

ArcUser

The Magazine for Esri Software Users

Sim Disaster

A better approach to disaster
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With online presentation
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Make Maps People Want to Look At

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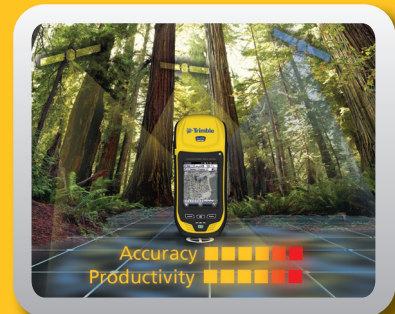
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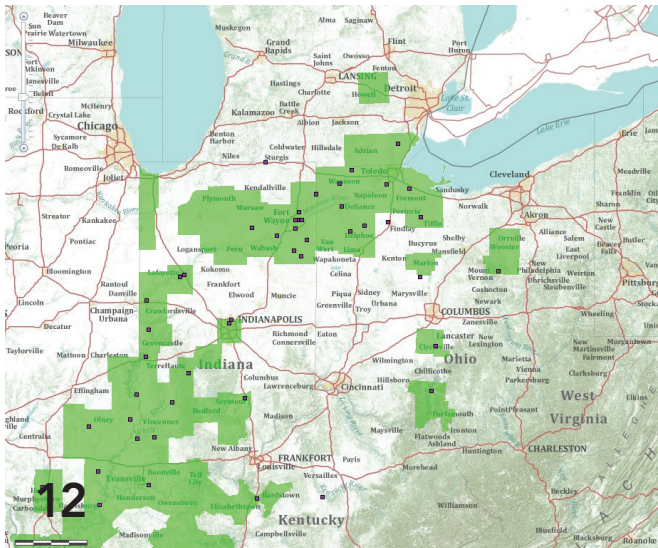


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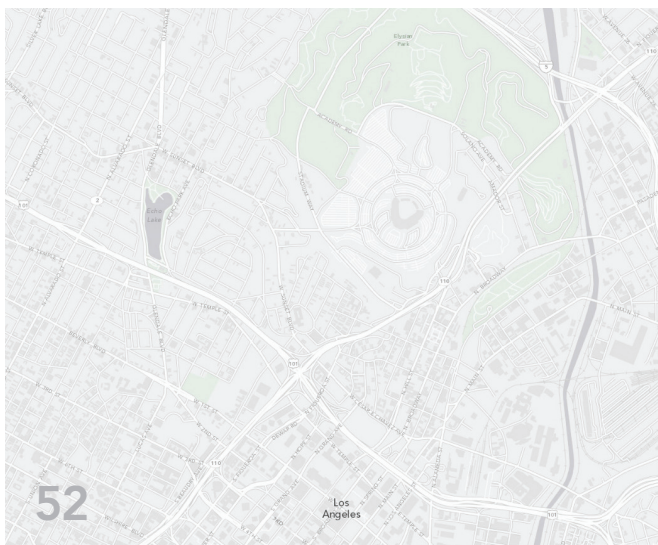
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Cover image was created using Esri CityEngine 2011.

7 Billion Reasons to Better Understand Our World

ArcUser

Winter 2012 Vol. 15 No. 1

The world passed a milestone on October 31, 2011. On that day, the United Nations announced that the world's population had exceeded seven billion.

Across the globe, the effects of population pressure have been identified by the Intergovernmental Panel on Climate Change (IPCC) in the Fourth Assessment Report (AR4) as contributing to "changes in atmospheric concentrations of greenhouse gases (GHGs) and aerosols, land cover and solar radiation [that] alter the energy balance of the climate system." These changes have been associated with many detrimental effects including an increasing number of severe weather-related disasters in recent years.

In the wake of the United Nations Framework Convention on Climate Change held in Durban, South Africa, at the end of 2011, it is clear that understanding the phenomenon of climate change, with its complexities and interdependencies, is both formidable and critical to our success as a species.

GIS offers a means for harnessing our collective intelligence to the task of understanding and dealing with these challenges. GIS technology, which is coevolving with and enabling other information technologies, can transform the mass of data, produced by the network of sensors measuring the natural world and the actions and effects of people on it, into actionable information.

In this sense, this is GIS for emergency management on the grandest scale—a scale that goes beyond its familiar application to disasters at local and regional levels to address global threats to people and the environment.

In particular, GIS—through GeoDesign—can address the planning, mitigation, and preparedness aspects of dealing with climate change. GeoDesign is a framework for combining geospatial technologies and design processes to quickly and interactively explore the relationship between human habitation and the environment to adapt existing communities or create more sustainable ones. In an essay on the Spatial Roundtable website, Esri president Jack Dangermond has asked the geospatial community how GeoDesign can best be used to live with unavoidable outcomes, improve sustainability where possible, and give us an "active role in designing where and how we live." Visit www.spatialroundtable.com to join in the discussion.

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New, Insightful Ways to Describe the World

Rule-based 3D mapping with Esri CityEngine

By Nathan Shephard,
3D Visualization Product Engineer Lead



Many GIS problems, particularly in the area of urban development, can only be solved in 3D. Esri CityEngine 2011 generates 3D urban environments for city planners, architects, military users, and those in film and entertainment. Most of the time, these users will be trying to replicate an as-built world and will try to closely match real-world objects in terms of physical location and size of 3D objects, such as buildings and trees.

However, there is another side to procedurally generated content to be explored—the construction of a cartographic view of the world. In this world, it is much less important to capture the physical size and shape of 3D objects. Instead the goal is to display geographic features in a way that makes them more understandable to the viewer.

For example, in the real world, a tree needs a trunk and limbs and height that reflects the species type. However, in the cartographic world, a tree can be represented simply as a colored ball on a stick—and be more understandable. Let's explore this idea in the context of something that seems simple: the display of a city's zoning rules on land parcels.



↑ Figure 1: A 2D zoning map often requires a legend to be understood.

2D versus 3D Cartographic Techniques

In 2D, a standard cartographic map uses hue, saturation, and value to distinguish the different zoning classifications (e.g., Single Family Residential, Medium Density Residential, Low Density Estates/Parks). While this simple technique is effective in differentiating between the zoning types, it also relies on the user being familiar with the meaning of the hues or having direct access to a legend. Furthermore, there is a limited number of hues that can be used before the meaning becomes ambiguous.

However, move that same data into a 3D map and there are opportunities to represent the data in a way that is more natural and recognizable for the viewer. For example, single family homes are usually set back from the edge of the parcel and—as any five-year-old with a crayon would attest—they should be drawn as rectangles with triangular, pitched roofs. On the other hand, medium-density residential areas typically consist of dwellings like townhouses that usually abut the parcel line and have multiple stories. Parks are commonly represented as areas with green grass and scattered trees.

The good news is that all three of these ways of representing zoning classification can be easily defined with procedural rules inside Esri CityEngine.

Compare the representation of the zoning rules in Figure 2 to that of the more traditional 2D map in Figure 1. The same hues are used in both views, but the cartographic display of the objects in 3D is instantly understandable without the need to refer to a legend because the symbols are familiar and recognizable. The 3D map in Figure 2 was created in CityEngine using a single procedural rule applied to all the GIS features inside CityEngine. That rule honored the feature attributes and constructed different 3D symbols.



↑ Figure 2: Zoning classes shown by a 3D map are more intuitive and reduce the need for a legend.

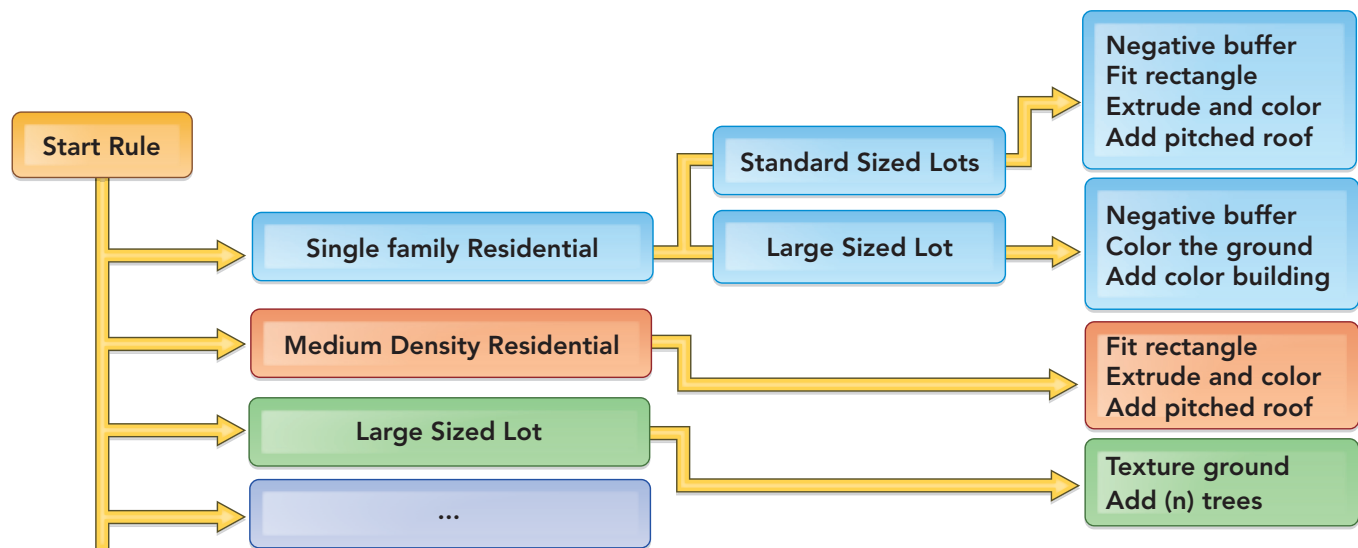
Solving Problems in 3D with CityEngine

CityEngine, a stand-alone 3D modeling and design tool, is the software of choice for 3D city modeling in urban planning, architecture, defense, simulation, game development, and film production. It can export generated 3D city models to other software packages: high-resolution simulation packages, data management/analysis packages (like ArcGIS), and web-ready clients.

In July 2011, Esri acquired Procedural, the creator of CityEngine. Esri will integrate CityEngine into ArcGIS, allowing ArcGIS users to create and design 3D urban environments leveraging their existing GIS data, such as parcels and street centerlines. CityEngine will continue evolving as a stand-alone product, and Procedural's offices in Zurich will become a leading-edge R&D center in the field of urban design and 3D content creation.

CityEngine allows GIS users to efficiently create 3D urban environments at a variety of resolutions based on existing GIS data using procedural modeling. With procedural modeling, rules (procedures) are used to generate 3D content. Procedural rules can use attribute data stored in GIS data to drive 3D content from 2D geometries and attributes such as number of floors, building height, floor height, roof type, wall material, and window type.

The newest release of the software, Esri CityEngine 2011, includes support for georeferenced data and an improved user interface. It now includes support for georeferenced data such as Esri's file geodatabase (GDB) and KML. The user interface has been greatly improved for ease of use with drag-and-drop data importing features.



↑ Figure 3: The design of the Zoning Classification rule file

The Anatomy of a Procedural Rule

A procedural rule in CityEngine, stored as a .cga file, works very much like a hierarchical scripting language. Figure 3 explains how the zoning classification rule was written.

All rule files require one or more start rules, which are initial entry points that are applied to the incoming raw geometry of the features that were, in this case, the parcel polygons. The single shared start rule uses the ZONECLASS feature attribute to distinguish the three kinds of objects to construct: Single Family Residential, Medium Density Residential, and Parks objects.

Single Family Residential polygons are further separated out into standard- and large-sized lots. This is done because standard-sized lots can be used directly to define a representative house shape, but larger lots look peculiar if they have a single, enormous house on them.

For standard-sized lots, the polygons are reduced in size via a negative buffer (to simulate open space [i.e., the side setback] between houses) and a best-fit rectangle shape is placed within the area that represents a simple house shape. This box is then extruded upward with a pitched roof to represent a single-story home.

For large-sized lots, the polygons are also reduced in size via a negative, but instead of extruding the shape upward into a house,

the ground is colored. In the last step, a single representative building model is placed in the center of the lot.

All Medium Density Residential polygons, regardless of size, are calculated with a single technique, because the variety in the size of these features is minimal. The rule simply creates the best-fit rectangle within the parcel and extrudes it up three stories with a pitched roof. This gives a townhouse appearance to the constructed geometries with parcels that have a common orientation, share boundaries, and stack up against each other.

The Park polygons are also handled using a single technique. First, the entire area is displayed with a grass texture and then tree models are distributed randomly over that area. The number of trees added is calculated as a function of the parcel's size so all parks have a similar appearance. You can probably already imagine how easily this rule could be used to create forests (using a denser algorithm to produce more trees) or open spaces with a sparser algorithm for fewer trees.

While the current rule only handles the three zoning classifications described, it can easily be expanded for other zoning types such as office space, commercial areas, and industrial zones.

Element	Description
case	Process objects differently based on an attribute or property
color	Set the object's base color
texture	Add a texture image onto an object
scatter	Spread models over an area
offset	Similar to a buffer operation
innerRect	Find a rectangle within an area
extrude	Expand the object upward to create a volumetric shape
roofHip	Create a ridged roof

↑ Key grammar elements used in the Zoning Classification rule

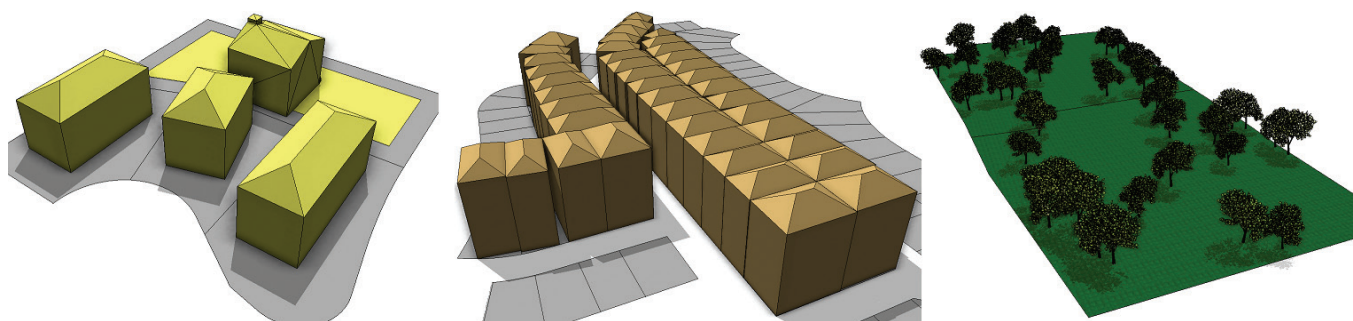
Conclusions

Viewing GIS data in 3D provides many opportunities to create new and insightful ways to describe the world we live in. The Esri CityEngine rule-based definition of symbology allows the inventive use of 3D shapes, models, colors, and texture for describing our complex world in a more natural and familiar way.

About the Author

Nathan Shephard is the 3D visualization product engineer lead at Esri in Redlands, California, where he works on the 3D Analyst extension product. He is also an honorary (though remote) member of the Esri R&D Center Zurich, which creates the Esri CityEngine product.

To view a code sample of a procedure, visit esri.com/arcuser.



↑ Figure 4: Land parcels with Single Family Residential, Medium Density Residential, and Parks zoning classifications displayed in Esri CityEngine using simple 3D cartographic techniques

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Now on the Android Platform

Free ArcGIS for Android app and ArcGIS Runtime SDK for Android

Access data and mapping capabilities on Android smartphones with the ArcGIS for Android application. ArcGIS for Android lets users find and share maps as well as deploy GIS data and functionality on Android devices. The free app can be downloaded directly from Android Market.

ArcGIS for Android is a native application that serves as a mobile gateway into the ArcGIS system. It provides an intuitive user experience for querying map layers and data and editing features and attribute information on the fly in the field. ArcGIS for Android includes a layer list, Favorites feature, and tool for measuring area and distance.

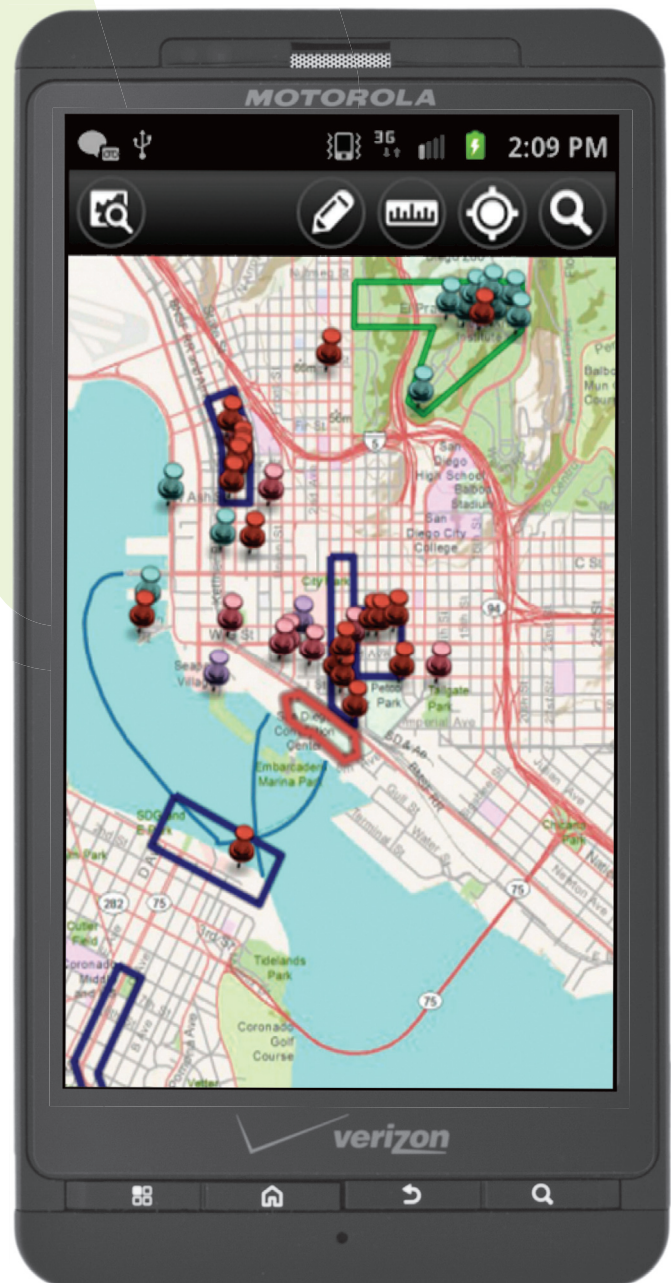
ArcGIS for Android is built on Esri's ArcGIS Runtime Software Development Kit (SDK) for Android. This SDK lets developers create custom spatially enabled applications for Android devices and is designed to use web services available from ArcGIS for Server and ArcGIS Online. Apps built using ArcGIS Runtime SDK can be deployed within the enterprise or to the public via Android Market.

ArcGIS Runtime SDK for Android lets developers build applications that utilize the powerful mapping, geocoding, geoprocessing, and custom capabilities provided by ArcGIS for Server using Java and deploy them to Android devices.

The SDK includes a plug-in to Eclipse, an integrated development environment (IDE) that provides a rich set of tools, documentation, and samples to help developers create great Android mapping applications.

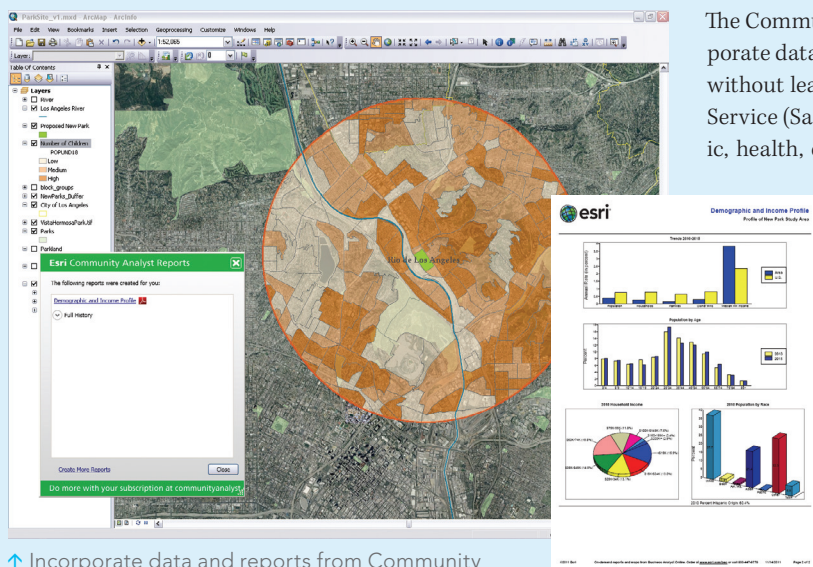
Send inquiries regarding the SDK to arcgis4android@esri.com.

Read "New Information Channel: Android App gets evacuation information to residents" on page 19 to learn about an emergency response app developed by the City and County of Honolulu.



Community Analyst on Your Desktop

Integrate data and reports using the add-in



↑ Incorporate data and reports from Community Analyst without leaving ArcMap.

The Community Analyst Add-in lets ArcGIS for Desktop users incorporate data and reports available from Community Analyst directly without leaving ArcMap. Community Analyst, Esri's Software as a Service (SaaS) mapping solution, provides thousands of demographic, health, economic, education, and business data variables, combined with instant reports and interactive color-coded maps, and can help evaluate community needs, plan for growth, and allocate resources. With the Community Analyst Add-in, users can generate reports for features created in ArcGIS for Desktop and access the latest data from Esri and append it to feature attributes in ArcGIS.

Get started right now by downloading the free add-in for ArcGIS for Desktop from esri.com/caaddin, installing it, and activating it. A free 30-day trial of the Community Analyst Add-in is available to ArcGIS for Desktop users. After the trial expires, users can purchase an annual subscription.

Making GIS Available to Everyone

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ArcGIS for Home Use makes GIS available to everyone. If you are an existing ArcGIS user, you can use the same powerful software you use at work at home for noncommercial personal use. ArcGIS for Home Use is great way to expand your GIS skills. For a \$100 annual fee, the ArcGIS for Home Use 12-month term license includes

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- ArcGIS Network Analyst
- ArcGIS Publisher
- ArcGIS Schematics
- ArcGIS Spatial Analyst
- ArcGIS Tracking Analyst

The ArcGIS for Home Use program is available worldwide to anyone. Tutorials for ArcGIS 10 are available online at help.arcgis.com. Esri also offers free and paid training. Find a course today at esri.training.com. ArcGIS for Home Use can be purchased online in the United States. Outside the United States, contact the local Esri distributor.

Answering Emergency Management Information Needs

Whether modeling disaster consequences or alerting residents to an impending tsunami, GIS-driven maps and apps help emergency personnel save lives, mitigate property damage, and speed recovery.

Situational awareness is the key to effective emergency management. The GIS-driven common operating picture (COP) has evolved over the past decade to furnish situational awareness and support missions across all phases of the emergency management cycle. COP is enhanced by GIS technology, not by the implementation of a single application. GIS is a platform for developing mission-specific applications that incorporate the abundance of GIS-ready data with operational data continually updated from the field to support analysis, decision making, and collaboration.

Before GIS was applied to emergency management, the information base for decisions was often limited to the work experience and intuition of individual emergency managers. GIS tremendously expanded the resources managers could consider when evaluating a situation.

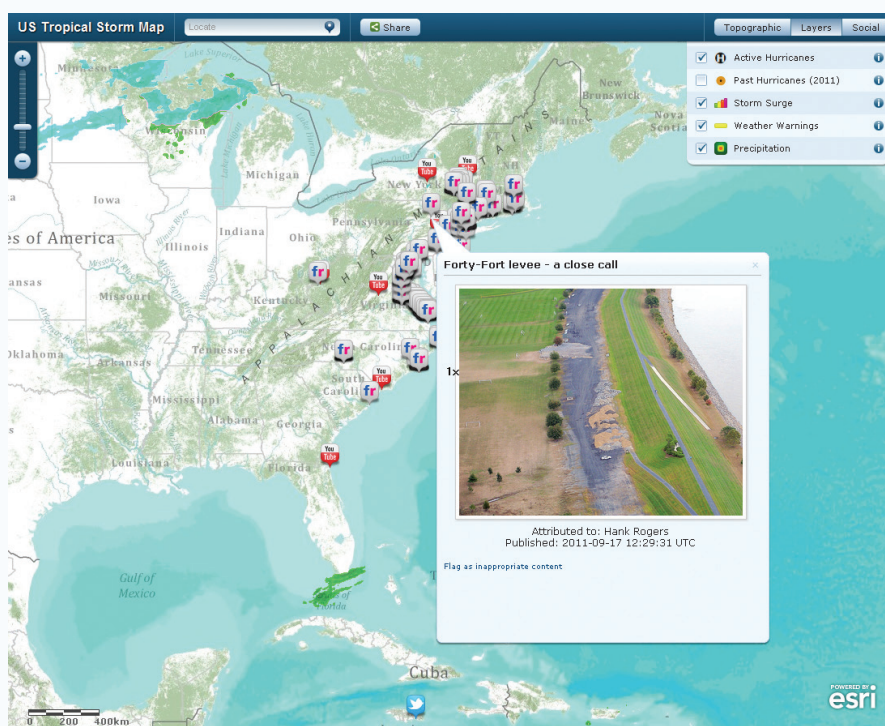
Initially, GIS use focused on response efforts, especially the production of paper maps for briefings and personnel in the field. Static maps produced by the first Internet mapping websites also improved situational awareness for managers and incident commanders and kept the public informed. However, paper maps and static images both suffered from latency and the absence of interactivity.

The timeliness of both products was dependent on the update cycle and could

not provide the most current information. Maps generated to answer one set of questions could not be queried to answer new questions spawned by response situations in constant flux or address additional scenarios when working on planning, mitigation, or preparedness efforts.

The initial challenge when setting up emergency management GIS applications was assembling and integrating the most current and accurate datasets. Because disasters don't respect jurisdictional boundaries, at least some of the required data would likely have to come from other government agencies or organizations. Building and maintaining regional foundation datasets to meet this need was a formidable task from both technological and organizational standpoints.

New patterns of GIS have emerged that answer needs for timeliness, interactivity, accessibility, and collaboration. ArcGIS Online is a pivotal part of these new capabilities. By using an open pattern of implementation that extends into the cloud, ArcGIS Online replaces downloading, processing, and managing datasets with accessing geospatial information contained in map services, map layers, and tools. Topographic, imagery, shaded relief, ocean, reference, and other basemaps, created by Esri and available from ArcGIS Online, can be immediately incorporated as a foundation for mapping operational layers. In addition to a gallery of basemaps, ArcGIS Online hosts a community of users who share maps, services, layers, apps, and tools that can be used to create intelligent



→ Live incident response apps can work two ways. They can share information about a disaster or capture additional data from Facebook, Twitter, Flickr, and YouTube posts.

→ The Public Safety Common Operational Picture template, available from arcgis.com, offers a standard overview of an incident, providing information that enables the incident commander and any supporting agencies to make effective decisions.

maps by mashing up these resources with local operational data.

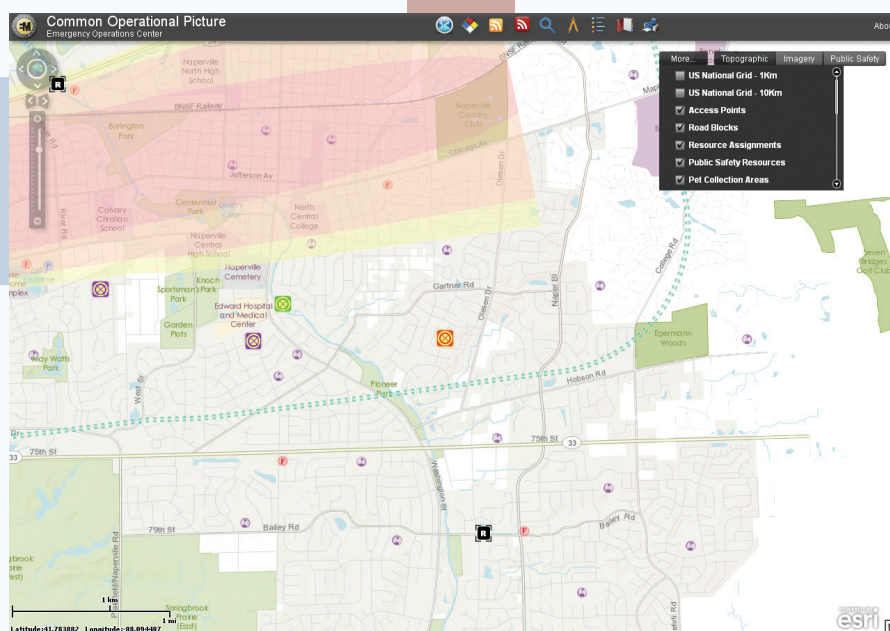
Demographic information, important to all aspects of emergency management, can be accessed as thematic map layers created by Esri and available from arcgis.com. These layers are based on current-year demographics. In addition to free resources, a full spectrum of ready-to-use, high-quality geospatial data licensed from industry-leading providers or built with Esri's proven methodologies can also be purchased.

Furnishing data to web apps and desktop GIS as map services also allows the use of live feeds that are critical when responding to the rapidly unfolding events of an incident. Dynamic data from the Pacific Disaster Center is available as an ArcGIS for Server service as well as live feeds for wind speed and direction, US weather warnings, and ground motion and shaking intensity.

Providing a wealth of data already configured in maps, map templates, and map layers means that data can be used immediately in interactive maps that can be styled, searched, queried, embedded, and shared.

The development and release of ArcGIS APIs for JavaScript, Flex, and Silverlight have furthered the goal of making current geospatial information accessible and comprehensible to nonspecialists. Interactive maps and apps for the web and mobile devices created with web mapping APIs can mash up online services, incorporate GeoRSS and social media feeds, and add tools and widgets.

