to determine if there is a relationship between them.

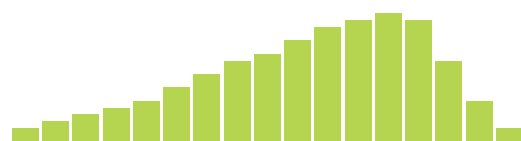
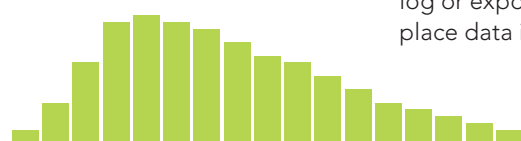
▲ Figure 4: Check variables to see if you have represented them in a way that will truly reflect a linear relationship.

✓ 4: Is my model biased?

This may seem like a tricky question, but it is actually very simple to answer. When an OLS model is properly specified, the model residuals (i.e., the over- and underpredictions) have a normal distribution with a mean of zero (think bell curve). With a biased model, the distribution of the residuals is unbalanced. The impact of this bias may be that the model does well for low values but is ineffective for high values (or



▲ Figure 5: With a biased model, the distribution of the residuals is unbalanced, and results predicted by these models can't be trusted.

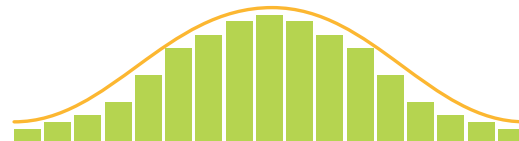
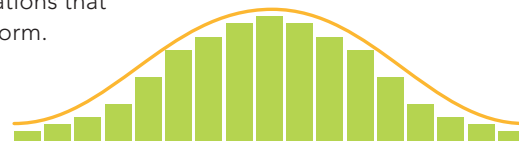


Positive Skewed Residuals

Negative Skewed Residuals

Log
Transformation

Exponential
Transformation



vice versa). For the childhood obesity example, this would mean that where you have low childhood obesity, the model is doing a great job, but in areas with high childhood obesity, predictions are off. Unfortunately, you cannot trust predictions from a biased model.

The good news is that there are a few strategies that often correct this problem. Sometimes the bias is the result of trying to model nonlinear relationships. In this case, creating a scatterplot matrix can be very useful. A scatterplot matrix is a graphic that displays two variables together. Linear relationships look like diagonal lines. Nonlinear relationships look more like curved lines. If your dependent variable has a nonlinear relationship with one of your explanatory variables, you have some work to do. OLS is a linear model that assumes that the relationships between your variables are linear.

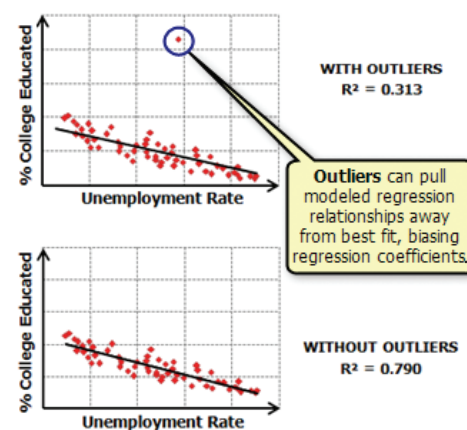
If they aren't, you can try to transform your variables so that the relationships become linear. A histogram is another useful output from a scatterplot. Create one for each variable. If some explanatory variables are strongly skewed, you may be able to remove model bias by transforming them. Figure 6 shows how different types of transformations can help you get data into its most useful form.

Model bias may also be a result of outliers influencing your model estimation. You can use the scatterplot matrix to find these too. Try running OLS both with and without the outli-

▼ Figure 6: Histograms created for each explanatory variable can show if they are strongly skewed. This type of model bias may be removed by applying log or exponential transformations that place data in its most useful form.

✓ 5: Have I found all the key explanatory variables?

The standard output from OLS is a map of the regression residuals representing model over- and underpredictions. Red areas indicate that actual observed values are higher than values the model predicted. Blue areas show where



▲ Figure 7: The presence of outliers can cause bias in a model. Use the scatterplot matrix to find these outliers and try running OLS both with and without the outliers to see how much impact they are having on model results.

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Finding a Meaningful Model

Continued from page 43

actual values are lower than the model predicted. Statistically significant spatial autocorrelation in your model residuals indicates that you are missing one or more key explanatory variables.

How do you know if you have statistically significant spatial autocorrelation in your model residuals? For regression residuals, spatial autocorrelation usually takes the form of clustering: the overpredictions cluster together, and the underpredictions cluster together. You can run the Spatial Autocorrelation (Moran's I) tool from the Spatial Statistics toolbox on your regression residuals to see if the observed clustering is statistically significant or not. If the Spatial Autocorrelation tool returns a statistically significant z-score, it indicates that you are missing key explanatory variables.

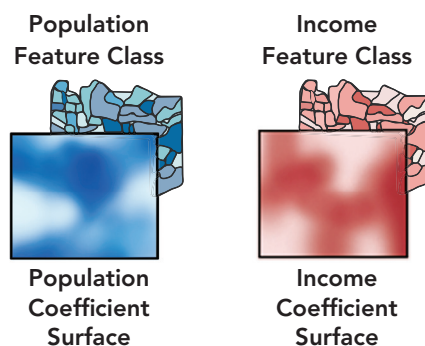
Many analyses begin with a hypothesis that certain variables will be important. You might think 5 particular variables will be good predictors of the phenomenon you are trying to model. Or perhaps you think there could be 10 related variables. Although it is important to approach a regression analysis with a hypothesis, allow your creativity and insight to dig a little deeper and go beyond your initial variable list.

- Consider all variables that might impact the phenomenon you are trying to model.
- Review the relevant literature again.
- Create thematic maps for each candidate explanatory variable and compare those to a map of the dependent variable. Use your intuition to look for relationships in this mapped data.
- Try to come up with as many candidate spatial explanatory variables as you can (e.g., distance to urban center, proximity to major highways, or access to large bodies of water); these will often be critical to your analysis, especially when you believe geographic processes influence the relationships in your data. Until you find explanatory variables that effectively capture the spatial structure in your dependent variable, you will likely continue to have problems with spatial autocorrelation in your regression residuals.
- Examine the residual map and look for clues about what might be missing. If you notice, for example, that your model is consistently overpredicting in urban areas, perhaps you are missing some kind of urban density variable; if it looks like the overpredictions are associated with moun-

tain peaks or valley bottoms, perhaps an elevation variable is needed. Do you see regional clusters of over- and underpredictions, or can you recognize a trend in the residual values? Sometimes creating dummy variables to capture regional differences or trends will resolve problems with statistically significant spatial autocorrelation. A classic example of a dummy spatial regime variable is one designed to capture urban/rural differences: assign all urban features a value of 0 and all rural features a value of 1. (Note: While spatial regime dummy variables are great to include in your OLS model, you will want to remove them when you run GWR; they aren't needed in GWR and will very likely create problems with local redundancy.)

You can also try running GWR and creating a coefficient surface for each candidate explanatory variable. Select one of your OLS models for this exercise. A good choice is a model with a high Adjusted R-Squared (R²) value that is passing all or most of the other diagnostic checks. Because GWR creates a regression equation for each feature in your study area, the GWR coefficient surfaces illustrate how relationships between the dependent variable and each explanatory variable fluctuate geographically. Sometimes you can see clues about potentially missing explanatory variables in these surfaces. You might notice, for example, that a particular explanatory variable is more effective near freeways but becomes less effective with distance from the coast or exhibits a strong east-to-west trend.

Finding those missing explanatory variables is often as much an art as a science. The process of finding them will often provide important insights into the phenomenon you are modeling.



▲ Figure 8: Run GWR and create a coefficient surface for each explanatory variable.

✓ 6: How well am I explaining my dependent variable?

Now it's finally time to evaluate model performance. The R² value is an important measure of how well your explanatory variables are modeling your dependent variable. Why leave this important check until the end? Because you cannot trust an R² value unless your model has passed the other five checks. If your model is biased, it doesn't matter how high your R² value is, because you can't trust your predictions. Likewise, if you have spatial autocorrelation of your residuals, you cannot trust the coefficient relationships or be sure your model will predict well for new observations. Once you have gone through the previous five checks and feel confident that you have met all the necessary criteria, it is time to figure out how well your model is explaining your dependent variable by assessing the R² value. R² values range between 0 and 1 and represent a percentage.

Suppose you are modeling crime rates and find a model that passes the first five checks with an R² value of 0.65. This indicates that your explanatory variables tell 65 percent of the crime rate story, or to put it more technically, the model explains 65 percent of the variation in the crime rate variable. Is 65 percent good enough? Well, it depends. R² values must be judged rather subjectively. In some areas of science, explaining 23 percent of a complex phenomenon is very exciting. In other fields, an R² value may have to be closer to 80 or 90 percent to be considered notable. Either way, R² values will help you judge the performance of your model.

Another important diagnostic for assessing model performance is known as Akaike's Information Criterion (AICc). The AICc value is a useful measure for comparing models that have the same dependent variables. You could use it to compare two models for student test scores when one model is based on socioeconomic variables and the other model is based on learning environments (e.g., classroom size, school facilities, tutoring programs). As long as the dependent variables for the two models are the same (in this case, student test scores), you can conclude that the model with the smaller AICc value performs better because it provides a better fit for the observed data.

What's Next?

Finding a properly specified OLS model (one that passes all six checks above) is definitely

reason to celebrate. The next step is to try the variables from your OLS model in GWR. You should run GWR using the same dependent variable you used for OLS, along with the same OLS explanatory variables, with the exception of any spatial regime variables. Compare the GWR AICc value to the one you obtained from your properly specified OLS model. If the AICc value from GWR is smaller than the AICc value returned by OLS, you have improved your model (and your results) by allowing relationships to vary across your study area.

The GWR output feature class contains coefficients for every feature and every explanatory variable. Create maps of these coefficient values (standard deviation rendering is appropriate) to see where each explanatory variable is most important. Suppose one of your explanatory variables for a model of longevity is traffic accidents or crime. Determining where these variables are important predictors of longevity can help you decide where to implement policies to encourage longevity.

It is important that you find a properly specified OLS model before you move to GWR analysis. GWR will not identify missing explanatory variables or model bias problems and doesn't have diagnostic tools to help you correct these problems. The only reason you might move to GWR without a properly specified OLS model is if you are confident that the variation among the relationships you are modeling (i.e., its nonstationary nature) is the only reason you haven't found a properly specified model.

Evidence that nonstationarity is the culprit would be finding that the GWR coefficients for theory-supported explanatory variables change signs dramatically (i.e., in some parts of your study area, the coefficients are positive, and in other parts, they are negative). Similarly, if you find a properly specified OLS model for one portion of your study area, but a different model with different explanatory variables works for another portion of your study area, you have strong evidence that nonstationarity is making it difficult for your initial model to pass all the OLS checks. If you can determine that nonstationarity is the only issue with your OLS model, it is appropriate to move to GWR, because this method of regression analysis was specifically designed to capture and model spatial nonstationarity.

Don't Forget...

The most important thing to remember when you are stepping through the process of building a properly specified regression model is that the goal of your analysis is to understand your data and use that understanding to solve problems and answer questions.

You may try a number of models (with and without transformed variables), analyze your coefficient surfaces, and still not find a properly specified OLS model but—and this is important—you will still be contributing to the body of knowledge on the phenomenon you are modeling. Even if the model you thought would be a great predictor turns out to be insignificant, discovering that fact is incredibly helpful information. The process of trying to find a meaningful model is always a valuable exercise because you learn so much along the way. Applying this knowledge helps answer why questions so you can more effectively evaluate various courses of action and make better decisions.

For more information about regression and other tools in the Spatial Statistics toolbox, go to bit.ly/spatialstats.

About the Authors

Lauren Rosenshein works on the ArcGIS geoprocessing team and is responsible for software support, education, documentation, and development of spatial statistics tools. She received her master's degree in geographic and cartographic science from George Mason University and her bachelor's degree in geography from McGill University.

Lauren Scott has more than 20 years of experience in software development. She works on the ArcGIS geoprocessing team and is responsible for software support, education, documentation, and development of spatial statistics tools. She holds a PhD in geography from the joint doctoral program at San Diego State University in California and the University of California, Santa Barbara.

Monica Pratt is the founding and current editor of *ArcUser* magazine and Esri publications team lead. She has more than 100 published articles on GIS and related technology topics and is a contributor to *Web GIS: Principles and Applications*, published by Esri Press.

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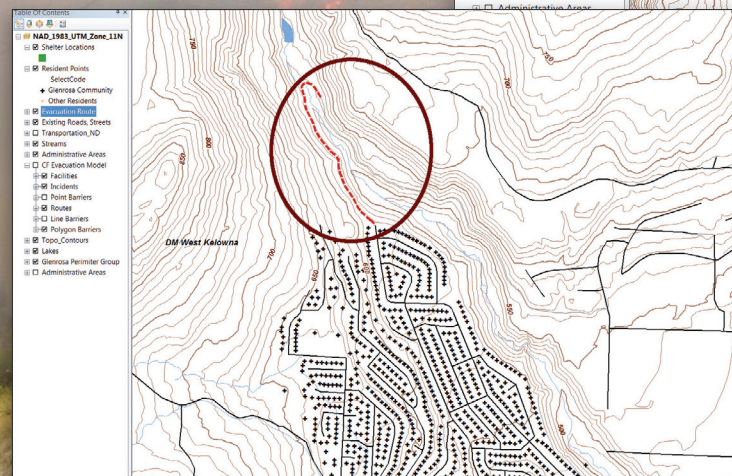
Revisiting the Glenrosa Fire

Evacuation modeling with ArcGIS Network Analyst 10

By Mike Price, Entrada/San Juan, Inc.

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▲ This is one of the two ovals on the map that highlight critical parts of the model. They will be used to refine the evacuation plan.

What You Will Need

- ArcGIS Desktop 10
- ArcGIS Network Analyst 10 extension
- Sample dataset downloaded from *ArcUser Online*

On July 18, 2009, at approximately 2:30 p.m., a small wildfire started in wooded hills west of Glenrosa, a neighborhood in West Kelowna, located on Lake Okanagan in southeastern British Columbia—an area that has seen its share of wildfires.

Pushed by 37 mph winds, the fire spread quickly to the Glenrosa neighborhood, and the residents of approximately 3,000 homes were quickly evacuated. An evacuation center was established at Royal LePage Center, a large civic complex next to the West Kelowna City Hall. In the five days required to contain it, the Glenrosa/Gellatly fire burned more than 900 acres and damaged or destroyed several homes. At its height, the fire caused the evacuation of more than 11,250 residents.

This ArcGIS 10 exercise shows how the ArcGIS Network Analyst extension can be used to identify, accumulate, and route an at-risk population from homes or workplaces to safety. This exercise walks the reader through assessing the evacuation potential of over 1,000 homes in the Glenrosa neighborhood and testing evacuation options using the actual Glenrosa/Gellatly fire footprint. Had the fire expanded only slightly, the entire community would have become cut off from safety. To respond to this scenario, the exercise will test a hypothetical “back door” that might allow evacuation of many residents directly away from the advancing fire.

