

# ArcUser

The Magazine for Esri Software Users

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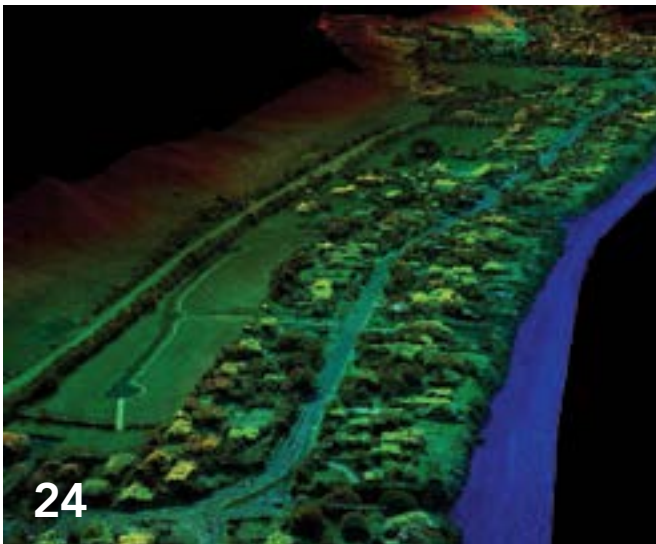
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### Take ArcUser with You

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Download the Esri Bookstore mobile app to access the contents of the current issue of ArcUser on Apple and Android mobile devices.

# It's All About the Data

Although Big Data has been receiving most of the attention lately, that “other data”—open data—should not be overlooked. It has tremendous potential for driving innovation and addressing some of the seemingly intractable problems and formidable challenges that we face as communities and individuals.

The 2014 Public Sector CIO Summit, held January 15–16 at Esri's headquarters in Redlands, California, offered numerous examples of start-ups that are working with Esri and using GIS and open data to address these problems. More rapidly rebuilding communities after natural disasters, enabling citizens to be involved in local government on their terms, and connecting workers with the right skills to local employers who need those skills are just a few of the solutions these start-ups have created.

In his address to summit attendees, Esri president Jack Dangermond noted that open data is only part of the answer. “Open data is kind of a nonstarter. People don't want open data; they want open services that they can build applications with or sell things with.” ArcGIS Online is a platform that provides both the infrastructure for maintaining authoritative data and delivering it in a form—a service—that can be quickly applied to solving problems.

At the summit, Esri announced a new capability for subscribers to ArcGIS Online called Open Data for ArcGIS. With it, an organization can make the data it wants to share available by configuring a custom view of public items and open data groups and disseminating that data through a branded website in as little as 10 minutes. With Open Data for ArcGIS, an organization can sustainably make data available to the public, other agencies, and entrepreneurs using the same platform it uses to create and maintain that data.

The US Environmental Protection Agency (EPA) will be the first organization to take advantage of this new capability. The agency, which launched its GeoPlatform for coordinating geospatial activities in 2012, will combine that infrastructure with Open Data for ArcGIS to make data more discoverable, accessible, and available in a timely manner.

Commenting on the EPA's adoption of Open Data for ArcGIS, Andrew Turner, chief technology officer of Esri's Research and Development Center in Washington, DC, said, “This is not open data for open data's sake. It's the EPA realizing the benefit of *[helping]* organizations outside the agency to do interesting things, from citizens to nonprofits to media to developers. All the data is consistent, all exportable in the same way. It's very easy to find and use the data.”

Monica Pratt  
ArcUser Editor

## editor's page

# ArcUser

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# Creating Understanding

## Out of Measurement, Knowledge, and Science

Esri has become a participant in the Global Earth Observation System of Systems (GEOSS) program, one of the most comprehensive efforts to monitor the earth.

Group on Earth Observations (GEO), a voluntary partnership of 89 countries; the European Commission; and 67 intergovernmental, international, and regional organizations, works together to coordinate and share earth observation data and science. The group was formed to meet the critical need for improved, near-simultaneous observation of the planet.

The GEOSS program brokers various forms of earth observation data and information via its online platform Discovery and Access Broker (DAB). The platform connects relevant information systems and infrastructures throughout the world. Many GEOSS contributors, such as the European Environment Agency, United Nations Environmental Program, and the Food and Agriculture Agency of the United Nations, already use Esri technology in

their services, making their systems and data inherently interoperable.

Esri is making GEOSS earth observation data and services available to the ArcGIS Online community. This collaboration will make ArcGIS Online a significant part of DAB's infrastructure. ArcGIS Online subscribers can discover and access the resources published by GEOSS, use GEOSS data services, and build applications.

A memorandum of understanding (MOU) between Esri and the Earth and Space Science Informatics Laboratory (headed by Professor Stefano Nativi) at the National Research Council of Italy Institute of Atmospheric Pollution Research (CNR-IIA) has created a partnership between the two organizations. Per the MOU, CNR-IIA and Esri are designing brokering arrangements and direct dataset access technologies as

well as open standards for data interoperability and cataloging.

"GIS becomes a platform for understanding, when users build on top of knowledge and measurements with the system to share new ideas," Esri president Jack Dangermond said. "We are trying to create understanding out of measurement, knowledge, and science so that people can act. These measurements provide the basis for interpreting science for design work such as land-use planning."

CNR-IIA and Esri are building two-way technology between the GEOSS DAB framework and ArcGIS Online using the ArcGIS Online API. Developers will engineer Esri and DAB interfaces and build interoperable web services that connect the two systems via pathways.

One pathway starts from an Esri portal



↓ Global streamflow map developed as part of the 6th GEOSS Architecture Implementation Pilot (AIP-6) initiative. Each marker is linked streamflow data published in Water Markup Language (WaterML). Web map was created by Fernando Salas.



and leads the user to discover the main systems of services provided by GEOSS. Through the DAB, ArcGIS Online users will access GEOSS networks such as DataOne, Committee on Earth Observation Satellites (CEOS), the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI), OneGeology, and the Integrated Ocean Observing System (IOOS).

Another pathway starts from the GEOSS portal, leading the user to discover Esri services. All public content from ArcGIS Online, such as Esri basemaps and imagery and contributed datasets and maps, will be discoverable through the many search portals in GEOSS. Users can lay operational data from the GEOSS on authoritative Esri basemaps and other ArcGIS Online datasets. This allows specialized communities to analyze their data within the framework of a common geography.

Dangermond said, "GEOSS serves as an earth measurement platform for monitoring change on the planet. Making GEOSS content available in ArcGIS Online

increases opportunities for scientists and other communities to visualize information in greater context. Moreover, because the platform supports authoritative and crowdsourcing information, GEOSS members can build networks into other disciplines."

However, the interconnected nature of earth systems will make designing technology that bridges disciplines challenging. Data capture, measurement, and quality differ across both disciplines and sensor systems. Data management practices also vary.

Esri and CNR-IIA considered these factors when formulating objectives for a platform design that would not require scientists to spend time learning and modifying technology. The first objective was the development of a specialized search engine for discovering datasets that allows users to obtain raw data accessible in a remote workstation or server environment. The second objective was the design of a flexible architecture that supports continual inclusion of interoperability with DAB. The third objective was to devise tools to

transform data services that can integrate sets of measurements.

The GEOSS and ArcGIS Online service is unique because the relationship between GEOSS and Esri is different from the scientific relationships between government and public agencies. Esri, a private company, operates ArcGIS Online and has more flexibility than government-driven platforms or single government initiative programs. In addition, ArcGIS Online is a repository for geospatial and imagery data for the entire planet, not just a specific region or area of interest. The data shared by hundreds of thousands of organizations in ArcGIS Online does not belong to Esri but to those organizations.

GEOSS brings many scientific communities together. Bringing GEOSS data into ArcGIS Online will help these communities extend their scope and work together to meet some of earth's critical challenges.

For additional information about GEOSS, visit [EarthObservations.org](http://EarthObservations.org) or [geoportal.org](http://geoportal.org).



# More Control

## Over Maps, Apps, Display, and Access in ArcGIS Online

Here are some of the new features and enhancements that were released in the December 2013 update to ArcGIS Online.

### More Control with Map Viewer

You can make a copy of a layer in your map and configure the properties of that copied layer, such as pop-up windows and symbols, and save it as a new layer. Layers imported into maps such as CSV files and map notes can also be saved.

Map authors can choose whether or not to allow others to save a copy of their map. The Modify Map option does not appear in the map viewer if a map author has enabled Save As protection on the map. Also, there is no option to save the map unless the user is signed in.

Administrators can set default map units for the scale bar, measure tool, directions, and analysis. ArcGIS Online members can modify these units on their own profile page.

Additional symbology options allow you to rotate point symbols, normalize your data, change the width of lines, and display a

graduated point symbol over a polygon. Optionally, time animation on time-enabled layers can be disabled so the time slider does not appear on the map.

For organizations that allow anonymous access, a simplified map viewer opens even if a user is not signed in, encouraging casual users to explore maps. However, there is no option to modify the map. The simplified viewer includes tools to show tables, edit features, change symbols, share, view data through time, and so on.

### Get Web App Template Codes

App template code can now be downloaded from GitHub so you can create customized apps hosted on your own server. You can create configurable apps and group gallery apps from Esri-featured app templates in the gallery. The Basic Viewer, Social Media, Legend, and Panels Geocoder templates now show a list of suggestions as search terms are typed.

The GPX template has been retired from the Esri default map viewer template gallery. You can still use this or other retired templates to create and publish apps by sharing them (and any other Esri template) to your custom template gallery.

↓ ArcGIS Online provides more choices for symbology.





## Updated Services

The profile template has been updated with the latest ArcGIS Online Elevation profile service (a free service). This worldwide service is based on General Bathymetric Chart of the Oceans (GEBCO) data at 30 arc-second spacing (approximately 1,000 meter) resolution and is worldwide between 60 degrees north and 56 degrees south based on the 3 arc-second (approximately 90 meter) resolution of the Shuttle Radar Topography Mission (SRTM) dataset. In the continental United States, the service is available at 10-meter and 30-meter resolution based on the USGS National Elevation Dataset (NED).

## More Analysis Tools

### Spatial Analysis

With the Enrich Layers tool, you can now select a group of data variables (data packs) or individual variables from each group. You can map the results from the Summarize Data tool using the new proportional symbols and get better visual clues for understanding your organization's data.

You can use the Extract Data tool to export a CSV file of feature attributes from area and line layers.