Extending GIS using cloud computing platforms, such as ArcGIS for Server deployed on the Amazon Elastic Compute Cloud (EC2), has made web maps and apps almost instantly accessible for response to disasters. Deploying ArcGIS for Server



via EC2 lets responders rapidly provide services without procuring hardware, installing software, or impacting existing on-premises infrastructure. An Amazon Machine Image (AMI) obtained from Esri comes with ArcGIS for Server installed and configured along with ArcGIS for Desktop, ArcSDE on Microsoft SQL Server Express, and 100 GB of attached storage. ArcGIS for Server can be configured to automatically spin up new instances during demand spikes and efficiently distribute capacity across instances.

The value of GIS in the cloud was demonstrated in 2010 when extensive flooding covered three-quarters of the state of Queensland, Australia. Responding agencies needed quick access to information on this rapidly changing situation. Ben Somerville and Nick Miller of Esri Australia Pty. Ltd. stood up a COP app in just 12 hours that gave access to the latest, most accurate information on the situation in Brisbane.

Live incident response apps have become an increasingly popular method for sharing information about a disaster or capturing additional data from the public via posts to Facebook, Twitter, Flickr, and YouTube. Simply download the Public Information Map template to learn how to create and deploy public media maps. To use data from social media for advanced visualization, the Ushahidi2ArcGIS ArcGIS for Desktop add-in prototype connects to a Ushahidi instance with the API enabled and can download

Ushahidi data into a geodatabase.

Mobile devices enabled by mobile, global networks let responders enjoy bidirectional situational awareness in near real time. The Alabama Marine Police demonstrated how bidirectional capability could be applied to a large-scale disaster event. Responding to the massive oil spill in the Gulf of Mexico caused by the Deepwater Horizon incident in 2010, crews documented the location of booms and other apparatus using focused apps on mobile devices. Maps, data, images, and video were immediately transmitted to incident command via a Broadband Global Area Network (BGAN). A Flex-based viewer displayed current maps at daily briefings. The result: everyone in a five-state area could see the same information at the same time—a tremendous leap forward in situational awareness.

Beyond heightened situational awareness and improvements in the processes associated with the entire emergency management cycle, GIS—through the GeoDesign framework—is being applied to the underlying cause of an increasing number of natural disasters: climate change.

GeoDesign, which brings together geospatial technologies and design processes to create innovative outcomes, is being used by governments, and nongovernmental organizations (NGOs) to make existing communities more resilient and new communities more sustainable.

SIM Disaster

A better approach to disaster consequence management

By Matthew DeMeritt, Esri Writer

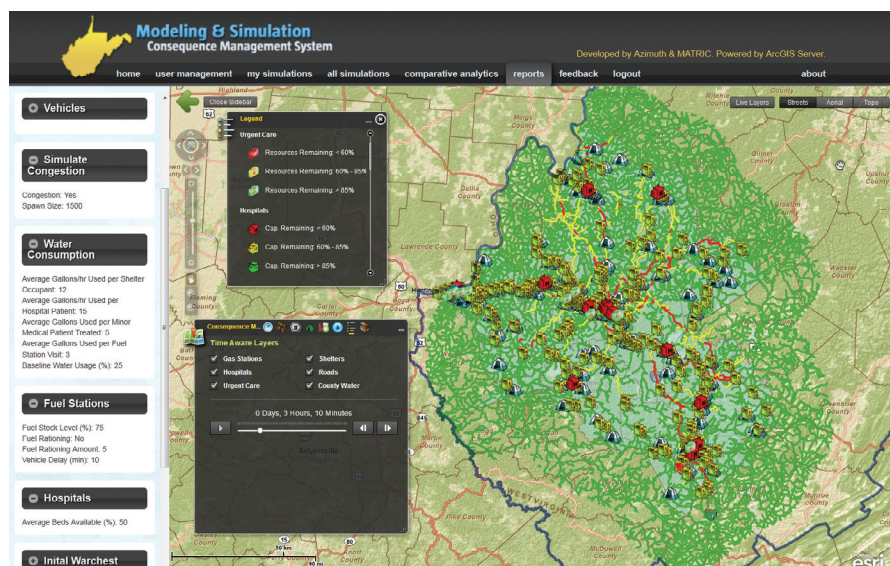
Large-scale disasters will always happen—often without warning. Computer modeling remains one of the most effective ways to lessen the impacts of these calamities and save lives. Simulating catastrophes can produce valuable data that helps emergency planners modify evacuation plans.

FEMA Funds New Research

In recognition of the importance of computer modeling in disaster preparation, the Federal Emergency Management Agency (FEMA) created the Regional Catastrophic Preparedness Grant Program (RCPGP) to support state-of-the-art research into emergency response methods and tools. Created to support the development of integrated planning bodies, protocols, and procedures following catastrophic events, such as wildfires, floods, hurricanes, or man-made disasters, RCPGP funds research by organizations to improve disaster response plans for the National Capital Region. *[The National Capital Region is the geographic area located within the boundaries of the District of Columbia; Montgomery and Prince Georges Counties in Maryland; Arlington, Fairfax, Loudoun, and Prince William Counties and the city of Alexandria in the Commonwealth of Virginia; and all cities and other units of government within the geographic areas of the district, counties, and city.]*

RCPGP awarded Azimuth Incorporated a contract to conduct data collection. Mid-Atlantic Technology, Research and Innovation Center (MATRIC) was chosen to develop a state-of-the-art modeling and simulation system that combines GIS with aspects of gaming. The result was Modeling & Simulation (M&S) Capability for Resource Consumption and Consequence Management, an interactive disaster simulation program that engages users by instantly showing the consequences of emergency response decisions.

The development team's approach to analytics and simulation addresses the failures of imagination, policy, capabilities, and management that were detailed in the *Final Report of the National Commission on Terrorist Attacks Upon the United States (The 9/11 Commission Report)*. The M&S solution provides seemingly limitless possibilities to explore what-if scenarios and integrate non-GIS and GIS technologies. It engages users by showing them the consequences of their decisions through a Flex map viewer front end. ArcGIS for Server processes and



↑ Modeling the impacts of a mass exodus from a metropolitan area on critical infrastructure and resource consumption

analyzes all the data on the back end. The advanced geoprocessing and comparative analytics functionality of ArcGIS for Server enabled more granular simulation than would have been possible with conventional disaster modeling software.

Model Your Own Disaster

Planning and preparing for catastrophic disasters is a top priority at FEMA. Following such an event, FEMA's two chief concerns are the availability of transportation and resources. MATRIC and Azimuth created the M&S system to simulate the impact of evacuees on transportation infrastructure, the consequences of allocating and deploying limited supplies in specific ways, and the corresponding consumption of critical resources (e.g., fuel, water, medical supplies) during an emergency.

With M&S, users have the ability to run scenarios using more than 30 expert-approved parameters including

- Total number of evacuees
- Percentage of evacuees seeking minor medical treatment
- Percentage of evacuees seeking major medical treatment
- Percentage of evacuees seeking shelter
- Average gallons of water used per hour per shelter occupant
- Evacuation or postimpact sheltering
- Average fuel economy per vehicle
- Hospital bed availability
- Ingress points used

The breadth of user-defined parameters enables emergency planners to model a virtually unlimited number of scenarios. The modular system architecture also allows the development team to include additional parameters to meet new customer requirements.

Additionally, users can compare key metrics between multiple simulations to identify which response plan performs the best for a specific scenario. Users can also generate after-action reports for a specific resource, such as hospital bed availability, or broader reports encompassing all resources and their depletion rates over time.

The program works by letting users interactively activate and deactivate shelters, place barriers, and enforce fuel rationing to evaluate the effectiveness of their response plan and experiment with alternative ➔

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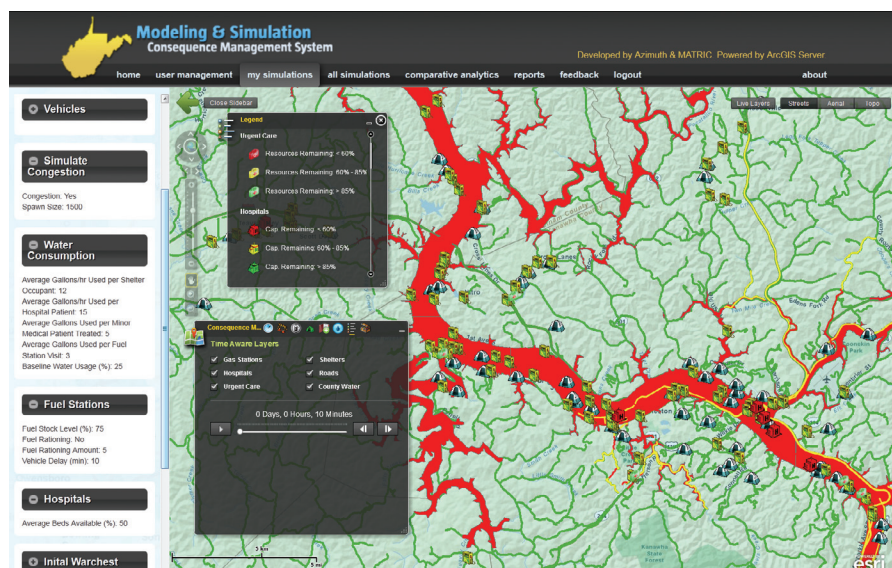
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↑ The flood inundation map is integrated with the modeling and simulation consequence management system to identify critical infrastructure at risk.

plans. The system incorporates Esri's temporal functionality. Users can pause, play, fast-forward, and rewind time to specify precisely when to execute an action during the simulation. The activation of resources, such as shelters, have a user-defined startup and per-occupant cost for required supplies for each activated shelter. The system deducts supplies for each activated resource from a "war chest" defined by the user for that simulation. The user defines the type and quantities of supplies available in the war chest and specifies the startup costs for each available user action (e.g., activate shelter, place barrier). Scenario options are limited only by the user's imagination.

SimCity Inspired

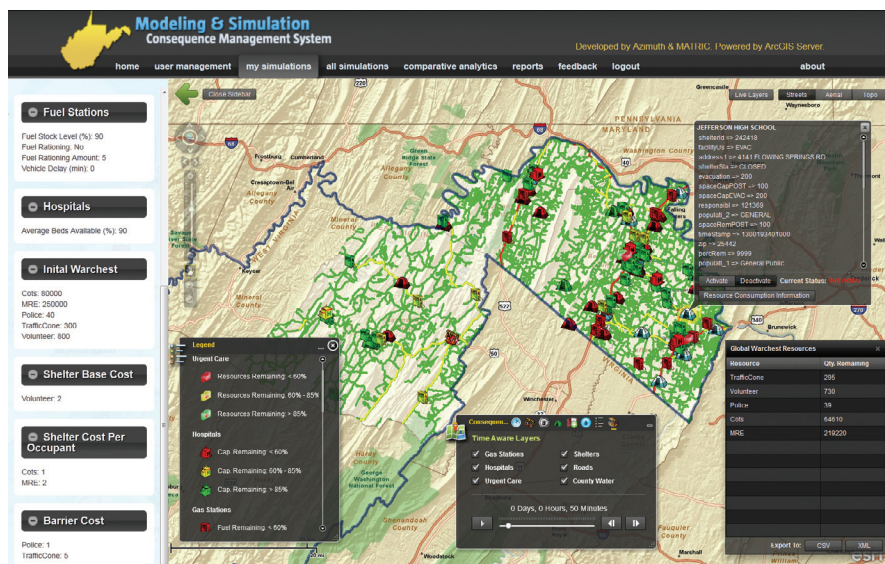
MATRIC's lead developer Vic Baker has been integrating GIS with interactive gaming concepts and virtual reality for more than a decade. The M&S system fuses GIS with gaming technologies for real-world planning and decision making. "SimCity is a useful analog to help familiarize people with this concept," said Baker. "In SimCity, you have to determine where best to deploy your available resources in any given situation."

To simulate a mass evacuation event involving millions of people, the development team needed a way to model roadways congested with millions of vehicles. Each vehicle is modeled as an intelligent agent that follows its own route, contains passengers with specific needs (e.g., seeking medical

attention, seeking shelter), and has dynamic fuel consumption. The team researched existing commercial tools for congestion modeling and quickly realized that existing tools did not provide the development extensibility that the modeling and simulation system requires. To that end, the development team implemented a time-aware, congestion modeling geoprocessing service built on ArcGIS for Server. The geoprocessing service generates temporal heat maps showing increasing levels of congestion as green, yellow, and red road segments.

Just like SimCity, M&S users start with

↓ The Modeling & Simulation prototype system simulates the impact of evacuees on the transportation infrastructure.



limited resources and must use them wisely. However, in SimCity, users who make poor decisions simply lose the game. With the M&S system, users who make poor decisions produce response plans that can endanger lives. "The point of M&S is to encourage users to experiment with scenarios and response plans so that planners can learn from the simulations," said Baker. "There's no better way to identify the flaws in a response plan than seeing it played out before your eyes."

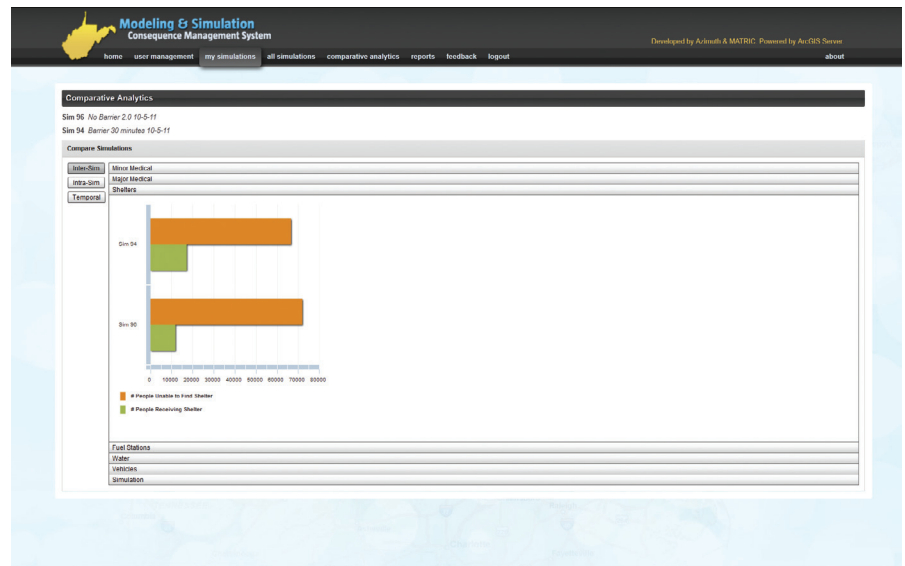
Modeling a Real-World Scenario

To model the potential impacts of an evacuation caused by a failure of the Bluestone Dam near Hinton, West Virginia, MATRIC integrated a barrier polygon tool from its West Virginia Common Operating Picture (COP) to simulate inaccessible areas within the M&S system. "We can use the polygonal barriers in our routing logic so that anything within the impacted areas is inaccessible, and any routes that cross it are off limits," said Baker. The team has also included a flood inundation map, provided by the US Army Corps of Engineers and the West Virginia National Guard, that lets the M&S system identify shelters and medical facilities that would be unavailable in an emergency. "The

inclusion of the flood inundation map allows users to identify which shelters and hospitals will be offline and thus should not be activated during the event.”

The Next Phase

For the project's next phase, MATRIC is collecting data for states surrounding the National Capital Region. The team is also investigating new functionality including sheltering in place, performance optimizations, improved after-action reporting tools, and enabling the user to specify custom areas of interest and data sources for the simulation extents. The underlying intelligent agent simulation technology in M&S can also be adapted to model the spread of contagious diseases and animal migration. For more information, visit www.MassEvacSim.com.



↑ The analytic tool compares key metrics from multiple simulations, enabling emergency managers to improve response plan preparation.

↓ The Modeling & Simulation system was used to simulate the failure of Bluestone Dam, a concrete gravity dam located on the New River. (Photo courtesy of the US Army Corps of Engineers)



Dealing with Rapid Growth and Program Compliance

Determining which properties need elevation certificates

By Christopher Wanamaker, Pinal County Flood Control District

From 2000 to 2010, the population of Pinal County, Arizona, grew from 179,727 to 375,770. During this period of extreme growth, the county's resources were taxed trying to keep up with new development.

This was especially true for the county's floodplain management program. In 2008, the Pinal County Flood Control District took over management of this program and began employing Esri's ArcGIS software to ensure that every property located within a floodplain had a copy of the Federal Emergency Management Agency's (FEMA) mandatory elevation certificate.

To bring the county's floodplain management program into compliance with the National Flood Insurance Program's guidelines, staff needed to quickly figure out which properties had elevation certificates and which properties needed them.

Staff began manually reviewing and entering the existing elevation certificates into a comprehensive Microsoft Excel spreadsheet. Meanwhile, flood control district's engineers were hard at work developing a complete dataset of all the properties that required elevation certificates. However, because the county's maps had recently been revised, this task wasn't a simple one.

Development of the property dataset began by joining the county tax assessor's parcel database (maintained in Microsoft Access) with property boundary data in ArcGIS. Next, all vacant parcels, parcels with buildings constructed before August 1983 (when Pinal County became a participant in the National Flood Insurance Program), and parcels located outside the flood control district's jurisdiction were removed. Finally, an additional field was added to the data to categorize the properties by building construction year. This field was used to separate the properties into two groups based on whether structures were built before or after the floodplain maps were revised in December 2007.



↑ This map shows the results of the completed analysis. Parcels needing new elevation certificates are highlighted in red.

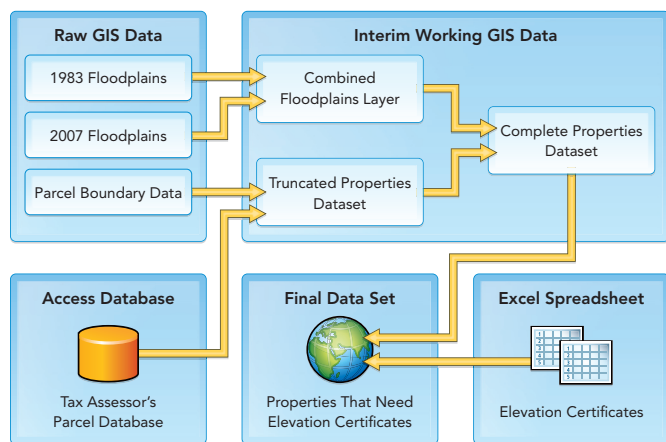
In the next step, Pinal County's older (1983) and newer (2007) floodplain maps were examined. Significant portions of Pinal County had been added to the floodplain after the 2007 map revision. There were hundreds of existing homes that did not necessarily require an elevation certificate for the county's purposes even though they were now shown as being located in a floodplain. When the two sets of floodplain maps were combined and processed, the result was a comprehensive data layer that clearly showed where newly designated and existing floodplains were located.

In the third step of the analysis, the modified property and floodplains datasets were combined. The data was further refined by identifying and removing duplicate parcel numbers using a simple Visual Basic for Applications (VBA) script. Parcels located in the new floodplain that had structures constructed prior to December 2007 were also removed from the list. The resultant comprehensive dataset showed Pinal County staff that nearly 1,845 properties needed elevation certificates.

In the final step, the original Excel spreadsheet containing the existing elevation certificate information was joined to the final parcel dataset in ArcGIS for Desktop Basic. The result gave a clear picture of which properties had elevation certificates and which needed new ones. Based on this GIS analysis, Pinal County was able to develop an accurate budget and reasonable time frame for obtaining elevation certificates for those 457 properties.

The most challenging part of this project was figuring out an efficient way for developing a comprehensive list of properties requiring new elevation certificates. The dataset was so large and there were so many variables involved in completing this analysis that it could not have been done without ArcGIS.

For more information about this project, contact Christopher Wanamaker, Pinal County Flood Control District engineer, Arizona, at 520-866-6010 or Christopher.Wanamaker@PinalCountyAZ.gov.



↑ The final dataset that identified which properties needed elevation certificates required processing five data sources in four steps.

New Information Channel

Android app gets evacuation information to residents

By Matthew DeMeritt, Esri Writer

When the 2011 Tōhoku earthquake, one of the strongest ever recorded, struck the coast of Japan, it sent a tsunami Hawaii's way.

In a sense, Hawaii had dodged a bullet. The March 11, 2011, earthquake transferred most of the tsunami's energy toward Japan's coast rather than toward Hawaii. The wave that Hawaii experienced was 1 meter high (compared to Japan's 10-meter wave) but still caused millions of dollars in damage to docks and seacraft but—fortunately—no deaths.

The tsunami alert sent many Hawaiians scrambling to find out if they were in a tsunami evacuation zone or where the nearest shelter was located. Requests to Honolulu's government website created a logjam that disabled the site.

During a government meeting to assess the tsunami's toll, Honolulu technical staff raised the issue of public access to critical evacuation zone maps during times of high demand on the county server.

“One of the GIS analysts mentioned that their site [*Honolulu.gov*] went down following the alert because too many residents were trying to find information related to the tsunami at once,” said Kyle Shimabukuro, a systems analyst for City and County of Honolulu. “That spurred discussion about why the bottleneck happened and how we could avoid it in the future.”

Staff eventually concluded that the emergency maps in local phone books also were not sufficient to disseminate critical information about tsunami evacuation zones immediately following a seismic event. Because a large percentage of Hawaiians exclusively depend on cell phone service for their telephone needs, many residents simply don't have phone books.

To avert a similar crisis in the future, systems staff at Honolulu created a tsunami evacuation zone app built with Esri's ArcGIS Runtime Software Development Kit (SDK) for Android to serve as a critical information channel. "It took an event like this to point out the obvious problem," said Shimabukuro. "Being an Android phone

owner, I knew that a large majority of those seeking information from the web had smartphones and that Esri had already created a variety of mapping solutions for them.”

Theoretically, a large percentage of requests could be transferred to a simple mapping app, similar to the ones Esri had already created, so Shimabukuro went looking for a way to make a custom app for Hawaii's Android phone owners. Because City and County of Honolulu had already integrated ArcGIS throughout its departments, Shimabukuro was familiar with Esri technology and its online customer support channels. He started his research at Esri's ArcGIS Resource Center and it immediately paid off. There he saw the beta version of the ArcGIS Runtime SDK for Android available for free download.

“Seeing the beta of the API confirmed my hunch that an evacuation zone app was within reach,” said Shimabukuro. “After a simple registration, I downloaded the API as well as information on how to build apps and add functionality. It was all well documented and easy to find.”

Esri's approach to customer support involves giving users access to example apps and preconfigured templates for developers to build on. Rather than having to start from scratch, the application available with the Android SDK gives developers a starting place for adding code and testing functionality during the development process.

“It’s good to know that documentation could provide the answers I needed, but having the sample apps to immediately reference saved me much time in not having to start from the ground up,” said Shimabukuro. “The examples gave me a logical starting point to pick and choose the kind

of functionality our app should have.”

Shimabukuro could easily add and remove code as needed and attach a variety of available map services using the runtime SDK. “I downloaded many libraries to see what each one did and incrementally built the app using that process, which would have been much harder without having access to the example apps and seeing how they operate,” he noted.

During development, Shimabukuro had envisioned using the smartphone's onboard GPS to verify whether the user was in an evacuation zone and generate driving directions from there. "The idea of exploiting the GPS technology already available on Android devices and producing something more than static maps was exciting," said Shimabukuro. "In addition to displaying the address of a given point, I was also able to pass that address to Google Navigation, an external navigation app, to give driving directions."

The final product, which includes full integration with GPS and a handy navigator, exceeded Honolulu's original objectives for the app. Honolulu has successfully promoted it to residents with nearly 1,000 installs. Shimabukuro plans to integrate additional services as they become available. ArcGIS Runtime SDK for Android is scheduled for official release before the 2012

Esri International User
Conference.

For more information on the Honolulu Tsunami Evacuation Zones app or to see it in action, visit the download site in Android Market. For more information, contact Kyle K. Shimabukuro at kshimabukuro@honolulu.gov.



- ← The app taps into the Android device's GPS and displays the user's current location.

Modeling Social Vulnerability in Burkina Faso

By Garth Arnold, Brett Carlock, Mike Harris, Adam Romney, Mario Rosa, Josh Zollweg, Anthony Vodacek, and Brian Tomaszewski

Graduate students at the Rochester Institute of Technology (RIT), funded via a National Science Foundation (NSF) Science Master's Program (SMP), have developed a social vulnerability model and visualization approach for Burkina Faso using ArcGIS.

Social vulnerability can be loosely defined as the predisposition of people, organizations, and societies to impacts from natural and man-made disasters. In the case of the model presented in this work, social vulnerability is assessed using social, economic, educational, and financial factors to try to create an index that will score the relative level of social vulnerability on a regional level.

The immediate purpose for developing the social vulnerability model was to make otherwise inaccessible data accessible to disaster management decision makers within the government of Burkina Faso such as the Conseil National de Secours d'Urgence et de Réhabilitation (CONASUR). CONASUR deals with humanitarian aid mobilization, natural disaster prevention, and management training. Although government agencies such as CONASUR are the primary target of this model, this does not preclude output products from the model (i.e., social vulnerability maps) from being used by health and aid organizations or by the people of Burkina Faso.

ArcGIS for Desktop is an indispensable tool in helping to manage, determine, and visualize social vulnerability as GIS helps provides essential geographic context to social vulnerability data. By creating a spatially explicit vulnerability model, decision makers can determine what areas are more vulnerable to different types of risks. Furthermore, social vulnerability data can be tracked and analyzed over time, enabling further understanding of risk and vulnerability in any given area.

Case Study: Burkina Faso

Burkina Faso is a landlocked country on the African continent bordered by Mali, Niger, Benin, Togo, Ghana, Togo, and the Ivory Coast. In this home to 16.3 million residents, or Burkinabé, six languages are spoken among its 63 ethnic groups. In 2009, the literacy rate was 26 percent. US Department of State data from 2010 shows the infant mortality rate was 91.7 per 1,000 live births with a life expectancy average of 56.7 years. Approximately 80 percent of Burkinabé rely on subsistence farming. According to statistics reported by Burkina Faso, the urban work force represents only 5 percent of the total population, while the rural work force comprises 12 percent of the population. With a per capita gross domestic product of \$580, Burkina Faso is ranked as one of the

poorest countries in the world according to the US Department of State. Given the level of poverty in Burkina Faso, it is an excellent candidate for a case study on social vulnerability.

Model Development

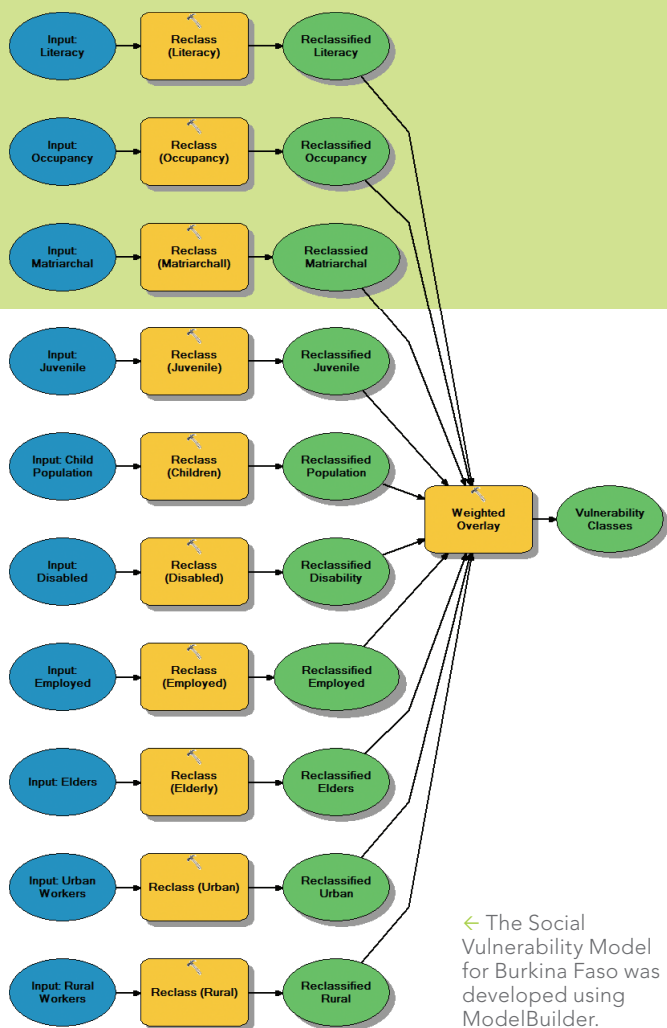
The social vulnerability model developed for Burkina Faso was inspired by the social vulnerability index (SoVI). *[This index was created by Susan L. Cutter, Jerry T. Mitchell, and Michael S. Scott to measure the social vulnerability of US counties to environmental hazards.]* SoVI quantitatively describes the overall vulnerability of a region to shocks based on socioeconomic variables using nine significant components that include socioeconomic status, elderly and children, rural agriculture, housing density, black female-headed households, gender, service industry employment, unemployed Native Americans, and infrastructure employment.

One of the first challenges the student team faced in building the model was that, for Burkina Faso, exact analogs of the SoVI categories are not present due to cultural differences between the United States and Burkina Faso. However, there were many variables in the data obtained from Burkina Faso similar to those in the SoVI. Ultimately, the students selected input variables for the Burkina Faso model that had the closest

Tableau 5.1: Répartition des ménages dirigés par les enfants selon la région de = résidence

REGION	URBAIN			RURAL			ENSEMBLE		
	Masc.	Fem.	Total	Masc.	Fem.	Total	Masc.	Fem.	Total
Boucle du Mouhoun	398	120	518	2846	696	3542	3244	816	4060
Cascades	328	81	409	788	146	934	1116	227	1343
Centre	3019	496	3515	569	79	648	3588	575	4163
Centre-Est	564	168	732	2110	1027	3137	2674	1195	3869

↑ A representative table of Burkina Faso census data provided in PDF format



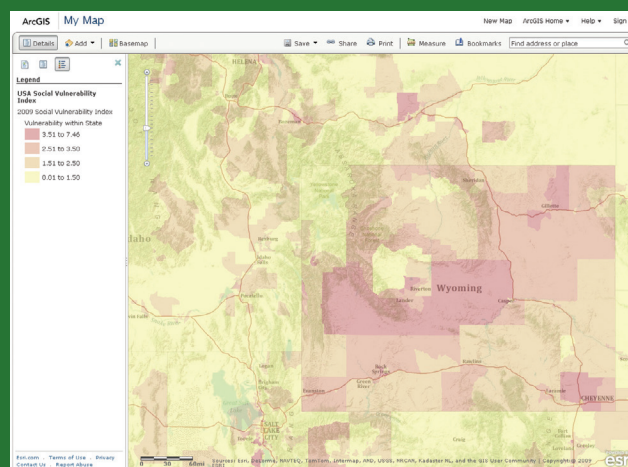
logical fit to the SoVI categories.