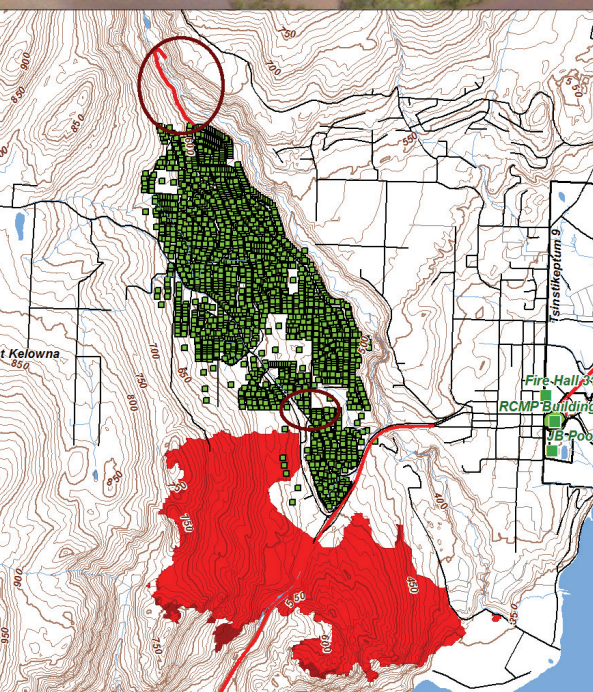
Part 1: An Overview of Evacuation Modeling with ArcGIS Network Analyst

Time-based evacuation modeling is a key component in any community disaster plan that requires assembling and relocating many residents to safe areas or having them simply leave their homes and workplaces. Because evacuations typically involve coordinating the actions of private citizens who may or may not be well informed, are traveling primarily in private vehicles, and are responding to an immediate or near immediate event, successful outcomes depend on careful planning, proper notification, and safe and timely community response. Defining, understanding, and anticipating traffic behaviors are key to a safe and efficient evacuation.

ArcGIS Network Analyst is an excellent tool for mapping and modeling time- and distance-based travel. Network Analyst’s Closest Facility (CF) solver connects evacuee points with identified shelters or egress points and calculates the optimal time and distance for travel by many evacuees to one or more safety points. Roads blocked by fire, flooding, wind damage, and other obstructions may be modeled. Multi-lane routes can be modeled to include both responding and evacuating traffic. Analysis identifies high-volume and restricted intersections and where traffic may be managed by traffic control or by diverting certain evacuees to an available secondary route.

The ArcGIS Network Analyst Closest Facility Solver

The Network Analyst extension contains several robust solvers that



▲ In the table of contents, right-click the CF Evacuation Model, select Properties, and open the Analysis Setting tab to verify that travel is set from incidents to one facility and no time cutoff has been applied.

On July 18, 2009, a small wildfire in the hills west of Glenrosa, in southeastern British Columbia, quickly spread and necessitated the evacuation of approximately 3,000 homes.

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Revisiting the Glenrosa Fire

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allow emergency service modelers to map and model many time and distance travel issues. The CF solver was designed to locate the closest service or care facility to a specific event. For example, in response to an automobile accident (i.e., Incident), a patient may require transport to a hospital (i.e., Facility), and a towing company may be needed to remove damaged vehicles from the scene. The CF solver maps the accident location and searches for one or more nearby medical facilities

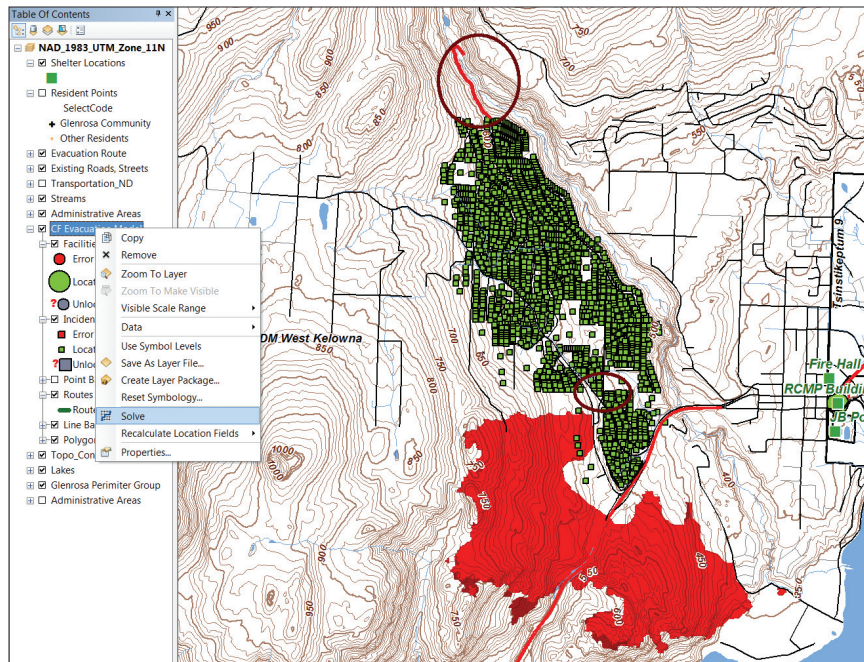
possible, compare streets to current aerial imagery and check alignments for accuracy, completeness, and connectivity. Imagery also aids locating and counting individual occupied structures or when mapping obscure, often private access to houses.

Next, identify the residents likely to be evacuated and locate them on a map. For existing residents, the county assessor's parcel map and actual building footprints are very helpful. If you have good aerial

imagery but no building polygons, you can add residence points to individual structures. As Census 2010 block-level data becomes available, rooftop dwelling counts can be verified. If the community has performed community-level mapping and a structure vulnerability assessment, include this information, too.

Future populations at risk may be derived from development plans, neighborhood as-built drawings, and population projections from growth plans. Proposed transportation corridors will come from transportation plans and growth management information. Add these corridors to a separate version of the primary street network or include them as a separate feature class included in a transportation feature dataset maintained in a file geodatabase.

Shelter capacity and shelter opening requirements must be determined and mapped. Many local and regional emergency response plans identify and describe evacuation shelters and the evacuation corridors leading to them. If possible, incorporate values for the carrying capacity of evacuation corridors into the street dataset. Locate and describe alternate shelter sites to accommodate both anticipated and unexpected changes



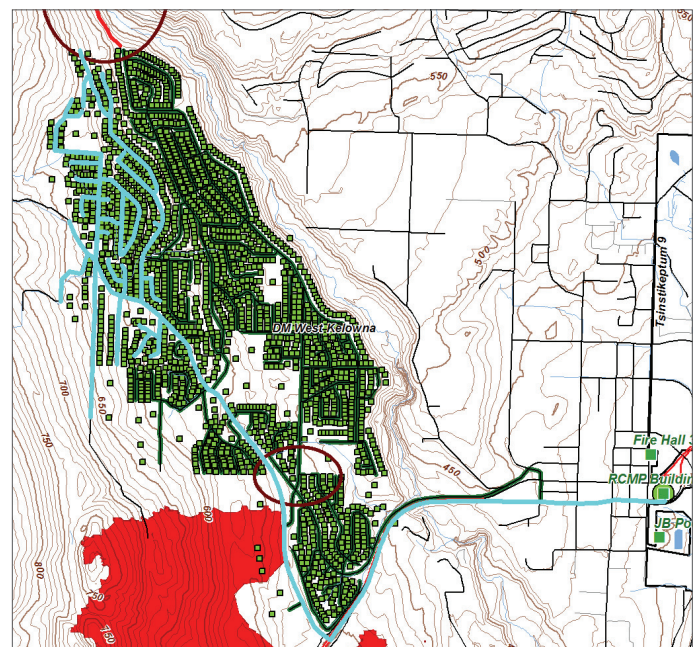
▲ After checking the properties for the CF Evacuation Model, right-click it in the TOC and choose Solve.

using a travel time solution. Because the services of a tow truck are not time sensitive, the CF solver might identify facilities based on the shortest travel distances from the accident.

To model evacuees with the CF solver, the evacuated households and other occupancies become the Incidents, and the evacuation centers, outside gates, or other points of egress become Facilities. If several shelters or gates are available, all evacuees may be modeled using several destinations. The solver returns an arrival time, arrival order, and distance traveled for each evacuee at one or more destinations. In ArcGIS 10, point, polyline, and polygon barriers may be used to restrict and reroute travel to simulate the effects of roads closed as a result of flooding, wildfire, earthquake, toxic plumes, or other adverse conditions. In addition to routing, the solver also identifies residents who may become trapped if the area involved in the Incident expands.

Preparing Input Data

Time-based travel modeling requires accurate, current, complete street datasets that have been properly designed and prepared. Street datasets must perform predictably in a network modeling environment and include proper impedance values (for speed and distance), connectivity, directionality, crossing geometries, and turn modifications. For more information about network streets, read "It's All about Streets: Tips and tricks for obtaining, building, and maintaining time-based network streets" in the Fall 2009 issue of *ArcUser* (bit.ly/c84qLc). If



▲ Using the Select By Polygon tool shows an accumulation of 456 residences evacuating on Glenrosa Road just below Country Pines Gate.

Data Sources for Evacuation Candidates	
Existing communities	Proposed development
Census block-level data	Site plans
Assessor parcels	Tentative tract maps
Residence counts based on use class, zoning designation, building footprints, or effective area	Estimated points
Data Sources for Network Streets	
Existing communities	Site plans
Local jurisdictions	Tentative tract maps
Commercial streets	Estimated centerlines
Proposed development	
Data Sources for Evacuation Destinations and Shelters	
Existing communities	Proposed development
Site plans	Local or regional jurisdiction(s) having authority
Emergency response plans	Tentative tract maps
Local or regional mapping datasets	Estimated locations
Data Sources for Evacuation Hazards	
Recognized hazards	Anticipated hazards
Local or regional jurisdiction(s) having authority	Modeled natural hazards (slope, vegetation/fuels, geologic hazards, flooding, wind damage, ice storm)
Emergency response plans	Transportation concerns (roads, bridges, terrain, blockage)
Local or regional mapping datasets	

Table 1: Sources for data

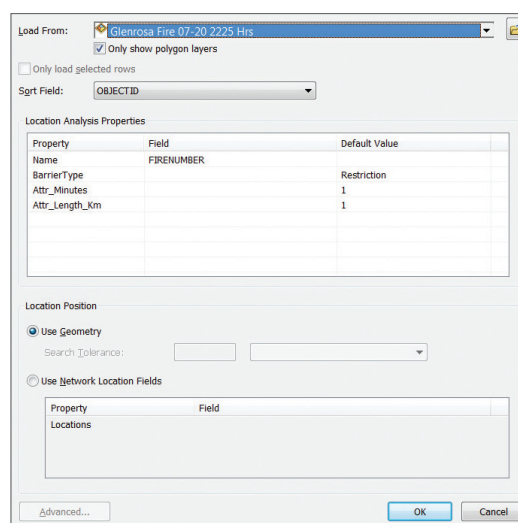
es in the development of an Incident. Define natural and man-caused hazards and risks in the community and include them in the study.

Finally, develop a community notification and communication network. Inform residents of the notification procedures, the primary egress routes, and locations and capacity of alternate shelters.

The Closest Facility Solver

After obtaining, standardizing, and mapping the data listed in Table 1, build a preliminary evacuation model. First, create an ArcGIS network and test it for connectivity and performance. Next, add evacuation shelters and/or egress portals to the map. Finally, add residence points. Each point represents an occupied structure, not an individual or vehicle. If available, add commercial or institutional facilities with attributes describing their occupancy.

After loading all input data, construct an initial CF solver. Shelters and egress points are loaded as Facilities, and the occupied structure points are loaded as Incidents. Multiple potential facilities may be modeled, routing evacuees to closest and alternate destinations. Set the travel direction from Incidents to Facilities. For most evacuation models, do not specify a maximum travel time. The CF solver is now ready to run; egress routes for the street network can be constructed, and travel times and distances can be accumulated along those routes.

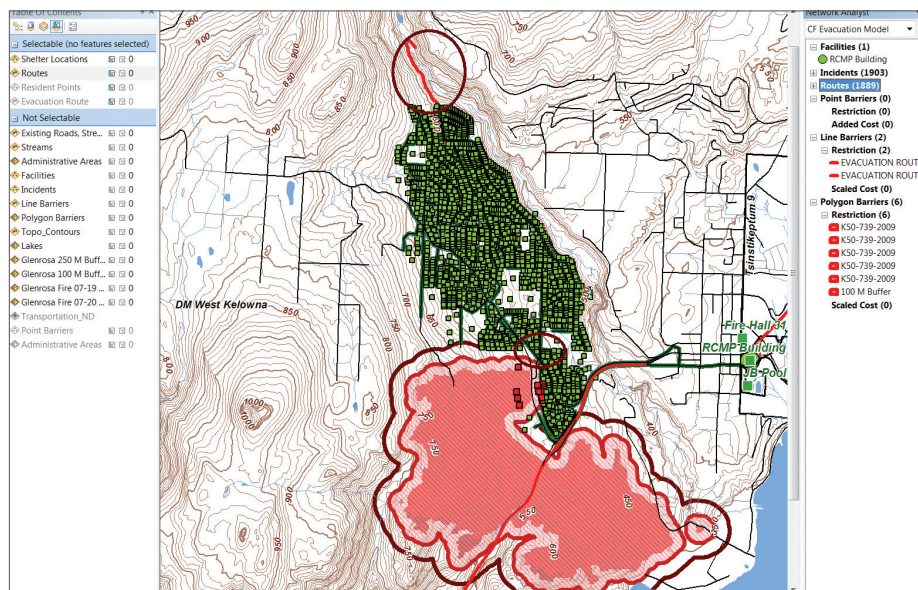


▲ In the Network Analyst Window, right-click Polygon Barriers and choose Load Locations. Load locations from Glenrosa Fire 07-20-2225 Hours and set the Sort field to OBJECTID and the Name field to FIRENUMBER.

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Revisiting the Glenrosa Fire

Continued from page 49



Inspect and verify the preliminary results. A large model with many residences and multiple egress points requires some time to run, so be patient. Once completed, you can inspect and count the number of evacuees using specific egress routes. Using procedures presented in a future article, you may join and tabulate and superimpose stacked evacuation routes on the underlying street dataset and apply polyline symbols of varying width and color to represent the accumulation of evacuees along assigned routes. Stacked routes at street intersections may be summarized to provide counts of all vehicles that will pass through specific intersections. If certain routes or intersections are overloaded, secondary evacuation routes may be assigned to selected evacuees. Routes and intersection events may be recounted, certain evacuees can be redirected to alternate routes, and the model can be run again.

If you add closed or restricted egress to the model, save and replicate this CF model as a base case. In ArcGIS 10, you can add point, polyline, or polygon barriers that represent road closures or blockages. New in ArcGIS 10, polygon and polyline barriers can include fire progression shells, expanding flood areas, and mobile toxic plumes. You can run multiple copies of the CF model to test the effect of an expanding or moving hazard.

Part II: Revisiting Glenrosa

To begin this evacuation modeling exercise, download and unzip training data from *ArcUser Online* (esri.com/arcuser) locally. Start ArcMap 10, navigate to the \WK_Evacuation folder, and open WK Evac01.mxd. Notice the many Residence Points within the Glenrosa neighborhood and the three Shelter Locations near the lake. The ultimate destination for evacuees will be the Royal LePage Center located approximately 3 miles east of the RCMP Building, so the RCMP facility will be used as the preliminary destination.

In the table of contents (TOC), inspect the CF Evacuation Model. For readers who are new to ArcGIS Network Analyst, the author has created a composite Network Dataset and initiated a CF solver. No Facilities (Shelters) or Incidents (Residences) are included in the solver; these will be added during the exercise.