A new tool, Find Existing Locations, has been added that allows you to query both spatial and nonspatial attributes in your data. And finally, you'll now see the consumption of service credits ahead of time for Enrich Layers and Create Drive-Time Areas.

### Network Analysis

Multi-Vehicle Route service credits usage has been reduced by 50 percent. Content has been updated and enhanced for India and Thailand. Live traffic is now available for visualization and analysis in Argentina.

The Location-Allocation service is in beta. Developers can include this service in their applications, and ArcGIS for Desktop users will see it as one of the ready-to-use services. There is an option to use live traffic in the Directions tool, including Drive Time Areas, Finding Nearest, and Summarize Nearby.

## Account Administration

To make it easier to manage your ArcGIS Online subscription, Esri has added a number of enhancements. You now have the ability to use your own custom geocoding services to find places and addresses. Custom geocoders can be useful for batch geocoding or geocoding your own data. A setting has been added for the default basemap in the map viewer to open at a default extent set by the organization. And you now have a setting to add Esri basemaps and templates to configure groups so you can automatically include the Esri default basemaps and default templates. A custom contact link has also been added in the footer of your ArcGIS Online website. Under My Organization, administrators can now see the date when members last logged in. Administrators also have a new tool for re-sending and removing invitations and disabling member log-ins.

## CityEngine Web Viewer

Several enhancements have been made to the CityEngine Web Viewer. Search has been improved to deliver search results faster, and search results are now highlighted in 3D view. New search tokens for attribute filtering, a new screen shot tool, and a new dedicated comments pane with filter for author and nonauthor comments have

also been added. The share dialog has been improved. Experimental support for Internet Explorer 11 has been added.

Geocomments created by the web scene author in the CityEngine Web Viewer that are symbolized differently can now be displayed independently of other comments. You will also see faster performance when working with scenes that contain many features.

## Featuring and Organizing Content

The gallery has been redesigned to include an Esri featured content section and your organization's own featured content section. The gallery also includes better tools for sorting and filtering items.

ArcGIS Online organization members will now see items they've designated as favorites in their My Favorites section. You can add search result items to your favorites or the gallery. You can view your favorites in a new My Favorites section of the gallery and search your favorites to add layers to your map.

You can change the URL of an ArcGIS for Server service layer you've moved to a different server by editing its details.

## Use a CSV URL

When you add a CSV file to ArcGIS Online and share it with everybody (public), the details page now displays the URL. You can then use the URL to reference the CSV file as a layer in web apps, pop-up windows, and so on.

Item details now include an option to protect against deleting the item. And now you can store items with the same title in the same folder.

## Dark Canvas Basemap

This new basemap is currently in beta at small scale (~1:577 kilometers). It will be updated and coverage will be expanded to larger scales worldwide in future releases. The Dark Canvas basemap lets you use a different color palette for all types of maps.

## More Helpful Help

Help has been reorganized to better highlight the main workflows of ArcGIS Online. This is part of an ongoing effort to improve the usability and attractiveness of the site.

# Try It, You'll Like It

## Sign up for a free 30-day trial

If your organization doesn't have an ArcGIS Online subscription yet, sign up for a free 30-day trial. You can invite up to five named users to participate in the trial, and you get 200 service credits. You also get Collector for ArcGIS, Operations Dashboard for ArcGIS, Esri Maps for Office, and Esri Maps for SharePoint as part of your trial. Once your trial is over, you can purchase a subscription to continue using all the features and services in the same ArcGIS Online subscription account. To sign up for the trial, go to [esri.com/agoleval](http://esri.com/agoleval).

# Current Landsat 8 Image Services in ArcGIS Online

Free with an ArcGIS Online organizational account

The latest and greatest Landsat 8 scenes are available from Esri as a new set of image services in ArcGIS Online. A subscription to ArcGIS Online for Organizations is required to access the services, but there is no charge for usage.

These Landsat 8 scenes from the US Geological Survey are accessible as image services that can be used in web maps, ArcGIS for Desktop, and other applications.

Each day, Esri downloads approximately 300 of the most recent Landsat 8 scenes and adds them to a set of image services that make 50,000 of the best Landsat 8 scenes available to users. The best scenes are determined by weighting cloud coverage and scene age. Users can reorder the scenes based on metadata attributes, lock to a specific scene, or use a time slider to see how an area changes with time.

Landsat 8 image services join the other Landsat imagery that Esri has made accessible. Esri first released more than eight terabytes of Landsat imagery services in ArcGIS Online two years ago. These image services made the collection of Landsat Global Land Survey (GLS) scenes spanning the epochs of 1980, 1990, 2000, 2005, and 2010 accessible as more than 20 dynamic, multispectral, and multitemporal image services. These dynamic services enable a wide range of client applications temporal access to any of the band combinations and products without downloading or locally processing any data. All these Landsat scenes are hosted on Esri's cloud infrastructure.

The Landsat 8 imagery, available in ArcGIS Online, provides several image services from the same source. Most popular is the Landsat 8 Views services, which allow users to view a range of different band combinations including Natural Color (bands 4, 3, 2) and Color Infrared (bands 5, 4, 3). The Agriculture band combination (bands 6, 5, 2) highlights differences in different crop types. The SWIR band combination (bands 7, 6, 5) provides better penetration for clouds. The bathymetric option (bands 4, 2, 1) provides better water penetration and is especially useful for coastal applications.

Users can also select any user-defined band combination. Functions can be applied with fixed enhancements or with Dynamic Range Adjustment Stretch, which requests the server to maximize the contrast so as to get the most out of the extended dynamic range of sensors.

The Landsat 8 Views service also provides two indexes: the colorized Normalized Difference Vegetation Index (NDVI) and the colorized

Normalized Difference Water Index. NDVI provides information on the health of vegetation. The colorized Normalized Difference Water Index highlights areas that have high moisture content.

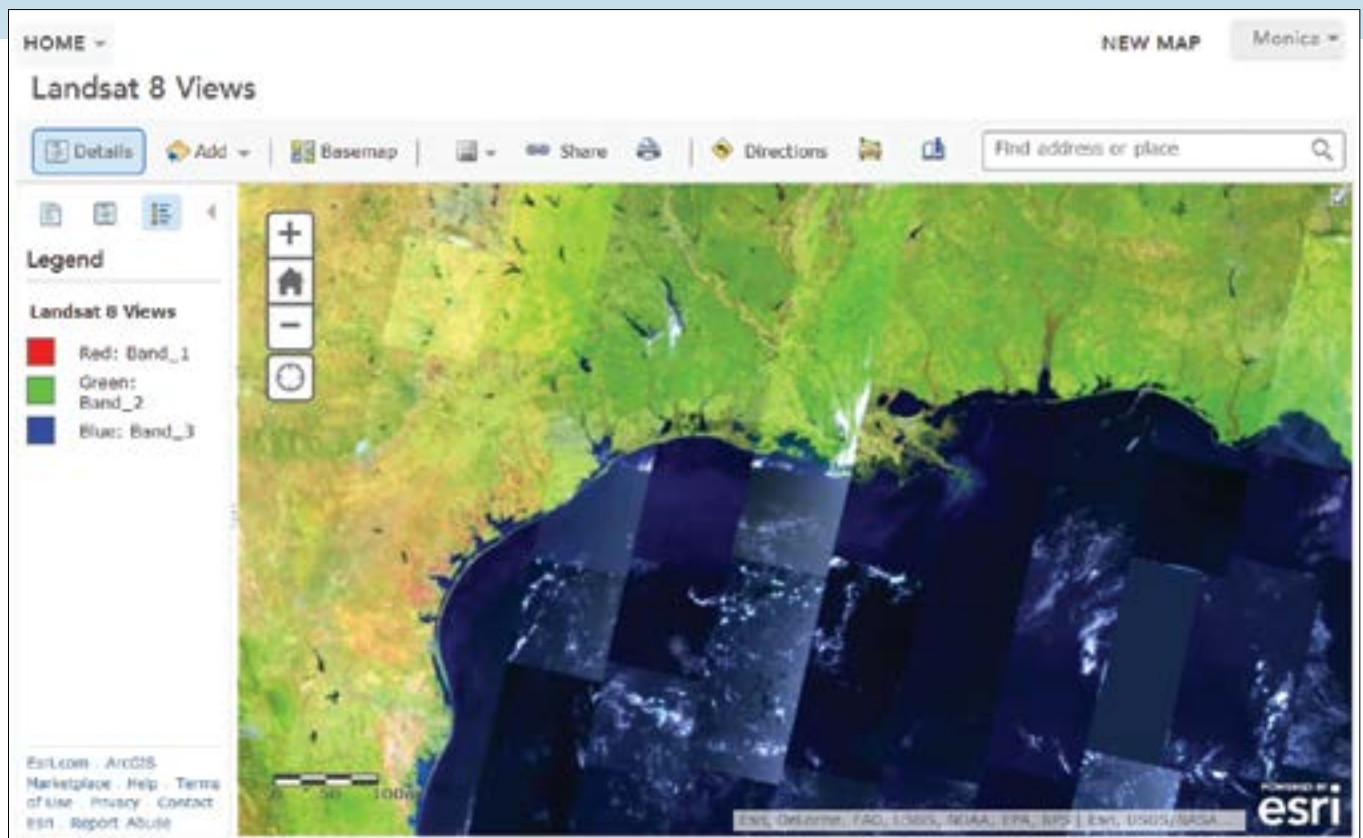
The PanSharpened service provides enhanced natural color imagery by sharpening the natural color bands (4, 3, 2) with 15-meter panchromatic imagery and giving direct access to the panchromatic imagery.

While all services return 8-bit rendered versions of different products, the Analytic service enables applications to access the full range of data values that are sometimes required by analysis applications. This service contains similar band options and indexes but returns computed apparent reflectance values versus colored renderings.