The final input variables for the Burkina Faso model included literacy level, housing occupancy, matriarchal households, juvenile-headed households, child population, disabled population, employed population, elderly population, urban workers, and rural workers. This article describes the methodologies for finding, evaluating, preparing, and managing the data for the model.

Data Methodologies

All input variable data for this project was obtained from the National Statistical System of Burkina Faso website (www.insd.bf/fr). This website does not provide GIS-ready data assets such as downloadable shapefiles. Rather, all the data was contained in tables within PDF-based national census reports.

Evaluation of dataset suitability for the model was based on whether or not a census report contained tables of interest to the project. Specifically, datasets should have a geographic reference (e.g., regions of Burkina Faso) and contain data that included variables such as child population, household heads by gender, literacy rates, disability rates, household heads employed, household heads that are children, household heads that are elderly, household quality, housing type, rural work force, and people per room. →

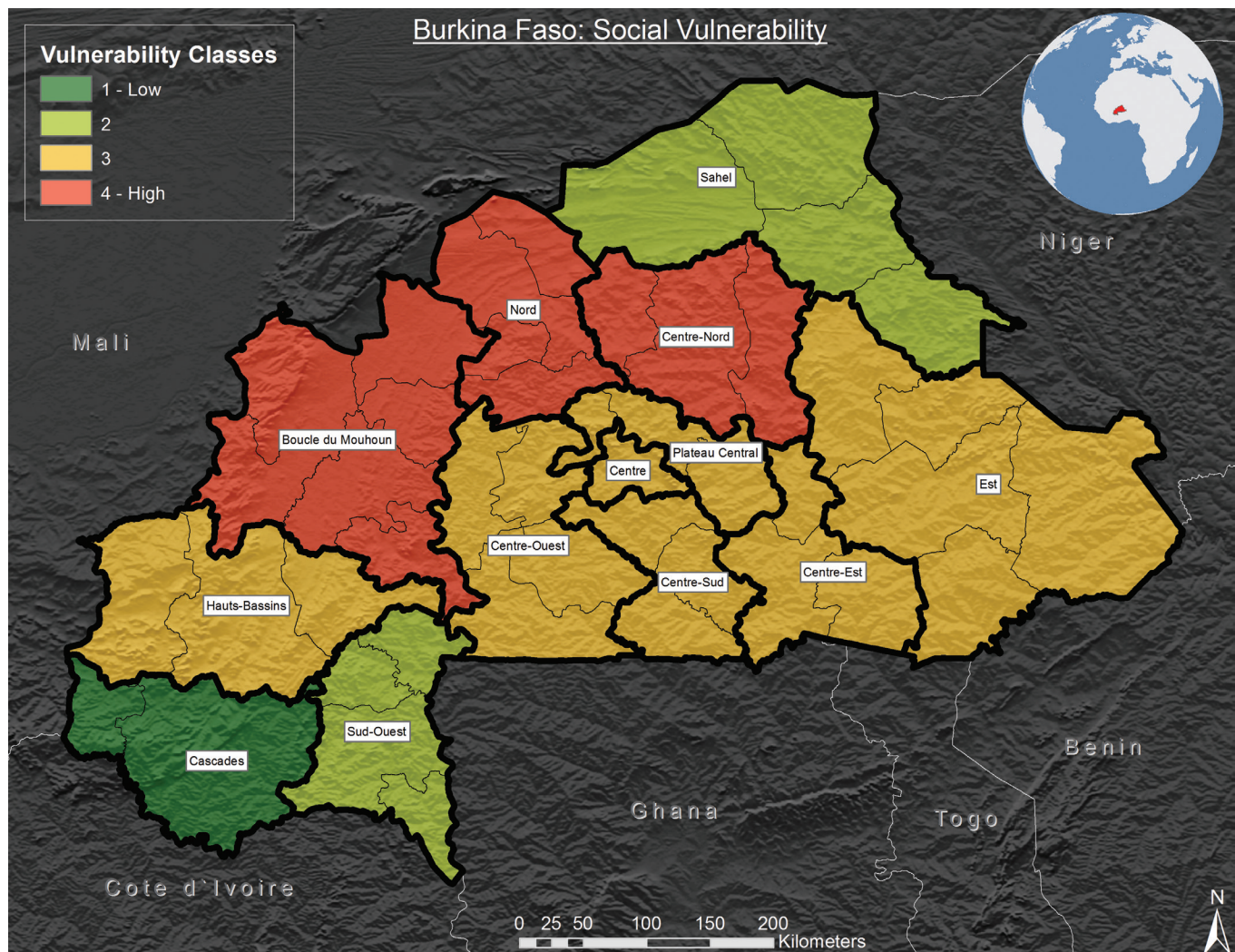


More SoVI Mapping

The Social Vulnerability Index (SoVI) for the United States provided the basis for modeling social vulnerability in Burkina Faso. At arcgis.com, you can explore social vulnerability down to the census block level for 2009 using the *USA Social Vulnerability Index* map.

The map, created by Esri, summarizes risk for states and counties. At scales greater than 1:3 million, vulnerability is calculated on the state level. At scales less than 1:3 million, scores are calculated for each county. Although this web service provides a simplistic view of social vulnerability, it shows which areas have a greater potential for damage caused by disaster events. Other SoVI maps have also been contributed to ArcGIS Online from various organizations addressing risks to specific areas or at different levels of geography. To view this map and others that deal with SoVI, search on SoVI at arcgis.com.

To learn more about recent methods and metrics for calculating social vulnerability, visit www.sovius.org.



↑ The model output was mapped to indicate the predominance of specific social vulnerability classes in each region of Burkina Faso.

If a table was deemed useful, based often on translating the table's title using the Google Translator tool (translate.google.com), it was extracted from the PDF file using Adobe Acrobat's Save as Table tools for importing the data into Microsoft Excel spreadsheets (.xls). Relevant parts of spreadsheets, such as column headings, were translated from French to English using Google language translation tools. Data cleanup performed on the spreadsheets included verifying that the text for each geographic reference in the data tables matched the text in a shapefile that it would be joining to. Other cleanup procedures included removing commas from numerical fields.

Once the data tables for each model variable were cleaned, each table was joined in ArcMap to a shapefile of administrative level 2 boundaries (i.e., second subnational level) of Burkina Faso obtained from the

Global Administrative Areas database (www.gadm.org/). After being joined, each shapefile was then converted from vector to raster using the Polygon To Raster tool in ArcToolbox. The vector to raster conversion was required so each model variable could be used with the Weighted Overlay tool (which only works with raster datasets).

After all input variables were converted, they were added to a ModelBuilder model. First, each input variable was reclassified using a range of values from 1 to 10 to normalize the values and provide a common measurement scale. Each input variable was processed using the Weighted Overlay tool and the reclassified input variables added together to generate a social vulnerability score. Because this was a pilot project, each factor was weighted equally in developing the initial social vulnerability score. Thus, each input variable contributed 10 percent

to the final social vulnerability calculation. The social vulnerability score for each region was set such that it fell into one of four classes, with class one being the least vulnerable and class four being the most vulnerable.

Future Work

To improve the proposed model, the authors intend to develop a web-based application that would allow weights to be adjustable to refine model outputs. Further research into the socioeconomic context of Burkina Faso can also determine a more precise and flexible model variable weighting scheme. For example, further insight into how global shocks, such as the recent economic crisis, have affected Burkina Faso could result in a determination that the employment variable should be more heavily weighted in the model.

Also, additional or different variables

could be brought into the model as new data becomes available. The student team collected and processed data on housing materials, but this data was not used in the model due to time constraints. Housing material data would add additional insight into the living condition component of social vulnerability. Housing conditions can be used as an indicator of the resistance to vulnerability of the social risk for a given area. It is likely that higher-quality structures will be found in areas that are less socially vulnerable.

Summary

GIS is an indispensable tool in helping to manage, determine, and visualize social vulnerability. It provides spatial context to social vulnerability data. Given the prevalence of poverty in Burkina Faso, this country is an excellent subject for the study of social vulnerability. The authors have targeted the government of Burkina Faso, at the top administrative levels and regional levels, as the end users for this model—the levels where vulnerability mitigation decision making might occur.

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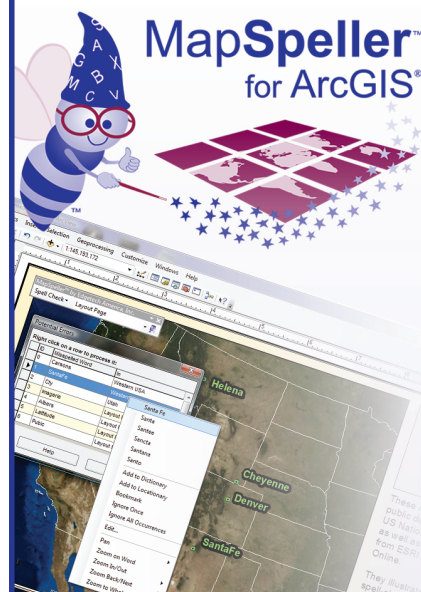
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Exploring Threats to Coral Reefs

With online presentation and GIS datasets

By Witold Fraczek, Esri, and Katie Reyntar, WRI

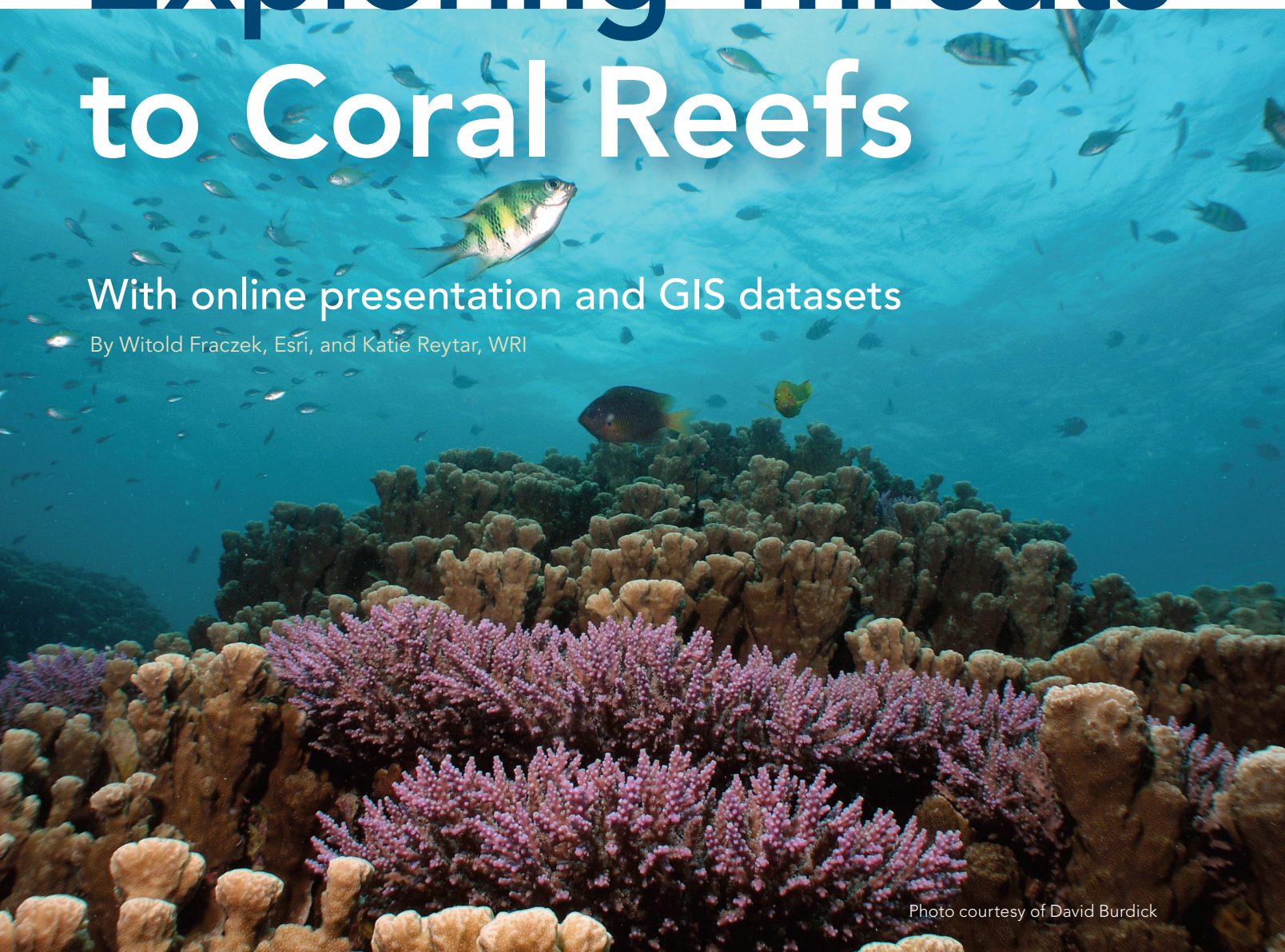
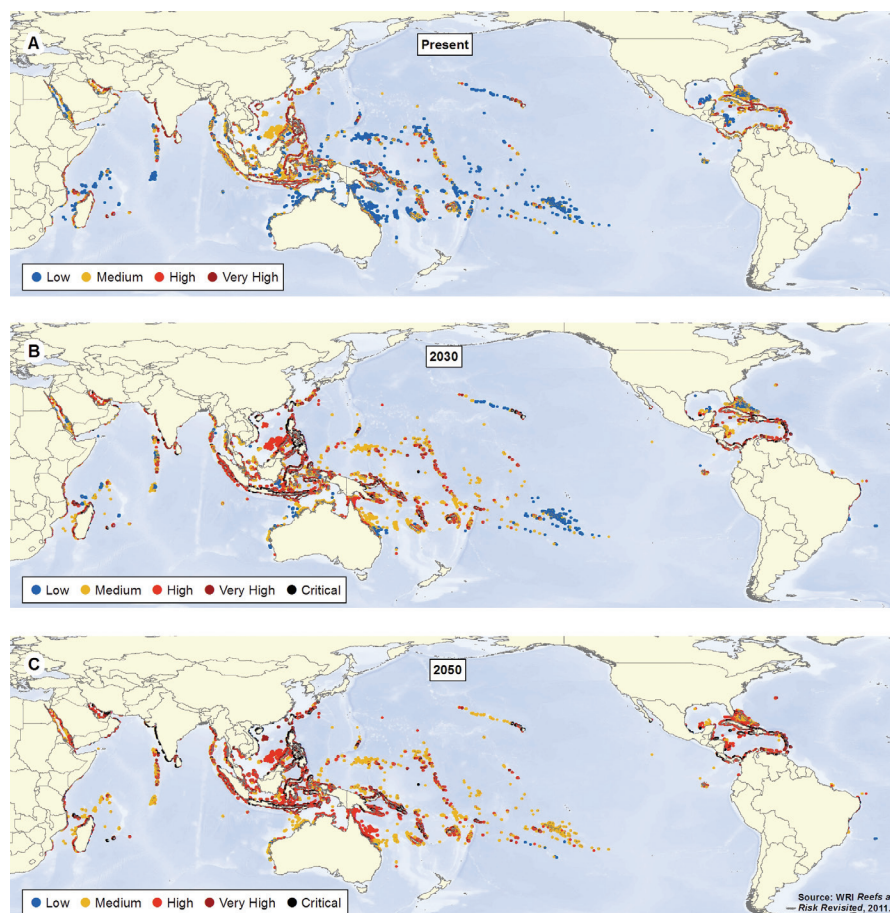


Photo courtesy of David Burdick

→ The top map (A) shows reefs classified by present integrated threats from local activities. In the middle (B) and bottom (C) maps, reefs are classified by integrated local threats and projections of thermal stress and ocean acidification for 2030 and 2050, respectively.



You can explore datasets from the World Resources Institute (WRI) *Reefs at Risk Revisited* project using ArcGIS Explorer Online (explorer.arcgis.com), Esri's free web viewer.

Assessing Threats, Raising Awareness

WRI has been using GIS to develop highly detailed maps of the threats to coral reefs worldwide since 1998. Coral reefs are vital to maintaining the diversity and viability of marine ecosystems. They provide livelihoods and food for coastal communities and shelter and protection for shorelines.

The goal of the Reefs at Risk project is to produce globally consistent data, maps, and reports that are hybrids of model results and observational evidence that can be used to raise awareness about the location and severity of specific threats to coral reefs. GIS is used to develop spatial indicators linking human activities and livelihoods to pressures on coral reef ecosystems.

The project has spawned four publications between 1998 and 2011—a global analysis; two detailed regional analyses; and, most recently, a high-resolution update of the first global analysis.

Reefs at Risk Revisited improves on the 1998 global analysis in several important ways. It uses a global map of coral reefs at 500-meter resolution and benefits from improvements in the many global datasets used to evaluate threats to reefs. Most threat data is at 1-square-kilometer resolution. For the first time, it also includes an assessment of climate-related threats to reefs as well as an assessment of the vulnerability of nations and territories to coral reef degradation, based on their dependence on coral reefs and their capacity to adapt. Finally, it takes advantage

of the many advances in online web mapping applications, such as ArcGIS Explorer Online, to reach a broader audience that is web savvy, but not necessarily GIS savvy.

Exploring Reefs at Risk Revisited Data

A presentation, *Reefs at Risk Revisited: Mapping Threats to Coral Reefs*, was created in ArcGIS Explorer Online displaying threats to the world's coral reefs using GIS data from the WRI project. The presentation, publicly available at the arcgis.com website, includes a set of 15 global thematic maps showing various threats to coral reefs such as over-fishing, destructive fishing, and projected changes in ocean chemistry due to climate change. Although the dataset is global →

in extent, to facilitate the presentation of the level of detail available, some slides are zoomed in to localized areas. In each map, users can navigate to regions of interest.

To view this application in ArcGIS Explorer Online, go to explorer.arcgis.com. In the Find Maps and Groups search box, type *reefs*. In the search results, find *Reefs at Risk Revisited: Mapping Threats to Coral Reefs*. Click the Details option to view information about the presentation.

The GIS data used in this map resides on an Esri server rather than locally. The map can be explored in two modes: mapping and presentation. In mapping mode, the user can change the visual appearance of the maps, change symbology, and edit legends and text. In presentation mode, maps are viewed as slides.

The map titles, pop-up legends, and data source information have been prepared individually for each map in the presentation. When the presentation opens on the first slide, click the red pin to read instructions on navigating the slide show. Two options are available for viewing the slides. The first option allows a user to select a slide from the panel of thumbnails at the bottom of the interface to view them in a limited size display window. If a lock icon appears in the upper right corner of the map window, click it, and the map will be freed for navigation.

The second option allows the user to view the slides in full-screen mode, which can be accessed by clicking the Start Presentation icon in the toolbar at the top of the window. In full-screen presentation mode, users can pan

and zoom with a mouse or with the Navigation tool located in the lower left corner of the display window. The XY icon at the bottom of the Navigation tool offers an option to display a scale bar and the geographic coordinates of the current cursor position.

Priceless Data Freely Available

In addition to exploring these datasets using the ArcGIS Explorer Online presentation, a comprehensive collection of the raw input data used in the modeling and model results are freely available.

- Marine conservation practitioners, resource managers, policy makers, and development agencies can use these datasets and maps to identify opportunities to protect reefs, set priorities, and plan



interventions.

- Businesses that rely on or affect coral reef ecosystems can use this information to mitigate risks and protect their long-term economic interests.
- Educators can use the datasets, reports, and online resources to build GIS and geography skills in their students as well as teach about threats to coral reefs, thereby planting the seeds for a new generation of marine conservationists.
- The media can use this data for immediate news and as the basis for future research and communication.

Data can be downloaded from the WRI Reefs at Risk website (www.wri.org/reefs) and is also available as a compiled DVD by request (e-mail: reefsatrisk@wri.org). In the first six months after its release, the website logged more than 900 downloads of *Reefs at Risk Revisited* datasets. A copy of the *Reefs at Risk Revisited* report can also be obtained at www.wri.org/reefs.

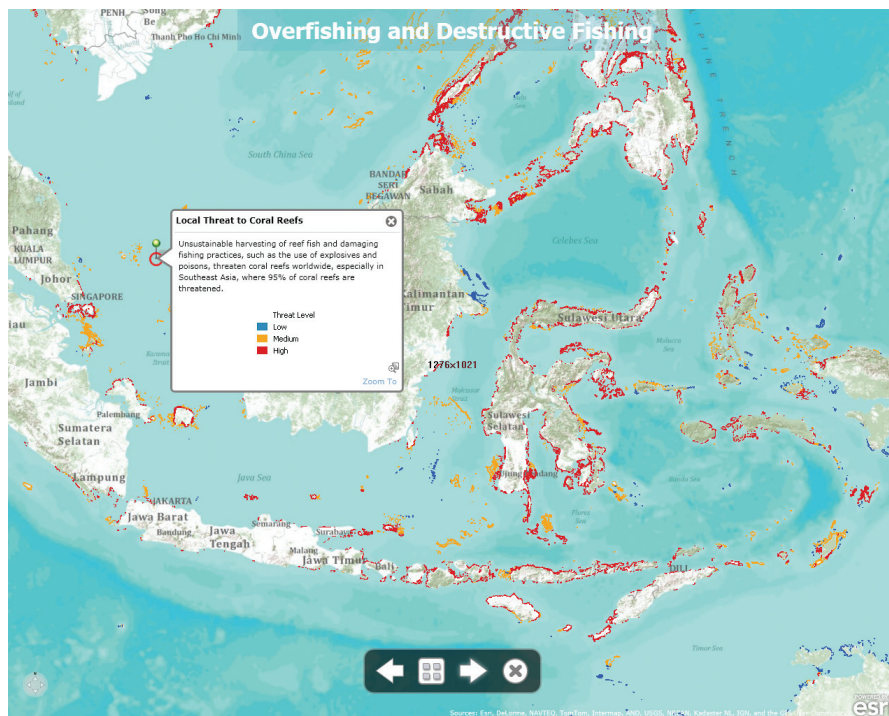
About the Authors



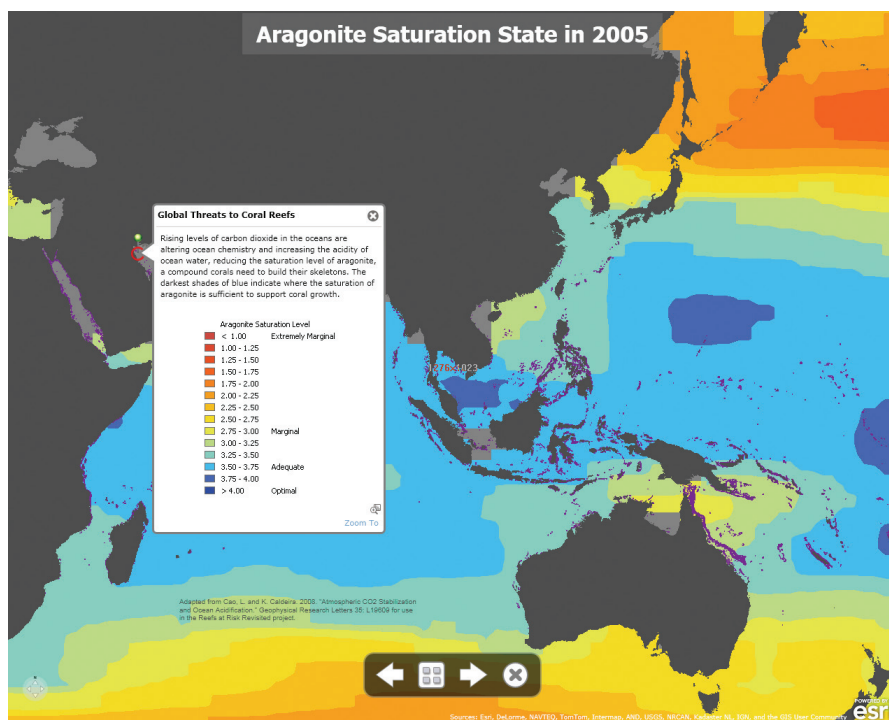
Witold Fraczek has a master's degree in hydrology from the University of Warsaw, Poland (1976), and another master's degree in environmental monitoring/remote sensing from the University of Wisconsin, Madison (1988). In 2006, he defended his PhD dissertation at the Forestry Department of the Agricultural University of Warsaw. He joined Esri in Redlands in late 1988 and, for the last several years, has worked at the Application Prototype Lab. His areas of interest include raster analysis, hydrology, geostatistics, cartography, and 3D visualization.



Katie Reyta is a research associate at WRI in Washington, D.C., where she specializes in applied GIS to manage and conserve coastal marine resources, and has worked on the *Reefs at Risk Revisited* project since 2008. She has a BS in civil and environmental engineering from Johns Hopkins University and a master of environmental science and management degree from the University of California, Santa Barbara.



↑ The data in the ArcGIS Explorer Online presentation demonstrates that coral reefs in Southeast Asia are the most threatened in the world.



↑ Learn more about the variety of threats to coral reefs by viewing the presentation. About 95 percent of coral reefs are at risk from local threats, primarily overfishing/destructive fishing, coastal development, and land-based pollution.



Maintaining Shifting Boundaries & Managing Shared Resources

Between Mexico and the United States

By Emily Meyertholen, Esri Writer

From the Gulf of Mexico to El Paso, Texas, and Ciudad Juárez, Chihuahua, Mexico, nearly two-thirds of the border between the United States and Mexico lies along the Rio Grande. In accordance with the 1970 Boundary Treaty, when the river shifts, the two countries can either correct the change by restoring the channel or accept the change and perform a land exchange or credit to the country that gained or lost land.

Along this border, the International Boundary and Water Commission of the United States and Mexico (IBWC, or Comisión Internacional de Límites y Aguas) administers the many boundary and water-rights treaties and agreements that have been established between the two nations. It serves as the liaison in any disputes that might arise and advises both countries on issues involving natural resources along the border, where flood control and water quality are major concerns.

"We try to address each issue individually, and GIS has helped us a lot," said Gilbert Anaya, supervisory environmental engineer for the United States Section of the IBWC (USIBWC). With the help of imagery accessed via ArcGIS for Server, his team built a dataset that defined the river boundary, making it easier to track changes and make informed decisions when boundary refinements are necessary.

"As a federal agency, we look at environmental concerns for all of our project areas, so our environmental management section is heavily invested in GIS to support analysis. We have compiled datasets over the years on factors such as cultural resources, locations of impacted areas, and areas where there's an environmental concern,

and we incorporate data from other agencies such as EPA to look at the whole gamut of environmental issues. When we collect imagery, we get permission from Mexico to also collect it there to ensure that we have good coverage for both of the project areas."

Starting in 2003, USIBWC began consolidating its GIS from several individual users into one central system in ArcGIS for Server so it could better collaborate among its own offices and with other agencies. Some datasets are currently available to the public via the USIBWC website, and plans are in the works to offer a web mapping interface so stakeholders have immediate access to GIS information, which is crucial during emergencies such as floods. The US and Mexican Sections are also working together to create a reference network for sharing datasets in an effort to complete a seamless dataset for the full border. Though the IBWC has created a digital line for the entire US-Mexico boundary, it is currently working with agencies in both countries to reach an agreement on the use of this line as the official boundary in all future datasets.

"There's still quite a bit of work to do," said Anaya. "We've started to assist the larger agencies, like the USGS and Mexico's mapping agency Instituto Nacional de Estadística y Geografía [INEGI] with national datasets such as watersheds, rivers, and elevation data, which are important to many stakeholders and are used quite a lot. We helped jump-start that effort when we started developing the river networks using something similar to the Arc Hydro model, where all of the tributaries and main rivers are now connected via the network for better analysis."

Many missions within the IBWC are concerned with controlling floods, and GIS proved valuable in creating inundation maps during record flooding of the Rio Grande in the summer of 2010. The USIBWC collected imagery and created templates in ArcGIS to automate map sheets that depicted river boundaries across the entire 1,254-mile stretch of the river that lies along the border.

“When we review our flood control procedures, look at hydraulic modeling scenarios, or study how our project areas have developed as the population grows, we go back up to a hundred years. It’s good to be able to have historic information to compare with current conditions. We are an over 120-year-old agency and we have a lot of valuable and interesting information that we’d like to put into GIS, but it’s going to take time,” Anaya added.

The western half of the US-Mexico boundary crosses vast tracts of the Sonoran and Chihuahuan Deserts, the Colorado River, and urban areas near San Diego and Tijuana. While the landscape doesn’t require clearing a demarcation line through forests and thick vegetation as it does along the US-Canada border, the United States and Mexico maintain 276 boundary monuments from El Paso, Texas, to the Pacific coast. Both countries share responsibility for maintaining each monument every five years to ensure that it is unobstructed and undamaged.

IBWC data is used by a wide variety of organizations and individuals, from fishermen who use bathymetric information to develop guide maps to federal agencies that leverage the data to better meet their missions, including Federal Emergency Management Agency (FEMA), the US Environmental Protection Agency (EPA), the Department of Homeland Security, the Army Corps of Engineers, and the Bureau of Reclamation. Collaboration with other federal organizations often involves hydraulic modeling or environmental analysis and always results in a GIS product.