1. In the TOC, right-click CF Evacuation Model and select Properties. Review the Analysis Setting tab and notice that Incidents are only rout-

◀ Resolve the model and inspect the Lower Glenrosa evacuation route. How many evacuees use this route now? How many use Glenrosa Road?

ed to one Facility and there is no time limit.

2. Open the table for Line Barriers. There are two records. These lines block the proposed evacuation route.

3. Inspect the three Shelter Locations and the Resident Points. The RCMP Building will be a destination staging area where evacuees will be sent before going on to the Royal LePage Center located a little more than 3 miles to the east.

This model includes 1,903 Glenrosa residences that were separated from other residences with a definition query. Residences, not occupants or vehicles, will be counted. Notice the ovals in the north and south, which will be used to highlight critical parts of the model.

4. In the TOC, make the Glenrosa Perimeter Group visible. This group contains perimeters for the evenings of July 18 and July 19 and two buffers for the July 19 perimeter. These will be used to refine the evacuation plan. Note that the fire burned right up to Glenrosa Road, the major access road for the community. If this road was blocked, evacuation could become very difficult.

5. Switch from layout view to data view, the view in which modeling will be performed. With the Glenrosa perimeter visible, zoom in to the southern ellipse, an area where blocking just two roads—Glenrosa, Webber, and Lower Glenrosa Roads—will isolate all residents north of this area. Using the Measure tool, determine that it is less than 250 m from the July 19 perimeter to the center of this critical area.

6. Now, zoom north to the second ellipse. The dashed red line represents a proposed secondary route in and out of the community. This hypothetical route will be used to test evacuation options if the southern route is blocked. Zoom back out using the map document bookmark WC 1:25,000.

7. Verify that Network Analyst is available and load its toolbar. Open the Network Analyst window and dock it on the right side of the interface.

Loading Shelters and Residences and Running a Prefire Model

1. In the Network Analyst window, right-click Facilities and select Load Locations. Load from Shelter Locations, select Index as the Sort field, set the Name to Label, and note the tight search tolerance of 0 meters. Click OK.

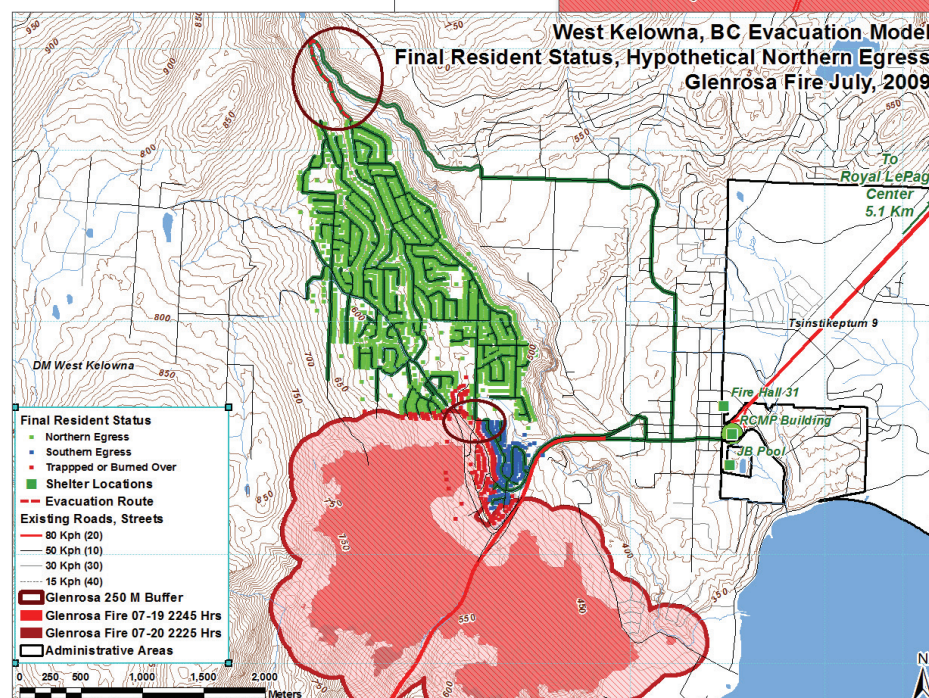
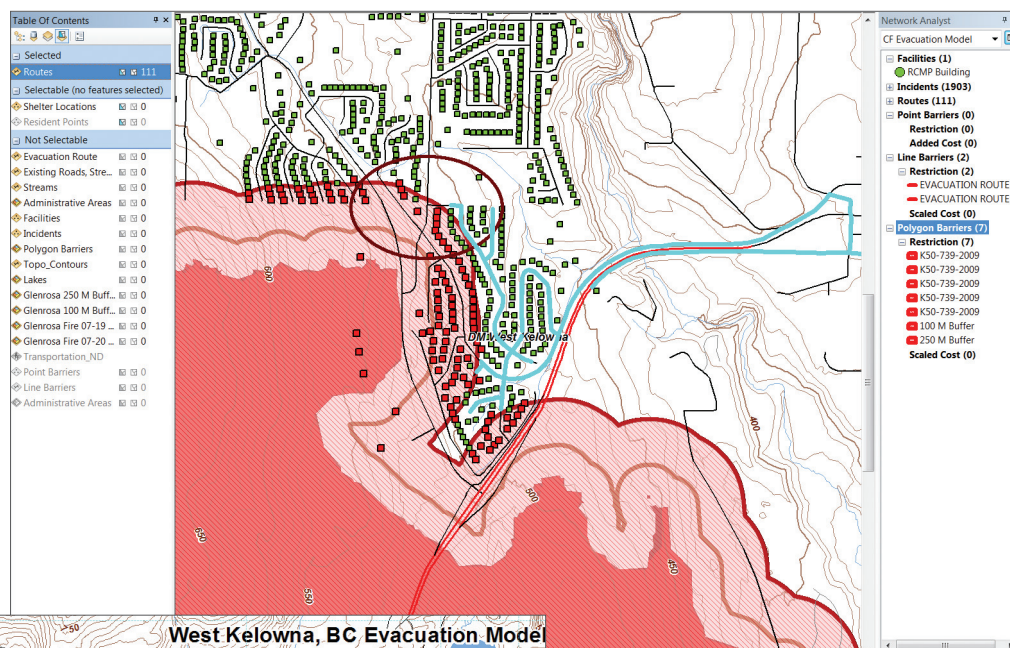
2. Right-click Incidents in the Network Analyst window and load the Glenrosa residences as Incidents from Residence Points. Set both the Sort field and Name to Index. Check the map and save it. Multiple iterations of this solver could be used by copying and pasting the original solver back into the TOC, renaming each copy. However, this exercise will modify just one solver.

3. In the TOC, locate the CF Evacuation Model and make Line Barriers visible. These lines are the current blocks on the proposed northern egress. Right-click the CF solver, select Properties, and open the Analysis Setting tab. Verify that travel is set from Incidents to one Facility without a time cutoff.

4. Close Properties and solve the model. Right-click the CF solver in the

► After adding the Glenrosa 250 M Buffer, only 111 residences can evacuate, and 1,792 residences are threatened.

▼ The Final Resident Status shows how relates, spatial selects, and some minor editing were used to code all Glenrosa residences to evacuation routing, taking into account the full 250 m fire buffer and the proposed northern egress. Residences subject to entrapment and direct fire exposure are noted.



TOC and choose Solve. Close the warning message after reading it. After the solver has finished working, inspect the results and save the project.

5. To quickly count evacuee routes, switch the TOC from List By Drawing Order to List By Selection. Make only Routes, Shelter Locations, Residences, and Evacuation Routes selectable and use the Select By Polygon tool to move to a location anywhere in the network to create a small selection box across the evacuation routes leading toward the shelter.

6. In the TOC, look at the count of routes that have accumulated. The count shows an accumulation of 456 residences evacuating on Glenrosa Road just below Country Pines Gate and 217 houses being evacuated from Herbert Road, about 0.7 km west of the RCMP Building. Testing just west of the RCMP Building should show that all 1,903 residents can safely reach the shelter.

Loading Polygon Barriers and Resolving

The next step will be to load the Glenrosa fire perimeter. ArcGIS 10 doesn't require placing and managing many barrier points to emulate complex geometries. Instead, restricting network travel is accomplished more simply by loading polyline and polygon barriers.

1. In the Network Analyst Window, right-click Polygon Barriers and select Load Locations. Load from Glenrosa Fire 07-20-2225 Hours. Set the Sort field to OBJECTID and set Name to FIRENUMBER. Click OK and save the project.
2. Because the TOC is set to List By Selection, solve the model again by clicking the Solve icon on the Network Analyst toolbar. (This solves using the current solver in the Network Analyst window, so be careful if the TOC contains multiple solvers.)
3. When the solver is finished, the Glenrosa fire perimeter should have closed Glenrosa Road, and 1,897 residences will now have to

evacuate by sneaking around on Lower Glenrosa Road.

Expanding the Fire by Loading Buffers

What happens if the fire crosses Glenrosa Road and extends into the Webber/Lower Glenrosa area? How will the thick smoke and close proximity to the flames along Glenrosa Road affect evacuation efforts?

1. Load the 100 m and 250 m buffers to test this possibility. In the TOC, momentarily return to List By Drawing Order, open the Glenrosa Perimeter Group, and make Glenrosa 100 M Buffer and Glenrosa 250 M Buffer visible.
2. Change the TOC back to List By Selection. Right-click Polygon Barriers in the Network Analyst window and choose Load Locations.

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Revisiting the Glenrosa Fire

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What happens if the fire crosses Glenrosa Road and extends into the Webber/Lower Glenrosa area? How will the thick smoke and close proximity to the flames along Glenrosa Road affect evacuation efforts?

Load the Glenrosa 100 M Buffer and specify OBJECTID for the Sort field and Label for the Name field. Resolve the network and inspect the Lower Glenrosa evacuation route. How many evacuees use this route now? How many use Glenrosa Road? Save the project.

Challenge Question: How many residences are burned over, and where are they located? How many residences are not accounted for in this iteration of the model? The answer is given at the end of the article.

3. To expand the fire footprint, load the Glenrosa 250 M Buffer in Locations and specify OBJECTID for the Sort field and Label for the Name field. Resolve the model and inspect the results. Select and count the evacuees arriving at the RCMP Building. Now 111 residences can evacuate, but 1,792 residences have been burned over. This must be fixed.

Opening the Back Door

In the area where urban development meets forest land (the wildland-urban interface), it is important for communities to have alternate means of egress in the event that primary routes are blocked. Using topography, imagery, and existing roads and trails, the author designed a hypothetical northern egress route that exits the Glenrosa community in the far north. However, to use this route requires opening the gates and instructing many evacuees to travel north instead of south. This proposed route is narrow and slow, but it is far from the fire threat.

In the Network Analyst window, right-click Line Barriers and select Delete All. Save the project and solve it again. Now, 1,643 residents have egress along the northern portal, and 111 residents will still be evacuated in the south. Unfortunately, 149 residences will be burned over. By preparing a series of relates and attribute queries, where residents live and work can be quickly determined so they can be quickly moved out of harm's way.

Finishing Up

1. To finish this exercise, switch back to List By Drawing Order in the TOC and zoom to the WK 1:25,000 bookmark.

2. Navigate to WK_Evacuation\SHPPFiles\UTM83Z11 and load the Final Resident Status Layer file.

3. Add this layer to the map's legend. Open its table, move to the far right, and inspect the Status field. Using a series of relates, spatial selects, and minor editing, the author coded all Glenrosa residences with their assigned evacuation routing using the full 250 m fire buffer and the proposed northern egress. Residences subject to entrapment and areas subject to direct fire exposure are identified. This map shows one way this data could be presented to the community.

Challenge Answer: Lower Glenrosa: 1,886; Glenrosa: 3; Unaccounted for: 14

Acknowledgments

The author thanks the staff of the District of West Kelowna—especially GIS analyst Kevin Wang—for the opportunity to re-create the Glenrosa Fire incident with actual district data and experiment with alternatives to extend and test the evacuation model. Thanks also go to the Vancouver and Kelowna offices of ESRI Canada Limited for their encouragement in choosing this incident to model.

Thanks go as well to the Esri Network Analyst development team members for their patience, recommendations, and support (both moral and technical) in the author's continued testing of this very effective and innovative product. Thanks for the polyline and polygon barriers—they are great!

Charming the Snake

An introduction to Python and the ArcPy site-package

By Thad Tilton, Geographic Information Services, Inc.

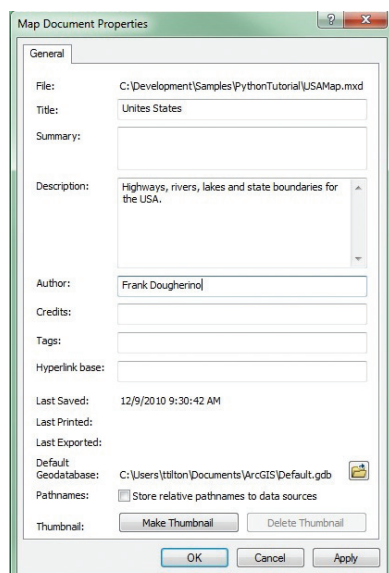
While fearing a real python might be justified, you shouldn't be intimidated by the Python language. Esri has embraced Python as the language that fulfills the needs of its user community.

Programming with Python using the new ArcPy site-package in ArcGIS 10 makes GIS programming accessible for the average GIS professional. For longtime GIS users who yearn for the simpler days of Avenue (the scripting language used with ArcView 3.x), Python has some of the same attractive features: a manageable number of well-documented classes and functions, scripts that can be easily loaded into a document and executed, code shared as simple text files, and (perhaps best of all) no need to know what QueryInterface means. Python is a widely used, nonproprietary language, so learning Python can be beneficial for non-GIS applications.

To help you get started with Python, this tutorial will describe how to create a script that produces a simple report for the current map document. The generated report will contain information about all data frames and layers in the map. Optionally, it can list any layers that have broken data links and create a map package (*.mpk) for the document.

While the script itself may not be particularly exciting, the tutorial's primary goal is illustrating techniques commonly used when writing Python scripts. Specifically, the tutorial will show how to

- Reference additional libraries (i.e., import functionality) for use in a script.
- Accept user-provided arguments.
- Show messages that report the script's progress.
- Get a reference to the current map document.
- Execute a geoprocessing tool.
- Access objects in a map document (data frames, layers, tables).
- Write branching and looping statements.
- Create, open, and write to files.



Make sure the map document has the Title, Description, and Author fields filled out.

What You Will Need

- ArcGIS Desktop 10 (ArcView, ArcEditor, or ArcInfo license)
- An ArcMap document containing at least two data frames with several data layers in each frame
- The script for this exercise, MxdReport.py, downloaded from esri.com/arcuser

Getting Started

Download MxdReport.py from the *ArcUser Online* Web site (esri.com/arcuser) so you can reference it as you do the exercise.

There are several ways to run Python code in ArcGIS. The Python Window, new with ArcGIS 10, can be used to run single lines of Python code or load an entire script into a command line-type dialog. However, for authoring full scripts, such as the one described in this tutorial, a Python integrated development environment (IDE) is the best option. Several IDEs are available for Python. The Python IDLE editor, which is included with ArcGIS 10, will be used in this exercise.