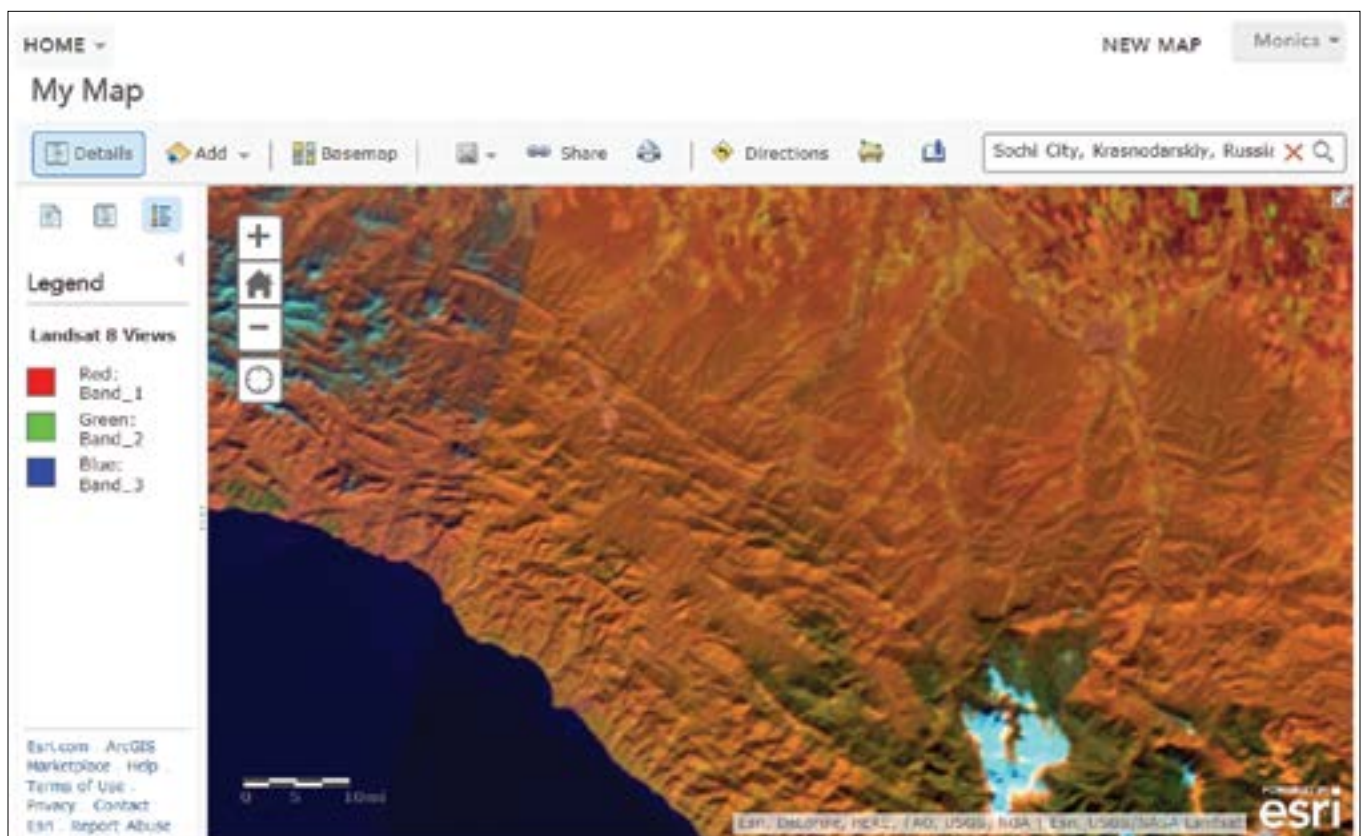
These services are powered by ArcGIS for Server and ArcGIS Image Extension. Processing and dynamic mosaicking are performed on the fly directly on the source data. All processing is applied on the source imagery as it is accessed by the server, enabling the creation of multiple products as well as enabling the full dynamic range of imagery that can be accessed even when using browsers that are limited to only 8 bits.

The server also applies user-controllable lossless compression, ensuring that the data is transmitted back to the client application quickly, even over low-bandwidth networks.

For more than 40 years, the United States government has invested billions in the collection and archiving of continuous worldwide Landsat imagery for earth observation. Through ArcGIS Online, Esri has made 30-meter spatial resolution Landsat imagery much more widely available. Imagery at this scale is excellent for mapping regional trends in climate change, agriculture, wildlife habitat, forestry, regional planning, coastal zones, and national security. Because data is collected in nonvisible wavelengths such as the infrared and optical (natural color) portions of the electromagnetic spectrum, Landsat satellite images allow researchers to see also more than the human eye can. Delivering imagery as services extends monitoring of the landscape to Internet users worldwide.



↑ This dynamic image service available in ArcGIS Online provides visual renderings of Landsat 8 OLI 30-meter 8-band multispectral scenes covering the landmass of the world. The service includes on-the-fly functions that render different band combinations and indexes.





# GIS Spurs Innovation

## Inaugural summit for CIOs

By Monica Pratt, *ArcUser* Editor

**The more than 100 CIOs** from start-ups, businesses, and government who were invited to the 2014 Esri Public Sector CIO Summit learned how GIS solves real problems in ways that matter. The event was held January 15–16, 2014, at Esri's Redlands headquarters.

Traditionally the CIO was the chief information officer for an organization. This was the person who managed the computer systems and worked on improving clerical productivity. More often these days, the *I* in CIO stands for innovation rather than information. In government as well as business, the CIO has become the driver of innovation designed to deliver better service or greater sales.

The summit served as a bit of a matchmaking service, introducing CIOs to GIS-driven solutions from the start-up community and Esri. CIOs met representatives from start-ups that are creating the next generation of tools, services, and resources for solving tough problems and enhancing the lives of citizens. Executives from start-ups, like D4H, MindMixer, Recovers, RFSpot, RideAmigos Corp, OpenCounter, Sensimob, thrdPlace, Valarm, and WorkHands Inc., were on hand

throughout the event.

In addition to hearing directly from innovators, the summit hosted panel discussions about how business intelligence is improved by location analytics. Over two days, attendees listened to talks and panel discussions highlighting how GIS is helping drive innovation in established

and emerging companies and government agencies of all types.

Steve Ressler, founder and CEO of GovLoop, praised governments for the important work they do but noted that they must deal with increased demands for government services, staggering deficits, rapid technology change, and a retiring work

↓ "GIS is in everything you do and just changing how we live," said Steve Ressler, founder and CEO of GovLoop.





force that is taking their expertise with them.

These developments in technology give governments opportunities to come up with new solutions that will enable them to cope with this changed landscape. Sea changes in technology, such as the marrying of sensors and the Internet of real-world devices, are making things happen differently. Now automatic texts warn of tsunamis and refrigerators that tell us when we are out of milk. Mobile devices are no longer just a way to consume information. They are changing the way we experience life.

And at the forefront of this quest is the chief innovation officer, characterized by Ressler as “the free safety of government innovation.” And GIS is powering many of these solutions. “GIS is in everything you do and just changing how we live,” he said. As one the largest purchasers of technology, government is in a position to benefit from these advances in technology, particularly GIS technology.

Jack Dangermond, president of Esri, in his talk noted that after 40 years, GIS is growing faster than it ever has. One reason for this continued growth is the human affinity for maps. Maps engender civic engagement. People use them to tell stories about disasters, history, where money is spent, and how climate is changing. Spatial analytics, as part of the burgeoning field of business intelligence, is taking off. “The ability to analyze one relative to another is very powerful, and people want that,” he said.

Also changes in technology continue supporting the adoption of GIS. Today’s web GIS is not like the GIS that ran on mainframes, or later GIS on minicomputers then workstations, PCs, client/server, and then server. With each of these stages, there have been orders of magnitude in increases in usage. In the age of cloud and web GIS, “usage has gone from millions to hundreds of millions.” In all these cases, GIS continues to deliver value in the context of making better decisions, improving communication, and driving efficiencies in every field.



↑ Clara Brenner, Tumml cofounder, supports “urban high impact entrepreneurs” who address problems unique to cities.

Government GIS is becoming an infrastructure for the other information systems in an organization. Some governments, like those in Abu Dhabi, United Arab Emirates, and Geneva, Switzerland, have their IT systems wrapped in GIS. Large corporations like General Motors, Nike, McDonald’s, and Starbucks are also seeing their businesses spatially. Bruce Wong, manager of advanced network analytics for General Motors Company, described how an established and substantial company is using spatial analytics to better understand its dealer network.

### Solving Urban Problems

During a panel discussion on community innovation, Esri platform adoption business manager Robin Jones sat down with Clara Brenner, founder and CEO of Tumml, and Thomas Fisher, dean of the College of Design, University of Minnesota, to talk about the work that is being done to improve life in cities.

Brenner’s San Francisco-based Tumml, a 501c3 nonprofit, nurtures what she termed “urban high-impact entrepreneurs.” These start-ups provide products and services that address problems unique to cities.

Tumml gives mentoring and seed money in exchange for a 5 percent equity stake in the new business.

Tumml is looking for businesses, not projects. It funds companies like Airbnb, which facilitates home sharing, and Lyft, which enables ride sharing. HandUp, a crowdfunding platform for the homeless, is a Tumml alumni. It was named *Fast Company*’s most innovative company of the day.

Another company that got its start with Tumml was WorkHands, which has been described as a blue-collar LinkedIn. It not only addresses unemployment but connects workers and employers in the right place. This has become increasingly important as more cities mandate local hiring. Brenner noted that these start-ups need the right data to thrive. Often the right data is maintained on a regional or state level, not by a city. Access to the current data at the right level is vital to success.

Fisher’s institution does \$800 million in research work. Right now, he feels the most important work his students are doing is in the invisible design world of systems, networks, infrastructures, processes, and procedures that relate directly to the success of organizations.



He observed that we are living in cities designed around the needs of the second industrial revolution, which was based on mass production and mass consumption. That economy “is in its endgame.” We are in a “phase change” as we transition into the third industrial revolution. “The way people live, work, and make things is going to radically change,” said Fisher.

Right now, cities are built to serve the needs of the people who run them, not the people who live in them. Opening up information to the public is a way to get processes and policies realigned to economic needs. He sees cities moving from rigid segregation of business, residential, and leisure uses to design that has people working, living, and playing in the same place.

GIS, and specifically geodesign, are powerful tools that will help cities face the challenges of a new era. Fisher believes if we map our assets, we will realize the wealth of human, social, cultural, and environment capital cities possess that has the potential to solve many of these issues. “Innovation is both learnable and teachable,” said Fisher. “Everyone can learn to be more innovative.”

## A Fresh Approach

GIS and innovation were recurrent themes in the Lightning Talks given during the summit by start-ups Recovers, MindMixer, D4H, and thrdPlace. Other start-ups in attendance were Valarm, WorkHands Inc., RFSpot, RideAmigos Corp., OpenCounter, and Sensimob.