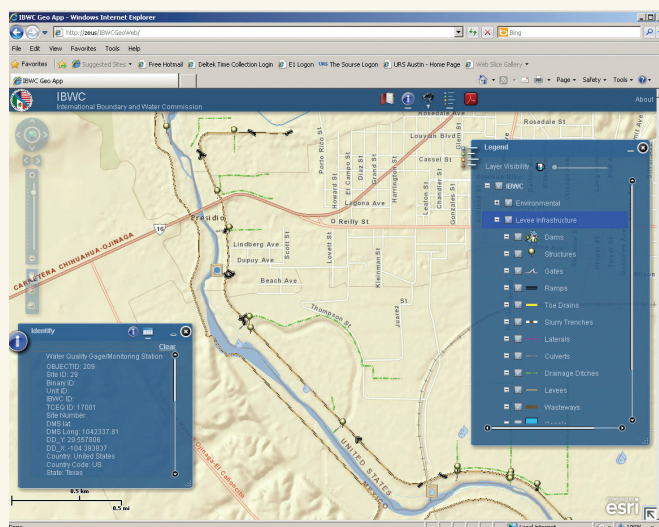
“The easiest way for people to visualize what we’re doing is to show it to them on a map,” said Anaya. “It’s always more effective than data or a table.”

Like the International Joint Commission (IJC) on the US-Canada border, the IBWC lead work groups focused on specific regions or environmental concerns. They have also formed technical work groups consisting of GIS professionals from both countries.

“Through open dialog, the work groups, and the use of GIS, there’s more transparency, and we are able to freely exchange information between countries,” said Anaya. “That is a big benefit we’ve seen within the last five years. We have a very good network of GIS users within federal and state agencies, and we’re working toward harmonizing that data and making sure it’s used as it was intended—to provide people with information.”

Boundary organizations from other countries have expressed interest in the way the United States and Mexico manage their border, and they often share similar concerns. Groups from China and the Middle East have inquired about the IBWC as a model for handling international boundary issues, especially transboundary rivers. Both the Rio Grande and the Jordan River, for example, serve residents of different countries, making it difficult to manage water use while ensuring a healthy ecosystem.

“That’s a common theme that we come across and that we struggle with as well,” said Anaya. “As resources become less available, there has to be a commitment to conserve and find a balance, especially in times of drought. When you couple that with another country that’s



↑ The IBWC GIS web application was developed to review license/lease information on federal properties managed by the commission.

experiencing a similar need, it’s twice as difficult. One of our jobs is to get people to notice the benefits of jointly managing resources and get the right people to the table. One of those components is providing the data to support proposed actions. Ultimately, that leads to visualizing what we’re trying to do, and that always leads back to GIS. You have to provide the science behind what you’re trying to do in order to get the support.”

To learn more about these organizations and their GIS work, visit the International Boundary and Water Commission of the United States and Mexico website at www.ibwc.gov, the International Joint Commission website at www.ijc.org, or contact

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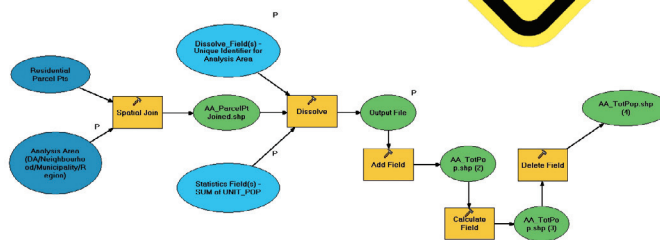
↑ This monument was erected as part of resurvey of monuments by commissioners J. W. Barlow (US) and Jacobo Blanco (Mexico) that was completed in 1896. (Photo courtesy of the IBWC—US and Mexico)

MODELING WALKABILITY



Automating analysis so it is easily repeated

By Arjun Rattan, Anthony Campese, and Chris Eden,
Regional Municipality of Halton, Ontario, Canada



↑ This model assigns total residential population to an analysis area.

The health and planning departments in one of Canada's regions have joined forces to analyze just how accessible stores and services in neighborhoods are by foot or bike. Walkable neighborhoods can also reduce pollution from greenhouse gas emissions generated by vehicles.

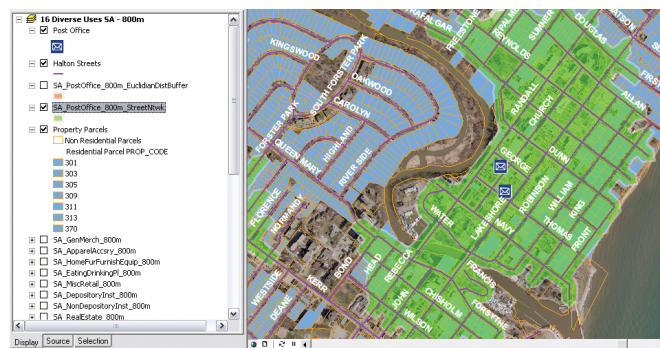
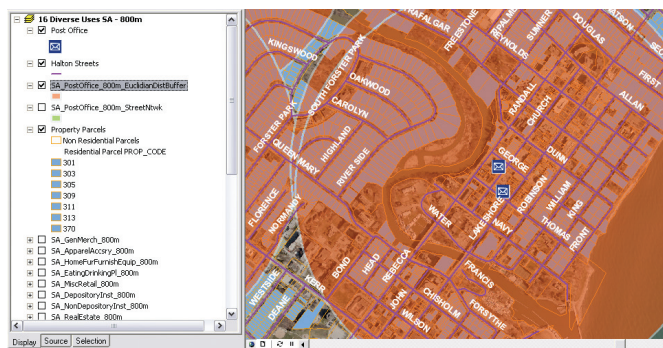
The GIS Services section within Halton Region's Planning Services Division, in collaboration with Halton Region's Health Department in Ontario, Canada, recently completed an analysis workflow to determine the walkability of the region. *[The region covers more than 232,000 acres, including a 25-kilometer frontage onto Lake Ontario, and has an approximate population of 467,200.]*

ArcGIS 9.3.1 geocoding tools, along with the Network Analyst 9.3 extension, were key technologies used to determine Halton's walkable areas. ArcGIS ModelBuilder 9.3 enabled automation of the workflow, making the process both quick and easily repeated without requiring extensive technical GIS knowledge.

Quantifying Walkability

For this project, three factors—density, diversity, and design—were calculated for use in measuring walkability. Density was quantified as residential population density and job density. Diversity was quantified as the percentage of residents within walking distance of defined diverse uses (DUs) that provide a measure of mixed-used development. Design was quantified as trail availability per 1,000 residents, bicycle path availability per 100 residents, and the number of intersections per square kilometer.

These factors were equally important when assessing the walkability of an area. From a GIS standpoint, calculations relating to density and diversity were relatively simple and enabled by ArcGIS technology.



↑ These screen captures illustrate the difference between service areas for a post office created using Euclidean distance buffering (left) and street network buffering (right). The residential parcels northwest of post offices are not classified as walkable when Network Analyst is used to create the buffer. In this realistic scenario, a water body impedes walkability of these post office locations. Note: Sample data used to protect privacy of residents.

Five analysis areas (AAs) in the Halton Region were specified for the project:

- Dissemination areas (small areas composed of one or more neighboring blocks with a population of 400 to 700 persons)
- Census tracts
- Neighborhoods
- Municipalities
- The Halton Region as a whole

Dissemination areas were the smallest AAs because they showed an acceptable level of detail while still allowing comparisons to census data.

Halton Region's Health Department defined three parameters needed to determine and quantify diversity:

- AAs for which walkability needs to be determined
- DUs needed by residents
- The distances to/from DUs (in meters) considered walkable distances

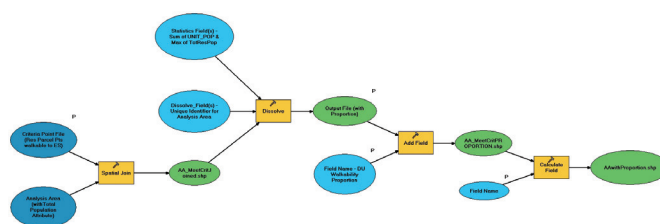
Table 1 lists the DUs used for the project, along with the walkable distance criteria to the DU location. These distances represent 5- and 10-minute walking times (except for elementary schools).

Gathering and Preparing Data for Analysis

Datasets required to conduct the walkability analysis were AAs as polygons, streets as lines, residential locations with population information as polygons and points, and DU locations as points. The AAs and streets layers were available from the region's spatial database. Residence locations were extracted from the Ontario Municipal Property Assessment Corporation (MPAC) parcel layer. The MPAC parcel, street, census tract, municipality, and region layers were current as of 2011. The dissemination areas file was from 2006, and the neighborhoods file was from 2009.

The MPAC parcel property code (PROP_CODE) and structure code (STRUCTURE_) fields were used to identify residential parcels. These parcels were exported and formed the residential parcel location polygon layer. A persons per unit (PPU) attribute field, added to the residential parcel layer, described the average number of people associated with a particular residential dwelling type (e.g., PPU for single-family dwelling units was 3.08).

PPU values were calculated by Halton Region's Planning Services. For parcels with multiple units, parcel roll numbers were used with the MPAC Municipal Connect online database to verify the number of residential units on a parcel. The PPU field was multiplied by the



↑ A model for calculating the total residential population of an analysis area

What Is Walkability?

Walkability is a measure of the effectiveness of community design in promoting walking and bicycling as alternatives to driving cars to reach shopping, schools, and other common destinations. The Centers for Disease Control and Prevention (CDC), the World Health Organization (WHO), and other health organizations advocate increasing the walkability of communities to promote fitness, combat obesity, and enhance sustainability.

number of units on the parcel to get the total population for the parcel. This value, stored in the UNIT_POP field, described the total population of a residential parcel. Calculating population using the PPU field enabled estimating current population on a per parcel basis. Moreover, census population information was outdated; the most recent census information was 2006.

A copy of the residential parcels polygon layer was exported as a point layer using the Feature To Point tool (ArcToolbox > Data Management > Features). Both residential parcel polygon and point layers were used later in the analysis workflow.

Diverse Use (DU)

Walking Distance Criteria

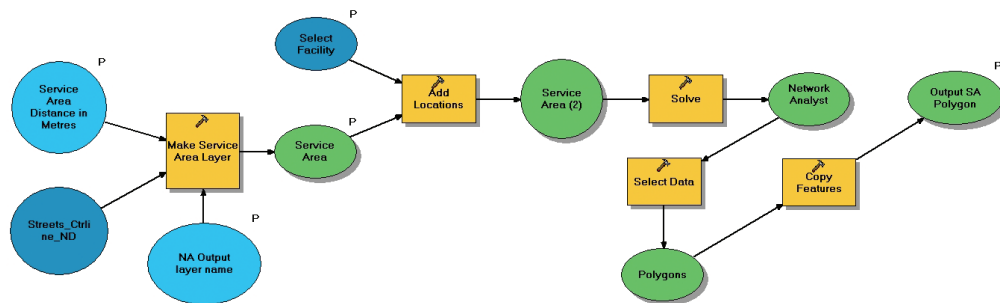
(i.e., distance from residence to DU)

Transit stops	≤ 400 meters
Grocery stores	≤ 800 meters
Fresh food places	≤ 800 meters
Convenience stores	≤ 400 meters
Elementary schools	≤ 1,500 meters

↑ Table 1: A sample of DUs used in the project along with walking distance criteria

Geocoding DU Addresses

Of the DU data items listed in Table 1, only transit stops were available as a shapefile. Most DU location addresses, available from a Microsoft Access database, were gathered as part of the 2010 Halton Region Places of Employment Survey. The required DUs were identified (and exported as Microsoft Excel tables) by North American Industry Classification System (NAICS) code field. (NAICS identifies business and service types.) Addresses for postal service locations (not available from the employment survey) were gathered from the Canada Post website. Education Services addresses were gathered by contacting school boards in the region, in addition to the addresses of private and public higher education institutions within ➔



← Model for calculating service areas for diverse uses and exporting it as a polygon

Halton. Similarly, Fresh Food Places address data was gathered by contacting local organic and fresh food stores.

Having the DU locations available as a point shapefile was critical to the walkability analysis workflow. ArcGIS 9.3.1's geocoding tools converted DU addresses into spatial points. A new geocoding address locator was created using an address point shapefile. The Zone field in the address locator enabled identification of street addresses with the same street name that are located in different municipalities (for example, 543 King Street exists in both Oakville and Halton Hills). A high minimum match score minimized the chance of a DU address being matched to the wrong address point.

The automated geocoding process achieved a success rate of more than 90 percent for all DU addresses geocoded. The Pick Address From Map tool in the Geocoding Review/Rematch Addresses function helped bring the geocoding match rate up to 100 percent. This tool was used to pick points on the map that were verified as locations of unmatched addresses.

Determining Diversity

Having gathered and prepared the data required for analysis, the next steps involved determining the percentage of residents who live a walkable distance from DUs. Analysis involved repeating workflow steps for different input parameters such as AAs and DUs. ModelBuilder 9.3 was used to automate this process. The workflow steps for this analysis included

- Calculate and assign the total residential population for each AA.
- Calculate a service area (SA) for a DU.
- Select residential parcels that intersect the SA for each DU.
- Calculate the percentage of residents in each AA with walkable access to a specified DU.
- Classify and visualize walkability.

Calculate and Assign the Total Residential Population for Each AA

The total residential population was calculated and assigned as the sum of the UNIT_POP field for all residential parcel points that were within the specified AA. In assigning total residential population to an AA, residential parcel points were used instead of residential parcels to prevent parcels that fall on the border of multiple AAs from being included in the total population calculation of multiple AAs.

Calculate Service Area for a DU

The SA for a DU was based on the walking distance criteria in Table 1 and represented all the locations that have walkable access to the specified DU. Using straight-line Euclidean distance to create a

buffer around the DU was initially considered as a solution to create the SAs. However, this method wasn't realistic from a walkability standpoint because it didn't account for physical barriers such as water bodies, railway lines, buildings, and other obstructions.

Network Analyst 9.3 tools were used in ModelBuilder to design an algorithm that calculated the SA for a DU, using the Halton street network. This SA model represented a more realistic visualization of walkable access to a DU by using the street network rather than Euclidean distance.

In ArcCatalog, the Halton streets layer (Streets_Ctrline.shp) was used to create a new network dataset for network analysis. The distance in meters was the only cost associated with the network dataset, because no network analysis involving travel time was required. After the SA is calculated, it is exported as a polygon layer. The Select Facility parameter specifies the DU for which SA is to be calculated. Created SA polygons were merged and trimmed to 30 meters. This distance was determined to be the best distance for ensuring that only residential parcels identified as walkable to the DU were selected.

Select Residential Parcels That Intersect the SA for Each DU

This step involved selecting residential parcels within walkable distance from a specific DU. The selected residential parcels were converted to residential parcel points to prevent walkable parcels that fall on AA borders from being included in multiple AAs in the next step.

Calculate the Percentage of Residents in Each AA with Walkable Access to Specified DU

Listing 1 illustrates how the percentage of residents with walkable access to a specific DU is calculated. This step also assigns the calculated proportion to the AA shapefile.

```
Dim x as Double
If ([MAX_TotRes] > 0) Then
    x = [SUM_UNIT_P] / [MAX_TotRes] * 100
Else
    x = 0
End If
```

↑ Listing 1: Percentage of population in walkable residences

The Visual Basic for Applications (VBA) code in Listing 1 was used in the Calculate Field tool to calculate the proportion of residents (PR16DUPost field) that live a walkable distance from a post office. A conditional statement is required to prevent illegal division by 0 (in the case that total residential population of an AA is zero).

Classify and Visualize Walkability

The results of the walkability analysis were used to construct a database that contained walkability calculations for density, diversity, and design for each dissemination area. This database was used to summarize results for census tracts, neighborhoods, municipalities, and the Halton Region. Choropleth map layouts for various DUs for different AAs were produced to visualize walkability to DUs. The maps displayed AAs classified by the walkability percentage field. The areas in red represent the areas with low walkability to elementary schools. A separate walkability map for each DU enables the planning process to focus on services that are most in need, for a given AA.

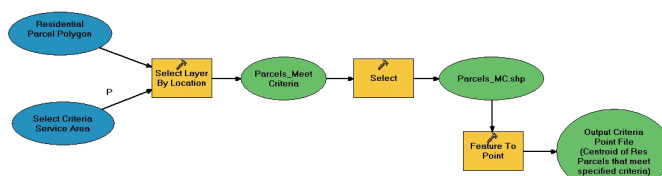
Project Repeatability

The walkability project took approximately three months to complete. A key goal for this project was repeatability. The analysis workflow should easily be repeated with updated data and criteria. Creating a custom ArcGIS toolbox that houses custom ModelBuilder models enables the project to be repeated in significantly shorter time periods by users who don't have extensive technical GIS knowledge.

The entire walkability analysis workflow for the diversity factor (excluding data gathering/preparation) can be repeated by running the four models in the custom Walkability Tools toolbox developed for this project. Running the models in batch mode lets models use multiple inputs simultaneously and saves both time and effort.

Conclusion

An area's walkability is not a single quantifiable measurement. Walkability, in this study, was measured using calculations related to an area's density, diversity, and design. These three factors provide valuable information for assessing an area's walkability. Examining the database and walkability maps of the various DUs for different AAs provides a context for determining whether an area needs more social marketing to encourage walking (if walkability is high) or better design to increase access (if walkability is low). ArcGIS 9.3.1 geocoding tools, ModelBuilder 9.3, and the Network Analyst 9.3 extension are key



↑ Model for selecting residential parcels that are in walking distance to a specified diverse use

GIS technologies that make a realistic determination and visualization of walkability feasibility. ModelBuilder, in particular, enables project repeatability while minimizing project completion timelines.

About the Authors

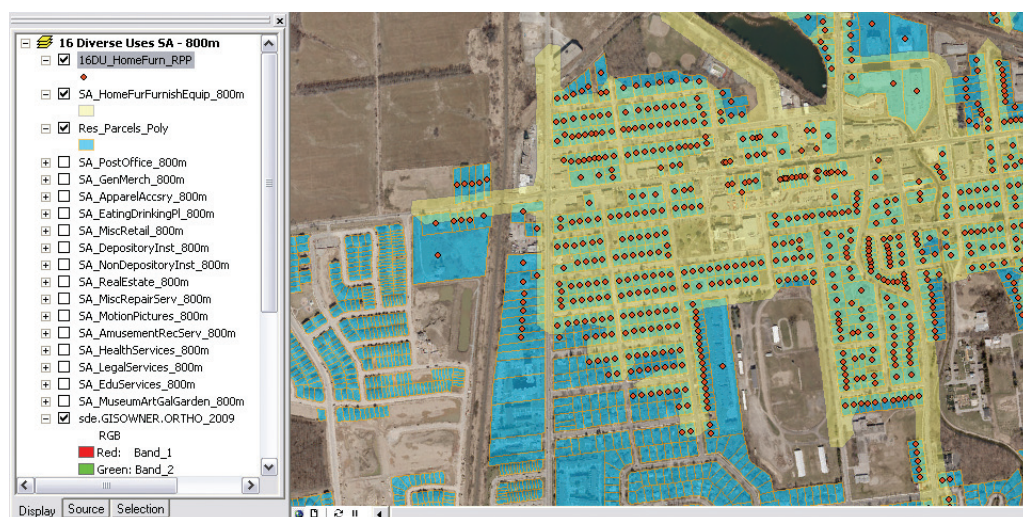
Arjun Rattan is a GIS planning assistant at Halton Region's Planning Services Division. Before joining Halton, he earned a bachelor's degree in urban studies and art history from the University of Toronto and completed a two-year diploma in geomatics from Sir Sandford Fleming College in Lindsay, Ontario.

Anthony Campese is a GIS analyst with the Legislative & Planning Services Department who is responsible for maintaining the GIS functions in the Planning Services Division and acts as a liaison with IT staff. He has worked in the public sector for 12 years. He is also an instructor in real property administration and public administration—municipal programs at Seneca College. He is a graduate of Fleming College's GIS Applications Specialist program and holds a degree in urban geography from Brock University.

Chris Eden is a GIS data technician with the Legislative & Planning Services Department. He is responsible for maintaining the planning data and field collection of data. Eden has been working in the public sector for eight years. He is a graduate of Ryerson University's Geographic Analysis program.



→ Intersecting residential parcel points for Home, Furniture, Furnishings, and Equipment Stores service areas



Open Source



Moving to the middle

By Victoria Kouyoumjian, Esri IT Strategies Architect

Recently, several of us at Esri had the opportunity to attend and support FOSS4G, the Free and Open Source Software for GIS conference, held this year in Denver, Colorado. Esri's sponsorship was large, with four speaking slots and a fully staffed booth. I'd like to think we were valuable contributors to this event, which seemed to be a terrific success with over 900 attendees.

When I became interested in open source and GIS at Esri, the geospatial community had an "us versus them" mentality. At the time, it also existed in the non-geo open source arena with Microsoft taking a hit. But over the past six or seven years, there has been a noticeable shift—a transformation in the IT industry resulting in a hybridization of technology portfolios, leveraging both open and closed source. In my observation, until recently, this trend towards a mixed source environment has been slower to be adopted in the geospatial community.

The largest glimmer of this shift happening was evidenced while at FOSS4G, with a majority of the attendees new to geospatial open source and unfamiliar with any of the historical baggage that some of us (like myself) have observed. Indeed, I have seen this move to the middle—leveraging of both open and closed source—within Esri as well. In the past few years, Esri has released several open source projects hosted on SourceForge, CodePlex, and Github, as well as making contributions to the GDAL [*Geospatial Data Abstraction Library*] project. It's hard to overlook the nearly 100 different open source APIs, libraries, and projects that the core ArcGIS system now consumes.

But time and again, many of us representing Esri at FOSS4G were asked directly, "What are you doing here?" (Most were polite.)

My response to geodevelopers, users, consultants, start-ups, SMBs [*small and medium businesses*], and large traditional organizations, closed and open alike: We're all in this together. If you want to further the cause and broaden the application of GIS, it's time to bridge the gap that apparently still exists in the geospatial community between open and closed source and transcend the bad game

Closed Source



of tug-of-war that has been going on between and within these GIS partitions. The interesting thing about tug-of-war is that—unless the rope breaks—both sides are exhausted in the end.

I would posit that the schism that has divided the open and closed source GIS communities must be bridged if we (collectively) are to succeed with the universal objective of witnessing GIS as ubiquitous—enabling better business and government and neighborhoods.

And imagine no longer taking three minutes to explain GIS to the unacquainted! (Frankly, I now find myself describing it as "geospatial analytics and intelligent mapping" to those unfamiliar.) If we lack a unified front in this regard, it can only weaken this objective. Acrimony can be infectious, spreading like a virus, serving only to break down the community continuity and unravel all the positive work and forward strides you all have made. It should not be a choice of "closed" or "open" taken in isolation. It's based on the best business model for you and your organization. The most appropriate tool provides fitness of purpose and ensures the greatest success for those consuming it, shining a bright light on the solution, the innovator, and the remarkable technology that enabled it to happen.

About the Author

Victoria Kouyoumjian joined Esri in 1995 and has been an eyewitness to changes, innovations, and tech challenges in IT and GIS. After several years as product manager for a suite of developer-focused software solutions, she now works as senior IT strategies architect and technology evangelist, dedicating research and attention to emerging technologies and trends, including the tech disrupters that may impact the geospatial community. She holds an MBA and bachelor's degrees in geography and English. Kouyoumjian coauthored *The Business Benefits of GIS: An ROI Approach*; often writes articles on cloud computing, open source, and emerging trends; and presents frequently on topics in high tech as burgeoning trends move into mainstream. You can follow her on Twitter (@Vkouyoumjian) or connect with her on LinkedIn.

Expense or Essential Investment?

Looking at the value of GIS training

By Suzanne Boden, Esri Training Services

Given what seems like a constant stream of conflicting economic news, it's not surprising that some organizations have a hunkered-down, wait-it-out mentality. Scrutinizing purchase requests and paring budgets to essential spending is the fiscally responsible way to operate these days. However, it begs the question, though: What is "essential spending"?

Howard Community College in Columbia, Maryland, offers customized training for business and work force development. It cites research and benefits to make the case that training is essential spending and posit that by investing in training, organizations will see returns in a variety of areas.

Employee Performance—Improvements in productivity, morale, motivation, and problem-solving skills accrue from training.

Employee Retention—Employees that feel valued and productive are less likely to leave. Hiring and training new employees is expensive and time-consuming.

Cost Savings—Trained employees make fewer mistakes. This results in less duplication of effort. Employees can do more work in less time than untrained employees and require less supervision.

Increased Profits—The less time managers spend answering employee questions about how to complete tasks, the more time managers have to focus on customer management, new revenue opportunities, and more efficient ways to do business—items that increase profits. Increased customer satisfaction resulting from higher-quality work produced by trained employees also helps retain existing customers and win new ones.

In many ways, the benefits of GIS mirror those of training. Improved productivity, operational efficiencies, problem solving, and business decision making are important reasons organizations invest in GIS technology. It's not a stretch, then, to say that investing in training is essential to realize the full benefits of GIS. The staff who create, manage, and use the GIS data, maps, and

apps are contributing to the success of the organization as a whole. To realize the greatest returns from a GIS investment, staff must understand capabilities (and constraints), efficient workflows, and best practices to achieve the desired results.

As the end of the year approaches, most organizations are well into 2012 budget planning. Next year's economic forecast is uncertain, but cost consciousness will remain. There are two Esri training solutions that can help organizations get the most value while maximizing the benefits from training investment: the Virtual Campus Annual User License and the Esri Training Pass.

Virtual Campus Annual User License

A Virtual Campus Annual User License provides one year of organization-wide access to the full catalog of Esri-authored web courses at a reduced price. Web courses are a convenient way to learn a variety of topics related to GIS, ArcGIS, and technologies such as Python scripting. Because courses are available 24/7, employees can take training during downtime or when they need to prepare for new projects.

While valuable to help GIS staff keep their skills up-to-date, web courses can also be a useful training option for knowledge and administrative workers who have no GIS experience. In just a few hours, these workers can expand their skill sets and be empowered to contribute more to the organization's bottom line.

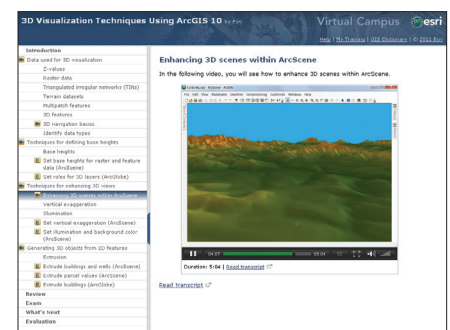
Mark Nowak, GIS manager at the City of Dover, Delaware, is taking advantage of the city's Annual User License to help non-GIS staff develop new skills. "One office assistant was able to pull occupied and vacant mobile home data for a recycling initiative from a program originally created for permitting," Nowak said. "I was surprised with how much she had learned. When I asked her to perform a task, she was able to do it without asking for help."

Esri Training Pass

The Esri Training Pass is the newest way to purchase training from Esri. As with a Virtual Campus Annual User License, it is purchased once and then used to train as many as needed. With a Training Pass, purchase the number of training days needed and redeem them throughout the term for any combination of instructor-led training, client coaching services, and Virtual Campus Annual User Licenses.

For managers, one of the beauties of the Training Pass is that it eliminates the hassle of dealing with individual purchase approvals throughout the year. With training days in place, managers can provide access to training as it is needed—to support staff development plans, prepare key staff for upcoming projects, onboard new employees, and respond agilely to those executive mandates for new GIS products or applications that crop up from time to time.

So there's reason for optimism as the new year approaches. By demonstrating that training bolsters the bottom line, even the most cost-conscious executive can be persuaded that GIS training is an essential investment, one that will reap dividends throughout the fiscal year and beyond.



↑ ArcGIS 10 web courses feature demos, graphic slide shows, and interactive activities designed to reinforce key concepts; are shorter (about three hours); and incorporate adult learning principles that emphasize problem solving and applying the software to complete realistic workflows.

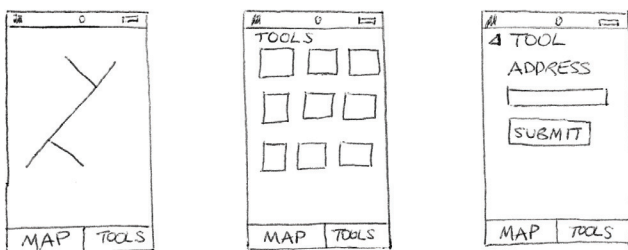
Developing a Custom ArcGIS Application for the iPad 2

By Rory Biggadike, WebMapsolutions.com

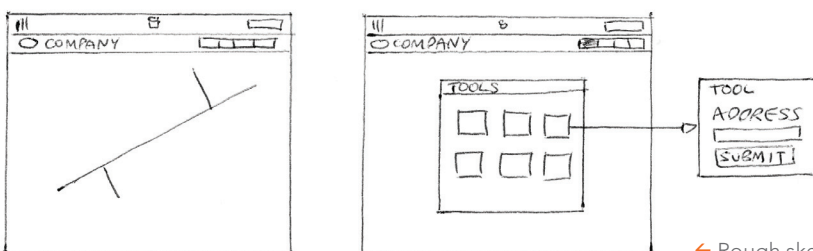
Steve Jobs said we've entered the post-PC era. Goldman Sachs has called tablets "one of the most disruptive forces in computing in nearly three decades." Only time will tell if this is truly the beginning of the end of the PC, but there is little doubt that the advent of mobile computing has already had a huge impact on society. Portability; instant Internet access; geolocation; and simple, more intuitive interaction are among the key benefits. Using ArcGIS on a mobile device in the field, in combination with geolocation (GPS), provides the context missing from existing GIS interaction.

This article is partially a discussion of ArcGIS for Mobile and partially a tutorial on developing an ArcGIS app. The tutorial portion describes the process of building an ArcGIS application using ArcGIS API for Flex 2.4, porting the code to Adobe AIR, and installing the app on an iPad 2. It is targeted at a wide audience and will attempt to avoid technical details. The goal is to provide a base for a broader discussion on real-world applications of ArcGIS on mobile devices.

IPHONE



IPAD



An Introduction to the Mobile Market

The mobile market is made up of laptops, smartphones, and tablets. Historically dominated by the iPhone and iPad, new launches by other manufacturers have started to challenge Apple's preeminence. The most popular platforms (mobile operating systems) are Apple's iOS, Android, Symbian, Windows, and BlackBerry. Mobile device screen size is an important application development and design consideration. Screen sizes range from the 2.6-inch HP Veer through the 3.5-inch iPhone and 9.7-inch iPad 2 to the 10.1-inch Samsung Galaxy Tab. Any ArcGIS map viewer needs to be designed with the screen size in mind. Larger screen sizes lend themselves to more complex applications.