1. Open ArcMap. Choose a map document for this exercise that contains several data frames. Each data frame should contain several layers.
2. Make sure the map document has the Title, Description, and Author fields filled out. With the map document open, go to File > Map Document Properties to verify this. Do not omit this step.
3. In ArcMap, display the ArcToolbox window by choosing Geoprocessing menu > ArcToolbox.
4. Open ArcCatalog. Right-click the geodatabase referenced by the map document. Choose New > Toolbox. Name the new toolbox GetStart.
5. Right-click ArcToolbox, choose Add Toolbox, and select the GetStart toolbox to add it.
6. Use Windows Notepad or another text editor to create a new text file called MxdReport.py.
7. Return to ArcMap and create a new script inside the new GetStart toolbox by right-clicking the toolbox and choosing Add > Script.
8. In the Script Wizard, name the script MxdReport, add the label Create MXD Report, and click Next.
9. For the script file, navigate to the MxdReport.py text file created earlier and add it. Click Next.
10. Add three parameters (Output Path, Package Map, and Track Broken Links, in this order) and choose the values shown in Table 1 for each parameter. Click Finish.
11. Open the MxdReport.py script in the IDLE editor by right-clicking on the script and choosing Edit. The IDLE editor will open with two windows. One will contain the MxdReport script file. The other, called the Python shell, can be used for executing Python statements interactively, but it won't be used here, so close it.

Continued on page 54

Charming the Snake

Continued from page 53

Parameter Name	Data Type	Default Value
Output Path	Folder	C:\Temp
Package Map	Boolean	False
Track Broken Links	Boolean	True

Table 1: MxdReport.py script parameters

Importing Additional Modules

Python modules are files used to organize sets of additional functionality so your script can access it. The import statement is one way to bring a module into a script and make the functionality it defines available. At the top of the script window, type the following import statements:

```
import os
import sys
import arcpy
import arcpy.mapping as mapping
```

The os and sys modules contain functions the script will need for working with files on disk. The ArcPy site-package will allow access to geoprocessing tools. The ArcPy mapping module provides functionality for working with the map document and the objects it contains.

Reading User Inputs

Commonly, a script will need some input from the user to run. When creating a script, parameters can be defined to specify the information to be entered by the user. ArcGIS uses parameter information to create the necessary input controls. The order of parameters defined for the script is important, because parameter values are read from an ordered list of inputs. Add the following code to read user inputs:

```
outDir = arcpy.GetParameterAsText(0)
packageMap = arcpy.GetParameter(1)
checkBrokenLayers = arcpy.GetParameter(2)
```

GetParameterAsText reads the user input for the output file location (for example) as a text string. GetParameter reads user input and returns an object (e.g., Boolean).

Getting a Reference to the Current Map

When scripting in any environment, the current document is often the key object. Once a reference to the current document is obtained, the script can drill down into the additional objects it contains. A reference to the map document will provide access to the data frames, layers, and tables the map contains. Add the code below to get a reference to the current map document and store it in a variable called mxd.

```
mxd = mapping.MapDocument('Current')
```

The required parameter for the MapDocument function is either a path to a map document on disk or the keyword Current to get the map in which the script is executing.

Opening a File on Disk

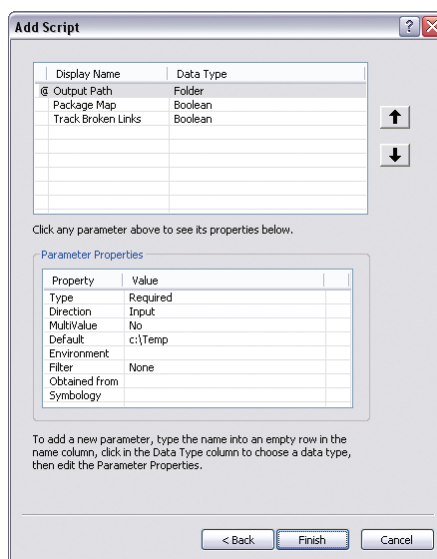
The report generated by this script will be output as a simple text file to a location specified by the user. Add the code below to build the output file name for the report:

```
reportPath = outDir + '\\\' + mxd.title + '.txt'
```

The + operator is used to concatenate strings in Python. The output report file will have the same name as the map, but with a .txt extension (e.g., C:\Temp\USA.mxd.txt).

Use the open function to open the file:

```
reportFile = open(reportPath, 'w')
```



Define the properties for the script by adding three parameters (Output Path, Package Map, and Track Broken Links) using the values shown in Table 1.

The open function takes two arguments: the file name and the file mode. Valid file modes are *w* for write, *r* for read, and *a* for append. If the file exists, it will be overwritten. If it does not exist, it will be created. Add the line of code below to report the script's status to the user. This message will appear in the script's output window as it executes.

```
arcpy.AddMessage('Writing report to ' + reportPath)
```

Getting Information about the Map

The MapDocument object has several properties for getting basic information about the map. Create a variable to hold the report text and begin writing the report.

```
reportText = 'Title: ' + mxd.title + '\n'
reportText += 'Author: ' + mxd.author + '\n'
reportText += 'Description: ' + mxd.description + '\n'
reportText += '~~~~~' + '\n'
```

The \n is an escape sequence used to generate a carriage return. The += combination is a shortcut for appending text to the end of the variable (e.g., reportText = reportText + "new text").

Writing a Simple Branching Statement

In all programming languages, the term *branching* refers to the ability to make decisions in the code. The most basic example is an IF/THEN statement, which will perform an action only if a specified condition is true. Define the following branching statement that checks if the user wants to create a map package:

```
if packageMap:
```

Indentation is often used in scripts to make code more readable. In Python, indentation has a functional importance. Code that is indented under a branching statement indicates that the code should run in response to the condition being true. To check indentations, refer to MxdReport.py, downloaded from *ArcUser Online*. Add code to build the output path for the map package.

```
packagePath = outDir + '\\\' + mxd.title.replace('.', '_') + '.mpk'
```

Build another branching statement that checks whether the output map package exists. If it does, add a message that informs the user the package will not be re-created:


```
if (os.path.exists(packagePath)):
    arcpy.AddMessage('Map package already exists
                    (' + packagePath + ')')
```

Executing a Geoprocessing Tool

Any geoprocessing tool that is available from ArcToolbox may be executed programmatically using ArcPy. To create a map package, you will execute the PackageMap geoprocessing tool and pass in the required arguments. Add an ELSE section to the branching statement started above. Add a message to indicate that the map package is being created:

```
else:
    arcpy.AddMessage('Creating map package
                    ' + packagePath + ')')
```

Use ArcPy to call the PackageMap geoprocessing tool.

```
arcpy.PackageMap_management(mxd.filePath,
                           packagePath)
```

PackageMap_management requires the path to the map document and the path to the output package file.

Loop through All Data Frames in the Map

In Python, you may wish to loop based on a condition (a WHILE loop) or over a collection of items (FOR loop). Use mapping.ListDataFrames to get a list of data frames from the map. Make sure to begin your code at the left edge of the editor (i.e., without indentation) to ensure it runs outside of the previous branching statement:

```
dataFrames = mapping.ListDataFrames(mxd, '')
```

The ListDataFrames function takes two arguments: a map document (or a path to one) and a wildcard string for filtering data frames based on name (e.g., La*). The function returns a Python list of data frames. Start a FOR loop to iterate over the data frames in the list:

```
for frame in dataFrames:
```

Add information about the data frame to reportText string. Like a branching statement, the code to execute inside a loop must be indented beneath the FOR statement.

```
reportText += '\nData Frame: ' + frame.name + '\n'
reportText += ('Spatial Reference: ' + frame.spatial
              Reference.name + '\n')
```

Loop Through All Layers in Each Data Frame

Inside the loop that iterates over data frame objects, a nested loop will iterate over the collection of layers inside each data frame. Add the code below to complete the nested loop of layer objects. Don't forget to indent this code beneath the parent loop.

```
layers = mapping.ListLayers(mxd, '', frame)
i = 0
for lyr in layers:
    reportText += '\tLayer ' + (str(i) + ': ' + lyr.
                             name + '\n')

    i += 1
```

Similar to the ListDataFrames function, ListLayers returns a Python list object containing layer objects. The str function converts a value (e.g., integer) to a string.

Find Layers That Have a Broken Data Source

Using Python to locate layers in the map that have missing data sources is easy. Rather than checking each layer individually, a single function—ListBrokenDataSources—can be used to return a Python list of broken layers. If the user has requested this information in the report, use ListBrokenDataSources to get a list of layers. The LEN function returns the number of items in a list.

```
if checkBrokenLayers:
    arcpy.AddMessage('Checking for missing data
                    sources')
    brokenList = mapping.ListBrokenDataSources(mxd)
    reportText += ('\nFound ' + str(len(brokenList))
                  + ' layers with missing data.')
    for broken in brokenList:
        reportText += '\t- ' + broken.name + '\n'
```

Write Text File to Disk

At this point, all the text for the report is contained in the reportText variable. All that's needed now is to write this string to the output file that was created earlier. After writing the text stored in the reportText variable to the file, close it and delete the mxd variable using this code.

```
reportFile.write(reportText)
reportFile.close()
del mxd
```

Test the Script

The script is now ready to run.

1. Save changes to the script in the IDLE editor.
2. Double-click the script in ArcToolbox to launch the input dialog. The controls were built from the settings you chose.
3. Specify an output folder for the report, check all check boxes, and run the script.
4. As the script executes, watch the output window for the messages you added. Once execution is complete, check the output text file and map package to verify that they were generated correctly.

Conclusion

With the ArcPy site-package, Esri has integrated Python into ArcGIS 10. Python's relative simplicity and power make it the scripting language of the future for ArcGIS. For more information, contact Thad Tilton at ttilton@gisinc.com.

About the Author

Thad Tilton is a senior GIS developer for Geographic Information Services, Inc.



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Python's relative simplicity and power
make it the scripting language of the
future for ArcGIS.

Just What You Need

Feature templates simplify editing workflow

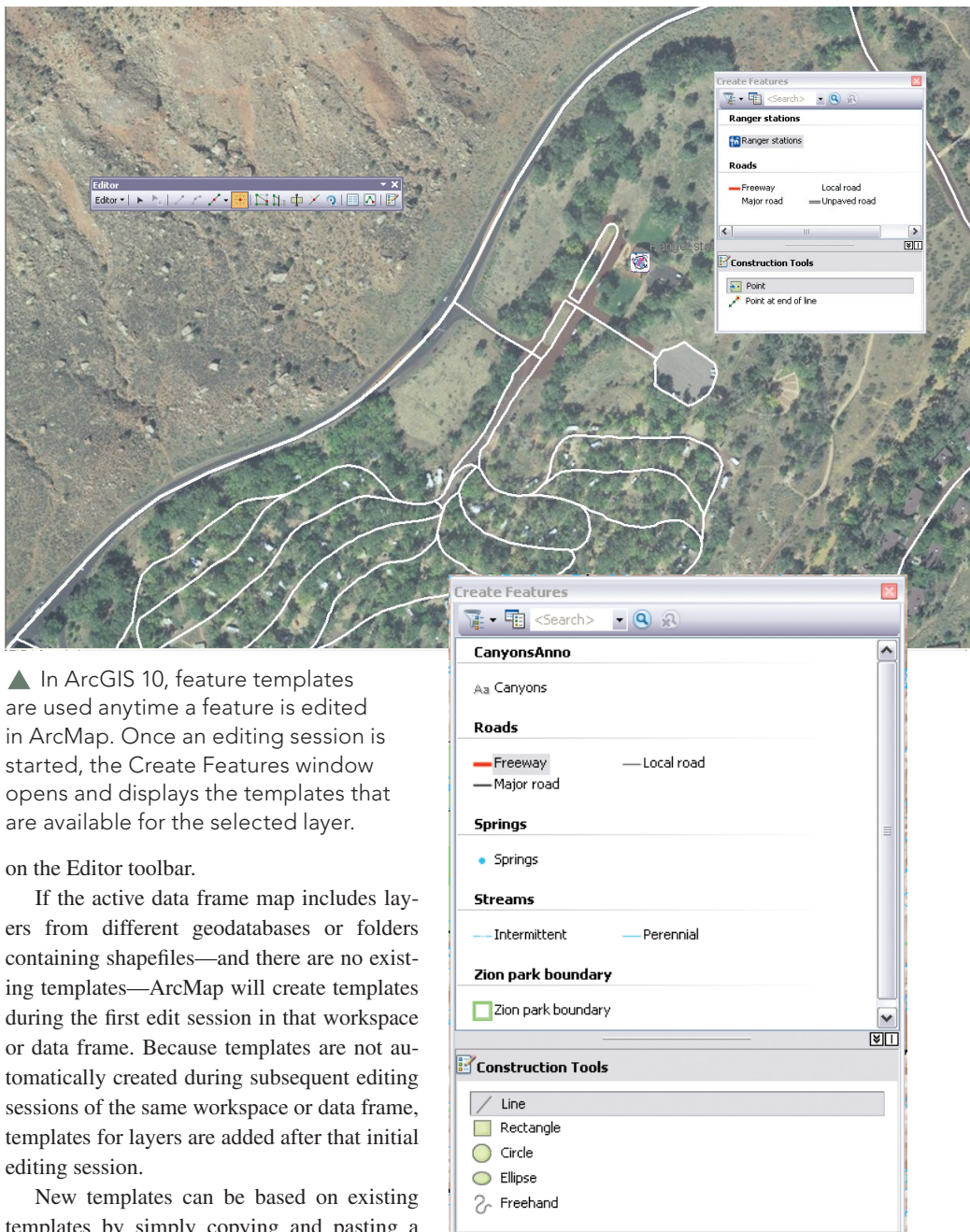
The feature template, new in ArcGIS 10, controls how new features are created by defining all the information required to create a feature. It controls the layer on which the feature will be stored, which attributes the feature will be created with, and the default tool that will be used to create the feature. Feature templates have names, descriptions, and tags so they can be more easily organized and located. This means fewer button clicks and simplified workflows that speed up editing tasks in ArcMap.

The Editor toolbar has been reconceptualized and reorganized. Some items previously accessed from the Task list have been converted to individual tools and placed on the Editor or Topology toolbar or in other parts of the interface so they could be combined with other tools that work in a similar environment. The Create Features window can be directly accessed via the Create Features button on the Editor toolbar.

Feature templates are used anytime features are edited and are based on the symbology of the layer, so there can be more than one feature template per layer. For example, when editing a roads layer, a new feature template would be created for each road type symbolized in that layer (e.g., freeway, major road, local road), because feature templates can have the same target layer property but different road type attributes. Using this example, creating a new feature using the freeway feature template would automatically assign the attribute for the road type as freeway, and the new feature would be correctly symbolized.

To use feature templates, simply start editing in ArcMap by right-clicking a layer in the table of contents and choosing Edit Features > Start Editing; the Create Features window opens.

With an editing session started, choose a feature template from the Create Features window and begin editing features by choosing a construction tool from the Create Features window. The bottom panel of the Create Features window lists the tools available to create features based on the feature type and feature template currently selected. If a point layer is being edited, only construction tools for creating points will be available. Save the edits by choosing Stop Editing from the Editor menu



▲ In ArcGIS 10, feature templates are used anytime a feature is edited in ArcMap. Once an editing session is started, the Create Features window opens and displays the templates that are available for the selected layer.

on the Editor toolbar.

If the active data frame map includes layers from different geodatabases or folders containing shapefiles—and there are no existing templates—ArcMap will create templates during the first edit session in that workspace or data frame. Because templates are not automatically created during subsequent editing sessions of the same workspace or data frame, templates for layers are added after that initial editing session.

New templates can be based on existing templates by simply copying and pasting a template and making slight changes to its properties. Carefully setting a feature template's default properties—particularly the default tool—will save time and improve accuracy.