## Recovers

Recovers harnesses the good intentions of residents and others in communities dealing with disasters such as floods and tornadoes by connecting local needs with local resources and local government. In his Lightning Talk, Chris Kuryak, chief operating officer for Recovers, observed that when a disaster strikes, individuals first look to local government. Because local governments are not set up to handle a barrage of phone calls, e-mails, texts, and other communications from constituents, they can quickly become overwhelmed.

This can result in little to no response

from government, which squanders the strong but short-lived interest of residents to help out. Typically 70 percent of offers of aid are made in the first four days after a disaster. Even with no encouragement, many local groups will step in to help but may not know how to help or who to help. This lack of organization causes inefficiencies and frustration—a secondary disaster that retards recovery.

Resources, a software company, steps into this void by helping communities prepare for and recover from disasters by

coordinating relief efforts. It is currently in 24 communities in the United States and Australia. It maps everything a community needs to recover. All information goes into a secure database that is used to identify needs, assign tasks, engage volunteers, and gain insights where gaps are in preparedness so communities are prepared and recovery time is shortened.

## MindMixer

Esri new partner of the year MindMixer set out to reinvent the townhall meeting and



↑ Thomas Fisher, dean of the College of Design, University of Minnesota, believes if we map our assets, we will realize the wealth of human, social, cultural, and environment capital cities possess that has the potential to solve many problems.

↑ “I like to think that geography component really elevates governments into the 21st century,” said Nathan Preheim of MindMixer.

capture great ideas. Nathan Preheim of MindMixer, formerly an urban planner, saw firsthand how traditional townhall meetings involved a very small number of citizens who have an inordinate effect. MindMixer believed that there had to be a better way to engage citizens.

These days, the citizenry is online and texting and that is where they should be engaged. Preheim and cofounder Nick Bowden wanted to use technology to discover great ideas, gather valuable feedback, and measure impact. This cycle results in actionable data that lets governments make more informed decisions. Preheim refers to MindMixer as “a decision support service.” Geography matters to MindMixer. Not only do they locate where participants are but also where they aren’t and where efforts to involve citizens should be increased. “I like to think that geography component really elevates governments into the 21st century,” said Preheim.

#### D4H

Headquartered in a lighthouse on an island off Ireland, D4H assesses the status of the equipment and personnel responding to a disaster and tracks incident trends and training requirements. The firm bills itself as experts in the right data when things go wrong. Its cloud-based system keeps tabs on the location and condition of equipment, the certifications of responders, and other data that is available on any device. Public safety personnel constantly create data but are not very good at capturing it. This is the very data that is needed to improve response. D4H helps capture and organize that data and makes it useful through decision-making tools that let users look at the data as a whole. D4H tools overlay geography with this baseline data so the best people and equipment for an incident can be more quickly dispatched.

#### thrdPlace

In the aftermath of Hurricane Katrina, the City of New Orleans and its community stakeholders had difficulty working to rebuild the communities. DeKoven Ashley, the founder of thrdPlace, was inspired to design



↑ DeKoven Ashley, the founder of thrdPlace, connected with CIOs at the summit.

a web and mobile platform that would connect for-profits, nonprofits, and governments and maximize, measure, and evaluate their community outreach and development. The ultimate vision of thrdPlace is to

create global movements driven by local community outreach and development by becoming the online marketplace that connects the needs of communities with available resources across stakeholders.

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# Unlocking Opportunity

ArcGIS Online makes open data accessible

You can make datasets maintained by organizations in ArcGIS Online available in a matter of minutes at no additional cost. This collaborative and social web application lets you share your authoritative data quickly and reliably using the ArcGIS Online infrastructure.

Adding Open Data for ArcGIS to your ArcGIS Online organizational account will help leverage open data so it can enable more efficient government operations, help solve interesting problems, and let citizens contribute their unique insights on how government can work better.

Open data is much more than a “feel good thing;” it is a huge economic opportunity. McKinsey Global Institute, a global management consulting firm, says it has the potential to generate \$3 trillion a year in areas such as utilities, transport, education, health, consumerism, and natural resources.

In as little as 10 minutes, organizations with an ArcGIS Online subscription can generate a branded open data website that leverages their existing data in ArcGIS Online and makes it searchable and downloadable. Open Data for ArcGIS is a part of ArcGIS Online organizational accounts and incurs no extra cost or credits. It creates a digital online public square where people can congregate online and do amazing things with data.

Organizations, such as government agencies, create and manage a vast amount of data. They desire or may be required to share specified data with the public. This is open data, and it must be freely available for use and redistribution. Like open source, open data aids in government transparency and fosters innovation as well as ensures data integrity.

Open data must be discoverable, explorable, and accessible. Open Data for ArcGIS makes it easy for people to discover data. It

provides a web interface for searching data and lets data be discovered through a general web search or through recommendations or notifications.

Once found, data must be accessible so that it can be reused in other applications and integrated with other data. Data can be made available via APIs, web services, and common data formats.

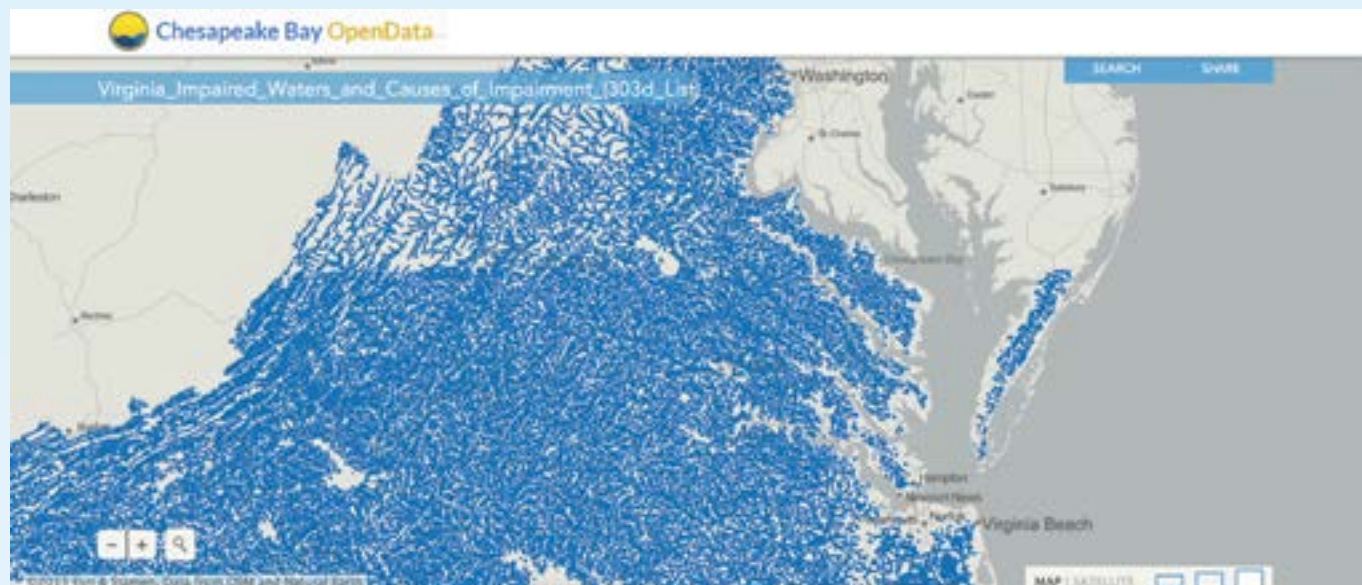
Ideally, the data is made available via multiple mediums that conform to open industry standards. The Esri shapefile (SHP) is an open data format and industry standard. Open Data for ArcGIS automatically makes your data available as shapefiles and also in Open Geospatial Consortium, Inc. (OGC), formats, including Keyhole Markup Language (KML), as well as comma-separated values (CSV) data format. In addition to combining data, you can filter, visualize, and analyze the data.

Because Open Data for ArcGIS is integrated into the ArcGIS platform, people can combine open data with other datasets in ArcGIS Online or bring the data into ArcGIS for Desktop for advanced geospatial analysis. Adherence to open standards means this data can also be used in spreadsheets, statistics packages, or other programs.

The value of open data is realized when the results of analysis and integration are shared back to the public and the source organization. Open Data for ArcGIS uses the capabilities built into ArcGIS Online for sharing and disseminating data through web and mobile applications.

This initiates a positive feedback loop that can lead to further exploration, analysis, and improvements. By making their data accessible and discoverable, organizations become part of the larger open data community on the web.

↓ Use Open Data for ArcGIS to create a branded open data portal in a matter of minutes.





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## Mapping more effective food waste utilization

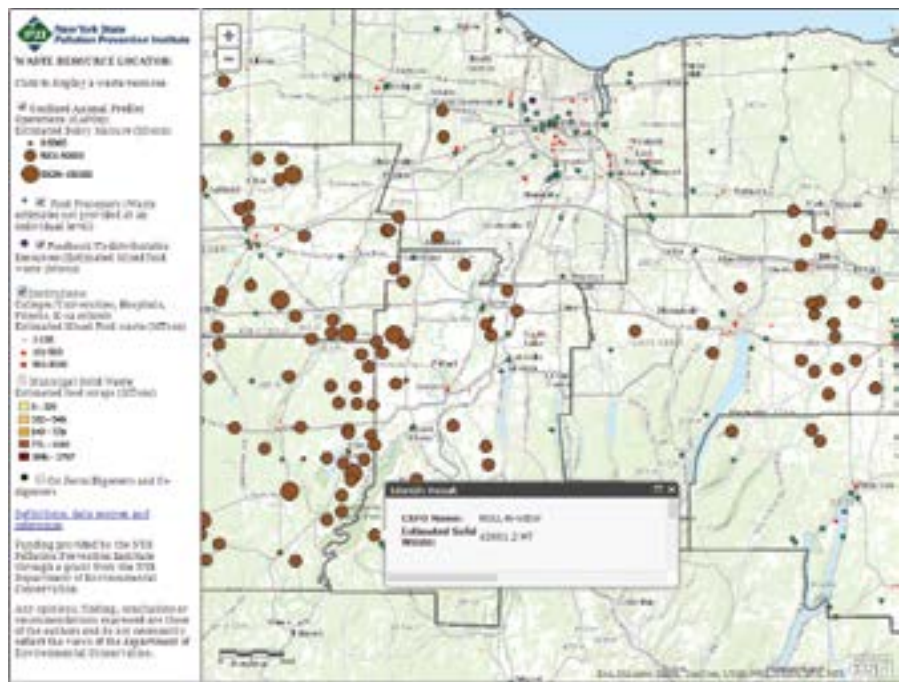
Although your mother always told you not to waste food, it is estimated by the US Department of Agriculture that 30 to 40 percent of the food supply goes to waste.