← Rough sketches of application designs

Accessing Mobile Applications

There are two ways to access applications on a mobile device. The first is to simply fire up the mobile web browser and access an existing web application. From a user's perspective, there are disadvantages to this approach. Arguably the biggest is the inability to access applications built using Adobe Flash/Flex or Microsoft Silverlight from any Apple iOS device. This relates to Apple's restrictions on installing plug-ins such as the Flash player. Thus the Esri 2.3.1 Flex viewer can be accessed from most mobile devices, but not the iPhone or the iPad 2. Apple is by no means alone in imposing these types of restrictions.

A second way to access an application on a mobile device is to install the application on the device. Apple, BlackBerry—even Amazon—offer both free and fee-based applications targeted at different platforms. These are downloaded, installed on the device, and optimized for both mobile use and specific OS platforms. Installed applications have advantages over web-based applications. Traditional web pages are targeted at PCs and mouse interaction. Finger interaction is quite different. Installed applications are built with this in mind. In addition, an installed application potentially allows data storage on the device using a lightweight transactional database engine such as SQLite.

There is an additional aspect to installed apps—native versus hybrid apps. For example, applications written in Objective-C are native to the Apple iOS. Applications like those written using Adobe AIR use browser interfaces and native mobile components and



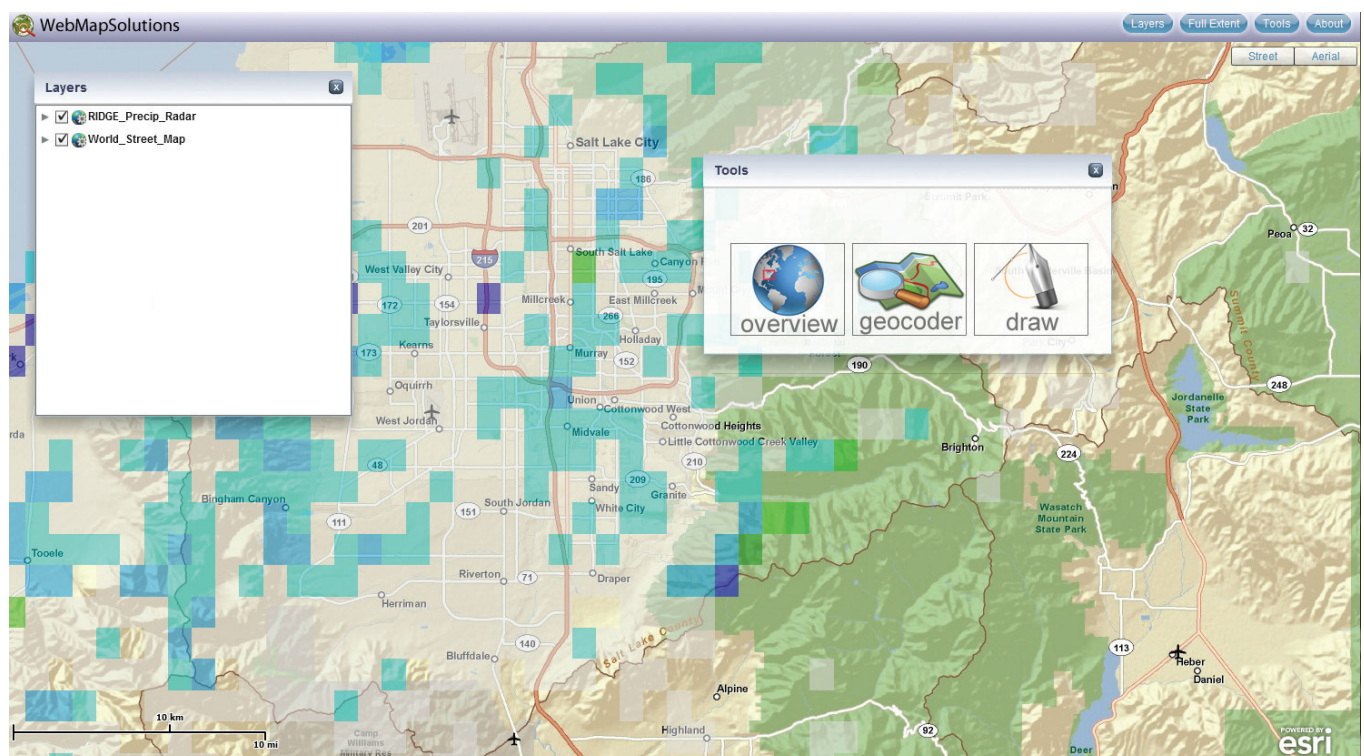
↑ ArcGIS tools pop-up with Tools Dashboard

are hybrid apps. *[Adobe AIR (Adobe Integrated Runtime) is a cross-platform development environment for creating applications that can be run on the desktop or mobile devices using Adobe Flash, Adobe Flex, HTML, and Ajax.]*

This article will focus on building an installed application using Adobe AIR. (The author has no affiliation with Adobe.) The decision to use AIR was driven by the recent release of Flash Builder 4.5. Using this new version of the Adobe developer tool, it is now possible to build a single application that runs on multiple platforms. With AIR you can create one application with one code base that runs on many devices rather than creating one application that requires multiple code bases (in multiple native languages) to run on multiple devices.

Esri is taking an interesting approach. The ArcGIS community can publish its data through ArcGIS Online. By installing the new ArcGIS native application, users can access this data from their mobile devices. →

↓ The final app (See flexmappers.com/arcuser/v3.1)



ArcGIS for Mobile: Development Process

The next part of the discussion focuses on the development process: from rough design to application framework to actual coding. From a programmer's perspective, this is where the fun begins. For clients and users, it is (hopefully) the evolution of a new and useful tool. This article was written in conjunction with the actual development of the application. It includes thoughts about this process as well as idle thoughts about developing mobile apps.

Design

All ArcGIS application development projects start with design. In practice, how design is done varies. A particularly effective approach is to grab a pencil and paper and start scribbling. The map tools are important and will need some thought. The limited screen real estate on these mobile devices means a dashboard approach might work. A single screen or pop-up shows a list of tools that can be opened within that screen. More on this later.

Application flow is something hard to represent in rough sketches. There are formal ways to step through and define the flow of an application (e.g., from button click to tab change). In this example, the flow will be tested during the coding phase.

Application Framework

It is now time to step gently into the technical part of this article: the development phase. Time has been spent brainstorming. A design—the blueprint for the developer—is in place. But before coding commences, the use of an application framework needs to be discussed.

The developer needs to consider whether the mobile application should be built using a programming framework. Model-view-controller (MVC) is a pattern commonly used with these types of applications. *[MVC separates the user interface from the business logic of the application.]* Swiz is a formal framework popular with Flex and AIR developers. Using a framework like Swiz, which follows the MVC pattern, helps teams work together on an application, provides code organization, and simplifies common tasks. This application will use the Swiz framework.

Application Development

It is finally time to start coding. As promised, the article will avoid most of the technical coding details. This initial coding effort will focus on an iPad 2 application. The work will be done in Adobe Flex initially and then migrated to an AIR mobile app. The first phase is focused on setting up the Swiz framework and designing the application header. The header includes buttons that open widgets managed by the framework.

During the brainstorming session, it was decided that a logo and four buttons (Layers, Full Extent, Tools, and About) should be included in the header. Users commonly zoom to full extent and wish to access the layer list so including these buttons in the header made sense.

The widgets are built from a common code base or template so changes to the general widget's look and behavior will propagate across the widgets. The general widget should be draggable and closable and cannot be moved off the screen.

ArcGIS iPad 2 Application Development

The next phase focuses on styling, basemaps, and layers. Styling is an ongoing process. Styling for buttons and headers uses easily changed style sheets. Using style sheets, with the Degrafa Flash library, headers have been given gradients and buttons have been styled beyond the basic look and feel. Interchangeable street and aerial basemaps can be changed using the buttons in the top right corner and have basic styling that resembles Google maps.

Layers can be added to the basemap. An ArcGIS weather layer is shown being loaded by the application. Using a configuration file, it would be possible for any appropriate ArcGIS endpoints to be loaded by the application in a similar way. Beyond visualizing layers, these widgets define the application and are the focus of the next phase of the development effort.

Widget Development

Four widgets were planned for the application. It has been designed to allow the easy addition of other widgets at a later stage. Any number of widgets could be added to the application. This development effort includes a small subset of widgets for illustrative purposes.

The completed ArcGIS Flex application includes fully functional versions of the widgets. Using the dashboard approach, this tool is selected and opened from within the Tools pop-up.

Flex ArcGIS to AIR ArcGIS

The application has reached a point where porting to Adobe AIR can be considered. Remember Flex is a web technology, designed to run in a browser using the Flash player. Adobe AIR is an installed technology that is independent of a browser. The new Flash Builder 4.5.1 includes mobile support. Thus, building AIR-based applications targeting smartphones or tablets for all mobile platforms just became considerably easier.

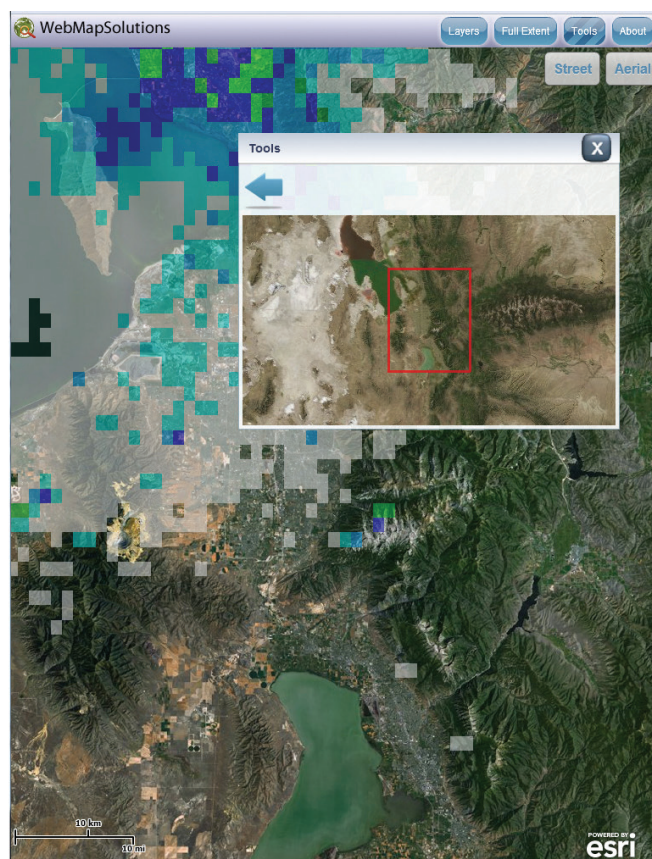
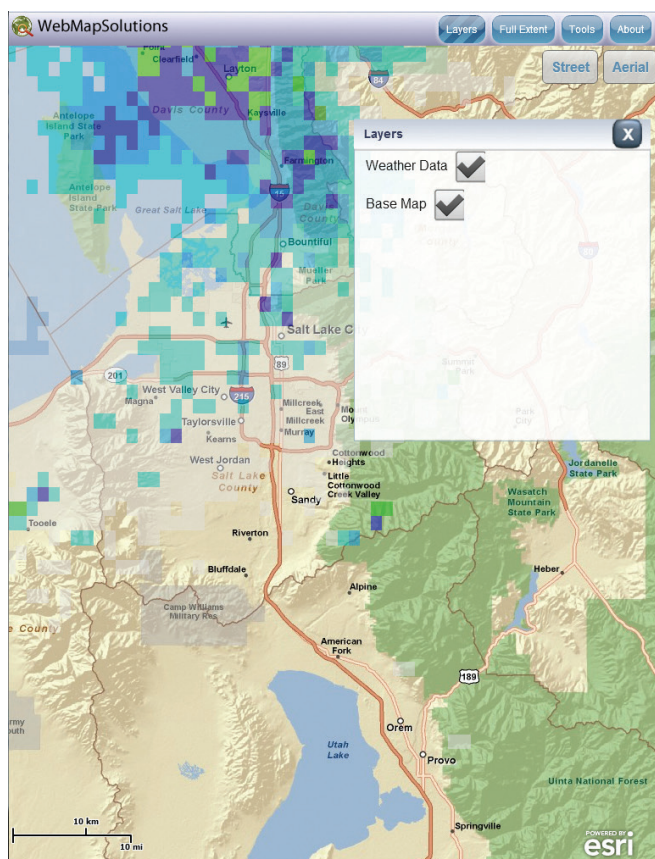
The move from Flex to AIR was straightforward. Some changes were made to the layout, particularly in the tools widget. Since the application is being built for the iPad 2, screen real estate still presents limitations versus a PC. The app needs to be designed with larger buttons that do not overload the interface. The balance must be carefully thought through.

The biggest change was to the Layers widget. This was originally based on a widget available in the Esri Flex 2.4 viewer. Though it ran nicely in the Flex application, in AIR it threw a number of errors. In its present form, the Layers widget cannot be ported to a mobile AIR app so the widget was reworked for the mobile app. All other tools seem to work nicely in the iPad 2 simulator. The next step is running the application on the actual device.

ArcGIS from the Web to the iPad 2

There are a series of steps to walk through to move an application from PC-based development to the iPad 2. The details are beyond the scope of this article. Adobe has made packaging the AIR application very easy in Flash Builder 4.5.1.

Apple has been similarly helpful, making certificate generation intuitive through its iOS development portal. The iPhone/iPhone



↑ The ArcGIS application ported to AIR (See a video showing the app running on an iPad 2 at www.webmapsolutions.com/ios-arcgis-ipad/.)

Touch Application (.ipa) file is a cross-compiled executable generated by Flash Builder that can be uploaded directly to the iPad 2 from iTunes.

Minor changes were made to the layout after testing on the iPad 2. Both landscape and portrait views of the application look good. Esri recently released the 2.4 version of the ArcGIS API for Flex. Many mobile improvements have been made. This has been included in the application and allowed for some code improvements.

Summary and Conclusions

Writing a Flex-based ArcGIS web application and porting it to Adobe AIR for installation on the iPad 2 proved to be both easy and seamless. The release of Flash Builder 4.5.1 and ArcGIS API for Flex 2.4 are significant milestones that have made building ArcGIS apps for mobile devices much easier. This AIR application will run on many mobile platforms beyond the Apple iOS.

Soon, this application will be released to the Apple App Store. This will allow readers of this article to test the application. It is anticipated that users may wish to add their own data to the viewer. This could be done by using a configuration file hosted by the user. This aspect was beyond the scope of the article, but the application was built with the potential for further development in mind.

ArcGIS offers many exciting mobile possibilities, and with the new releases from Esri and Adobe, the community can now in earnest start extending and broadening location-based solutions.

About the Author

Rory Biggadike is senior developer and principal at WebMapsolutions.com. The company builds web and mobile location-based solutions. Biggadike has been developing web-based GIS solutions for 14 years. Much of his development experience has been with Esri software—from MapObjects IMS to ArcIMS and ArcGIS. Mobile has become an important part of his work with a focus on both GIS and location-based services (LBS).

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Real-Time Updating of ArcSDE through SQL

An Introduction

By Chad D. Cooper, GISP, University of Arkansas

Pushing real-time data into an ArcSDE geodatabase for immediate consumption by end users can be challenging. However, with the advent of Microsoft's SQL Server 2008 and Esri support for the built-in SQL Server 2008 spatial data types, real-time updating of ArcSDE feature classes in SQL Server 2008 has gotten easier. By utilizing the SQL Server geometry and geography data types, SQL stored procedures, and triggers, we can essentially bypass the Esri ArcSDE stack and push attribute and spatial updates directly to nonversioned feature class tables. Simple to complex insertions and updates can be performed through SQL, allowing us to provide (upon map refresh or redraw) instant feature class updates to end users.

A Word of Caution

What we are about to tackle can be very dangerous, as changes to nonversioned data cannot be rolled back. It is highly recommended that the methodology about to be discussed be thoroughly tested in a development and/or testing environment before ever being attempted in production.

Why Do This?

Real-time data is becoming more and more prevalent in the world around us and therefore in greater demand within GIS applications. So how can real-time data be pushed to an ArcSDE geodatabase? Third-party applications, such as Informatica and Safe Software's FME, can do this. Both products work very nicely (I've used them both) but can be too costly for many organizations. ArcObjects can also be used, but not all organizations have access to a developer capable of creating an application for updating ArcSDE. Instead, let's look at a simpler method using SQL to directly update the feature class table.

Using the SQL Server Geometry and Geography Data Types

By default, ArcSDE databases in SQL Server use the ArcSDE compressed binary type for feature geometry storage within the SHAPE field. To use the Microsoft geometry and geography data types instead for feature geometry storage, we need to specify them when creating our feature class. Since we cannot change the geometry field type of an existing feature class, we will create a new feature class and specify the GEOGRAPHY configuration keyword during the process.

In ArcCatalog, create a new polygon feature class as you normally would, but when you get to the database storage configuration, use either the GEOGRAPHY or GEOMETRY configuration keyword instead of taking the DEFAULTS option. We will use GEOGRAPHY, which instructs ArcSDE to use the GEOGRAPHY binary data type, to store our spatial information in the SHAPE field (Figure 1).

What You Will Need

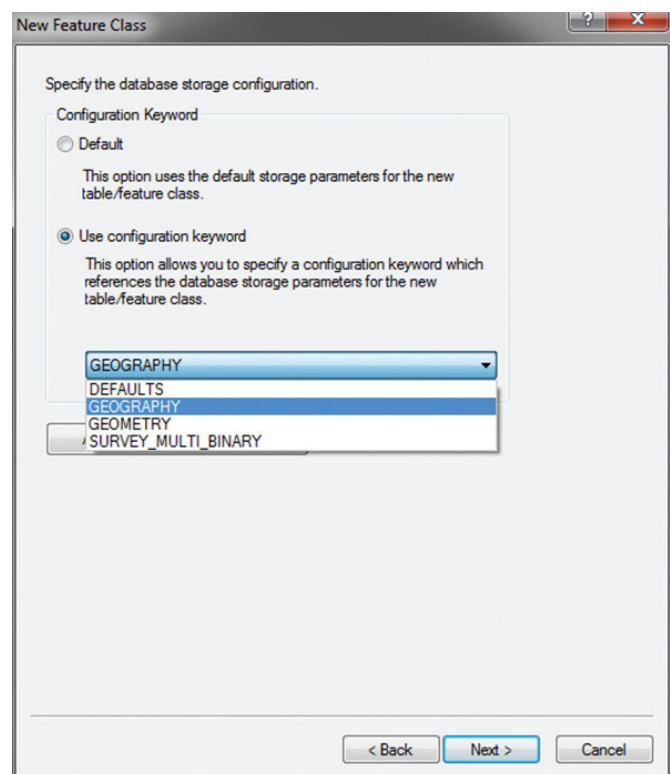
- Microsoft SQL Server 2008 (Enterprise or Express; Express used for the examples)
- Enterprise ArcSDE for your DBMS
- SQL Server Management Studio (available for both SQL Server Enterprise and Express)
- Command line access to ArcSDE with necessary account permissions
- Testing or development ArcSDE database environment (**Do not attempt this in a production environment.**)

Populating Our Feature Class with Data

With SQL Server Spatial, you create and update features through SQL statements issued against the feature class table. These SQL statements can be issued to your ArcSDE database (in this example, it is called City) through SQL Server Management Studio. Listing 1 demonstrates how to add a record into the Tracts table, populating the OBJECTID, TRACT_ID, TRACT_NAME—and most importantly—SHAPE fields. This looks like any other SQL INSERT statement with one difference: the usage of the geography::STPolyFromText method to create the feature geometry from well-known text (WKT). The Tract polygon is represented by coordinate pairs, each representing a polygon vertex, led by the POLYGON keyword, passed into the geography::STPolyFromText method. The coordinate string is followed by the spatial reference identifier (SRID), which in this case is EPSG:4326, WGS84.

```
BEGIN
INSERT INTO [City].[dbo].[Tracts]
(
    OBJECTID,
    TRACT_ID,
    TRACT_NAME,
    SHAPE
)
SELECT 1,1000,'Smith',
geography::STPolyFromText(
    'POLYGON(
    (-77.0532238483429 38.870863029297695,
-77.05468297004701 38.87304314667469,
-77.05788016319276 38.872800914712734,
-77.05849170684814 38.870219840133124,
-77.05556273460388 38.8690670969385,
-77.0532238483429 38.870863029297695
    ))',
    4326)
END
```

↑ Listing 1. Inserting a record into the Tracts feature class



↑ Figure 1. Specifying the GEOGRAPHY storage configuration keyword

Querying the Data

Once we have data in our table, we can query it using SQL Server Management Studio.

```
SELECT [OBJECTID]
      ,[TRACT _ ID]
      ,[TRACT _ NAME]
      ,[SHAPE]
FROM [City].[dbo].[TRACTS]
```

↑ Listing 2: Querying Tracts feature class

OBJECTID	TRACT_ID	TRACT_ NAME	SHAPE
3	1000	Smith	0xE61000000104060000008610937078EF424000000005684353C07C7BB9E0BFEF424001000ED7F4353C0174EBCF0B7EF42400100004FB44353C0DFD91C5D63EF424000000054BE43530033973DEF4240000000578E4353C08610937078EF424000000005684353C001000000020000000001000000FFFFFFFF0000000003

↑ The return from the query in Listing 2

What about that SHAPE field data? Data contained in the Microsoft SQL Server 2008 geometry and geography data types are stored as a stream of binary data, which is what was returned from the query in the SHAPE field. We won't go into the details of binary storage (which you can find on the web). Luckily, there are built-in methods that allow us to retrieve the WKT representations of instances of spatial data. Here are three of these methods: STAsText(), STAsTextZM(), and ToString(). To get each point in our geometry, we can modify our query slightly by adding the STAsText() method to the SHAPE instance as shown in Listing 3.

```
SELECT [OBJECTID]
      ,[TRACT _ ID]
      ,[TRACT _ NAME]
      ,[SHAPE].STAsText()
FROM [City].[dbo].[TRACTS]
```

↑ Listing 3: Adding the STAsText() method

OBJECTID	TRACT_ID	TRACT_NAME	SHAPE
3	1000	Smith	POLYGON ((-77.0532238483429 37.870863029297695, -77.054682970047011 37.873043146674689, -77.057880163192763 37.872800914712734, -77.058491706848145 37.870219840133124, -77.055562734603882 37.8690670969385, -77.0532238483429 37.870863029297695))

↑ The return from the query in Listing 3

Setting the Feature Class Spatial Extent and Adding a Spatial Index

An important step in this process is setting the spatial extent of our feature class and adding a spatial index. I will set the spatial extent at the command line via the `sdelayer` alter command and let ArcSDE calculate the extent for me using the `-E calc` flag:

```
C:\>sdelayer -o alter -l Tracts,Shape -E calc -i
sde:sqlserver:server_name\sqlexpress -s server_name -
-D City -u user -p pass
```

↑ Listing 4: Setting the extent

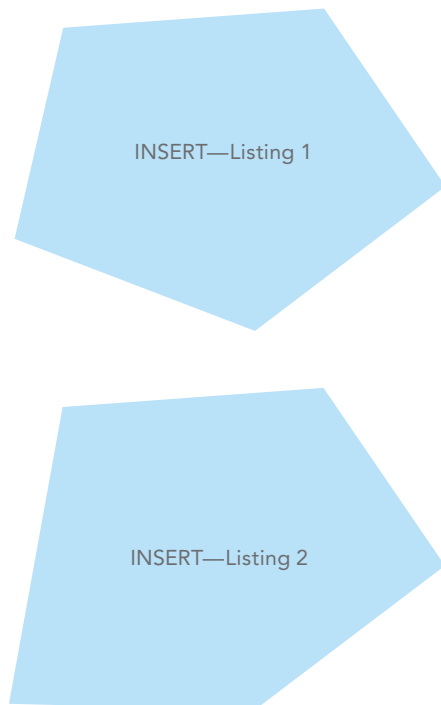
Next, we can add a spatial index using the Add Spatial Index ArcToolbox tool. (Other ways to set the spatial extent and spatial indexes can be found in the ArcGIS documentation.)

Editing the Feature Class

One of the benefits of editing an enterprise ArcSDE feature class through SQL is that the editing can be performed while the feature class is being consumed by multiple clients such as ArcMap or ArcGIS for Server map services. When a feature is updated or inserted, it is visible to the client upon map refresh (caused by pan, zoom, or refresh map commands). Listing 5 shows the SQL statements used to edit the feature we inserted in Listing 1. Figure 2 shows the result. Again, this is a typical SQL UPDATE statement with the exception of the geography::STPolyFromText method call.



↑ Figure 2. Our feature after insert and after edit



```

BEGIN
UPDATE [City].[dbo].[Tracts]
SET SHAPE = geography::STPolyFromText(
    'POLYGON(
(-77.0532238483429 38.870863029297695,
-77.05468297004701 38.87304314667469,
-77.05788016319276 38.872800914712734,
-77.05849961836481 38.869157633013312,
-77.05556273460388 38.8690670969385,
-77.0532238483429 38.870863029297695
))',
4326)
WHERE TRACT_ID = 1
END

```

↑ Listing 5: Editing a vertex (highlighted line) in our feature class feature

Expanding the Possibilities

In addition to adding and updating features, SQL Server has many other spatial functions such as the ability to perform spatial analyses. SQL Server 2008 includes support for methods that are defined by the Open Geospatial Consortium (OGC) standard and a set of Microsoft extensions to support that standard. Full documentation of these methods can be found on the MSDN site (msdn.microsoft.com; search for “spatial data type method reference”). Some of the more interesting methods are listed below in Table 1.

Method	What It Does
STIntersects()	Tests whether two objects intersect
STDistance()	Returns the shortest LineString between two object instances
STIntersection()	Returns an object representing the points where an object instance intersects another object instance

↑ Table 1. Some of the spatial methods available in SQL Server 2008

SQL Server spatial methods can be incorporated into stored procedures and, along with database triggers, can be a powerful way to programmatically update features. Spatial operations, such as testing if a point location lies within a polygon boundary, can be quickly performed directly in the database. Stored procedures in SQL Server can be called programmatically with .NET (the System.Data.SqlClient namespace) and Python (pymssql, pyodbc libraries), along with other methods in other languages.

Editing Caveats

As was pointed out earlier, directly editing your enterprise database is not to be taken lightly, nor is it for the faint of heart. This article was written as a brief introduction to utilizing the Microsoft spatial data types with ArcSDE. It is highly recommended that if you are interested in using the methods described here, you educate yourself on the inner workings of ArcSDE, versioning, concurrency, locking, editing constraints, isolation levels, and spatial data types and how these all apply to and work with your flavor of geodatabase. Of particular importance is your dataset extent, which must be carefully set because adding features outside of the current extent can cause issues. Detailed information on these topics can be found in the Professional and Administrator libraries in the ArcGIS 10 for Desktop online help at the ArcGIS Resource Center.

Conclusion

Using SQL to directly edit spatial data in ArcSDE is a very powerful concept. It is a fast and lightweight method to provide timely updates to end users. Features can be both inserted and updated. A plethora of static and extended methods exist to help in manipulating and analyzing spatial data. SQL statements can be incorporated into stored procedures, enabling your SQL code to be called programmatically. Lastly, ArcGIS 10.1 will allow for direct access to SQL Server spatial database tables, thereby making utilization of the SQL Server spatial data types a more viable option for many organizations.

With great power comes great responsibility. Know the limitations and requirements of your database and use them to your advantage. For more information, contact Chad Cooper at chad@coopergeo.com.

Further Reading

Aitchison, Alastair. 2009. *Beginning Spatial with SQL Server 2008*. New York City, NY: Apress. 459 pp.

ArcGIS 10 Resource Center help topics (resources.arcgis.com/content/web-based-help)

Search for these phrases:

- ArcSDE and Microsoft spatial types
- Editing nonversioned geodatabase data in SQL Server using SQL
- Concurrency and locking

MSDN (msdn.microsoft.com): Search for "spatial data type method reference"

About the Author



Over the last nine years, **Chad Cooper** has worked in many technical roles in state government, the private sector, and higher edu-

cation. He is currently a geospatial research and development specialist with the Center for Advanced Spatial Technologies at the University of Arkansas, Fayetteville, where he can be found doing anything from translating data to writing code to experimenting with web applications. He also consults through his company, Cooper GeoSolutions (www.coopergeo.com).

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Make Maps People Want to Look At

Five primary design principles
for cartography

By Aileen Buckley, Esri

Cartographers apply many design principles when compiling their maps and constructing page layouts. Five of the main design principles are legibility, visual contrast, figure-ground organization, hierarchical organization, and balance. Together these principles form a system for seeing and understanding the relative importance of the content in the map and on the page. Without these, map-based communication will fail.

Visual contrast and legibility provide the basis for seeing the contents on the map. Figure-ground organization, hierarchical organization, and balance lead the map reader through the contents to determine the importance of things and ultimately find patterns.

This article introduces you to these five principles and explains their importance in cartography. It's worth noting that these principles are not applied in isolation but instead are complementary. Collectively, they help cartographers create maps that successfully communicate geographic information.

1

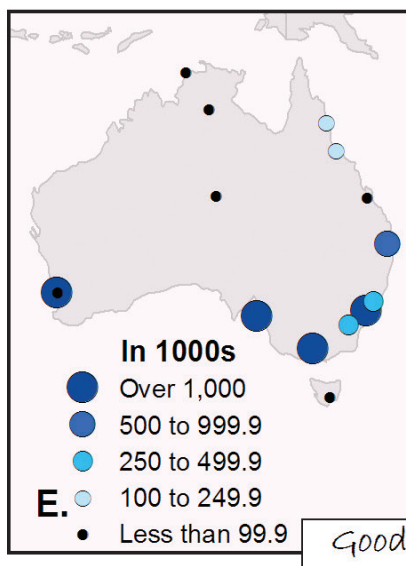
Visual Contrast

Visual contrast relates how map features and page elements contrast with each other and their background. To understand this principle at work, consider your inability to see well in a dark environment. Your eyes are not receiving much reflected light, so there is little visual contrast between the objects in your field of view and you cannot easily distinguish objects from one another or from their surroundings. Increase illumination, and you are now able to distinguish features from the background. However, the features will still need to be large enough to be seen and understood so that your mind can decipher what your eyes are detecting.