Templates are synchronized with the table of contents. If a layer is not visible because it is turned off, does not satisfy a definition query, or is out of display scale perimeters, its feature template will not be available. Before creating a

▲ Feature templates can share the same target layer. The Roads layer has templates for Freeway, Major Road, and Local road features. Using the feature template for the Freeway layer, new features are automatically assigned freeway as road type and are correctly symbolized.

feature template, make sure that layer is visible.

Open the Organize Feature Template dialog box before creating a new template to determine if any templates already exist for this layer. This avoids duplication of existing templates. If ArcMap automatically created templates for layers that will not be used for editing, use the Organize Feature Templates window to identify and delete them so it will be easier to find the templates that will be used.

Give templates clear and descriptive names so they can be easily located. Also, enter a description of the template's contents and intended use. This description will appear as a ToolTip when the cursor hovers over a template in the dialog box.

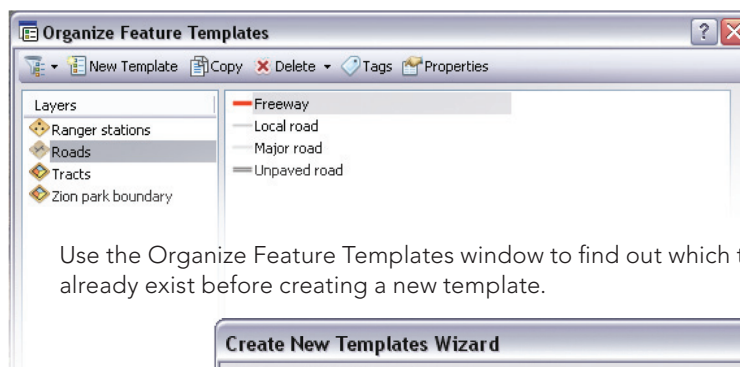
Tags (e.g., keywords, metadata) can also be added to templates to categorize them so they will be filtered in searches. This can also be used to limit the template list displayed in the Create Features dialog box.

Templates are saved in the map document (.mxd) and the layer file (.lyr). They are used only when a feature is being created. If the default attribute values of a template are subsequently changed, those changes are not retroactively applied to existing features that used the template.

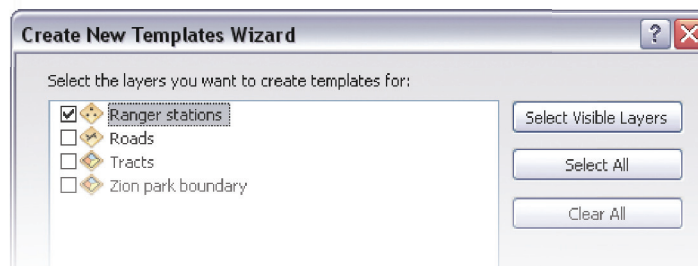
If a layer's symbology is significantly changed, a new template should be created for that layer. If rendering of several layers in a map document has been changed, deleting all the associated templates may be the easiest method for synchronizing the templates with the map document. Then, use the Create New Templates wizard to create templates only for layers that will be edited.

To avoid this situation, a better practice would be to carefully prepare the map and its symbology before editing and creating templates. If the map will be edited by others, either directly on the desktop or as a map served by ArcGIS Server, make sure layers and symbol labels are clearly named, because these names are used to identify feature templates in the Create Features window.

For more on editing in ArcGIS 10, see the ArcGIS Desktop Help available from arcgis.com.

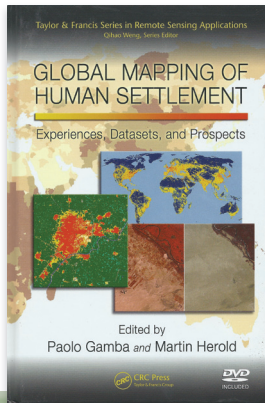


Use the Organize Feature Templates window to find out which templates already exist before creating a new template.



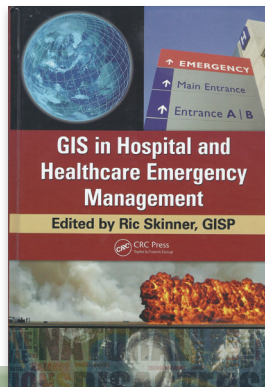
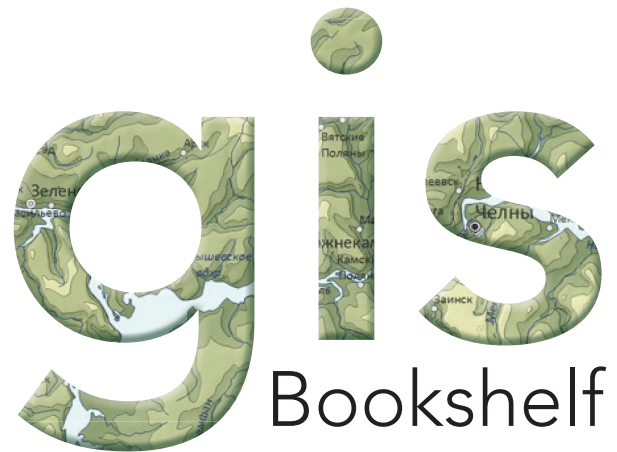
Although ArcGIS automatically creates templates during the first edit session in a workspace or data frame, to create additional templates, use the Create New Templates wizard, which is available from the Organize Feature Templates window.

**The right tools to integrate imagery
into your ArcGIS® Workflows**



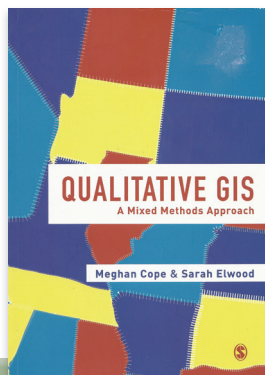
Global Mapping of Human Settlement Experiences, Datasets, and Prospects

Edited by Paolo Gamba and Martin Herold
One in a series of books from this publisher on recent developments in remote sensing, *Global Mapping of Human Settlement* focuses on the use of remote sensing for assessing the impact of urban areas on the environment. Urbanization is changing the face of the earth more rapidly now than in any other time period. Recent improvements in the spectral resolution of this data, coupled with more rapid processing by commercial suppliers, have made it far more useful in studying urban areas—a pressing concern, as more than 60 percent of the world's population may be living in urban areas by 2030. This text reviews the methodologies, datasets, and approaches associated with the use of remotely sensed data when analyzing city landscapes, particularly as related to the challenges of delineating and classifying urban areas. CRC Press, 2009, 374 pp., ISBN-13: 9781420083392



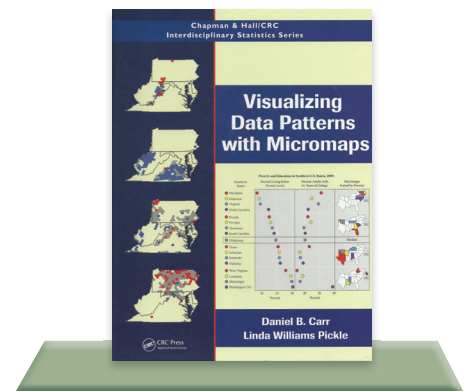
GIS in Hospital and Healthcare Emergency Management

Edited by Ric Skinner, GISP
Although many books are available on the use of GIS in health care or emergency management, this book contains practical information on its use in both. In this book, Skinner brings together leaders in this area who provide insights that should improve both planning and response to health care emergencies. Conceptual Approach, the first of the book's three sections, discusses the role and value of GIS. The Applications section addresses specific tasks associated with health care emergencies that improved with the use of GIS—evacuation and sheltering, situational awareness, and optimal siting for alternative care and trauma centers. The Case Studies section draws from examples on many scales, from preparing hospital disaster plans to deal with pandemics to regional planning for mass casualties. CRC Press, 2010, 279 pp., ISBN-13: 9781439821299



Qualitative GIS: A Mixed Methods Approach

Edited by Meghan Cope and Sarah Elwood
Historically, GIS has been based on quantitative methods. This scholarly collection of articles explores the adoption of qualitative GIS, incorporating noncartographic data and analyses that provide interpretation of both situations and processes. The text is structured around three themes: representations, analysis, and theory. Readers learn how to frame questions, collect data, analyze results, and represent findings in a truly integrated way. SAGE Publications Ltd, 2009, 192 pp., ISBN-13: 9781412945660

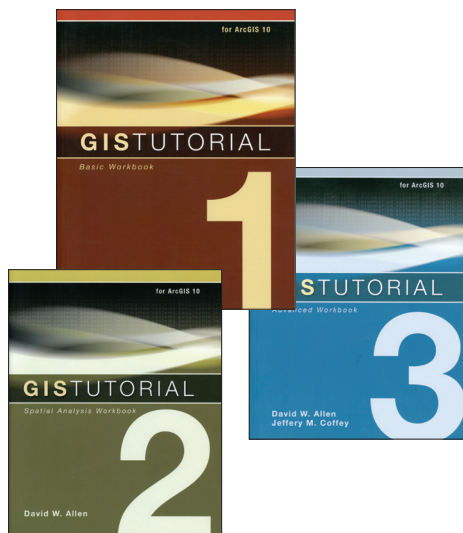


Visualizing Data Patterns with Micromaps

By Daniel B. Carr and Linda Williams Pickle
Micromaps link statistical information to an organized set of small maps that reveal the statistical and geographic patterns in the data. The design of these maps incorporates research in cognitive psychology, statistical graphics, computer science, and cartography. After the introduction of the three kinds of micromaps—linked, conditioned, and comparative—in the first chapter, the following chapters explain the research behind micromaps and how this research was applied in designing these maps, then apply all three techniques to the same data to illustrate the purpose of each type, its strengths, and its limitations. This book is part of the Chapman & Hall/CRC Interdisciplinary Statistics Series and has an accompanying Web site that supplies datasets and examples. The authors are leaders in this field. Carr, a professor of statistics at George Mason University in Fairfax, Virginia, has been developing graphic and computational methods for exploratory visualization for more than 30 years. Pickle is principal and chief statistician at StatNet Consulting LLC. CRC Press, 2010, 182 pp., ISBN-13: 9781420075731

Resources for Learning ArcGIS 10

New titles for users with different needs



Esri Press has released a variety of new and updated titles to help users learn how to use ArcGIS 10. From introductory texts for beginners to workbooks for more advanced users, these books use different styles of presenting material that is tailored to the needs of different learners.

GIS Tutorial for ArcGIS 10 Series

Esri Press revamped the two previously released GIS Tutorial workbooks to be compatible with ArcGIS 10 and added a new workbook on advanced topics to complete the series. Each workbook includes all the data required to complete the exercises and a 180-day trial version of ArcGIS Desktop 10 software on DVD. These books can be used for both self-study or classroom instruction.

GIS Tutorial 1: Basic Workbook

by Wilpen L. Gorr and Kristen S. Kurland
Now in its fourth edition, this volume introduces GIS concepts through ArcGIS self-study exercises. Ideal for GIS beginners, it provides easy-to-follow, step-by-step instruction for basic GIS activities such as collecting data, creating maps, and performing simple spatial analysis. These lessons gradually increase students' skills and confidence and help develop critical thinking skills through solving problems based on real-world issues. Esri Press, 2010, 428 pp., ISBN-13: 9781589482593

GIS Tutorial 2: Spatial Analysis Workbook

by David W. Allen

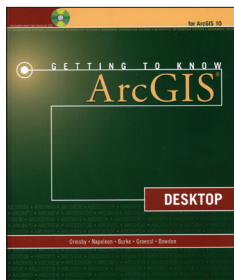
This workbook, in its second edition, continues building students' problem-solving and spatial analysis skills using the tools in ArcGIS Desktop. The text assumes readers possess intermediate GIS skills. Exercises deal with location analysis, change over time, location and value comparisons, geographic distribution, pattern analysis, and cluster identification. Esri Press, 2010, 340 pp., ISBN-13: 9781589482586

GIS Tutorial 3: Advanced Workbook

by David W. Allen and Jeffery M. Coffey

This newest volume in the series examines the full breadth of ArcGIS Desktop capabilities by exploring the more complex functions available in ArcEditor and ArcInfo. The book addresses geodatabase framework design, data creation and management, workflow optimization, and labeling and symbolizing. In addition to step-by-step instruction, this book includes exercises that reinforce the concepts taught along with reviews, study questions, and real-world applications. The intended audience is GIS professionals and students who possess intermediate to advanced GIS skills. Esri Press, 2010, 412 pp., ISBN-13: 9781589482074

Getting to Know ArcGIS Desktop, Second Edition, Updated for ArcGIS 10
by Tim Ormsby, Eileen J. Napoleon, Robert Burke, Carolyn Groessl, and Laura Bowden



that step the reader through the basic tasks associated with creating and editing data, making maps, and querying data. This best-selling GIS book was originally published in 2001.

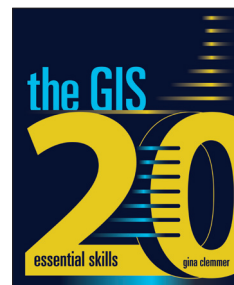
Getting to Know ArcGIS Desktop, Second Edition, Updated for ArcGIS 10, is a workbook for beginners that teaches the core functionality of ArcGIS software through exercises

A team of technical and education specialists created it as a hands-on guide for classroom work or a resource for on-the-job training. Lessons teach skills through exercises placed in the context of real-world projects. No prior knowledge of GIS is assumed. All data needed for the exercises is supplied on the accompanying disc. Esri Press, 2010, 600 pp., ISBN-13: 9781589482609

The GIS 20: Essential Skills

by Gina Clemmer

This slender volume takes a very different



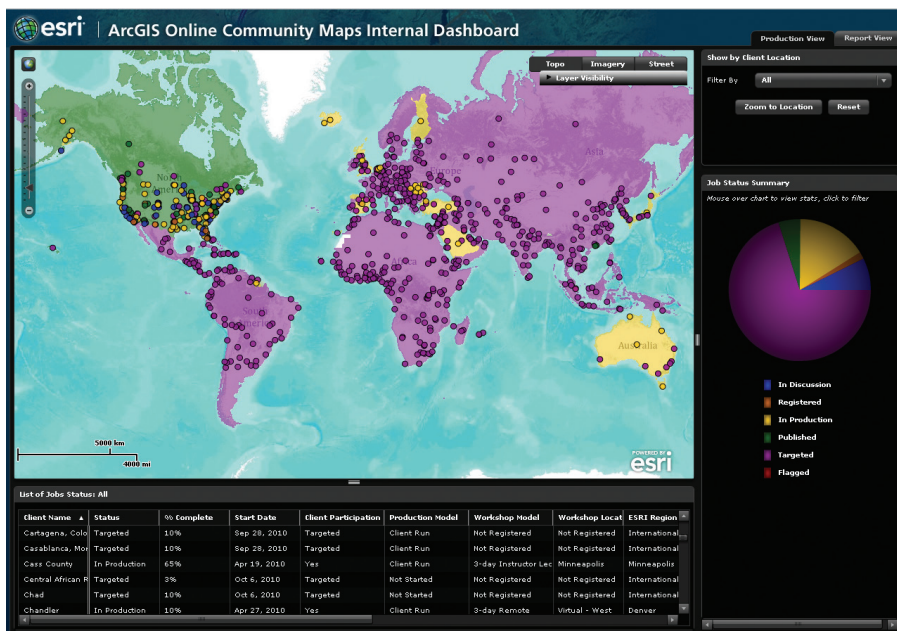
approach to teaching readers how to use ArcGIS Desktop software. The information is organized and presented to teach the specific skills needed to accomplish common

tasks. This practical approach makes it a great guide for professionals who have no time for classroom training. It can be used for independent study or as a reference. This book is the direct result of Clemmer's survey of GIS professionals that identified the primary skills needed to be a successful GIS user. Each chapter covers a specific topic: creating map layouts, preparing data, joining data to maps, working with attribute tables, mapping addresses, querying location, and publishing maps. Clemmer, president of the research and training company New Urban Research, Inc., has trained thousands of beginning GIS users. The book also includes a CD containing the data for completing the exercises. Esri Press, 2010, 155 pp., ISBN-13: 9781589482562

Purchase these books from online retailers worldwide, at esri.com/esripress, or by calling 1-800-447-9778. Outside the United States, visit esri.com/esripressorders for complete ordering options or visit esri.com/ distributors to contact a local Esri distributor.