Not all of this is plate waste. Scraps such as peels, by-products of food production, or rejected products are examples of organic wastes generated at virtually every step along the path from farm to fork. The disposal of food waste costs money and often has negative environmental impacts. For example, food waste sent to a landfill releases methane, a powerful greenhouse gas.

However, organic materials such as food waste can become valuable resources for renewable bioproducts that don't use land that otherwise might be used for food production. Although for centuries many methods have been used to convert bioresources to bioproducts, interest and investment in bioproduct technologies have increased in recent years as environmental and energy security concerns have grown.

Waste utilization is an inherently local problem. Unlike fossil resources, transporting food waste over large distances is difficult to justify. Furthermore, the food waste produced in a given region is unique because it depends on the distribution of agriculture, industry, and food service institutions. These characteristics of waste influence how it can be utilized.

For example, in the Finger Lakes region of New York State, there is a strong dairy industry. Large dairy farms in this region are beginning to use anaerobic digestion for dairy manure treatment. Anaerobic digestion (AD) is a series of bacterial processes in which organic matter is degraded in an environment without oxygen. The process, similar to the process that occurs inside a cow's stomach, results in biogas. Anaerobic digestion is useful to farmers as a way to



↑ Organic Resource Locator users can display waste sources by type (e.g., manure, food processing waste) or AD facilities. Clicking on site locations brings up information on food

manage odor and the nutrient loading on their soil resulting from applying manure as fertilizer on fields.

Composed primarily of methane and carbon dioxide, biogas can be used in many of the same ways as natural gas. Biogas produced as a product of the anaerobic digestion process is often used to generate electricity that can offset on-site electricity use or be sold back to the electric grid. However, high anaerobic digestion infrastructure investment costs and the modest volumes of biogas produced from the anaerobic digestion of manure have made the financial viability of this strategy challenging.

If a region has a large amount of food processors and other food waste sources, one solution is codigestion, which utilizes food

waste along with manure as anaerobic digestion feedstock. Since food waste has not yet been digested by an animal, it generally has a higher potential to produce biogas. Combining food waste with manure often creates synergies that can make the process run more efficiently.

Codigestion has been found to increase biogas production. In fact, research by the International Energy Agency (IEA) reported biogas production increases of 25–400 percent for codigestion compared to just manure. In addition, the disposal of food waste often generates much needed revenue in the form of tipping fees, which are the fees paid to a business for disposing of waste.

However, finding information about food processing, cafeteria, or other sources of

food waste is not easy. The Organic Resource Locator (ORL) is addressing this problem. Under development by the Rochester Institute of Technology (RIT) and the New York State Pollution Prevention Institute (NYP2I) housed at RIT, ORL uses Esri technology. Funding for the ORL has been made possible by New York's Department of Environmental Conservation (NYDEC).

ORL utilizes customizable ArcGIS for Server-based web applications that allow every aspect of the application to be controlled—from basemap selection to cartographic design—and the incorporation of advanced spatial analytic tools. The extensive library of web-based geospatial tools and sample code for many common functions available through Esri's online support and user forums has made implementation of the ORL easier.

A variety of GIS data sources is used in ORL, including geocoded data from the US Departments of Health and Education that locates hospitals and schools. Address or coordinate information from NYDEC environmental permitting records was incorporated so regulated livestock farms could be located. Business databases provided information on food processors. Estimates of the amount of waste generated annually were made based on empirical relationships derived from waste audits reported in scientific journals or surveys. This data was combined with characterization of the type of wastes, which is important to ORL users.

Businesses, such as food processors, that generate waste can see where anaerobic digestion facilities are located. Conversely, existing facilities or those developing anaerobic digestion projects can see what types of food waste are available and where these are generated.

Supporting facilities that specialize in anaerobic digestion of food waste supports the state of New York's renewable energy portfolio and is aligned with the goals of the New York Power Authority (NYPA) and the New York State Renewable Energy Development Authority (NYSERDA). ORL has been used to support several projects to assist regional anaerobic digestion developers through the green technology development programs provided through the NYP2I. Data on available waste supplied by ORL helped developers with financial analysis and system sizing

as well as informing anaerobic digestion system design and operating parameters.

### Positive Feedback

Initial feedback on the ORL has been positive. It was demonstrated at an anaerobic digestion workshop. Stakeholders from nearby Vermont, where a ban on landfilling of organics was recently passed, share a vision for a similar tool. The Cornell Manure Management website formerly housed a similar food waste sourcing tool.

"Several people have inquired when the tool would be updated and relaunched," said Jennifer Pronto, a research assistant at Cornell. "Many farms constructing anaerobic digesters are now able to accept off-farm substrates and need assistance in locating suitable sources. This new tool developed by RIT will help anaerobic digester operators and their advisers perform a comprehensive local search for digester substrates matching a specified profile, while simultaneously helping food processors find an anaerobic digester system within a viable transportation distance."

ORL is available on the NY Pollution Prevention website ([www.rit.edu/affiliate/nysp2i/organic-resource-locator-0](http://www.rit.edu/affiliate/nysp2i/organic-resource-locator-0)), where it will be maintained and enhanced. Future developments include expanding the tool beyond the Finger Lakes Region to all of New York state. Additional waste utilization pathways are also planned that include incorporating data on anaerobic digestion at a waste-to-ethanol production plant, wastewater treatment plants, compost facilities, and other beneficial-use facilities. The hope is that ORL will be an invaluable tool to move from an era in which food waste is seen as a burden to an era in which food waste is a valuable, sustainable energy resource.

### About the Authors

**Jacqueline Ebner** is a PhD candidate at the Rochester Institute of Technology, Golisano Institute of Sustainability. Her research focus is on waste utilization and waste-to-energy technologies.

**Brian Tomaszewski, PhD**, is an assistant professor in the Department of Information Sciences & Technologies and extended faculty member of the Golisano Institute of Sustainability at the Rochester Institute of

Technology. His research interests include geographic visualization, spatial thinking, and disaster management GIS applications.

### Resources

Learn more about reducing food waste at the US Environmental Protection Agency's Food Recovery Challenge website ([www.epa.gov/smm/foodrecovery/](http://www.epa.gov/smm/foodrecovery/)).

Braun, Rudolf, and Arthur Wellinger. (2010) Potential of Codigestion. [www.iea-biogas.net/files/daten-redaktion/download/publi-task37/Potential%20of%20Codigestion%20short%20Brosch221203.pdf](http://www.iea-biogas.net/files/daten-redaktion/download/publi-task37/Potential%20of%20Codigestion%20short%20Brosch221203.pdf)

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↓ Wildfires are increasingly commonplace across much of the western United States, with catastrophic consequences to not only the landscape but to the people living through them. Photo courtesy of ISU GIS TreC.

# Accelerating Wildfire Recovery

By Keith T. Weber, Idaho State University

A new web services-enabled decision support system makes time-sensitive geospatial data immediately accessible to those working on postfire rehabilitation efforts.

For land managers across the western United States, the task of drafting postfire recovery planning has become daunting as the number of wildfires has increased. Agency land managers, who are responsible for the stewardship of public lands, ensure that natural disasters such as wildfires do not cause permanent or long-term loss of the benefits from affected ecosystems.

Once a wildfire has been contained, a land manager assigned to the fire typically has two weeks to complete a postfire rehabilitation plan. This plan includes details about the fire and how the ecosystem will be rehabilitated or returned to its prefire condition. It takes into account the effects of the fire on wildlife habitat; water quality; and endangered, threatened, or sensitive species that may be present, as well as economic and social considerations, and a host of other site-specific factors. The plan is ultimately approved by the governing agency.

Typically, land managers can spend as many as 4 of the 14 allotted days locating and acquiring the data necessary to assess the fire's impact and develop a good plan. While each fire is unique, the key to

addressing many of the critical questions faced by land managers is geospatial in nature. Often the necessary geospatial data is scattered across various data centers and stored in a variety of projections and formats.

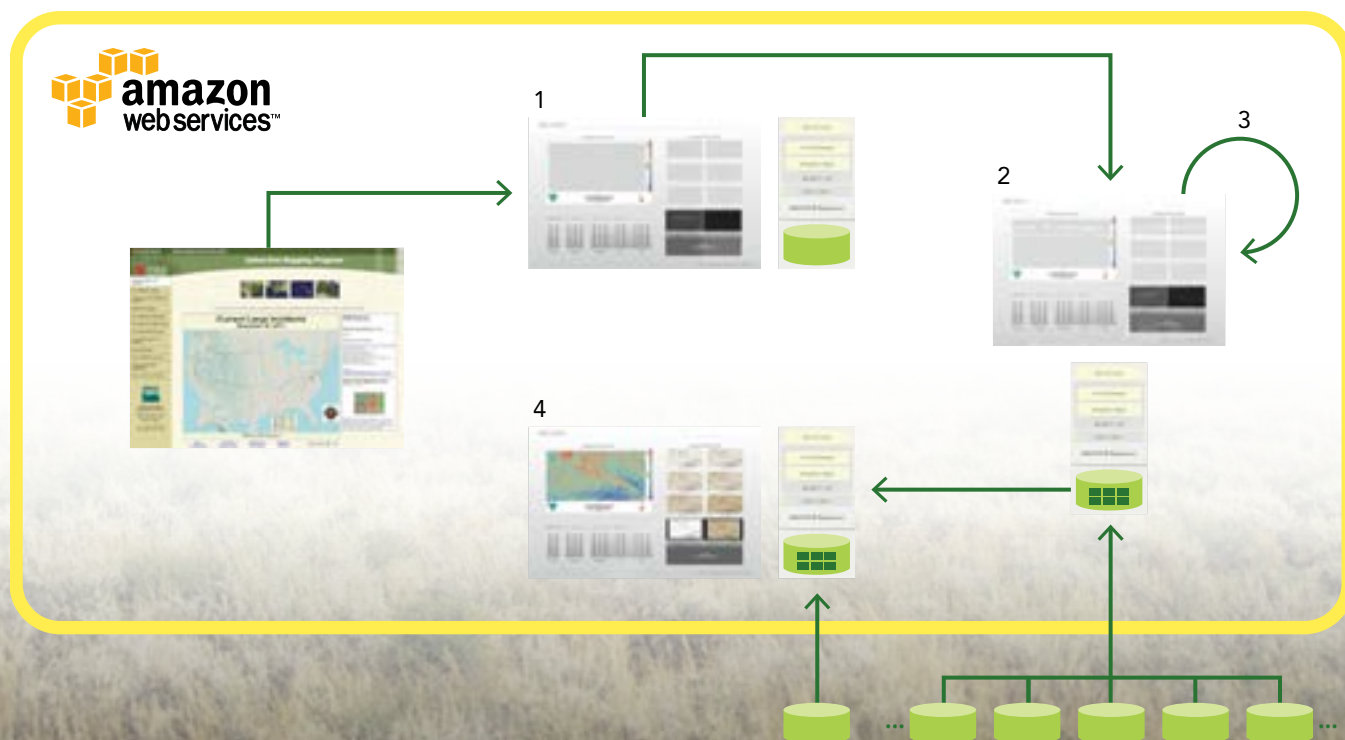
## More Rapid BAER

Keith T. Weber, GIS director at Idaho State University (ISU) in Pocatello, Idaho, and John L. Schnase of the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center in Greenbelt, Maryland, believed ready-to-use geospatial web services could be leveraged to create a system that quickly organized critical fire-specific data and made that data conveniently available to the land managers dealing with the aftermath of wildfires. Weber and Schnase had previously worked together on smaller projects that studied the use of satellite data to monitor postfire rehabilitation.