The concept of visual contrast also applies in cartography (Figure 1). A well-designed map with a high degree of visual contrast can result in a crisp, clean, sharp-looking map. The higher the contrast between features, the more some features will stand out (usually features that are darker or brighter). Conversely, a map that has low visual contrast can be used to promote a more subtle impression. Features that have less contrast appear to belong together.



2000 Population in Cities



2000 Population in Cities

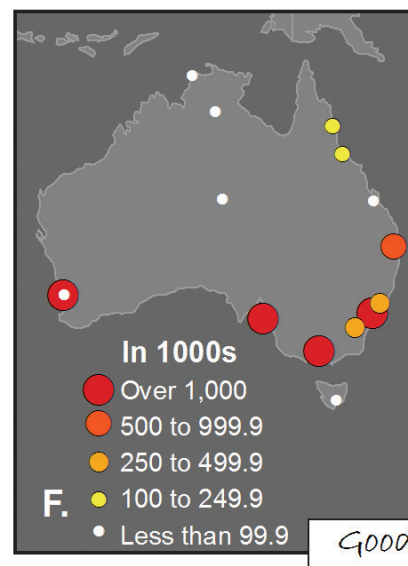


Figure 1. Although black and white (A) provide the best visual contrast, this is not always the best color combination for maps. When using colors of similar high (B) or low (C) saturation (brightness), the hues (blue and green, in this case) must be distinguishable. If they are not, varying the saturation or value (lightness or darkness) of a color (as with the water in D) can create the contrast that is missing. Operational overlays should contrast with the basemap (E and F).

2010 Population

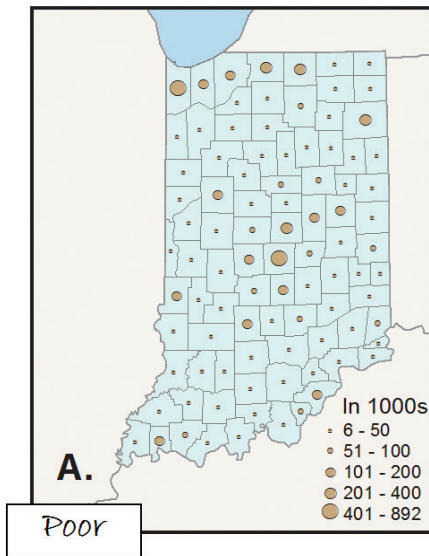
2010 Population

2

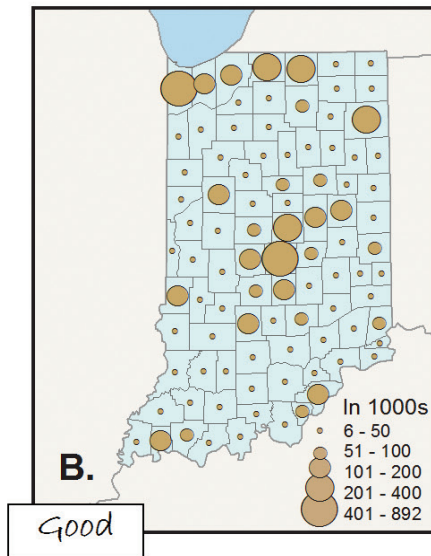
Legibility

Legibility is the ability to be seen and understood. Many people strive to make their map contents and page elements easily seen, but it is also important that they can be understood. Legibility depends on good decision making when selecting symbols. Choosing symbols that are familiar and are appropriate sizes results in symbols that are effortlessly seen and easily understood (Figure 2). Geometric symbols are easier to read at smaller sizes. More complex symbols require more space to be legible.

Visual contrast and legibility can also be used to promote the other design principles: figure-ground organization, hierarchical organization, and balance.



Major Metropolitan Areas



Major Metropolitan Areas

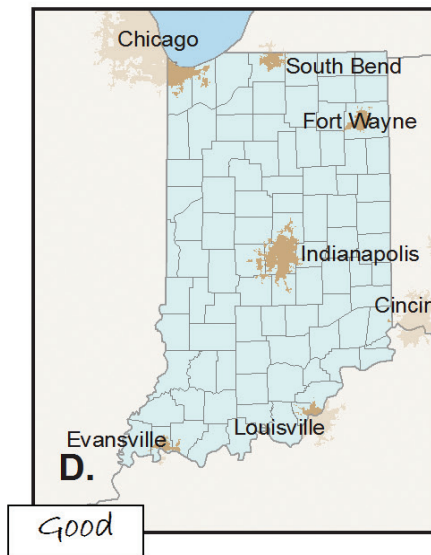
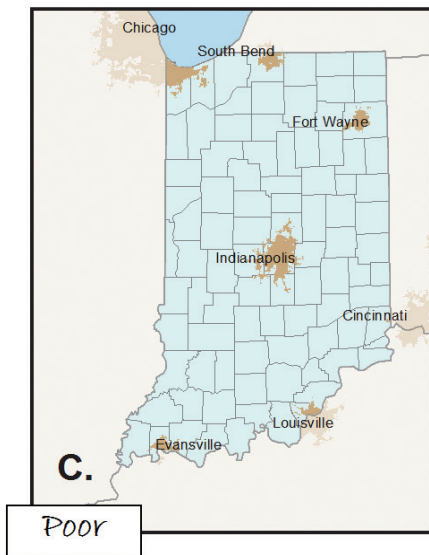
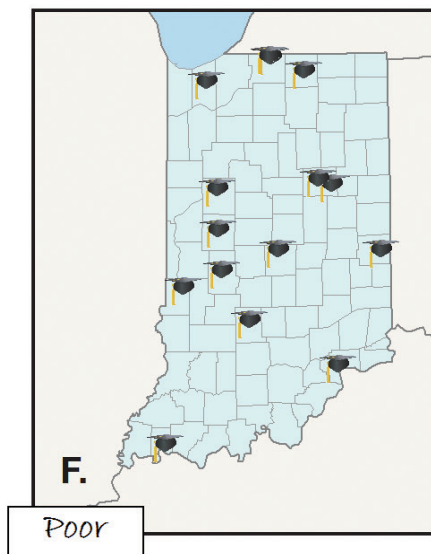
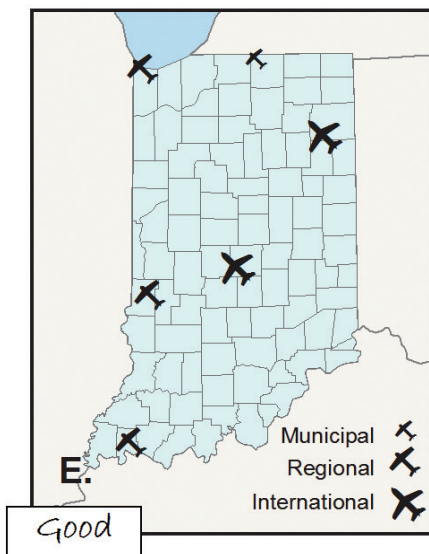
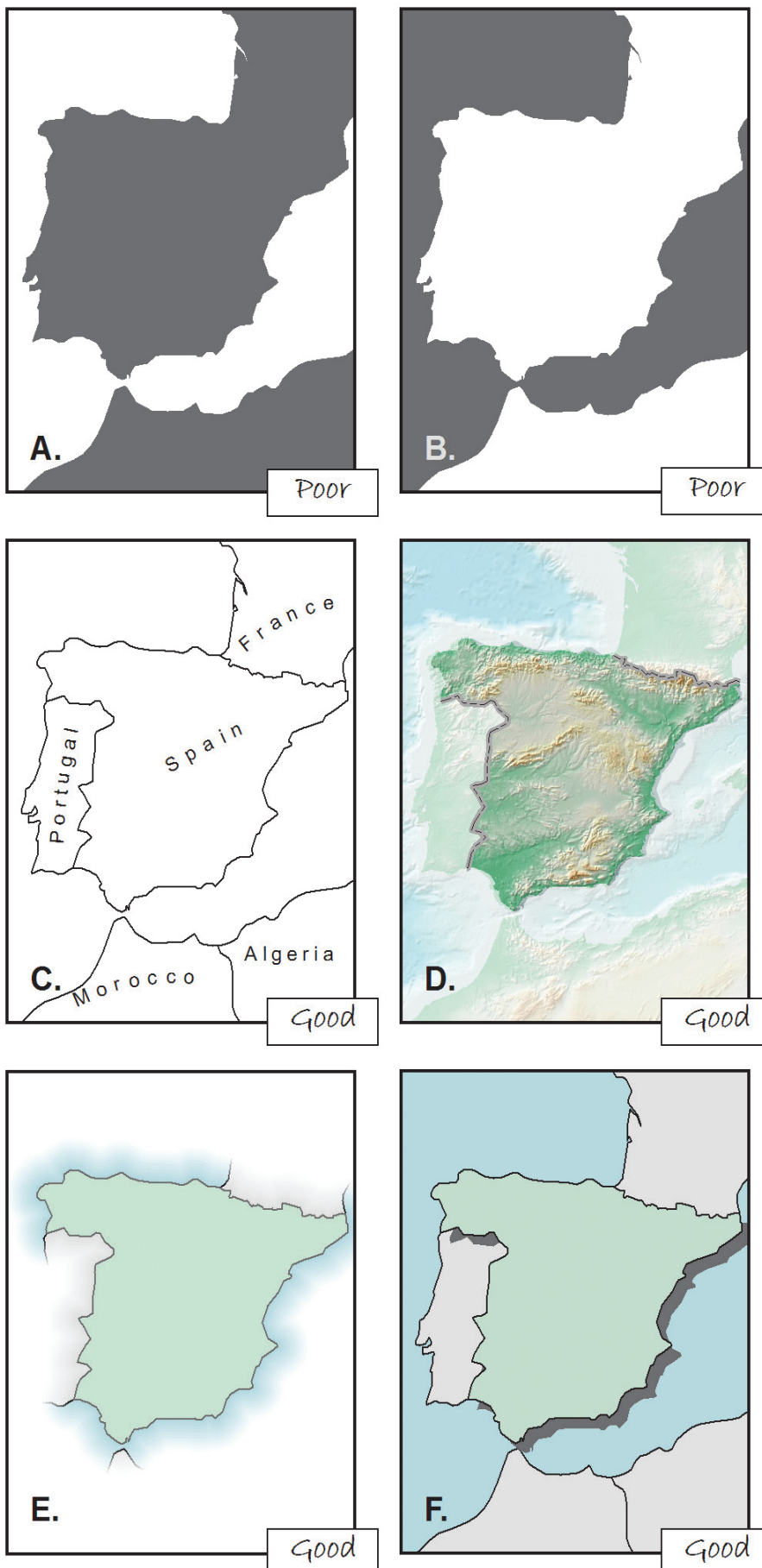


Figure 2. Symbols (A) and text (C) that are too small are illegible. Appropriately sized symbols (B) and text (D) can be easily distinguished and read. Using familiar geometric icons, such as an airplane for airports (E), helps readers immediately understand the meaning of the symbol. More complex symbols, such as a mortarboard for universities (F), need to be larger to be legible.

Major Airports

Fifteen Top Colleges





3

Figure-Ground Organization

Figure-ground organization is the spontaneous separation of the figure in the foreground from an amorphous background. Cartographers use this design principle to help map readers focus on a specific area of the map. There are many ways to promote figure-ground organization, such as adding detail to the map or using a whitewash, a drop shadow, or feathering. ➔

Figure 3. It is sometimes hard to tell what is the figure and what is the ground (A and B). Simply adding detail to the map (C) can help map readers distinguish the figure from the ground. Using a whitewash (D), feathering (E), or a drop shadow (F) can also help.

4

Hierarchical Organization

As noted in *Elements of Cartography*, Sixth Edition, one of the major objectives in mapmaking is to “separate meaningful characteristics and to portray likenesses, differences, and interrelationships.” The internal graphic structuring of the map (and, more generally, the page layout) is fundamental to helping people read your map. You can think of a hierarchy as the visual separation of your map into layers of information. Some types of features will be seen as more important than other kinds of features, and some features will seem more important than other features of the same type. Some page elements (e.g., the map) will seem more important than others (e.g., the title or legend).

This visual layering of information within the map and on the page helps readers focus on what is important and lets them identify patterns. The hierarchical organization of reference maps (those that show the location of a variety of physical and cultural features, such as terrain, roads, boundaries, and settlements) works differently than for thematic maps (those that concentrate on the distribution of a single attribute or the relationship among several attributes). For reference maps, many features should be no more important than one another and so—visually—they should lie on essentially the same visual plane. In reference maps, hierarchy is usually more subtle and the map reader brings elements to the forefront by focusing attention on them. For thematic maps, the theme is more important than the base that provides geographic context.

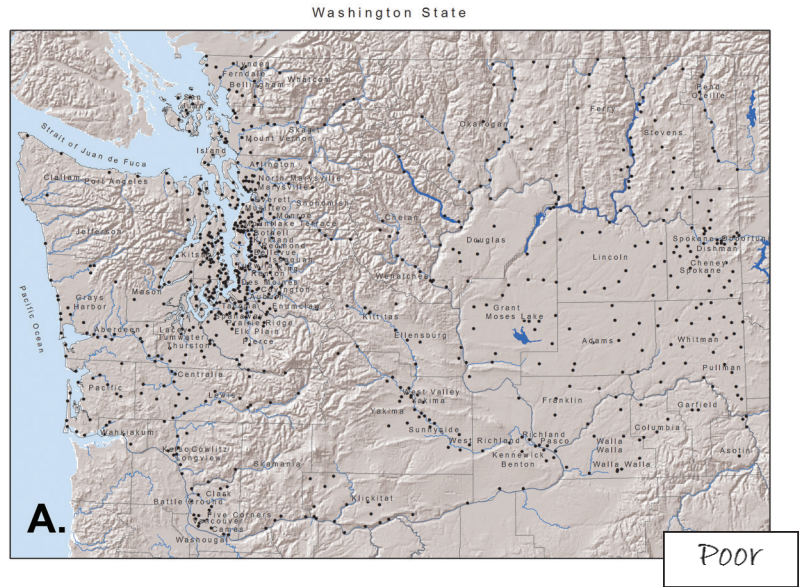


Figure 4. When the symbols and labels are on the same visual plane (A), it is difficult for the map reader to distinguish among them and determine which are more important. For a general reference map (B), using different sizes for the text and symbols (e.g., city points and labels), different line styles (e.g., administrative boundaries), and different line widths (e.g., rivers) are some of the ways you can add hierarchy to the map. When mapping thematic data (C), the base information (e.g., county boundaries and county seats) should be kept to a minimum so that the theme (e.g., soils) is at the highest visual level in the hierarchy.

Figure 5. Positioning heavier elements together can make the page look top-heavy (A) or bottom heavy (B). Centering the map slightly above center (C) ensures that it is in the most prominent position on the page. The position of elements can also cause the eye to move in a desired direction. In D, the title is the first thing read, followed by the locator map, then the map of Africa, and finally the legend.

5

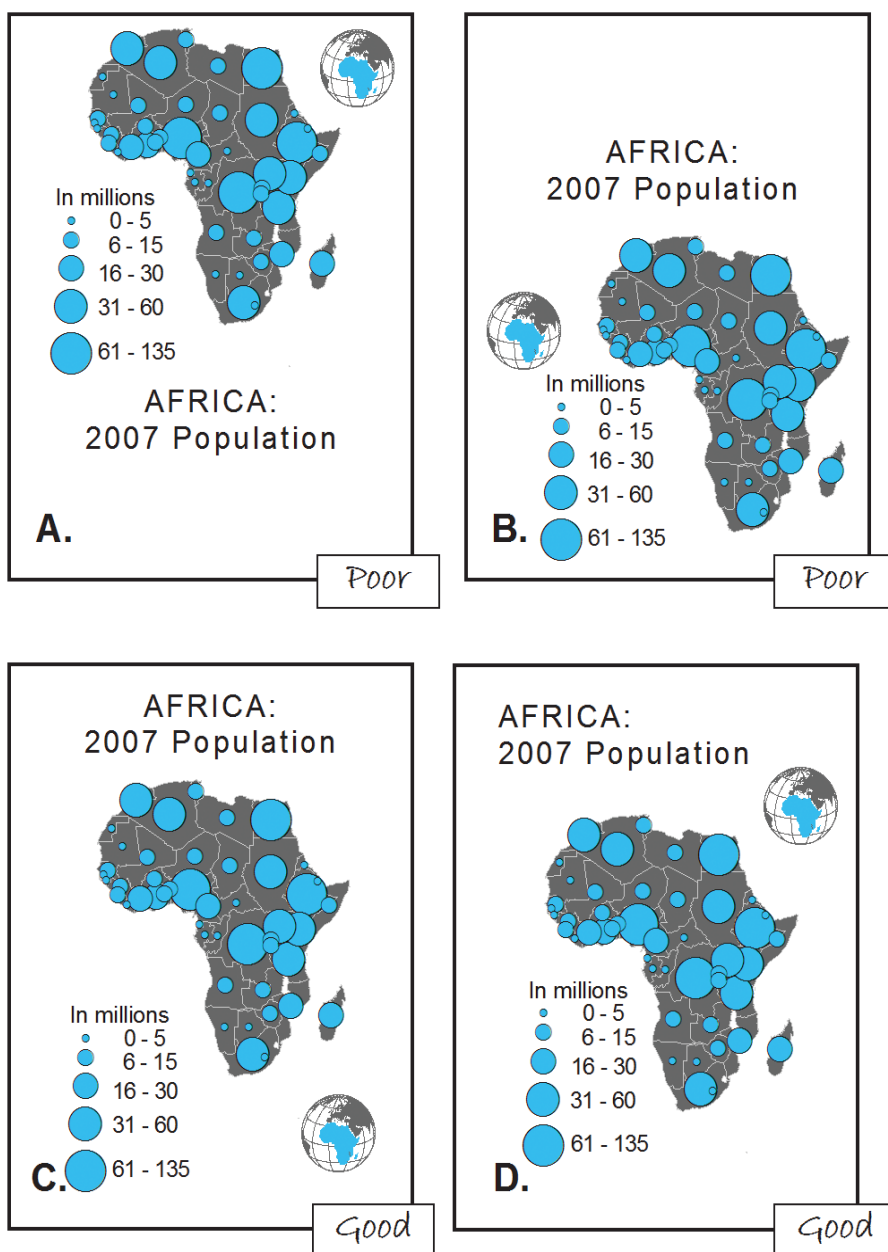
Balance

Balance involves the organization of the map and other elements on the page. A well-balanced map page results in an impression of equilibrium and harmony. You can also use balance in different ways to promote edginess or tension or create an impression that is more organic. Balance results from two primary factors: visual weight and visual direction. If you imagine that the center of your map page is balancing on a fulcrum, the factors that will tip the map in a particular direction include the relative location, shape, size, and subject matter of the elements on the page.

Together these five design principles have a significant impact on your map. How they are used will either draw the attention of map readers or potentially repel them. Giving careful thought to the design of your maps using these principles will help you to assure that your maps are ones people will want to look at!

Resources

These cartography textbooks provide more in-depth discussions of the design principles described in this article and how they are applied in cartography.



Dent, Borden D., Jeffrey S. Torguson, and Thomas H. Hodler. 2009. *Cartography: Thematic Map Design*, Sixth Edition, 207–222. Boston, MA: WCB-McGraw Hill.

Robinson, Arthur H., Joel L. Morrison, Phillip C. Muehrcke, A. Jon Kimerling, and Stephen C. Guptill. 1995. *Elements of Cartography*, Fifth Edition, 324–330. New York City, NY: John Wiley & Sons, Inc.

Slocum, Terry, Robert B. McMaster, Fritz C. Kessler, and Hugh H. Howard. 2009. *Thematic Cartography and Geographic Visualization*, Third Edition, 212–221. Upper Saddle River, NJ: Pearson Prentice Hall.

About the Author

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



↑ At larger scales, the *Light Gray Canvas* map reveals more features, including roads, parks, and labels on water bodies, and feature labels appear along with building footprints (in some cities).

The new *Light Gray Canvas* map, available in ArcGIS Online in the basemap gallery or in ArcGIS Explorer Online, provides a neutral, uncluttered background that is extremely useful for displaying economic, demographic, behavioral, health, and other data. Limiting the amount of information displayed by the basemap ensures it is not competing with the map's operational layers for visual attention.

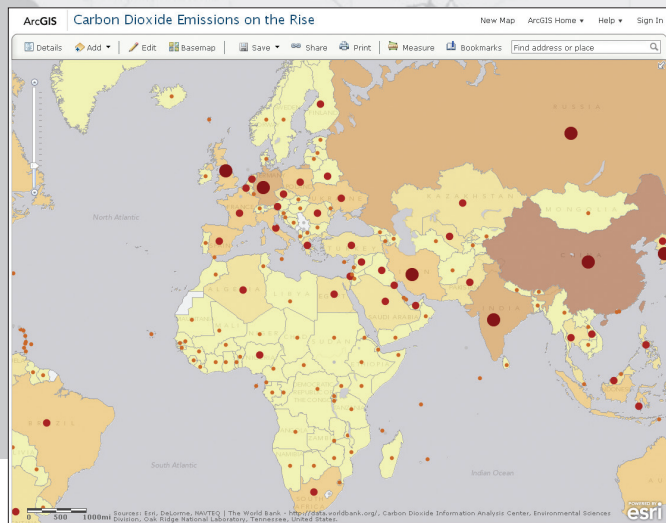
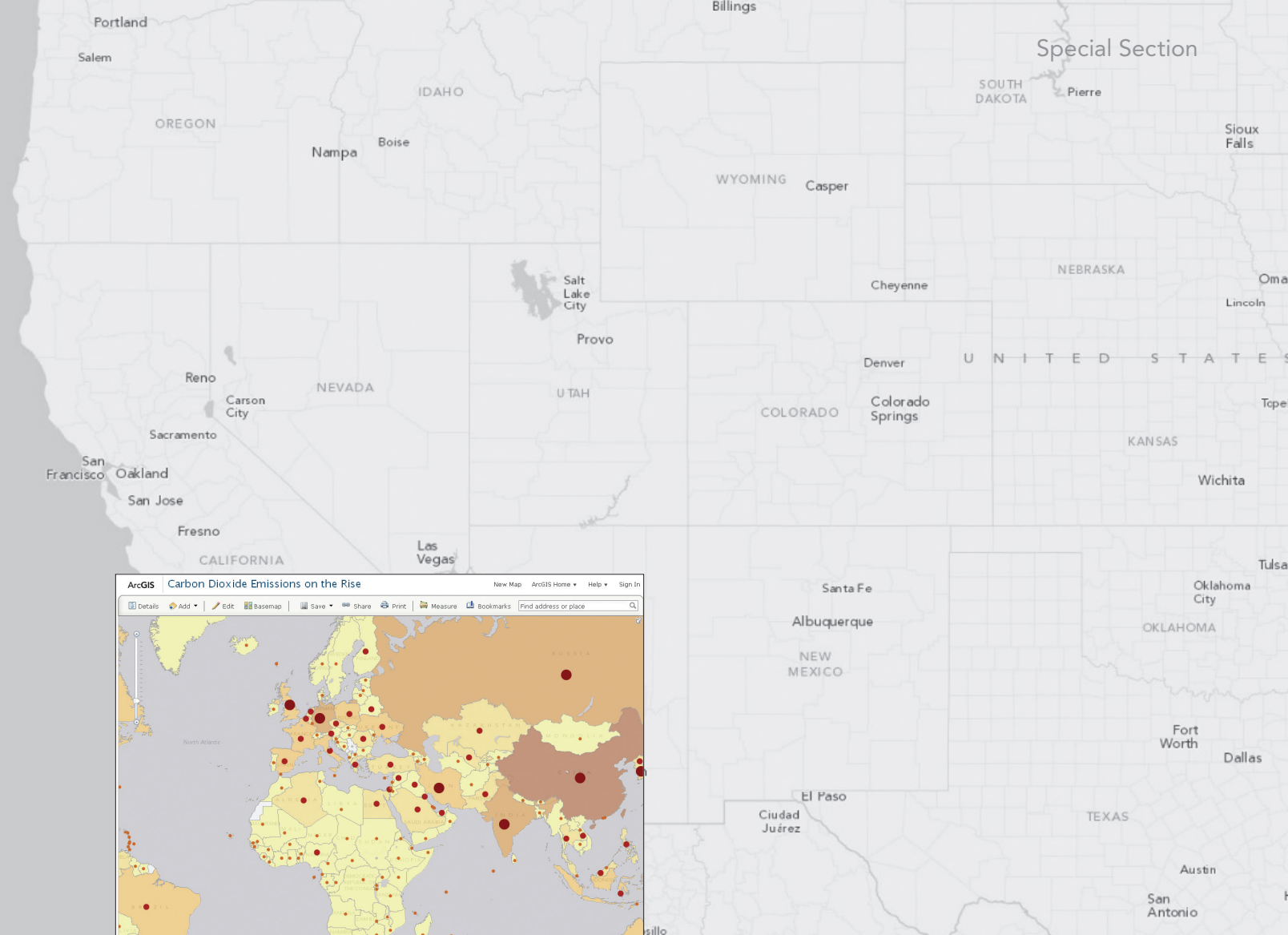
"People process visual imagery so efficiently, and this basemap helps ensure your map's story is in plain view," said Jim Herries, a cartographic product engineer at the Esri Mapping Center. "Your map's theme becomes something that resonates with people who know the area but also will be informative to people who don't know the area."

Basemaps are moving toward the minimalist style of information graphics popularized in magazines, newspapers, and other media. Online mapping demands that basemaps provide a backdrop for user data. These operational layers deliver

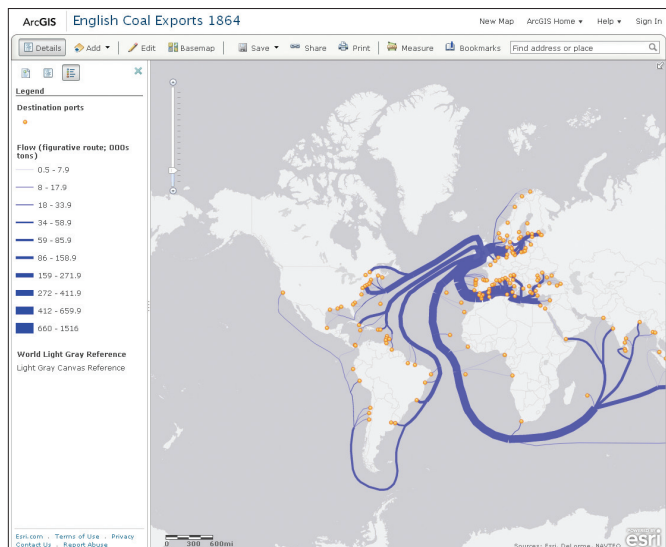
the map's message. Basemaps should support that communication by not distracting the map reader. This basemap, which uses a soft, light gray color for land and darker gray for water, was specifically designed to emphasize thematic data, symbolized using bright colors, so the map's story is easily discerned.

At small scales, the *Light Gray Canvas* basemap contains the bare minimum needed to provide a contextual backdrop. Streets, buildings, labels, topographic features, and imagery that can vie for readers' attention are limited or omitted. At larger scales, it reveals major roads and big parks and then labels on the roads and parks. At 1:9,000, the largest scale, additional roads, water bodies, parks, and feature labels appear along with building footprints (in some cities).

The *Light Gray Canvas* map supports the basic design principles of figure-ground organization and visual contrast. Its monochromatic color palette promotes visual contrast, and



↑ This map, created by Allen Carroll of Esri displays the dramatic rise of CO₂ emissions around the world between 1960 and 2007. The World Bank data used stands out dramatically on the *Light Gray Canvas* map.



↑ At smaller scales, the basemap provide a contextual backdrop but limits features that compete for readers' attention.

the map creator has more color options without fear of clashing with colors in the basemap.

"The basic idea behind canvas maps is that less is more. You have something clean to work from," said Mamata Akella, cartographic product engineer at the Esri Mapping Center and design lead on the *Light Gray Canvas* map project.

For more information on cartographic design principles, see "Make Maps People Want to Look At: Five primary design principles for cartography" in this issue. Also read the blog posts "Esri Canvas Maps Part I" and "Part II" on the Esri Mapping Center website.

← This web map, *English Coal Exports 1864*, traces coal exports from England to ports around the world. Esri cartographer Ken Fields used route widths to represent approximate coal tonnages, which stand out against the subtle gray of the basemap.