Join the Community Maps Program

Building basemaps from the best data



◀ The organizations worldwide that are contributing to the Community Maps Program are shown in the program's online dashboard.

Esri and its data integration partner will publish updates to existing basemaps at least twice per year. Content that is accepted will be scheduled for publishing in one of these updates.

Esri supports the program through the Community Basemap Resource Center (bit.ly/bQt4rB) as a one-stop shop for current and future participants. For program participants, the site has map templates, geodatabase designs, and other helpful resources that include instructional videos, tips and tricks, and a forum. On the site, participants can also sign up to attend free workshops that teach suggested workflows for preparing data, authoring map documents, and caching data. The Community Maps Program team is also working on instructions, tools,

In the Community Maps Program, Esri and the ArcGIS user community have joined forces to build multiscale basemaps of the world using the best data available from GIS professionals who work in all kinds of organizations: cities, counties, countries, and companies. This data will be made available through fast, authoritative Web maps authored at scales as large as 1:1,000.

These high-quality, accurate, and up-to-date maps can benefit organizations by reducing the cost of making data widely available. The Community Maps Program provides a foundation for thematic mapping and is a framework for delivering more effective applications.

Jeffrey Stoval, chief information officer of the City of Charlotte, North Carolina, sees the program as a way to deliver services without having to make large initial investments. "We do have investment limitations. We can't afford to always put these capabilities on premises. So the community basemap allows us to move some of those assets to the cloud to not have to have them on premises and yet provide a level of transparency to our citizens and our businesses to meet their needs."

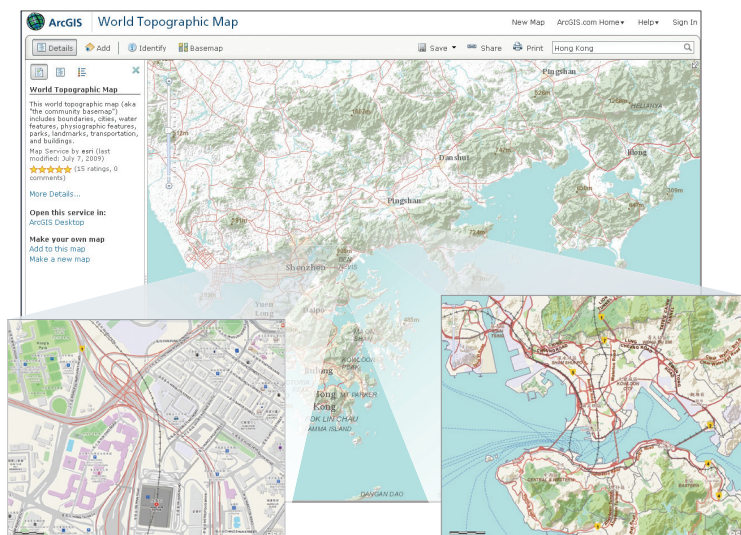
The primary goal of the Community Maps Program is providing additional detail and coverage to existing basemaps:

- World Imagery—A global imagery map that has high-resolution imagery in selected areas
- World Street Map—A multiscale street map that is useful for geocoding, routing, and other applications
- World Topographic Map—A multiscale basemap designed to be used as a reference map or a foundation for adding operational layers

Each basemap is built with data from multiple governmental and commercial data providers. Accepted data contributed by program participants will be integrated into an existing map. The map will be processed into a map cache format (i.e., JPEG or PNG tiles) for display at multiple scales in 2D or 3D and may be included in Esri's ArcGIS Data Appliance, which is used to support the ArcGIS Online infrastructure.

and templates for participants who are migrating from ArcGIS 9.3.1 to ArcGIS 10. Those contemplating joining the program can visit the site to view a video introducing the program or sign up.

This program draws on the powerful data resources of the GIS community combined with a program that rigorously curates that data to ensure high quality. From a global scale to the level of single buildings, these online basemaps provide a reliable way for the GIS community to deliver a variety of applications through a hosted environment.



▲ From a global scale to the level of single buildings, these online basemaps provide a reliable way for the GIS community to deliver a variety of applications through a hosted environment.

Getting Off to a Great Start

Many GIS careers begin at Esri



Many new graduates start their GIS careers at Esri. Tope Bello graduated in 2005 from the University of Texas, Dallas (UT Dallas) with a master's degree in geospatial information sciences. In this interview with Esri writer Leslie Roundy, he talks about his role as a product specialist in Professional Services.

How did you get to know about Esri?

Most of the software we used in the GIS program at UT Dallas was ArcGIS. That was my original exposure to who Esri is and what they do. Then, in 2005, I was accepted to the Esri International User Conference Student Assistantship Program. It gave me the opportunity to interact with other GIS professionals and talk to people about Esri. It really opened my eyes to the capabilities of GIS, how it is applied in different industries, and how people are within the company.

What appealed to you the most when you were interviewing here?

The main thing for me was the fact that if you're in the GIS industry, working for Esri is the pinnacle of your career. This is where you want to be. You're exposed to cutting-edge technology, exposed to so many knowledge avenues in the sense that these are the people that actually make the products we used in school. What better place to learn than from them? Another fact is that Esri is headquartered in Southern California. You've got the beaches, Nevada, the desert, so not only do you have the whole technical aspect of Esri, but it's also in a very good location.

Tell me a little about the kind of work you do.

In Implementation Services, we have a program called Rent-a-Tech, where we implement GIS software and provide support at various customer sites, such as desktop customization, training, or response to emergency operations. For example, after Hurricane Katrina, we had people that went there and worked on the emergency response. GIS was used to help get aid to the people affected by the flood.

The first big project I worked on after being hired was during one of the largest fires in Southern California, up in Cabazon. We went on-site and helped them use our software to map the extent of the fire perimeters and calculate the total acreage of land the fire affected. The maps created were used by firefighters to come up with strategies of how to best tackle the fire.

Soon after that, I started working on developing more solution products. My role is more of a product specialist, meaning that I take the requirements from the user, translate them, and pass them on to the developer to build an application. Or I take the requirements from the user and help them understand how we think they could use our software to solve their problem—so basically, being a user advocate back to the developer.

Currently, I'm focused on ArcGIS Workflow Manager, an extension to ArcGIS Desktop and ArcGIS Server that provides users with tools that help them automate their GIS and non-GIS processes. Not only do I do training and implementation on customer sites, I also interact with customers almost daily and help them troubleshoot their problems.

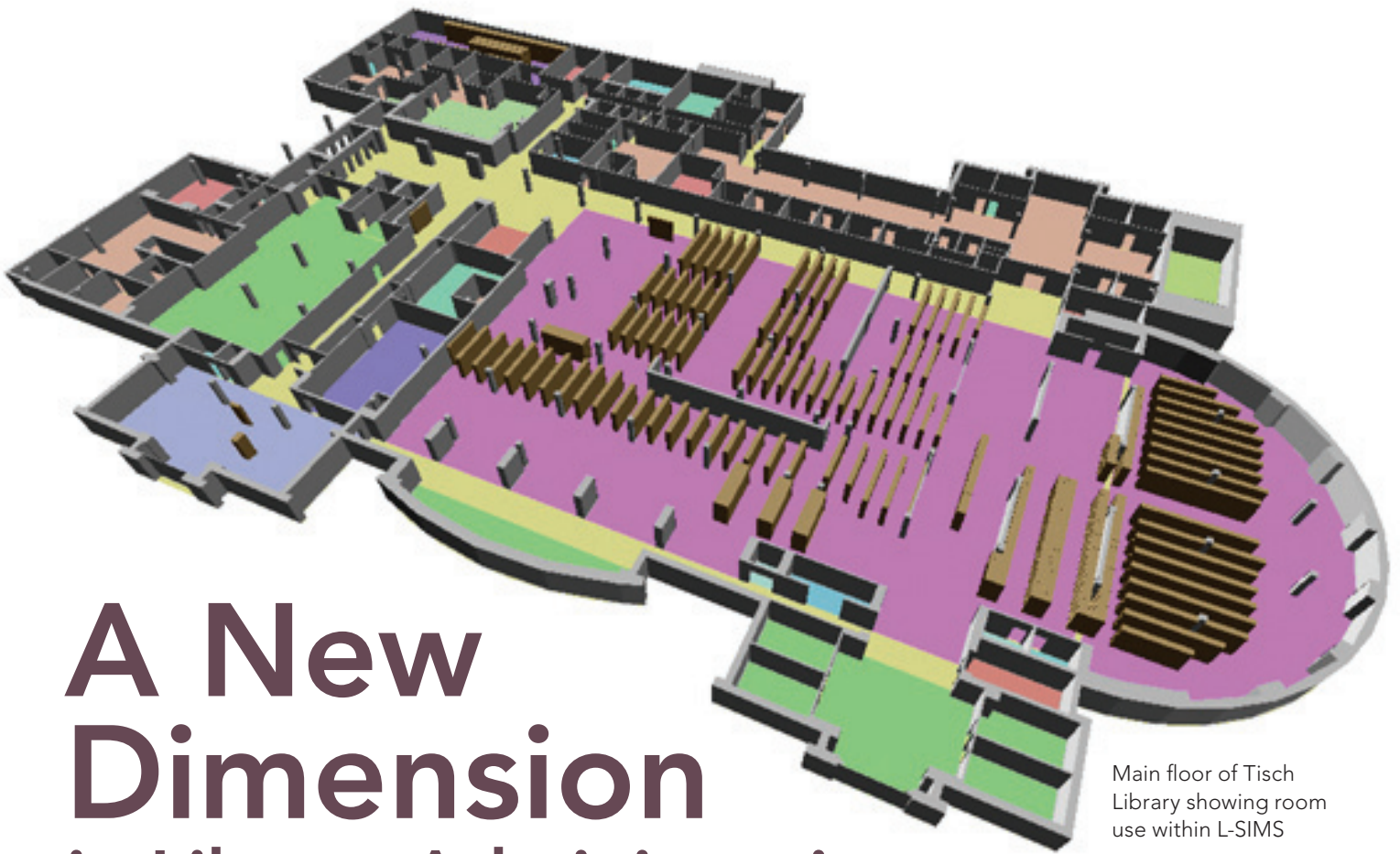
We also provide an avenue for our customers to give us feedback via the forums. A colleague and I monitor the Workflow Manager forum to gather information on our users' experiences. And all that is taken back to our development team in Professional Services so they'll know what customers expect to see in the software.

Sounds like there is a lot of variety in your job. Is there one thing that gives you the most satisfaction?

I think it's a mixture of everything. It's always good to get positive feedback from customers. It's always good to know you've had an impact on how they perform their jobs and that we help them be more productive. Knowing that gives me some sort of satisfaction and also being able to say there have been expectations set and we met them. It's a very fulfilling experience.

What do you think sets Esri apart from other employers?

I think the main thing that stood out to me when I started was the "baptism by fire." The approach is, you've got to figure things out—not by yourself, but you're not spoon-fed either. You're basically given all the tools you need to be successful. You're expected to put those tools together and become a good employee. The opportunities are limitless—the resources are available to you to learn and to be successful in this field. The technical knowledge of the folks I work with and interact with on a daily basis is amazing.



Main floor of Tisch Library showing room use within L-SIMS

A New Dimension in Library Administration

3D GIS aids resource planning and facility management at Tufts

By Jim Baumann, Esri Writer

The Tufts College Library has grown from a small collection of books the university's first president shared with students to a library system with holdings of more than 1.2 million volumes and other materials. To manage this collection, the library developed a 3D GIS-based library information system that incorporates the library's existing data management programs.

Founded by the Universalist religious denomination in 1852, Tufts University is a small liberal arts school located in Medford, Massachusetts. The university has an enrollment of about 9,000 students and fosters a tradition of social responsibility.

The Tufts College Library began as a collection of books kept by Hosea Ballou II, the first president of Tufts. Ballou circulated the books from his office in the College Building, now Ballou Hall, personally signing them out to students. As the college grew, adding schools and campuses, the library system expanded to meet the increasing needs of the institution.

Today, the largest facility in the Tufts University Library system is the Library for Arts and Sciences, now called the Tisch Library, on the Medford campus. Tisch houses the majority of the library system collection including 700,000 books, 30,000 electronic journals, 20,000 electronic books, and 20,000 video recordings. The library facilities in-

clude a student café, offices, group study rooms, research areas, and a media lab for viewing DVDs and videotapes. In addition, the Tisch Library has an active research instruction program and offers both one-on-one consultations and an instant messaging reference service.

Tisch Library continues growing and evolving, with additions to special collections and the need to provide supplemental materials when new courses are introduced at the university. Management of its facilities and resources is a significant concern for university library administrators, who are continually trying to improve access to the expanding collections within the confines of the existing space.

Recognizing the need to better manage both its facilities and collections, Tufts Library administrators enlisted a team of university employees, including Thom Cox, technical project manager, and Patrick Florance, GIS center manager, to help develop and implement a GIS-based library information system that incorporated the library's existing data management programs. The project was funded by the Berger Family Technology Transfer Endowment.

Said Florance, "The Tufts University Information Technology group partnered with Tisch Library Information Technology Services [LITS] to create L-SIMS [Library Spatial Information Management System], a fully functioning, 3D GIS-based view of the interior space of the library

“The ability to quickly generate high-quality maps is one of the greatest benefits of using L-SIMS.”

that merges databases from LITS, facilities management, and various library collections.”

The L-SIMS project began with an extensive needs assessment study that involved consultations with library staff and students concerning current and potential use of the library, an examination of existing databases, and a detailed inspection of the library and its contents.

After the needs assessment, the Tufts team created a data model for L-SIMS, which involved the development of a unique identifier schema to link the various feature types to the appropriate databases. A significant component of the project was the database development and conversion. The library’s CAD floor plans were brought into ArcGIS, georeferenced, and cleaned significantly to create feature topology. The floor plans were ground truthed, and a significant amount of editing was performed in areas that had experienced recent renovations.

“We hired Tufts students to complete the work, so it also became a real-world learning experience for those students looking to further develop their GIS and spatial thinking skills,” commented Florance.

About 30 distinct features were coded for the L-SIMS geodatabase, including rooms, walls, doors, doorways, emergency exits, stacks and shelving, fire extinguishers, panic buttons, electrical outlets, computers, and Ethernet connections, as well as the collection itself—all the features that are commonly found within a library. Then several different databases related to those features were integrated into the system. This included the facilities database that identifies room numbers, room use, square footage, who is responsible for the room, occupants, and so on. The LITS database was also included. This holds information about all the computers in the library, such as the computer ID, the processor, whether it has a CD or DVD drive, and all the software on it. Also integrated is the collections database, which stores the different reference numbers and collection types for all the stacks in the library.