With funding from the NASA Applied Sciences Program, Weber and Schnase partnered with the Bureau of Land Management (BLM) and Idaho Department of Lands (IDL) to test their vision. Mark Carroll, Roger Gill, and Molly E. Brown of NASA also worked on the project. RECOVER is the realization of this vision. It is an automated burned area emergency response (BAER) decision support system for post-fire rehabilitation management across the western United States.

By the end of the 2013 fire season, RECOVER had been used





↑ The RECOVER automated response process.

(1) An instance of the RECOVER decision support system deployed in the Amazon Elastic Compute Cloud (EC2). (2) The RECOVER Server connects through web service interfaces to various geospatial resources such as those hosted by ISU GIS TReC or Esri landscape analysis services. NASA's RECOVER Server stages site-specific data layers to the server instance. (3) These staged products are refreshed as needed to maintain coverage and currency throughout the fire. (4) The decision support products and the RECOVER web map client are ready for use by the burned area emergency response (BAER) team in minutes.

successfully on major wildfires that included the 2 ½ Mile, Mabey, Pony, State Line, Incendiary Creek, and Ridgetop fires. This test laid the foundation for a broader operational deployment of RECOVER throughout the western United States.

The key to RECOVER's success is its rapid response capabilities. These capabilities are enabled by well-prepared statewide geospatial datasets, web services, and NASA's cloud-based data management technologies. The RECOVER system is made up of a RECOVER Server and a RECOVER Client. The RECOVER Server is a specialized Integrated Rule-Oriented Data System (iRODS) data grid server deployed in the Amazon Elastic Compute Cloud (EC2). The RECOVER Client is full featured and was initially prototyped using ArcGIS Viewer for Flex. It was then migrated and customized using ArcGIS API for Flex in the Adobe Flex programming environment. RECOVER currently uses version 3.2 of the API.

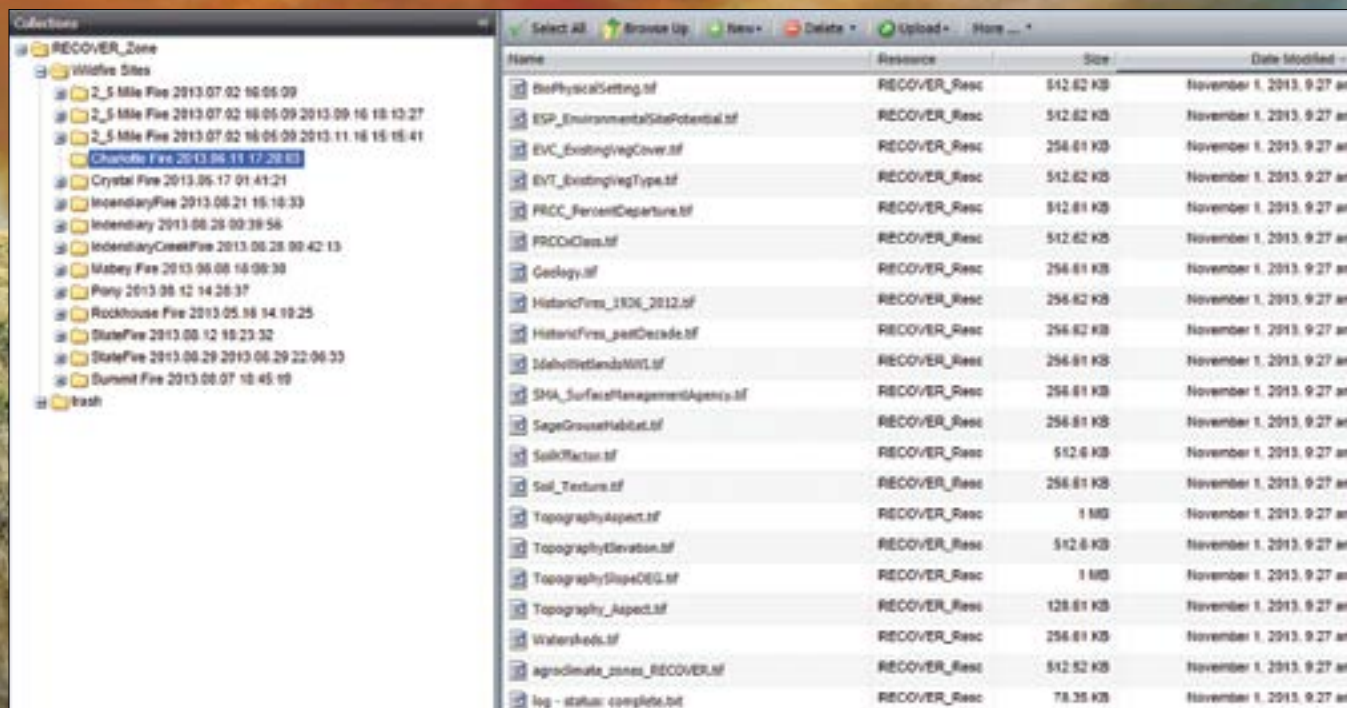
When provided with a wildfire name and geospatial extent, the RECOVER Server aggregates site-specific data from predesignated, geographically distributed data archives and performs the transformations and reprojections necessary so that the data can be used by the RECOVER Client. It exposes the tailored collection of site-specific data to the RECOVER Client through web services residing on the server. This automatic aggregation can take place in a matter of minutes.

## Two Great Ideas Come Together

During the 2013 fire season, the RECOVER team learned of Esri's Landscape Analysis System, a project that in many ways shared a common vision of making critical landscape layers readily available via web services. Esri's Landscape Analysis System was developed in response to the needs of land managers working in government, academia, nonprofits, and industry. Esri consulted with these professionals and found that while their work varies greatly, they have core needs. They need efficient data access, consistent and compatible data formats, and tools that simply help them do their jobs.

In traditional landscape analysis, many hours are dedicated to locating, obtaining, preprocessing, storing, and maintaining geospatial data. Web services, like those offered by RECOVER and the Landscape Analysis System, lessen the time required for these activities by offering single point of access to much of the necessary data from trusted sources such as NASA, BLM, US Geological Survey (USGS), and Natural Resources Conservation Service (NRCS).

These datasets are generally offered as map services (vector data) and image services (raster data). Map services providing access to these datasets open up enormous potential by enabling applications such as the RECOVER web mapping client, mobile smartphone and tablet decision support tools, the ArcGIS ArcToolbox suite of geospatial analysis tools, and user-constructed geoprocessing models. ➔



↑ The RECOVER Server and Client interfaces are designed to be intuitive, fast, and easy to use.

These capabilities are useful to postfire planning as well as land-use planning, hazards assessment, wildlife corridor design, and conservation planning.

RECOVER complements the Landscape Analysis System by providing improved spatial resolution and a host of temporally rich satellite imagery libraries for long-term monitoring. RECOVER data, as well as Web Coverage Service (WCS) and Web Map Service (WMS) services made available from the ISU GIS Training and Research Center (GIS TReC), can be found in the Landscape for Contributors group on ArcGIS Online ([esriurl.com/L4C](http://esriurl.com/L4C)), which is a part of the Landscape Analysis System reserved for data providers who want to contribute directly to the system and update and curate the data themselves.

## Empowering Better Decisions

Not many years ago, RECOVER would have been a pipedream. Web services and cloud servers were in their infancy. Today, these technologies can empower better informed decisions. The success of this and other similar solutions depends on the rapid response capability enabled by cloud-based web services.

RECOVER has reduced the time needed to acquire all the necessary geospatial data and even some summary reports to minutes.

This data is abundant, current, and highly spatially resolved. This will allow for a better informed decision on the part of the land manager.

Because RECOVER is web based, the land manager and the hydrologists, soils specialists, state supervisors, and other agency people involved in the fire recovery efforts can view and share data in real time. This benefits meetings, planning sessions, and long-term monitoring reviews, ultimately saving not only money but also time.

For more information about the RECOVER project, visit [giscenter.isu.edu/research/Techpg/nasa\\_RECOVER](http://giscenter.isu.edu/research/Techpg/nasa_RECOVER) or contact Keith T. Weber, GIS director, GIS Training and Research Center, Idaho State University, at [webekeit@isu.edu](mailto:webekeit@isu.edu) or Pete Aniello, technical manager for Esri Database Services, at [paniello@esri.com](mailto:paniello@esri.com).



## About the Author

**Keith T. Weber** is the GIS director at Idaho State University and principal investigator on the RECOVER project. He has a master's degree from the University of Montana, and his research interests include GIScience, object-relational database design, web services, and CyberGIS.





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# UAV and GIS

## An Emerging Dynamic Duo



A conversation with Devon Humphrey of Waypoint Mapping

Devon Humphrey has worked on emerging technologies in GIS for the past three decades. When he became GIS manager for Lee County Appraisal District in Texas in 1991, he was one of the first to use GPS to georeference the county's aerial photo archive, which greatly improved the county's parcel management.