The Importance of Cartographic Design

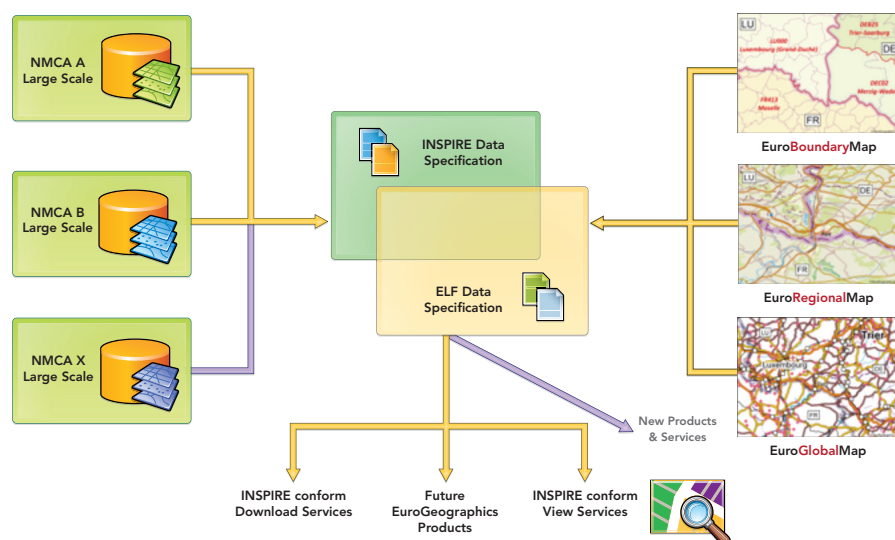
In the SDI environment

By Karen Richardson, Esri Writer

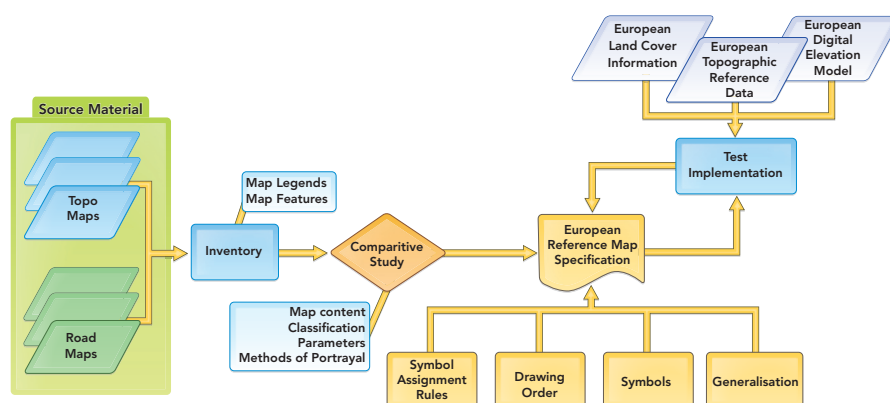


Dr. Anja Hopfstock

Esri writer Karen Richardson sat down with Dr. Anja Hopfstock to ask a few questions about cartographic design in the spatial data infrastructure (SDI) environment. Hopfstock is an executive officer with the Federal Agency for Cartography and Geodesy, known as BKG, for the Federal Republic of Germany and technical manager for EuroRegionalMap, a Pan-European reference dataset from EuroGeographics located in Brussels, Belgium. Her doctoral thesis, "A User-Oriented Map Design in the SDI Environment Using the Example of a European Reference Map at Medium Scale," deals with this topic.



↑ ESDIN data specifications



↑ The cartographic reverse-engineering approach aiming at the optimal cartographic design for a European reference map.

Richardson: You have focused quite a bit of your doctoral work on the advantages and disadvantages of a common cartographic representation of European topographic data that can be shared among countries. Tell me why you feel this is such an important topic to address.

Hopfstock: Similar to the national level, good governance across Europe requires relevant, harmonized, and quality geographic information for the formulation, implementation, monitoring, and evaluation of European Community policies. Today, Pan-European datasets, such as the EuroGeographics products EuroBoundaryMap, EuroRegionalMap, and EuroGlobalMap, provide a continuous, seamless, and object-based description of the European landscape. Built from national contributions, they fulfill the INSPIRE [*Infrastructure for Spatial Information in Europe*] principles and can be regarded as elements of the European SDI [*spatial data infrastructure*] data collection. However, the international cooperation currently focuses solely on the harmonization of feature and attribute concepts.

Based on the understanding that geographic information is the result of human geospatial information processing, it is argued that cartography is essential in the SDI context to achieve the overall objectives of SDI. My thesis aimed at exploring the concept of user-oriented map design in relation to SDI and elaborating a methodology for creating effective cartographic representations for SDI-relevant user types.

Richardson: How can SDI be used successfully by the many different types of users you are serving?

Hopfstock: In general, two main groups of SDI end users can be distinguished, considering their abilities and capabilities to handle geospatial data: expert users [*e.g., spatial planners*] and nonexpert users [*e.g., decision makers and the general public*].

The visualization of geospatial data has a key function for data discovery and evaluation, because the data becomes easier to understand and interpret if presented in the appropriate context. Currently, SDI geoportals provide a marketplace for users to access SDI data collections. Discovery and view, download, and transformation services assist users to find, locate, and transform the data for their task-specific aims. So far, the presentation of geospatial data has only been considered at a basic level. However, the user's acceptance in terms of usability depends on a useful graphical presentation of the geospatial data.

A comprehensive access service to the underlying geospatial data should not be limited to simple discovery, view, and download functionalities but should include graphical presentations that consider the user's capabilities and abilities to handle geospatial data. This means that the visual component of the data is used in the data supply chain so that the graphic presentation enables a communicative, map-based acquisition of geographic information that stimulates the visual reasoning of users and, ultimately, supports decision making.

Richardson: Tell me about your experiences working with the INSPIRE group and helping national mapping organizations comply with INSPIRE.

Hopfstock: As a EuroGeographics expert, I was a member of the Thematic Working Group, setting up the data specification for the INSPIRE Annex I theme Hydrography.

For the last two and a half years, I have led the working group, elaborating how to migrate the existing EuroGeographics [www.eurogeographics.org] products into the INSPIRE framework. The European Spatial Data Infrastructure with a Best Practice Network (ESDIN) [www.esdin.eu] project, cofunded by the European Commission, had an ambitious mission to provide best practices in creating harmonized data across Europe to help countries meet their INSPIRE obligations. ESDIN has gone beyond this to lay the ➔

foundations for the European Location Framework of data and services. It has created an integrated data model and successfully transformed the existing EuroGeographics products into a dataset for Pan-European harmonization. ESDIN has proposed extensions to the INSPIRE specifications which enable the interoperability of topographic, administrative, and cadastral reference data to comply with the INSPIRE Directive and other user requirements at the European level. Conformance to these specifications will enable national mapping organizations to fulfill INSPIRE requirements.

Richardson: How do you see the INSPIRE Directive helping ensure that proper symbology and understanding of geographic data permeates throughout Europe?

Hopfstock: Member states of the European Union are obliged to make geospatial datasets available in conformance with the INSPIRE data specification through services that allow visualization, overlay, or spatial and temporal analysis of spatial information from different sources.

The INSPIRE Implementing Rules for View Services recommend that “datasets belonging to the same theme shall be rendered following the same portrayal rules, in a default rendering style. This style shall be defined for each layer across Europe.” The current version of INSPIRE Data Specifications for Annex I themes (v3.0) defines only a basic default style per spatial object type despite the recommendations on how to establish the portrayal rules. These are given in section A.11, Portrayal of the INSPIRE methodology for the development of data specifications:

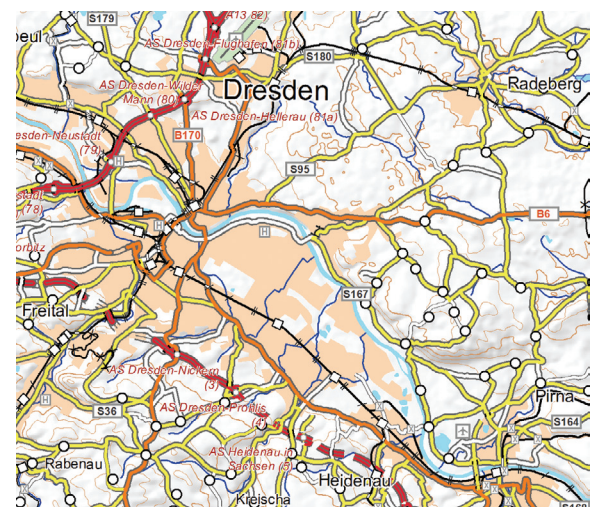
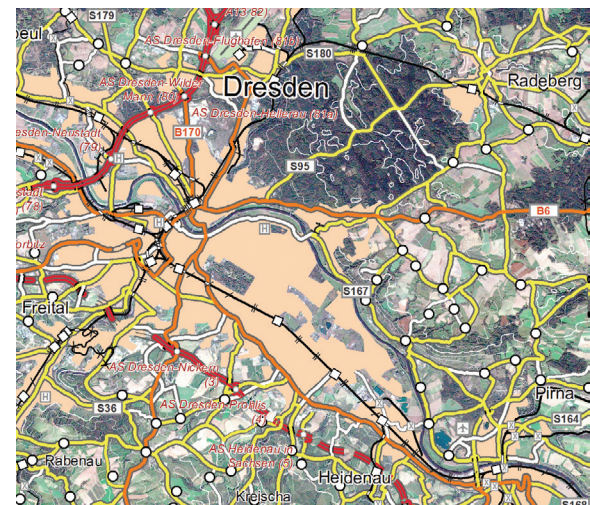
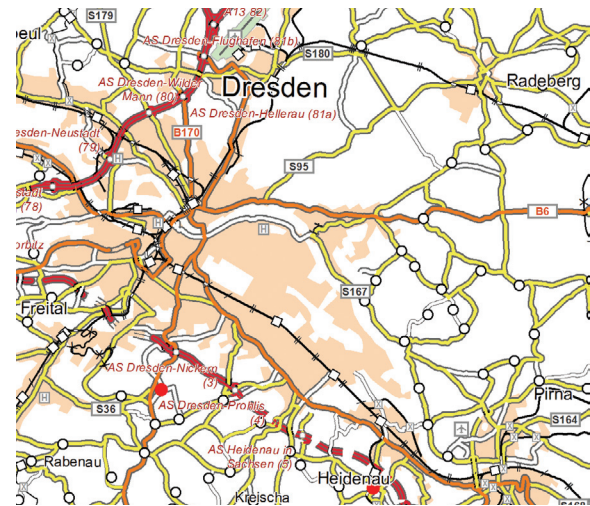
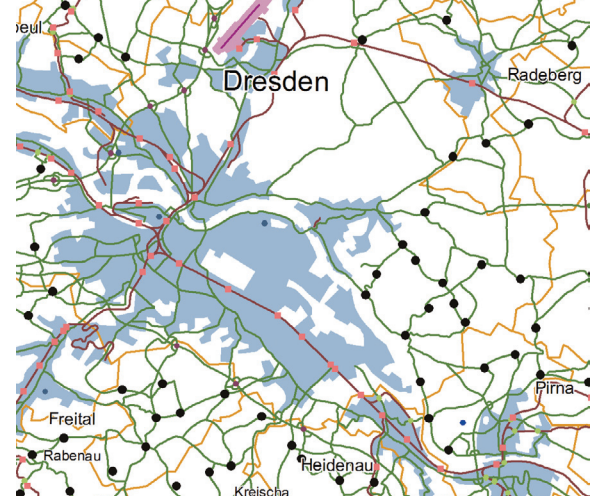
- The symbology should be chosen in order to have cartographically correct data representation.
- Portrayal rules in INSPIRE should be built upon existing cartographic experience and upon common traditions, if they exist.
- If, for a given theme, harmonized rules about portrayal already exist, they should be adopted by INSPIRE data specifications.
- With respect to the current and future availability and usability of geospatial data, there are certain doubts that spatial datasets provided for INSPIRE from different member states can be used directly for the production of a reference map at a certain scale. A thorough analysis of metadata and data quality will be required to evaluate the data fitness for use.

Richardson: Tell me how you developed a map design specification to meet this challenge.

Hopfstock: The development of the map design specification for a European reference map at a scale of 1:250,000 was approached by evaluating and comparing existing map products to achieve an optimal cartographic design. Using a cartographic reverse-engineering approach, an inventory and comparative study of 24 European topographic and commercial road maps were carried out.

The inventory gave a general overview about the map content and the bandwidth of cartographic representations used in Europe today. The comparative study then offered an insight into the basic principles and elements of their map composition. For the test implementation, three different source datasets were acquired from European SDI stakeholders: EuroRegionalMap, EuroDEM, and Image2000. The gap analysis of the EuroRegionalMap dataset against the proposed map content concept revealed a high overlap. The preparation of the other two source datasets required extensive preparation and preprocessing to transform the data into cartographic representations according to their intended usage.

→ Different design variants for the European reference map at medium scale



ArcGIS provided the underlying technical environment for the transformation of the source data into cartographic representations and map compilation. I did this because the EuroRegionalMap and EuroDEM datasets were available in Esri data formats. Also, ArcGIS provided all the necessary functions to handle and transform the data.

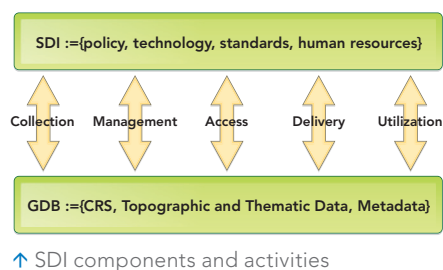
Richardson: Based on your study, do you feel it is achievable to expect so many different countries to work together on a harmonized European symbol catalog?

Hopfstock: In general, yes, it is achievable, but there are still some issues to solve regarding the data harmonization and technological aspects. Map design in the SDI context is a challenging task. The wide range of map use contexts requires a great flexibility of design variants depending on the dimension of human-map interaction. The map design needs to be user driven for efficiency. Besides their function as a graphic interface, maps facilitate a common understanding of the depicted geographic features and phenomena when sharing geographic information between SDI users.

The case study proved that it is feasible to produce a reference map from multiple sources. However, comparable and consistent map content requires semantically and geometrically harmonized reference data. Providing geospatial data just based on national classifications might not be sufficient for work at the European level. If a European SDI aims at facilitating a common understanding of the European landscape, it is essential to introduce European classification schemes for feature and attribute concepts.

Another field for research concerns the development and introduction of a map design knowledge base and a registry for design solutions within an SDI.

For more information on Esri solutions for INSPIRE, visit esri.com/inspire.



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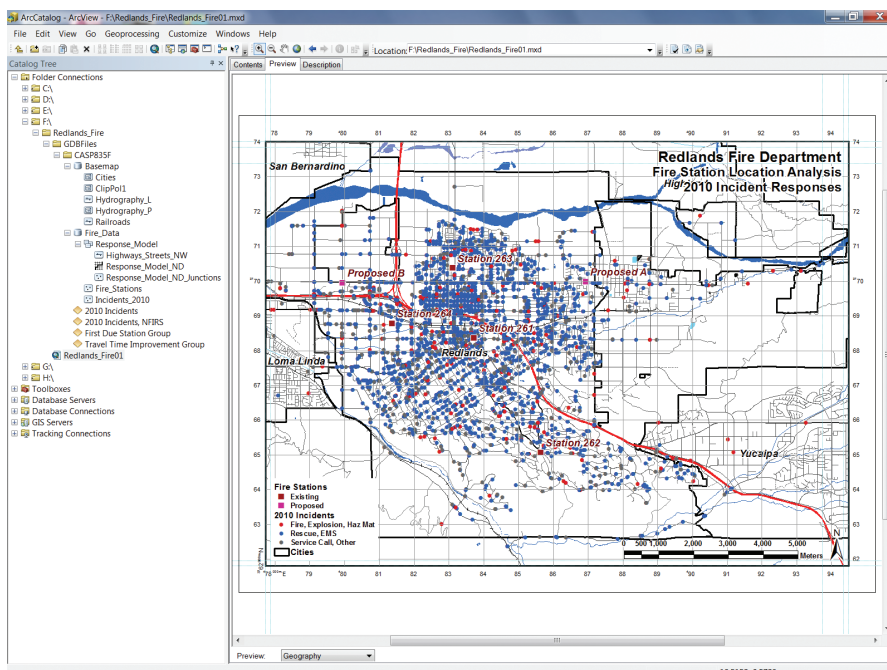
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Emergency Services Modeling

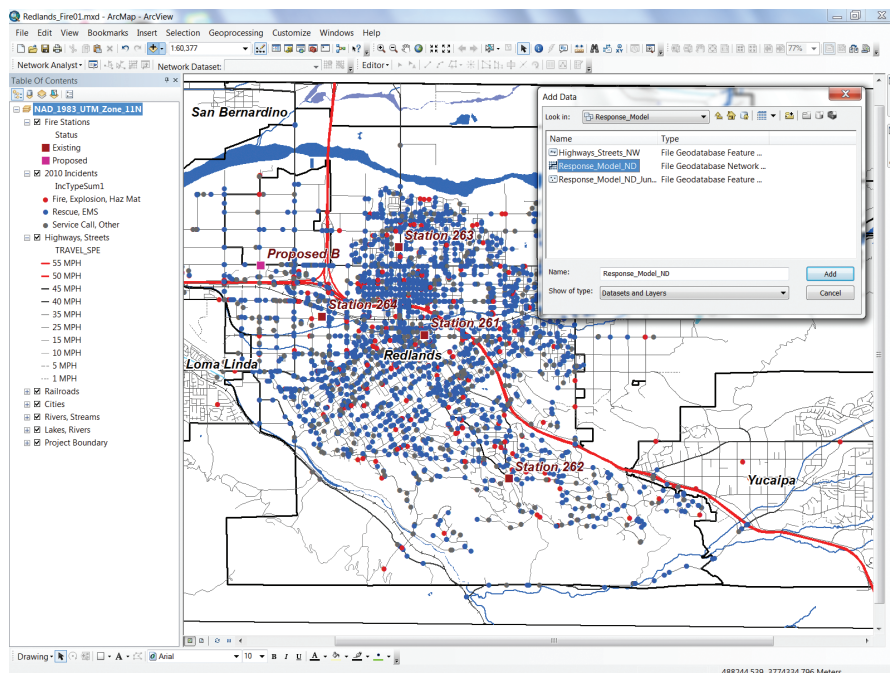
Analyzing changes
in response using
Network Analyst

By Mike Price, Entrada/San Juan, Inc.



↑ To begin the exercise, open Redlands_Fire01.mxd in ArcMap.

→ In the Fire Data geodatabase, expand the Response_Model feature dataset and add only the prebuilt Response_Model_ND network dataset.



This tutorial shows how to use the Closest Facility (CF) solver in ArcGIS Network Analyst to model travel from a single facility to the closest incidents. The model will be modified to reflect proposed changes in station locations.

In the current economic climate, public safety administrators and planners are often faced with complex decisions regarding moving or closing essential facilities. Fire station closure, consolidation, or relocation studies occur throughout the United States. Public safety officials try to make best use of existing resources and provide comparable or improved levels of service. To analyze existing and future conditions, comprehensive data is required to represent current conditions, reflect past performance, and plan for the future.

In Esri's home town of Redlands, California, the Redlands Fire Department is facing considerable commercial and residential growth in the northern part of the city. Redlands is currently protected by four fire stations in Redlands and a station in Loma Linda, located to the west.

In 2010, Redlands firefighters and emergency medical technicians (EMTs) responded to more than 8,000 incidents in and

around the city. By mapping the likelihood of where, when, and how incidents have occurred, historic incidents often provide the best estimate of community risk. Historic risk is used to demonstrate an adequate Standard of Coverage; identify underserved, problem, or frequent call locations; and project future demand for services.

The CF solver in ArcGIS Network Analyst is an excellent tool for modeling optimal travel from fixed facilities to historic incidents. By adding or substituting new or relocated stations in CF templates, it is easy to perform multiple analyses.

Getting Started

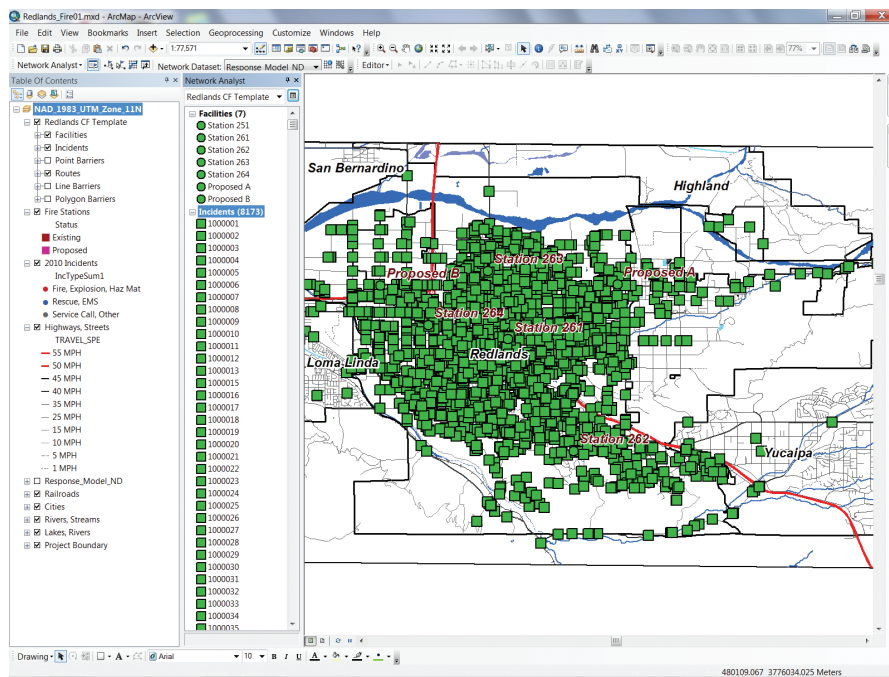
To begin this exercise, go to the *ArcUser* website (esri.com/arcuser) and download the zipped training dataset. Unzip it in a project area on your computer. Open ArcCatalog and navigate to the \Redlands_Fire folder and explore its contents. This project contains two file geodatabases and several small utility files. The training data is projected in California State Plane North American Datum 1983 (NAD83) Zone 5 US Feet. To support a US National Grid spatial reference, the data frame projection is set to universal transverse Mercator (UTM) NAD83 Zone 11 Meters.

Inspect the geodatabase feature classes and layer files in the geodatabases. In the Fire Data geodatabase, open the Response_Model feature dataset and inspect Response_Model_ND. To quickly start the analysis portion of this tutorial, a very functional network dataset was prebuilt.

Notice that two layer files, First Due Station Group and Travel Time Improvement Group, cannot be viewed. **Do not load them until instructed.** These layer templates will be added to the map later to display results.

Modeling Response with Network Analyst Closest Facility Solver

The CF solver is traditionally used to locate one or more destination facilities within reasonable travel time of a specific incident. Turned upside down, the CF solver maps travel from one or more fixed facilities to multiple incidents. In this exercise, the CF solver will be used to model travel away from single facilities toward the closest incidents, but facilities will be modified to reflect station changes.



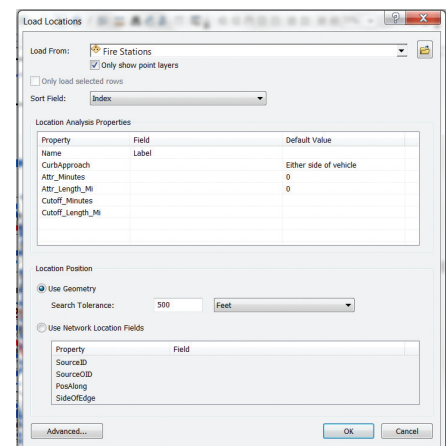
← To load incidents, right-click Incidents and click Load From 2010 Incidents. Set the Sort Field to OBJECT_ID and select Inc_Number for Name. Click OK and wait patiently as all 8,173 incidents load.

Using actual 2010 incidents and a section clipped from the street network provided by the regional dispatch center, this tutorial will use the CF solver to compare optimal existing coverage to coverage provided by adding one or two proposed stations in northern areas of Redlands. For another innovative use of the CF solver, see another article in *ArcUser*, “Run Orders: Modeling and mapping public safety arrival orders,” in the Fall 2009 issue.

1. To begin the exercise, close ArcCatalog and start ArcMap. Open Redlands_Fire01.mxd and inspect its contents. If you completed the exercise in the article “Analyzing Frequent Response: Using a US National Grid spatial index” in the Summer 2011 issue of *ArcUser*, this map will look very familiar.
2. Open and inspect the 2010 Incidents attribute table. Study the rightmost fields that are filled with zeros. These fields will be used to record response statistics. The table includes fields for station numbers and travel times to accommodate a base case and three scenarios. Three fields on the far right will soon contain differential travel times between the base case and each scenario. This map includes a new time-based street dataset so its network dataset must now be loaded.
3. Switch from layout to data view. Click Add Data and navigate to \Fire_Data\. Expand the Response_Model feature dataset and add only the Response_Model_ND file geodatabase network dataset. **Do not add other participating feature classes.**
4. In the table of contents (TOC), move Response_Model_ND below Highways, Streets and make it nonvisible. If necessary, enable the Network Analyst extension and load its toolbar.
5. Save the project.

Creating a Closest Facilities Template

1. In the Network Analyst drop-down, select and load New Closest Facility.
2. Once loaded, open its properties and click the Analysis Settings tab. Set Travel From to Facility to Incident and Facilities to Find to 1. Under the Accumulation tab, check both Length_Mi and Minutes. Click the General tab and name the solver Redlands CF Template.
3. Before cloning this template, all facilities and incidents will be added using the Network Analyst window. From the Network Analyst toolbar, click the Network Analyst Window button and dock the window to the right of the TOC.
4. Right-click Facilities and select Load Locations. Set Load From to Fire Stations, Sort Field to Index, Name to Label, and Search Tolerance to 500 Feet. Click OK and check your work.

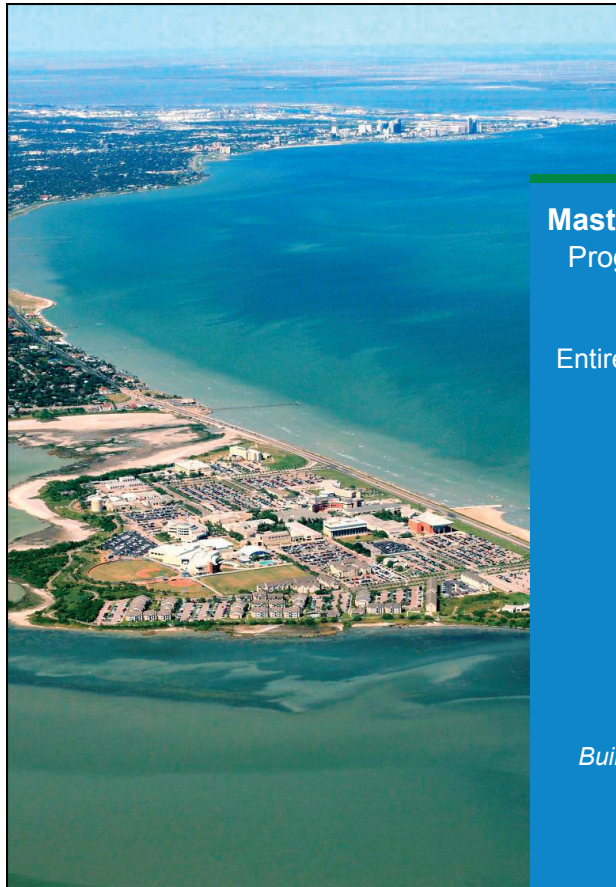


↑ Right-click Facilities and select Load Locations. Set Load From to Fire Stations, Sort Field to Index, Name to Label, and Search Tolerance to 500 Feet and click OK.

5. To load incidents, right-click Incidents and click Load From 2010 Incidents. Set the Sort Field to OBJECT_ID and select Inc_Number for Name. Click OK and wait patiently as all 8,173 incidents load.
6. Choose the bookmark Redlands Fire 1:60,000 and verify your work.
7. In the TOC, right-click the Redlands CF Template and select Copy. Right-click the data frame name and select Paste Layer(s). Repeat this procedure until you have four copies of the original Redlands CF Template at or near the top of the TOC.
8. Select all five Redlands CF Template layers and right-click any one of them. Choose Select Group, rename the Group layer Redlands CF Group, make all group elements nonvisible, and move the group to the bottom of the TOC.

Building and Solving Multiple Scenarios

1. Rename the first four CF templates as Redlands CF Base Case, Redlands CF Prop A, Redlands CF Prop B, Redlands CF Prop A, B. Save the project.
2. These templates still have all seven stations listed as Facilities, so the next step is to remove specific stations to customize each scenario. In the Network Analyst window, select Redlands CF Base Case > Facilities, hold the Control key, and select Proposed A and Proposed B. Right-click and select Delete.
3. Next, select Redlands CF Proposed A and delete Proposed B.
4. Finally, select Redlands CF Proposed B and delete the Proposed A facility. Save again. Now you have a five-station base case, two six-station scenarios, and one seven-station scenario for a total of four scenarios. You also have a template that can be cloned for additional analyses.
5. Solve all four scenarios by right-clicking each scenario in the TOC and choosing Solve. Do not solve the template. These scenarios are rather large, so be patient.
6. After successfully solving all four scenarios, inspect the results. Open any of the Routes tables and look at the fields. The FacilityID name is a concatenation of each incident's closest station and incident number. IncidentID will be used to join each route back to its incident point. Total_Minutes provides the modeled travel time from the closest facility to each incident. To expand mapping area, close the Network Analyst window and zoom to the bookmark Redlands Fire 1:60,000. If all looks well, save again. ➔



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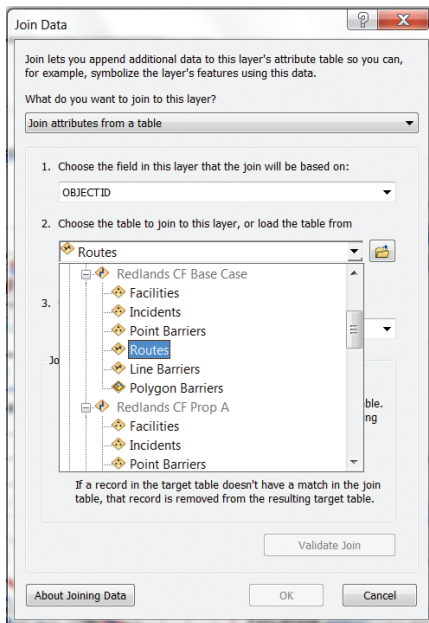
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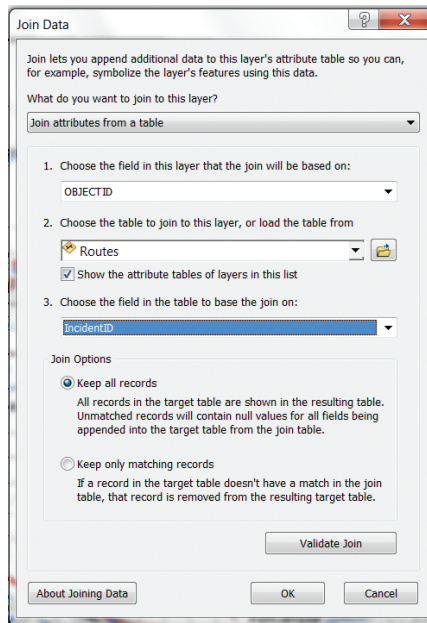
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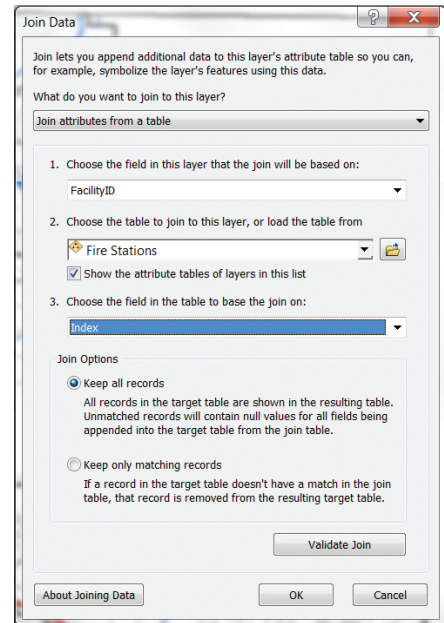
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↑ In the TOC, right-click 2010 Incidents and choose Joins and Relates > Join. For Item 1, select OBJECTID, and for Item 2, specify Redlands CF Base Case > Routes. *Be sure to specify Base Case!*



↑ For Item 3, select IncidentID. Click OK to join and bypass indexing. Since you are joining to an active network dataset, indexing does not work.