L-SIMS helps reference librarians better direct students to the resources in the library in addition to assisting with tasks such as developing plans for facilitating disaster planning, determining the location and contents of special collections, and accessing the availability of computer resources.

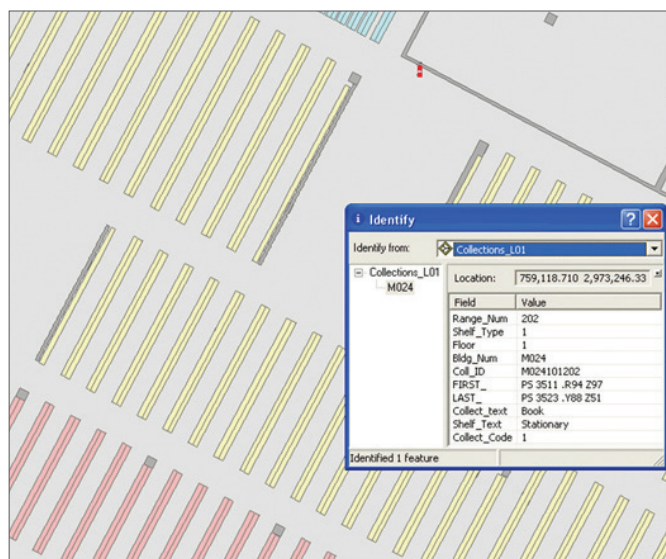
The Tufts GIS center used ArcGIS to generate high-quality maps. Key library staff were trained and became ArcGIS users and the data stewards for the new system. Tufts also created a Web-based prototype of L-SIMS using ArcGIS Server.

“L-SIMS really serves as a resource management tool. Several library staff members have commented on how excited they are about the new system,” said Florance. Previously, when changes occurred, they would have to remap sections of the library for each specific use—often a time-consuming process. Added Cox, “The ability to quickly generate high-quality maps is one of the greatest benefits of using L-SIMS. Detailed floor maps are posted on each floor of the library that indicate the location of various book collections, as well as important emergency information such as exits, panic buttons, and fire extinguishers. When library resources are altered, the maps must be re-created to

reflect those changes.”

Now when a student comes to the reference desk requesting help locating a book, the reference librarian can provide an accurate, highly detailed map showing the stack where the book can be found. L-SIMS is regularly updated so the maps produced from the database always reflect the current status of the library collection.

Using L-SIMS, librarians can also analyze the use of specific elements of the Tisch Library collection. Access to those parts of the collection that are in great demand can be optimized by relocating them to a more prominent location, while those materials that attract less interest can be stored in or relocated to a less prominent place.



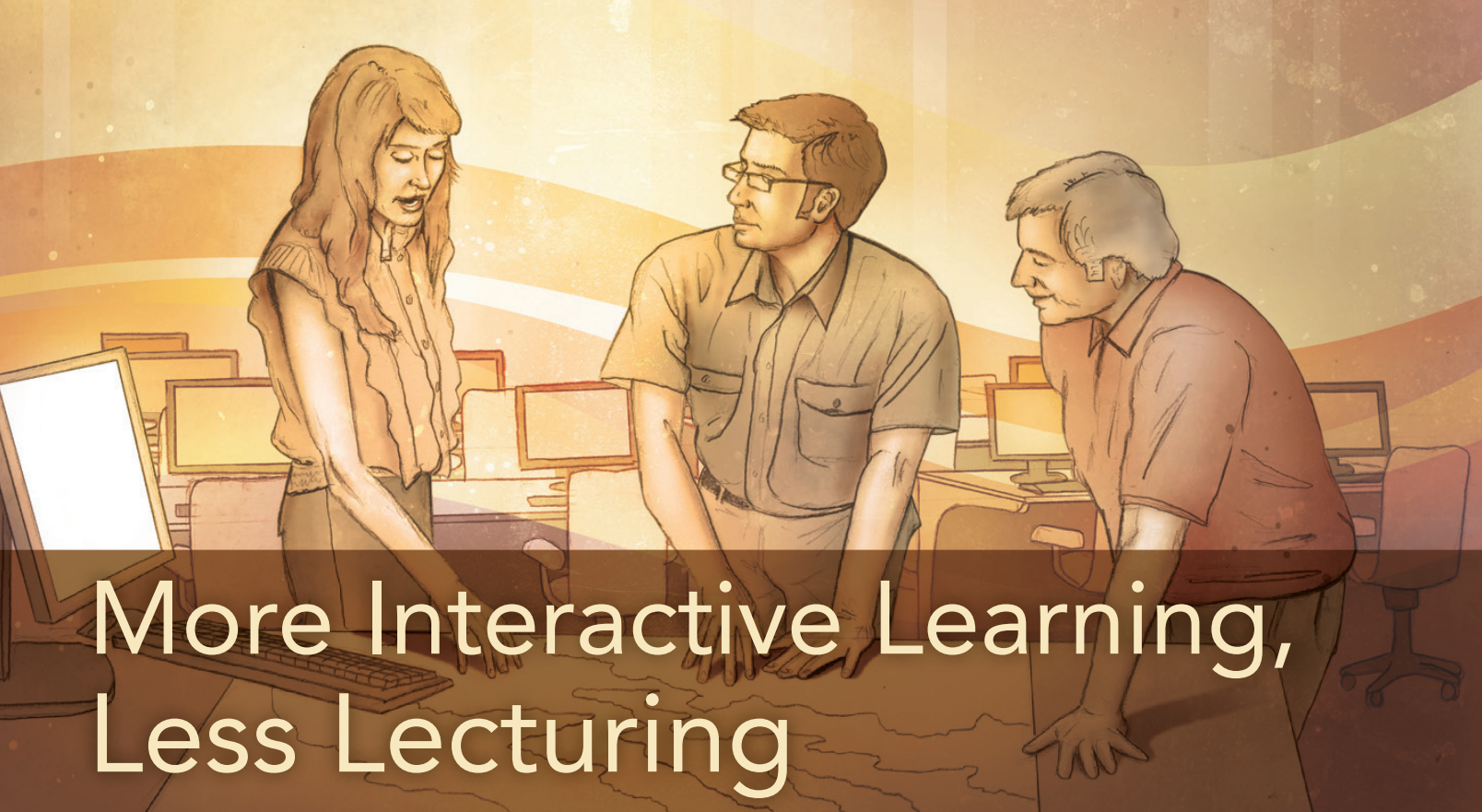
Tisch Library collections database within L-SIMS

“It is the hope of the L-SIMS project team that this foundation work will be the impetus for the future development of a public, Web-based, interactive mapping application to provide comprehensive information and access to library resources. Both students and Tisch staff will be able to explore the contents of the library online and identify topics of interest. For example, a user searching for a specific book could pan to a library stack to see the collection type and the related reference numbers to locate the required material. Or, they could click on a displayed computer to see what software is loaded on it,” concluded Cox.

L-SIMS is so successful that several schools and departments at Tufts are asking the library to build geoenabled SIMS or business inventory management systems (BIMS) for them.

About the Author

Jim Baumann writes about GIS-related topics for Esri. He has written articles on various aspects of GIS and information technology for more than 20 years.



More Interactive Learning, Less Lecturing

Esri charts a new course in training

By Carla Wheeler, Esri Writer

Before they started lessons on symbolizing data and creating map layouts, Dave Donley and Delores Fillingame cracked open their fortune cookies.

Instructor Mark Stewart gave the cookies to his students as he welcomed them to *ArcGIS Desktop II: Tools and Functionality*, one of 35 GIS courses Esri offers. He asked everyone to introduce themselves, read their fortune aloud, and add “with ArcGIS” to the end of each fortune.

“Nothing is impossible with ArcGIS,” Fillingame said. “Love and you shall be loved with ArcGIS,” said Donley. Laughter filled the classroom at the Esri Learning Center in Redlands, California, as other students chimed in: “Eat chocolate and have a sweet life with ArcGIS”; “Your smile has great charm with ArcGIS”; and, perhaps most appropriate, “A lesson well learned is never forgotten with ArcGIS.”

Esri wants students to learn GIS well and never forget what they’ve learned. That’s why Esri Training, which develops and delivers the company’s software classes, recently adopted a new course design and training delivery style that stresses interactive, peer-to-peer learning; real-world GIS skills; and, yes, even having

fun. Say goodbye to formal lectures and hello to lessons that focus on essential theories, concepts, and skills and stimulate students to speak up and share their GIS knowledge.

“We want learning to be fun, easy, and applicable,” said Esri national instructor manager Krista Page when explaining why this new training approach was adopted. “Research on adult learning shows students retain more when they are actively involved in the learning experience. So now we’ve expanded the interactive component.”

Students Take On New Role

Until now, Esri instructors typically taught in a traditional style. They would lecture for up to 45 minutes, give a demonstration, then assign a hands-on software exercise. Students usually worked by themselves.

Instructors did most of the talking; students listened. Today, however, students take a greater role in the classroom, answering questions and contributing ideas. The instructors act as facilitators, encouraging the class to think and talk about the GIS concepts, tools, and skills they’re learning. By helping students understand how this new information relates to their jobs and letting them integrate their experience, instructors help them better relate the material with what they already know. “Every adult comes to class with a certain level of experience, and being able to share what you already know and then to build on that, that’s a

big deal,” Page said.

The new course design and delivery style incorporates

- Icebreakers (like the fortune cookie readings) and brainteasers to energize and involve everyone and help people get to know each other. When students are more at ease with each other, they will feel more comfortable participating in class.
- Problem-solving exercises conducted in small groups or at whiteboards. In the online instructor-led Virtual Classroom (where 50 percent of Esri’s courses are taught), those exercises take place in breakout “rooms” on the Web.
- Instruction, demonstrations, and hands-on software exercises that emphasize practical, real-world scenarios and situations.
- More questions posed by the instructor that spur students to think and share their on-the-job experiences, insights, and knowledge of GIS with classmates.
- Review questions to ensure that students understand the concepts, skills, and software tools taught in each lesson. A new supplemental workbook also includes tests that reinforce understanding.

According to Page, students like this mix of activities. “The more senses you use, the more likely you are to learn and retain,” she said. “Previously, there would have been a lot of listening. Now there’s listening, there’s talking, there’s writing, and after an activity, there’s a

summary of takeaways from the lesson.”

Group activities have been added. “There’s a greater focus on student-to-student interaction,” Page said. “When you pair people up and they start learning from each other and sharing their experiences, the knowledge transfer increases.”

Stewart, who began teaching at Esri 14 years ago, said that combining short interactive lectures, hands-on exercises, brainteasers, and demonstrations keeps people alert and learning. “You are causing the brain to shift gears,” he said.

In general, adults have short attention spans. Page observed that when she listens to a lecture that drags, she starts mentally compiling a grocery list or thinking about her unanswered e-mails. “By engaging students and interacting with them in a variety of ways, students will learn more,” she said. “They’ll also retain more. And more importantly, they will be able to quickly adapt and apply what they have learned when they get back to their jobs on Monday morning.”

A New Teaching Style

Before class began in earnest, the 12 students in Stewart’s class learned he wanted to hear from them rather than just listen to his own voice for the next three days. For each lesson, Stewart lectured for 15 or 20 minutes. Then he showed the students a demo, organized a group exercise, assigned a hands-on exercise using GIS software, then recapped and discussed with the students what they learned.

He drew people into a conversation by gently working questions into the lesson. Stewart never likes to put anyone on the spot, so he usually poses questions to the entire group. “We want to challenge students and keep the learning environment a safe and comfortable place.”

During one lesson, Stewart broke the class up into small groups based on where students sat and handed out several maps for them to study. A map of the Gulf of Mexico after the oil spill that displayed various layers of data, including the locations of debilitated turtles and injured marine animals, generated a lot of interest. “What would you guys do with this map?” Stewart asked.

One student offered that it would give an idea of where to focus rehabilitation efforts. “It would help you be able to find out which specific industries were affected by the spill,” said Donley. More ideas followed, fast and furious. This is the type of conversation instruc-

tors hope to stimulate using the new course design and delivery style.

Donley, a fire captain and GIS manager for the California Department of Forestry and Fire Protection (CAL Fire) assigned to Riverside County said Stewart’s class was fun, inclusive, and drew on the experience of GIS professionals. “Instead of it being a lecture, there are more questions and answers,” Donley said during a break. “He throws [a topic] out there and lets you speak up. We have almost as much input as he did.”

Fillingame, who uses GIS to map gas lines and other utilities for the U.S. Navy in San Diego, California, said she enjoyed the interactive aspects of the class. “It was a lot more fun than sitting and listening to a lecture,” she said. “You got to hear what other people thought—their experiences. And Mark is a crack-up. He made it fun with the bit with the fortune cookies.” She also said a brainteaser he gave the class after lunch one day was just

the ticket to get them back in a learning mode. “It got us moving and thinking,” she said.

Though handing out fortune cookies in the Virtual Classroom isn’t possible—yet—students can laugh using emoticons. Instructors also host small group activities in virtual breakout rooms that include writing on group whiteboards, chatting, and polling. Students can interact with each other and the instructor during virtual lectures, demonstrations, and exercises. Instructors can even peer into students’ computers to monitor progress during individual exercises or check in on groups and facilitate discussion.

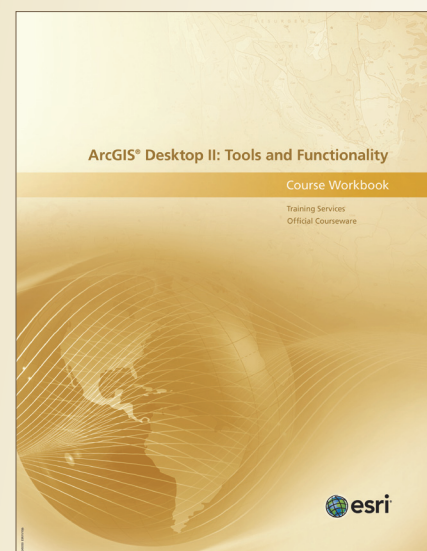
Instructor Colin Childs, who teaches in the Virtual Classroom, said he now e-mails students in advance so he can find out a bit about their experience level using GIS software so he can—to a certain extent—tailor what he teaches to the individuals in the group. “You want to fill in the gaps of what they don’t know,” Childs said.

Continued on page 66

New Student Workbooks Complement Interactive Learning Approach

New single-course workbooks complement Esri’s new teaching style. According to many educators, adults learn best when they can actively participate and solve problems in class and clearly understand how what’s being taught relates to their jobs. Esri instructors have incorporated these ideas into a new course design and delivery system as described in the accompanying article “More Interactive Learning, Less Lecturing: Esri charts a new course in training.”

Esri’s content group, which develops course curriculum, has updated course materials to incorporate these adult learning principles and support the new teaching methodology. A new single workbook for each class replaces the separate lecture and exercise books previously supplied to students. The new workbook supplies supporting information related to all concepts, topics, and exercises included in each lesson with ample space for note taking. Depending on the concept or topic, supporting materials might be content from a slide the instructor presented, a workbook activity that reinforces a concept or topic such as a scenario-based question, a graphic representing a concept or topic, or text that summarizes key points. “We refer to it as a workbook because learners will actually work in it while taking their course,” said Patty McGray of Esri’s Educational Services.



More Interactive Learning, Less Lecturing

Continued from page 65

Adult Learning Principles in Action

How do adults learn best? Researching this question prompted Esri Training to change the course design and delivery style of its instructor-led courses so students could more easily apply the skills and concepts they learned.