After working at Texas General Land Office on its oil spill prevention and response GIS, he joined Esri as a technical marketing representative while also teaching GIS for emergency response at Texas A&M University. Later, as a regional technical manager for Pictometry International Corp., he evangelized to ArcGIS users about the benefits of oblique aerial imagery technology.

During the 2010 Deepwater Horizon oil spill in the Gulf of Mexico, Humphrey served as the geographic information officer (GIO) at the Louisiana Incident Command Post, designing and deploying GIS and imagery solutions at a time when real-time visual intelligence sources were scarce.

Soon after the incident, Humphrey refocused his GIS consulting business, Waypoint Mapping, to provide a common operating picture for critical infrastructure organizations within the energy and utility industries.

Convinced of the revolutionary potential of imagery capture by unmanned aerial vehicles (UAVs) as a data source for GIS users, Humphrey created a dedicated UAV division at Waypoint Mapping in 2012 called Flightline Geographics.

In this interview, Humphrey discusses the use of UAVs for GIS data capture with Esri writer Matthew DeMeritt.

## You recently started Flightline Geographics as the aerial division of Waypoint Mapping. When did your interest in UAV mapping begin?

GIS users have always craved high-quality, near real-time imagery. Over the years, expectations for resolution and fast delivery have been significantly raised. Much of our work at Waypoint involves emergency management. Real-time visual intelligence is absolutely critical to complete the common operational picture. Short of having an on-call manned air fleet, UAVs offer the unique ability for users to capture their own data, on their own time frame.

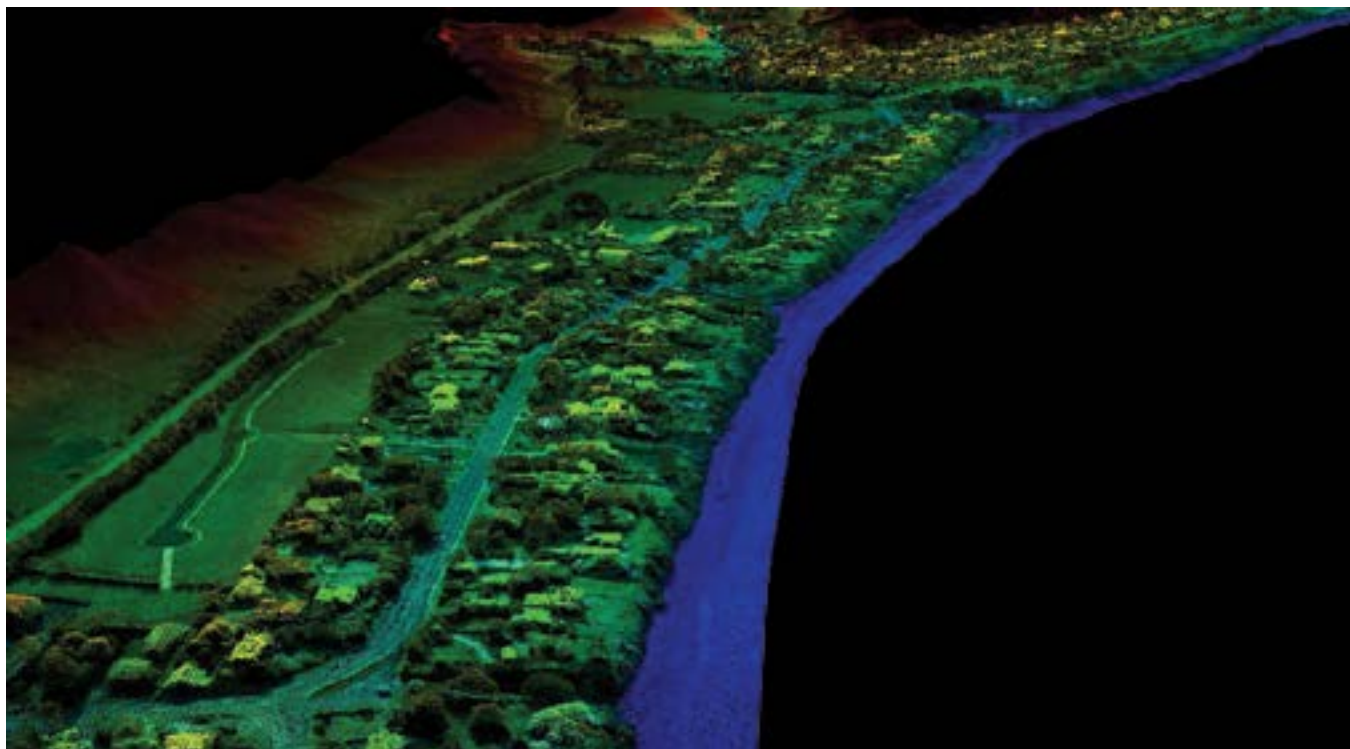
Waypoint started experimenting with unmanned imagery in 2007. Since then, it's exploded as battery and optical technologies have evolved, allowing for larger areas to be captured at higher resolutions.

## Autonomous flight and advanced optics have been used in the military for years. Is that where the two technologies began to naturally converge?

Yes, the military has been working with a combination of the two technologies for a couple of decades now. But as far as everyday use cases, it has a lot to do with the technical components inside, such as the autopilot and the processing software that are used to create orthomosaics and 3D point clouds for GIS. Once these →

← Launching the Hawkeye UAV into flight is as easy as throwing a paper airplane.

↓ A 3D point cloud depicting a coastal area. Similar to lidar, point clouds provide 3D information that can be combined with the air photos for analysis and visualization.





technologies matured and became more affordable, their combination with an airframe was almost trivial.

The combination was just beginning to lead to breakthroughs just before 9/11 [*terrorist attacks on September 11, 2001*] happened, and then the FAA [*Federal Aviation Administration*] understandably prohibited unchecked use of UAV in the interest of national security. That hampered UAV's development and proliferation—at least here in the US. Other parts of the world excelled technologically and commercially at this time, as a result.

### The benefits of UAV capture are higher-quality imagery and temporality. Can you expand on that and the other benefits you see in this technology?

Due to the unique flight characteristics of UAVs, the imagery is sharper and offers some unique advantages. Drones fly very low compared to manned aircraft—400 feet is a typical altitude. This means that the camera captures high ground resolution on the order of two to five centimeters. In addition, because there is a large amount of overlap in the imagery, digital photogrammetric processing results in 3D point clouds of similar resolution. Turnaround time is a few hours, instead of days, weeks, or months in the case of traditional delivery times. The user also controls the process rather than working with an outside vendor or being stuck using “day-old donuts,” generic imagery that doesn't meet the temporal requirements.

### What are some of the most recent developments with regard to FAA regulation?

The US Congress has seen the benefits of UAVs for professional use and has ordered the FAA to produce the “rules of the skies” for incorporation into the National Airspace. Naturally, the FAA is concerned with safety first, but it is really taking its time on this. Collision avoidance is a concern, as is impact with objects on the ground. But most of the UAVs that would be used for mapping are small, lightweight airframes that fly far below the normal air traffic.

As we see with Amazon recently divulging its plans to deliver merchandise via drones, the private sector will force the issue. I predict that if the FAA does not accelerate the rule-making process, the commercial and consumer market will simply fly without permission. It is already happening. While that is not the right answer, I do think this prospect will influence the pace of the process and, hopefully, speed things up.

### What is the FAA doing now?

The FAA has selected a set of university-based test sites to work on issues of collision avoidance and other issues. One of them is at Texas A&M University. Research will go on for a year or more. In the meantime, more and more drones are being sold through places like Amazon.com, not necessarily for mapping, but for hobbyists. They are everywhere. If you go to Town Lake in Austin, Texas, on a nice







↑ The Hawkeye UAV lands by parachute, a far safer method of making an emergency landing than a belly landing.

weekend afternoon or evening, you will see dozens of them buzzing around. They are the modern-day equivalent of kites. Of course, there are privacy issues to consider, but the FAA does not deal with privacy—just safety.

At a recent UAV conference in California, an FAA official almost opened the skies unknowingly. He stated in response to a question, that “If a farmer wants to get a UAV and fly his crops, we don’t care.” While I don’t think that is the official position, it demonstrates the tide of influence the commercial market is generating. Frankly, I don’t think there is much they could do to stop it.

Everyone wants safe skies. But the uses and demand for UAV-collected data for GIS is becoming overwhelming. The congress will continue to press for the FAA to get on with the rule making. If it involves taking an exam, obtaining a license, or registration of airframes, those are all possibilities. But let’s get on with it.

## What industries are using the technology the most today?

The range is incredible. As with GIS, almost any use case can benefit from higher-resolution, self-service imagery and 3D point cloud data. As I mentioned, here in the US we are limited. In other parts of the world, the technology is booming. But we are doing work in the US with federal, state, and university partners. Those organizations can apply for FAA Certificates of Authorization to fly a given model of UAV in a very specific geographic location. We have done agricultural projects (vineyards) and wildfire research projects. We also requested UAV use on the Gulf oil disaster, recent wildfires, and flooding incidents, but to date, the FAA has not approved UAV use for these events. The typical response has been that, “This could be done with a manned aircraft, so no.”

Agriculture is poised to be the single largest beneficiary of the combination of UAV and GIS. Farmers are already purchasing their own UAVs and inspecting their fields.

← UAV capturing vineyard imagery for analysis.

## What are some of the visualization benefits of UAV in a GIS?

[One is] Full Motion Video [FMV]! The military has developed a technology that lines up the video with a digital map through image stabilization and georeferencing. We have dozens of uses for it in ArcGIS—it’s completely integrated into the ArcGIS toolset.

Currently, we are using FMV to monitor test fires for wildfire research. Another recent project involves pipeline monitoring. The UAV flies along the pipeline and captures FMV, which, since it is georeferenced, can be used to heads-up digitize features of interest directly from the video frame. This can include encroachments, leaks, erosion, etc. It is much easier to watch a video in the comfort of your office and capture features of interest than to try to do the same thing in a plane or helicopter.

## Describe the current UAV market and where you think it’s headed.

The current market is overseas. There is a limited market in the US within government and university research. Places like Canada, Australia, New Zealand, Mexico, South Africa, China, and other locations, have already adopted the tool, and it is following the adoption curve of GPS in the 1990s. In other words, explosive growth.

Again, we are lagging behind on this in the US. Within the next five years, every survey company and many GIS organizations will own and operate small UAVs for mapping. It is a no-brainer. And it’s fun, if done safely.