↑ For the second join, set Item 1 to FacilityID, Item 2 to Fire Stations, and Item 3 to Index.

Enhancing Closest Facility Data for the Base Case

Now comes the tricky part. If you tackled the Fall 2009 exercise in “Run Orders: Modeling and mapping public safety arrival orders,” you might remember performing a series of tabular joins coupled to field calculations. You will perform similar joins and calculations with this data, but this time, you will create two consecutive joins. Follow along carefully because this workflow is very specific.

Performing Two Joins

1. In the TOC, right-click 2010 Incidents and choose Joins and Relates > Joins. For Item 1, select OBJECTID.
2. For Item 2, specify Redlands CF Base Case > Routes. **Be sure to specify Base Case.**
3. For Item 3, select IncidentID. Click Validate and, when validation is complete, click OK to join. Don't index (because you are joining to an active Network Dataset, indexing does not work).
4. To build the second join, right-click again on 2010 Incidents and choose Joins and Relates > Joins.
5. For Item 1, select FacilityID.
6. For Item 2, select Fire Stations.
7. For Item 3, select Index. Validate and click OK again. This time, indexing will work, so allow indexing.
8. When the second join finishes, open the 2010 Incidents table and verify that Base Case Routes and appropriate station data have been successfully joined to all incidents. If the join was not successful, remove all joins and try again.

Calculating Travel Times

1. To calculate the closest base case stations and travel times for all incidents, open the 2010 Incidents attribute table and locate the Station_Base and Time_Base fields. Right-click Station_Base, select Field Calculator, and click Load. Navigate to \Redlands_Fire, open Station_No.cal, and click OK. Watch as ArcGIS assigns the closest Base Case stations to all incidents.

2. Next, right-click Time_Base, select Field Calculator, load Total_Minutes.cal, and click OK to post Base Case travel times.
3. Finally, right-click 2010 Incidents in the TOC and select Joins and Relates > Remove Join(s) > Remove All Joins. **This is an important step. Do not skip it.**

Joining and Calculating the Scenarios

Now that the closest station and travel time have been calculated for Base Case, the same procedure will be used for each scenario. The only difference will be that in the first join, Item 2 will change (e.g., Redlands CF Prop A > Routes, Redlands CF Prop B > Routes, and Redlands CF Prop C > Routes). *Although the workflow becomes a bit tedious now, it is critical to proceed carefully.* Make the two joins for each layer, successively calculate the Station_A, Time_A, Station_B, Time_B, and Station_AB and Time_AB fields, making sure to remove all joins after calculating the stations and time for each scenario. Carefully check the calculations and save the project. If one or more joins/calculations did not work, clear and rebuild the necessary join and recalculate.

Calculating Travel Improvements

With Base Case and scenario times for all analyses, you can use the Field Calculator to calculate the Change_A, Change_B, and Change_AB fields that are currently filled with zeros in the 2010 Incidents attribute table.

1. In the 2010 Incidents table, right-click Change_A and choose Field Calculator. To calculate the time change between the Base Case and all incidents modified by response from Proposed A, select or type the expression

$[Time_A] - [Time_Base]$

in the calculation window and click OK.

If the Proposed A station, located in northeastern Redlands, can access a 2010 incident before the closest Base Case station, this field represents the time differential as a negative number. If Proposed A is not the closest station, the number will remain zero. If you were modeling closed or relocated stations rather than proposed stations, this number might be positive, representing the additional time required to access an incident, compared to an earlier location.

2. Calculate the time differential for Scenario B and Base Case in field Change_B, modifying the expression:

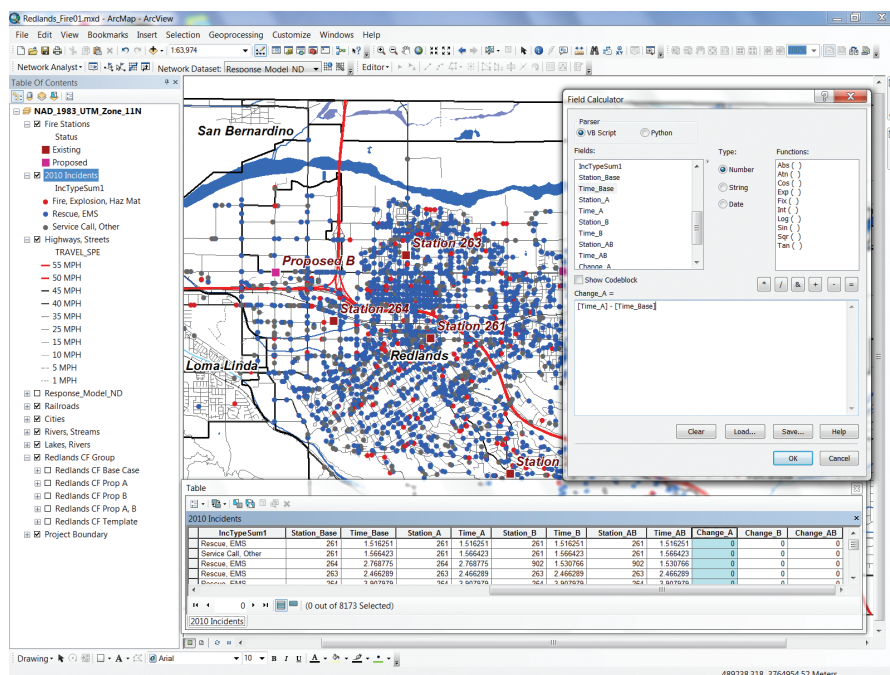
$[Time_B] - [Time_Base]$

Negative values in this column represent improved responses from the Proposed B location in northwest Redlands.

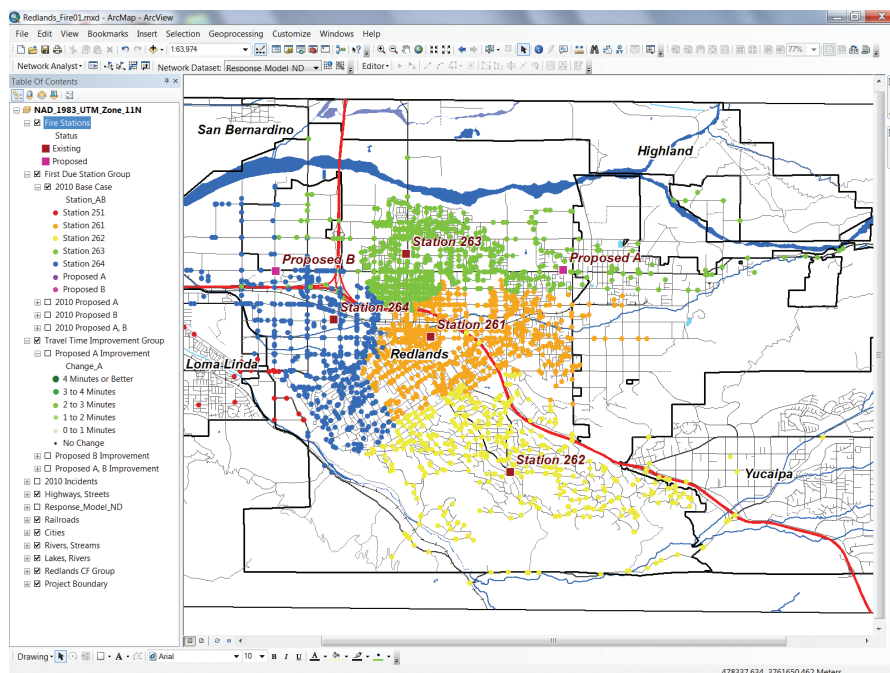
3. Finally, calculate the combined effect of Proposed A and Proposed B by right-clicking the Change_AB field and modifying the expression to read:

$[Time_AB] - [Time_Base]$

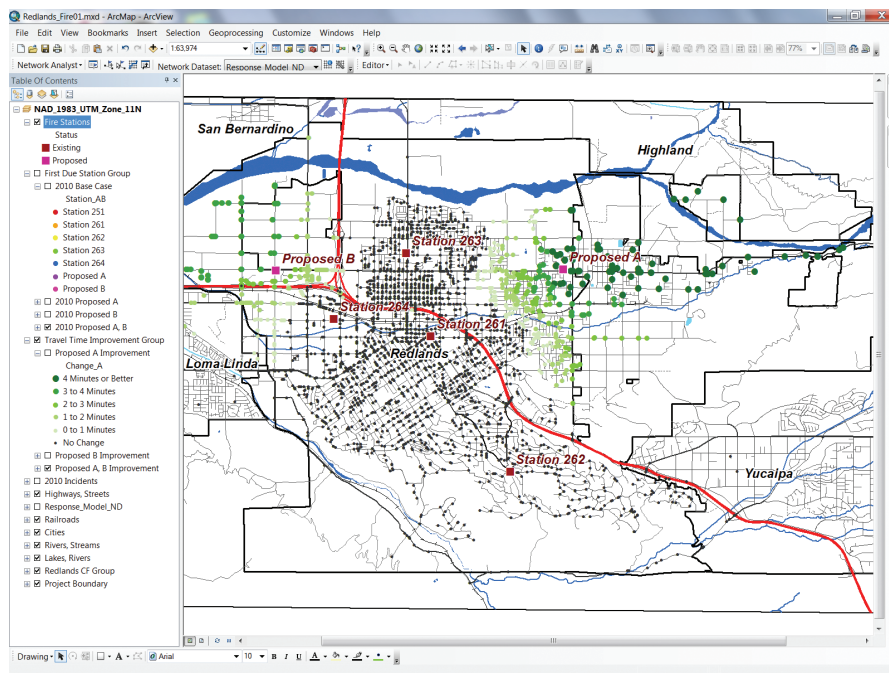
4. Sort and review the differential times to see that some incidents improve, while many remain unchanged. Since you have not removed any stations, no incidents display positive values that represent a net travel time increase. Save the map. ➔



↑ To calculate the time change between Base Case and all incidents modified by response from Proposed A, select or type $[Time_A] - [Time_Base]$ in the calculation window and click OK.



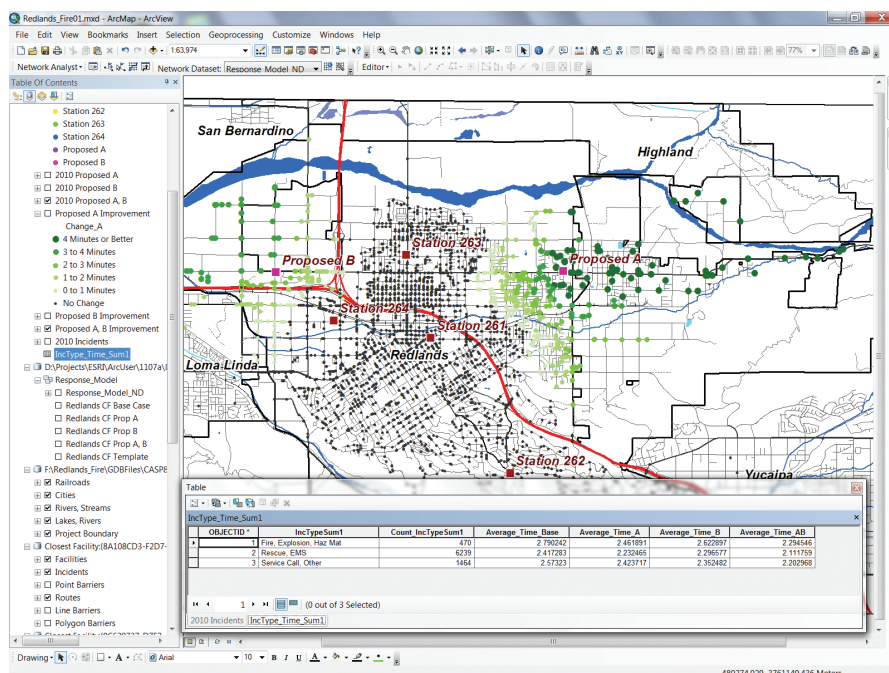
↑ In the First Due Station Group, turn on 2010 Base Case and inspect the incident distribution.



Mapping

Look at the results on a map. There are many ways that you could map and chart these time-based analyses. A rather basic map would plot closest stations to all incidents for each scenario. Because you have assigned a station number to all incidents, you can readily map this relationship. Station_ field is an integer. Proposed A is designated as 901 and Proposed B is designated as 902. A second map series can show the time change between the Base Case and the three scenarios. You can use a graduated size and color scheme to show how much time is gained or lost as stations open, close, or move. The fields holding differential calculation times contain necessary double precision values.

1. Now you can load the layer files for First Due Station Group and Travel Time Improvement Group. Click the Add Data button and navigate to \Redlands_Fire\GDBFiles\CASP835F to add these groups and quickly create several map series. Position the two groups in the TOC just below Fire Stations.
2. In First Due Station Group, turn on 2010 Base Case and inspect the incident distribution. Notice how incidents in differing colors cluster around closest stations.
3. Individually turn on 2010 Proposed A, 2010 Proposed B, and 2010 Proposed A, B. Individually open the Travel Time Improvement Group series to show the time decreases for Proposed A, Proposed B, and Proposed A plus Proposed B. Green is good; this is the kind of information that the fire chief and commissioners like to see.

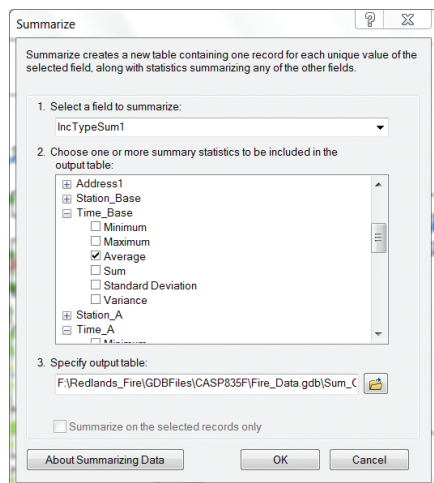


↑ Inspect the analysis results. Notice the average times for fire responses, EMS calls, and service calls.

Summarizing

Finally, summarize the Base Case and Scenario times for different incident types. Open the 2010 Incidents table, right-click the IncTypeSum1 field, and choose Summarize. Under Item 2, expand Time_Base, Time_A, Time_B, and Time_AB and check the Average box under each. Under Item 3, save the summary table as IncType_Time_Sum1 in Fire_Data.gdb. Add the resultant summary table to the map.

Inspect the results and notice the average times for fire responses, emergency medical service (EMS) calls, and service calls. The proportions and time trends in this table are not unusual. More than 75 percent of all 2010 responses were EMS or rescue calls and average times for these calls are typically the shortest. Nearly 18 percent of all calls are classified as service calls or other calls. Fire and related calls comprise less than 6 percent of all responses. Check out the average times for your scenarios. The average modeled travel time for Proposed A plus B is closing in on two minutes.



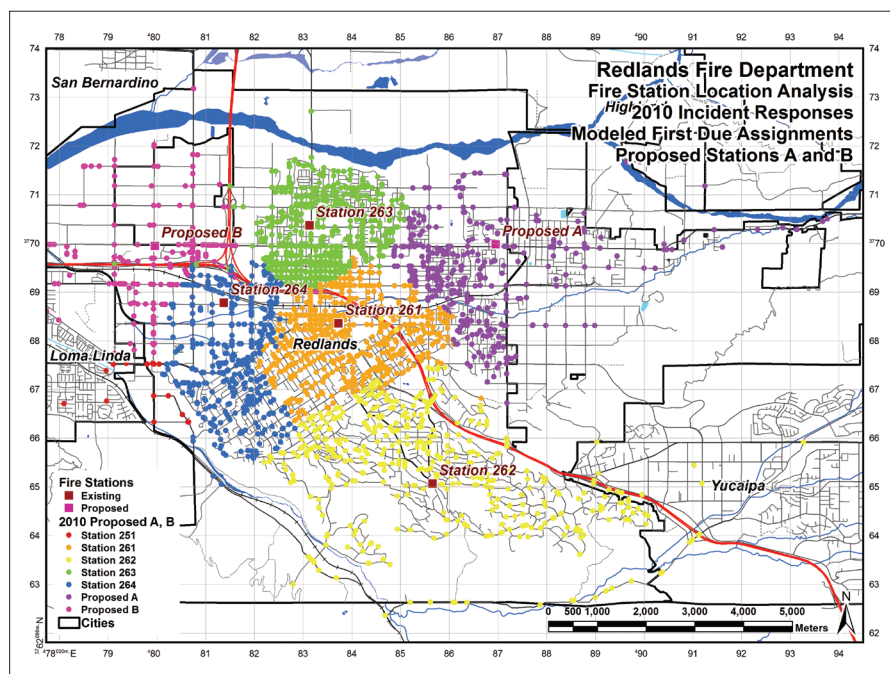
↑ Return to the 2010 Incidents table and locate the IncTypeSum1 field. Right-click this field and select Summarize. Save the summary table in Fire_Data.gdb and calculate average times for Time_Base, Time_A, Time_B, and Time_AB.

Future Opportunities

You have only scratched the surface of emergency services modeling. There are many more analyses, maps, charts, and determinations that could be prepared with this data. For a challenge, experiment with actual station relocation or removal. For example, try removing Station 263, located between Proposed A and B, and see how times increase and decrease. Also, experiment with charting in ArcGIS or your favorite spreadsheet program to graphically display the changing data. This is a training dataset, so use your imagination and have fun.

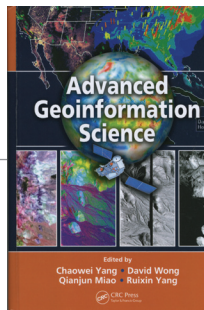
Acknowledgments

Thanks to the fine staff of Redlands Fire Department and City of Redlands GIS for providing this very interesting and complex dataset. Thanks also go to the Confire Communications Center dispatch center for the opportunity to use its excellent time-based streets network in this exercise. The Redlands Fire Department will use many of the same methods and procedures presented here to model and analyze historic, current, and future protection capabilities. Redlands and Esri are very fortunate to have the high level of emergency fire and medical response provided by the Redlands Fire Department.



↑ Final map showing modeling of 2010 incident with both Proposed A and Proposed B stations

GIS Bookshelf

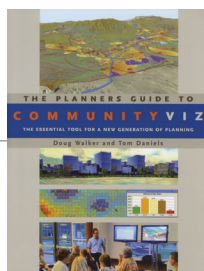


Advanced Geoinformation Science

Edited by Chaowei Yang, David Wong, Qianjun Miao, and Ruixin Yang

The impetus behind *Advanced Geoinformation Science* was the need to address technical aspects of geoinformation related to the demand for better response to events—such as economic crises, epidemics, and natural disasters—that occur on regional and global scales. These events require both a deeper understanding of phenomena and better collaboration. The book was an outgrowth of an international training program first conducted in 2006 at the Center for Intelligent Spatial Computing at George Mason University. This program helped the editors select specific topics for the chapters in the book and engage contributors to write them.

Advanced Geoinformation Science provides a systematic overview of the current state of geoinformation science that covers platforms, data systems, analysis, information extraction, geoinformation infrastructure, and applications. It concludes with a vision of how geoinformation could fundamentally alter our view of the world and what changes in the educational system will be needed to prepare the work force to achieve this vision. The editors see two target audiences for this book: senior undergraduate and graduate students in information technology, geography, and geoinformation science and managers who use geoinformation to deal with regional and global issues. CRC Press, 2010, 525 pp., ISBN: 978-1439810606



The Planners Guide to CommunityViz: The Essential Tool for a New Generation of Planning

This book comprehensively teaches how to use CommunityViz for more effective planning, not just how to operate CommunityViz software. CommunityViz, an extension to ArcGIS for Desktop created by Esri partner Placeways LLC, was designed expressly to promote public participation in the planning process to foster better decisions and transparency in that process and build community trust. It enables planners to compile, analyze, and understand large amounts of data that can be used to develop plans. With CommunityViz, planners can measure the impacts of those plans on the economic, environmental, and social systems of a community. The effective use of 3D in planning is addressed throughout the book. Each chapter in the book covers a planning process, product, or project and provides information and advice on how to best use the software to enhance both community planning and citizen engagement. American Planning Association (Planners Press), 2011, 304 pp., ISBN: 978-1932364934



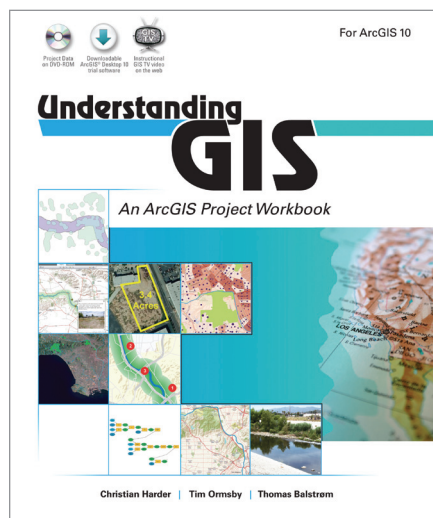
No Dig, No Fly, No Go: How Maps Restrict and Control

By Mark Monmonier

In another lively book on cartography, Mark Monmonier points out how maps impact our lives. In *How to Lie with Maps*, he illustrated how maps influence public opinion. This new book, *No Dig, No Fly, No Go: How Maps Restrict and Control*, is all about the lines on what he terms “prohibitive maps.” These boundary lines tell us where we live (national boundaries), where we can’t live (redlining), and where we can’t dig or travel. He outlines the role maps play in determining, protecting, and modifying real property rights. He asserts that artificial national boundaries that were not based on ethnicity, language, race, or religion have been the underlying cause of unrest in Africa, the Balkans, and the Middle East. While the delineation of these states was the work of a few moments with a straightedge and a map, demarcation and enforcement of these boundaries has often been problematic at best and the work of many years. Although zoning maps were devised to protect residents from unharmonious uses and the environment from degradation, they have often had unintended consequences. The target audience for this book is twofold: general readers who aspire to be informed citizens and “geospatial professionals who seek a broader view of their work.” University of Chicago Press, 2010, 242 pp., ISBN: 978-0226534688

Learn How to Apply Full-Scale GIS Analysis

Methods, tools, and processes



Understanding GIS: An ArcGIS Project Workbook, a new GIS tutorial book from Esri Press, not only teaches how to become proficient with ArcGIS 10 software but also how to use ArcGIS and a geographically based methodology to solve real-world problems.

In this book, the reader assumes the role of a GIS analyst who must find the best location for a new park along the Los Angeles River in Southern California. The book's nine self-paced lessons deal with the steps involved in solving this problem: framing the problem, exploring the study area, preparing data, carrying out analysis, interpreting the results of analysis, and presenting those results. Each lesson explains key concepts and provides step-by-step instructions and graphics that are used to validate results.

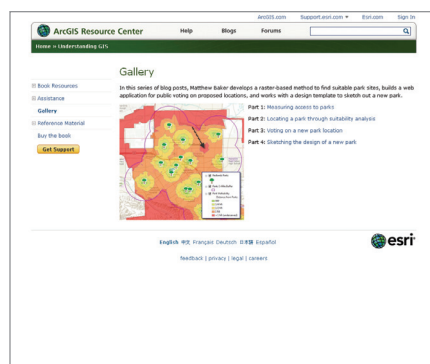
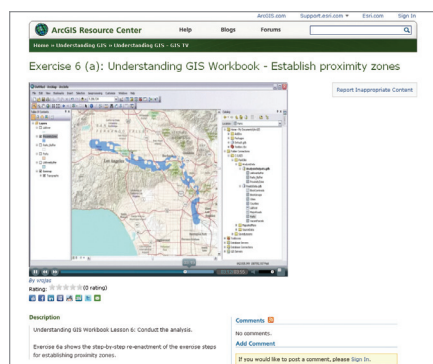
The process mapped out in the book teaches best practices in evaluating, organizing, and managing data. It emphasizes working more intelligently—planning rather than

just diving into tasks such as model building. Along the way, readers learn how to efficiently use the software, take advantage of shortcuts, and understand how geoprocessing tools are used, not just how to run them.

The book comes with access to a 90-day trial version of ArcGIS 10 and a DVD containing the data needed to start the book's project. The Understanding GIS Resource Center supplies the book's final lesson in PDF format, GIS TV videos to walk the reader through the exercises in real time, exercise results for each lesson, and other resources.

Understanding GIS can be used by a broad audience: college or graduate students, college-level teachers, GIS professionals who need to know more about ArcGIS 10 for Desktop, professionals in other fields who use GIS, and current users of earlier versions of ArcGIS for Desktop who need to transition to version 10.

The authors, Christian Harder, Tim Ormsby, and Thomas Balstrøm, bring years of experience writing about and teaching GIS. Harder, a writer at Esri, is the author of case study books on GIS. Ormsby, a technical writer at Esri, has created and contributed to ArcGIS training courses for both the classroom and online learning and co-authored the best-selling workbook *Getting to Know ArcGIS Desktop* (Esri Press 2010). Balstrøm is the coauthor of the Danish-language *Book of GIS and Geodata*. After two decades as an associate professor in GIS and physical geography at University of Copenhagen, Denmark, he is now a freelance GIS consultant.



↑ The Understanding GIS Resource Center provides additional resources including GIS TV videos to walk the reader through the exercises in real time and exercise results for each lesson.





Habinomics

Looking at need and affordable housing potential

By Karen Richardson, Esri Writer

Dallas Area Habitat for Humanity is looking for areas with low family incomes and a high percentage of renters, and Esri Community Analyst is helping in this search.

“These hardworking families often have no choice but to spend unsustainable levels—frequently 50 percent of their income or more—on housing,” said Bill Hall, CEO of Dallas Area Habitat for Humanity.

The local chapter of this international nonprofit organization, which is headquartered in Atlanta, Georgia, has a mission to eliminate poverty and homelessness from the world. Each year Dallas Habitat provides low-income families in the area with affordable housing options.

Local chapters of Habitat assess levels of need by evaluating income based on family size and monthly budget. Households strapped because a large percentage of monthly income is spent on housing find it difficult to pay for other basic necessities such as food, health care, and clothing. Many times, these families find themselves living in dangerous conditions in substandard housing. Any unexpected expense or the loss of a job can make it impossible to pay rent or make a mortgage payment. These families may be forced to leave their homes and live in unstable transitional housing or on the streets.

To answer the question, “Where are low-income areas with a high percentage of renters located in Dallas?” Jane Massey, director of neighborhood research and revitalization for Habitat, knew she needed census data for the county for her analyses. Massey was familiar with the organization’s use of GIS. She thought that finding this information and presenting it in a map would be the best way to

show areas that matched these criteria.

Dallas Habitat had been using ArcGIS in-house for about a year to create map books for advocacy planning. Prior to this, a local Catholic high school, Bishop Dunne, had provided mapping services for them.

The map books, made available to city council members, display parcel boundaries in each city council member’s district as well as identify parcels that have poor condition ratings based on the Dallas Central Appraisal District condition codes used for property tax valuations. Using these map books, Dallas Habitat staff hoped to show the city council where problem properties are located to focus the community’s response to neighborhood blight.

Under Massey’s direction, Dallas Habitat acquired an Esri Community Analyst license. This Software as a Service (SaaS) mapping solution includes both GIS capabilities and access to thousands of demographic, health, economic, education, and business data variables. Community Analyst also provides access to the most current census data, including American Community Survey (ACS) data. ACS data provides much of the information traditionally furnished by the decennial census but is updated and released more frequently.

Using Community Analyst, Massey quickly downloaded the census data she needed. With the help of Brookhaven Community College student intern David Guthmueller, Dallas Habitat was able to easily create the requested maps. The initial map was created in just five minutes. Guthmueller used Smart Map Search, which allowed him to find the two variables—low income and high percentage of

“By simply having access to this data through an easy-to-use mapping interface, we were able to model different scenarios and look at the need level in many communities around Dallas County.”

renters—and display them by census tract.

“By simply having access to this data through an easy-to-use mapping interface, we were able to model different scenarios and look at the need level in many communities around Dallas County,” said Massey.

Finding qualified families with Community Analyst allows Dallas Habitat to streamline its efforts and provide services to the people who need it. Over its 25 years of operation, Dallas Habitat has helped a thousand families become homeowners by providing houses at below cost with no cash down payment and a zero percentage mortgage for 25 years. In lieu of a down payment, homeowners are required to contribute 400 hours of sweat equity building their own homes and those of their neighbors. This saves first-time home buyers more than \$90,000 over the duration of the loan. Money that used to go toward high housing costs can now go to basic necessities.

By bringing together both public and private funding and thousands of volunteers, Dallas Habitat is addressing the affordable housing crisis in Dallas. More than 9,000 volunteers each year donate their time and skills. They contribute more than \$1.8 million in value to the community, an innovative model referred to as “Habinomics” by the Dallas Habitat staff.

Massey explains that today staff members wouldn’t dream of walking into a meeting without a map. From presenting information to potential donors to determining the best sites for homes, GIS is a key part of the organization’s effort to develop communities throughout the Dallas area.



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