However, the change wasn't driven by negative student feedback. "Our former course design had served us well, but we think we have something better," Page said. The seeds of this change were planted when Esri instructors became certified through the Computing Technology Industry Association (CompTIA). A nonprofit trade association, CompTIA sets standards for information technology (IT) companies and professionals such as instructors. All Esri instructors are now Certified Technical Trainers.

"Adults need to be motivated—they want to know, what's in it for me?" Page said. Students wonder what they will get out of a course

and how it will apply to their jobs. That's why course materials now include a supplemental workbook revamped with more real-world scenarios that teach concepts and skills.

In the new course format, the instructors outline course goals when class begins, go over the learning objectives for each lesson, and test students to make sure they've understood the material taught in that lesson. Tests are usually a short series of questions that also appear in the supplemental student workbooks where students can jot down answers.

Page said the scenarios and the clear, step-by-step exercises in the new workbook make the courses more interesting and useful. "When I take a training class, I want to be able to go back to my job and take what I have learned and start using it right away," she said, adding that she thinks that will now happen more often with the GIS courses. "You're motivated. You understand why you are learn-

ing this. You start to see these real examples of how this plays into the world and how to bring it into your organization. You get excited. You're learning from your peers and the instructor. And after you get back to work, you are kind of ready to go. You've learned some valuable skills that you can put into practice right away."

About the Author

Carla Wheeler is Esri's defense and intelligence staff writer and the editor of *ArcWatch*, a free monthly e-magazine that covers GIS news and trends; provides information on new products, training, and books; and offers technical tips. She joined Esri in 2006 after spending more than 20 years working as a newspaper reporter and editor in California and Minnesota. Follow her on Twitter @gis-journo.

Upgrade Your GIS Skills ■ Strategies to find time for training

Finding time for GIS training can be a challenge. Esri has resources that can help you reach your training goal—whether it is staying current with the industry, upgrading your skills, or investigating a new career path—no matter how much or how little time you can spare. Even if you don't have days to devote to training, you can accumulate GIS training by devoting a few minutes or hours per week.

10 minutes	Listen to a podcast.	esri.com/podcasts
	Read a blog post on a topic of interest.	esri.com/blogs
	Read a free Esri newsletter.	esri.com/newsletters
20 minutes	Explore an Esri Resource Center.	resources.arcgis.com
	Read an <i>ArcUser</i> article.	esri.com/arcuser
	Read an <i>ArcNews</i> article.	esri.com/arcnews
1 hour	Watch a free training seminar.	training.esri.com/seminars
	Complete a tutorial.	webhelp.esri.com
	Download and explore a map template.	resources.esri.com/maptemplates/
	Complete a Web course exercise.	training.esri.com
2 to 3 hours	Complete one module of a Web course.	training.esri.com
	Read a GIS Best Practices booklet.	esri.com/bestpractices
1 to 3 days	Complete a Web course.	training.esri.com
	Go through a software workbook.	esri.com/esripress
	Attend an instructor-led class.	training.esri.com

New Esri Authorized Instructors

The Authorized Training Program (ATP) is pleased to acknowledge the newest class of Esri Authorized Instructors. These candidates have passed all ATP requirements and have been granted authorization to teach the specified Esri courses within the United States and United States territories. These instructors join a network of Authorized Instructors. To locate an Authorized Instructor in your area, please visit esri.com/atp; contact ATP by e-mail at atp@esri.com; or call 909-793-2853, ext. 1-2111.

Code	Class
AGD1	ArcGIS Desktop I
AGD2	ArcGIS Desktop II
BGDB	Building Geodatabases

Colorado

R. J. Kern
GIS Learning LLC
Denver, CO
303-474-0983
rjkern2000@mac.com
BGDB

Maryland

Tracie Bishop
University of Maryland
Eastern Shore
Princess Anne, MD
410-651-6383
tjbishop@umes.edu
AGD2

New Jersey

Richard Citkowitz
Civil Solutions: A Division of ARH
Hammonton, NJ
800-924-0482
rcitk@arh-us.com
AGD2

Wisconsin

Doug Miskowiak
University of Wisconsin, Stevens
Point, GIS Center
Stevens Point, WI
715-346-4789
Doug.Miskowiak@uwsp.edu
AGD1, BGDB

“Our Web-based Esri/Laserfiche integration is so intuitive, members of the public can search for information themselves, freeing up our staff to complete their regular workload without interruption.”

Thomas Trammell
Engineer Tech, City of Bakersfield, CA

By integrating their Laserfiche enterprise content management and Esri® GIS systems, the City of Bakersfield saved over **\$18,000 in personnel hours and \$163,000 in staffing costs.**

Discover how Laserfiche integrates with Esri GIS software to bring a world of information to staff and citizens.



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Run Smarter®

Laserfiche®

New on Campus?

There's an app for that

The UOregon iPhone app supplies routing to classes, points of interest, and events in addition to news, campus safety information, and links to social media.

For incoming students at the University of Oregon (UOregon) this past fall, orientation was as easy as reaching for their iPhones. The free UOregon iPhone app, originally developed as part of the annual Week of Welcome, not only helps students find the locations of classes, buildings, and points of interest on the university's 295-acre Eugene campus but also keeps them up to date with university events and news.

The app's Walk Me feature is particularly useful. It displays start and end points for any route on campus and provides an estimate of the time it will take to get to the stipulated destination. En route, students can listen to the Oregon Marching Band play the school's fight song, "Mighty Oregon"—another of the app's features.

Students can also view photos and videos of the campus, keep up with social media, and even access campus security in an emergency. The app is GPS enabled and displays the user's location on campus. In addition to

walking directions, the app provides bicycle routes and the safest routes at night. Parking and transit maps and aerial map overlays with campus images from 2008, 1947, and 1913 are also included.

The app has been a resounding success. Currently, 5,000 faculty and students use it, and it has garnered favorable Apple App Store ratings.

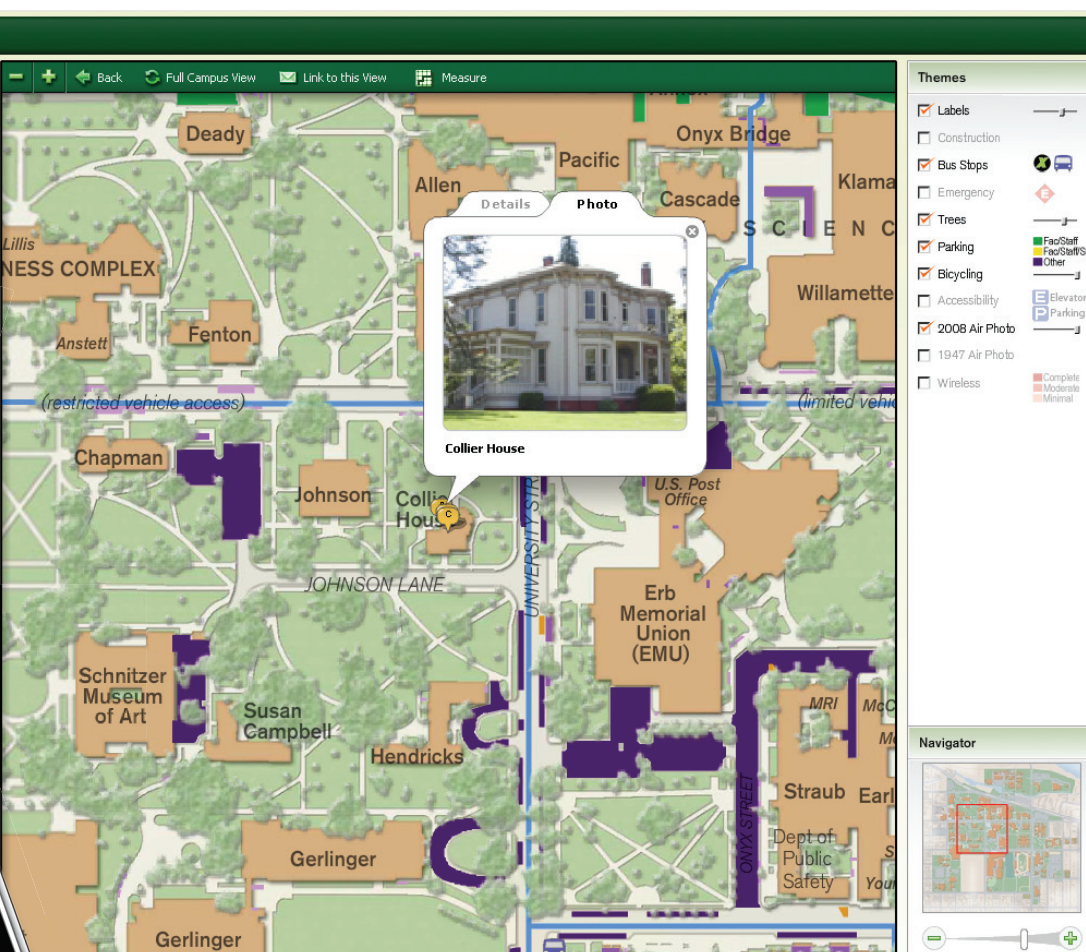
The students and staff in the university's own InfoGraphics Lab in the Department of Geography developed the UOregon iPhone app in conjunction with the Office of Communications as a free mobile mapping application that would provide maps and tools for the entire campus. The social media-savvy institution is actively involved in developing new ways of engaging students. Potential students learn about programs and admission processes and can interact with staff through the University of Oregon Admissions Facebook page.

The lab's graduate student developers and staff had previous experience using Esri's Web

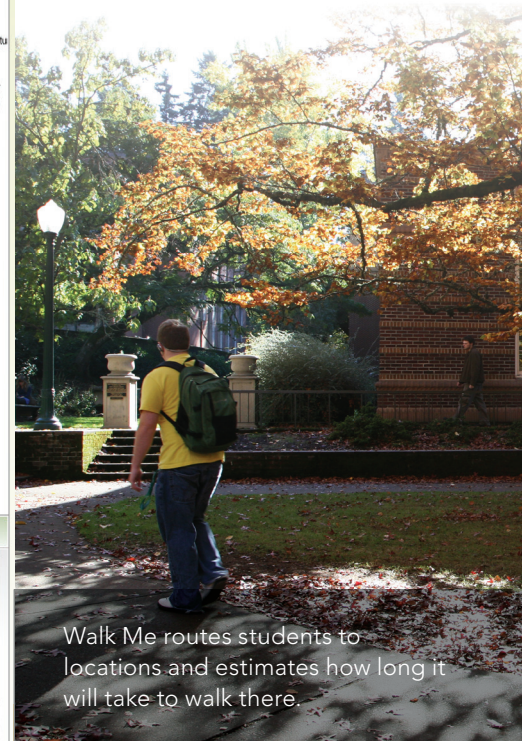
mapping APIs and were early adopters of the ArcGIS API for iOS, so it took just a couple of weeks to build the initial iPhone prototype app. Because they wanted to go beyond simply geocoding points on Google maps, they needed an application that could accommodate high-resolution vector overlays and render them correctly. The ArcGIS API for iOS furnished this capability and plenty of resources and gave them the ability to serve maps out as tiled image caches.

Enabling the creation and maintenance of these Web and print maps of the campus, as well as the iPhone app, is a robust enterprise-wide geodatabase that provides staff and





◀ The UOregon Interactive Map serves the most current and accurate information available through Web-based maps.



Walk Me routes students to locations and estimates how long it will take to walk there.

ArcGIS API for iOS Now Available

Esri recently released the ArcGIS API for the Apple iOS platform. ArcGIS API for iOS enables developers to build and deploy custom iPhone, iPod touch, and iPad applications. This API uses the powerful mapping, geocoding, geoprocessing, and editing capabilities that ArcGIS Server provides. It uses Web services available from ArcGIS Server and ArcGIS Online. Users can access dynamic, tiled, and image map services; overlay graphics; search for and identify features; locate addresses; collect and update data; and perform GIS analysis. Users also have the ability to embed ArcGIS maps and tasks into line-of-business applications. The API can now be downloaded from the Esri Resource Center at no cost.

managers with asset information to the room level and includes utility systems, networks, hazardous materials, and capital construction projects located throughout the campus buildings and grounds. One of the biggest challenges in developing the app was rethinking and redesigning these existing campus maps for effective display on the iPhone's small screen.

The InfoGraphics Lab integrated search and map features in the ArcGIS API into the iPhone application. "We were clearly inspired by Esri's ArcGIS API for iOS and associated application. We used many different aspects of

Esri's iPhone application to create ours," said Ken Kato, assistant director of University of Oregon's InfoGraphics Lab.

In addition to campus mapping and GIS, the lab works on a variety of other projects such as the Rural Lands Database and pilot projects that are building a statewide transportation framework. It also produced the acclaimed *Atlas of Oregon* (both print and interactive editions), which received the 2001 Association of American Geographers Globe Award for Public Understanding of Geography.

The lab maintains and makes available an

array of high-quality maps for specific purposes. The InfoGraphics Lab Map Gallery displays samples of these campus maps as well as some of the stunning maps the lab has produced for atlases, reports, and projects.

The UOregon Interactive Map serves the most current and accurate information available through Web-based maps. It uses Flash, .NET, and ArcGIS Server to furnish many of the same utilities found in the phone app.

For more information on the UOregon iPhone app, visit uoregon.edu/mobile.

Corporate Directory

Esri Corporate Headquarters:

380 New York Street
Redlands, CA 92373-8100 USA
Tel.: 909-793-2853
Fax: 909-793-5953
E-mail: info@esri.com
Web: esri.com

Esri Technical Support
Tel.: 888-377-4575
Fax: 909-792-0960
E-mail: support@esri.com
Web: esri.com/support

Online Discussion Forums
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Web: edn.esri.com

U.S. Regional Offices:

Boston
Danvers, MA
Tel.: 978-777-4543
Fax: 978-777-8476

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Redlands, CA
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ESRI France
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NIIT GIS Limited (ESRI India)
New Delhi
Tel.: 91-11-4057-0700
E-mail: info@esriindia.com
Web: esriindia.com

ESRI Italia
Rome, Italy
Tel.: 39-06-406-961
E-mail: info@esriitalia.it
Web: esriitalia.it

ESRI Japan Corporation
Tokyo
Tel.: 81-3-3222-3941
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ESRI Korea, Inc.
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Tel.: 82-2-2025-6700
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Tel.: 202-2271-1941
E-mail: info@esrinea.com
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Tel.: 48-22-390-4700
E-mail: esripol@esripolska.com.pl
Web: esripolska.com.pl

ESRI Portugal—Sistemas e Informação
Geográfica, S.A.
Lisbon
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E-mail: market@esri-portugal.pt
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E-mail: esri@esriro.ro
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ESRI S-GROUP Sverige AB
Gävle, Sweden
Tel.: 46-771-98-48-00
E-mail: info@esri-sgroup.se
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Web: esriuk.com

Grupo ESRI de Venezuela, C.A.
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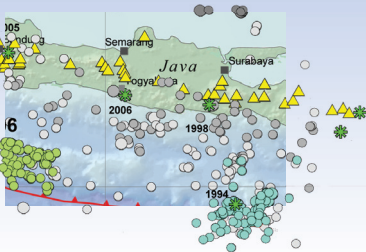
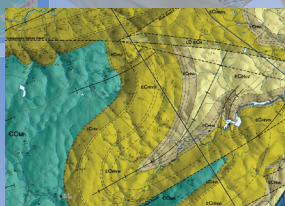


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