## What’s on the horizon for Flightline Geographics?

We are continuing to work with clients that can use UAVs—government, universities, and overseas. We are also not totally dismissing the use of manned aircraft. UAVs have flight durations ranging from 30 minutes to several hours, so sometimes a manned aircraft is needed for larger projects, such as flying a 1,000-mile pipeline in a day.

We are also working to support the viticulture industry in Texas. Vineyards can use UAV technology to perform early detection of pests and view overall vegetative health. UAV remote-sensing analysis can highlight trouble spots before they can be seen with the naked eye. Vegetative density can also be seen in the 3D point clouds at high resolution.

We are working with Hawkeye UAV from New Zealand to conduct flight demonstrations and training, so that when the rules allow, GIS users can be ready to integrate UAVs into their geospatial toolkits. Some GIS organizations may not feel comfortable launching a UAV that costs somewhere between \$10,000–\$100,000 with an expensive camera into the sky for a data collection mission. In those cases, we offer capture services. Many users will choose this option. Imagine explaining to the boss that you crashed his \$100,000 bird and camera . . . It’s something to consider.

For more information on UAV paired with GIS, visit [flightlinegeographics.com](http://flightlinegeographics.com) or e-mail Devon Humphrey at [dhumphrey@flightlinegeographics.com](mailto:dhumphrey@flightlinegeographics.com).

# Providing More Value

## City turns necessity to its advantage

By Bob Blackwelder, City of Chula Vista, California



↑ Photo courtesy of Mark eggrole/Flickr (cc)

A Southern California city of slightly more than 250,000 is using the latest GIS technology to help it implement a management philosophy that eliminates waste and tightens processes to deliver better service more efficiently.

Like many local governments around the country, the City of Chula Vista has experienced a reduction in city staffing, resources, and funding during the recent economic downturn. To help counteract this loss of manpower and resources, in 2012 the city adopted the Lean/Continuous Improvement (CI) program, which was derived from the Toyota Production System as a way to improve overall productivity and efficiency.

A number of city employees were trained in the Lean/CI concepts that focused on reviewing current work processes and eliminating wasteful steps and unnecessary tasks that do not provide value to the organization. With the reduction in staffing, all employees have been asked to take a closer look at how they do things and find more creative ways to do business to maintain quality service to the citizens of Chula Vista. "Doing more with less" is the new motto throughout City Hall.

### Lean and GIS

At the same time, GIS has continued evolving. Recent changes in GIS data types and the database technologies underlying them

must be learned and implemented. The Lean training encouraged GIS staff to focus on leveraging the latest technology whenever possible to create more dynamic, self-sustaining GIS layers and applications while eliminating additional maintenance work and duplicate data entry.

Chula Vista's GIS section recently upgraded its citywide GIS Viewer (commonly referred to as CVMapper). Although the older version was widely used by city staff in almost every department, the viewer used ArcIMS technology. It could not utilize published map services and other technology advancements available with ArcGIS for Server.

An updated version of CVMapper, developed by WebGIS-Solutions, utilizes ArcGIS API for Silverlight and provides a number of enhancements to the mapping system including custom map themes and the ability to add web-based map services and layers on the fly.

In addition to the out-of-the-box tools, WebGIS-Solutions also developed a number of modules to extend the viewer's capabilities. Chula Vista's Public Works staff immediately expressed interest in the work order module, which can display current fieldwork performed on city-maintained assets. This add-on module, including an intuitive, dashboard-like interface, has tools that display fieldwork based on asset type, status of work, and date the work was performed.

### Seizing an Opportunity

The work order module would be easy to add to the CVMapper interface, but it required that all work orders be mapped as a single point layer before being published as a map service. Although Public Works staff have streamlined how work orders are attached to the city GIS, at the time there was a lack of consistency in how work was entered into the city's Work Management System (LuCity). In certain cases, Public Works crews entered work locations into LuCity as x,y coordinates, while other crews were attaching work directly to GIS features such as street segments, storm mains, and sewer mains. The GIS team had to find a process for aggregating all work orders into a single point feature class, regardless of asset type or the method used to enter the work in LuCity.

Chula Vista, which maintains its GIS data in an enterprise geodatabase, had recently upgraded to Microsoft SQL Server version 2008/R2. With the upgrade, the GIS team also migrated to the new SQL Server geometry spatial type. Staff viewed this as a great opportunity to explore query layers and leverage the new spatial functions that are available in SQL Server.

## Implementing the Latest Technology

The first step in building the query layer needed for the work order module was to compile all the fieldwork to be mapped. With the help of Chula Vista's LuCity administrator, Claudia Block, a SQL Server database view was created containing all fieldwork for 2013. This view contained not only all work associated with each asset type (e.g., storm main, wastewater main, pump stations) but also the date and type of work performed, field crew that was assigned, and location of work performed (provided as a GIS asset ID or an x,y location).

After identifying the information needed from LuCity and compiling this data into a SQL Server view, the next step involved spatially enabling this view to create a unique point feature for each work order. With a basic understanding of Structured Query Language (SQL), GIS staff members were able to use Esri's online samples to write a SQL statement creating point features showing all fieldwork with an associated x,y location.

The team set out to create point features that showed the work

orders associated with linear assets like street segments or sewer mains. In these cases, only the associated GIS Asset ID was stored in the work management system, so staff members had to somehow create point features to represent the approximate midpoint of these linear assets.

To resolve this issue, staff downloaded and installed SQLSpatialTools, a SQL Server spatial toolset available from CodePlex, Microsoft's open-source project hosting website. Included in this toolset is a spatial function called `LocateAlongGeom(shape, distance)` that will generate a point feature at a certain distance along a line segment. This allowed staff to merge the work order data with the appropriate GIS layer and generate points for all fieldwork attached to linear assets such as sewer and storm mains.

The SQL function `UNION ALL` was then used to group the different asset types into a single SQL statement before copying the SQL query to the Add Query Layer tool in ArcMap and publishing the point layer as a map service. ➔

```
-- Graffiti locations entered as x/y. Use STGeomFromText()
-- function to return point object for each x/y location.
```

```
SELECT geometry::STGeomFromText('POINT(' + CAST(X_COORDINATE AS VARCHAR(20))
+ ' ' + CAST(Y_COORDINATE AS VARCHAR(20)) + ')', 2230) AS 'SHAPE'
FROM WorkMaster.dbo.GIS_LucityWorkOrders
WHERE WO_DEPT_TY LIKE 'GRAF%'
```

↑ Example of a SQL statement that creates point features for all fieldwork associated with an x,y location.

```
-- Pothole locations attached to street segments. Use LocateAlongGeom()
-- and STLength() functions to return mid-point of line segment.
```

```
SELECT dbo.LocateAlongGeom(g shape, g shape.STLength() / 2) AS 'SHAPE'
FROM gisadmin.STREET AS g, WorkMaster.dbo.GIS_LucityWorkOrders AS w
WHERE w.AS_INV_ID = g.GBALINK AND w.WO_ACTN_TY LIKE 'Pothole%'
```

↑ The `LocateAlongGeom(shape, distance)` function was used to generate a point feature at a certain distance along a line segment.



-- Merge different asset types into single sql statement using  
-- UNION ALL operator. Requires identical field names and field types.

--SEWER PIPES (Lucity asset type = 6)

```
SELECT g.OBJECTID, g.GBALINK, dbo.LocateAlongGeom(g.SHAPE, g.SHAPE.STLength()/2) AS 'SHAPE', w.WO_NUMBER AS  
'WO_Number', w.AS_TYPE AS 'AssetType', w.WO_STAT_TY AS 'Status'  
FROM gisadmin.WW_MAIN AS g, WorkMaster.dbo.GIS_LucityWorkOrders as w  
WHERE g.GBALINK = w.AS_INV_ID AND w.AS_CAT_INV = 6
```

UNION ALL

--SEWER STRUCTURES (Lucity asset type = 2)

```
SELECT g.OBJECTID, g.GBALINK, g.SHAPE AS 'SHAPE',  
w.WO_NUMBER AS 'WO_Number', w.AS_TYPE AS 'AssetType', w.WO_STAT_TY AS 'Status'  
FROM gisadmin.WW_JUNCTION AS g, WorkMaster.dbo.GIS_LucityWorkOrders AS w  
WHERE g.GBALINK = w.AS_INV_ID AND w.AS_CAT_INV = 2
```

↑ The UNION ALL function was used to group different asset types into a single SQL statement.

## Doing More with Less

Once the new GIS work order layer was published and added to CVMapper, it was a great information resource for Public Works managers and engineers. The module provides unique symbols for different asset types. It allows users to toggle between open and closed work orders so they can quickly assess and investigate the status of work orders performed in the field and identify possible patterns or trends. Being able to visualize this data can allow them to quickly see assets that need further attention.

"The work order module has allowed our crews to search for property information and access the mapping features from the field to better prioritize which work orders to respond to, allowing us to be more efficient with our limited resources," explained Michael Lengyel, senior management analyst with the Chula Vista Public Works Department.

## More Ways to Leverage Existing Data

Chula Vista's city staff, like many local governments, needs access to GIS layers that have authoritative attribute data stored in nonspatial databases such as work management systems, business license databases, or land management/permitting systems. City staff is now looking at GIS layers like day-care facilities and historic homes that can be leveraged using spatial functions and query layers.

For example, when a new day-care facility is approved by planning staff, the data is entered into the city's land management system (Accela). A hard-copy approval sheet is sent to GIS staff who reenter the same attribute information into the GIS. The GIS team can take advantage of query layers and database views to merge spatial (GIS) data and nonspatial data and provide city staff with more accurate, dynamic GIS layers. In the future, when a new day-care facility is approved and entered into Accela, the spatial location and attribute information of the new day-care facility will automatically be added to CVMapper without additional work by GIS staff. As a result, end

users will have more confidence in CVMapper, because they will know the underlying data is coming directly from the system or database that maintains or owns that data.

This solution also fits into Chula Vista's long-term goal of eliminating data silos and duplicate data entry into key city databases. Data will be entered one time and maintained in the most appropriate system.

## Conclusion

The idea behind Lean is to eliminate waste and ensure there is value in everything the city does and the services it provides including GIS. During the next few months, the GIS team plans to meet with staff members from every city department to review each of their GIS layers and attribute information to determine where they can leverage the latest technology, such as query layers, to provide more dynamic data; minimize or eliminate duplicate data entry; and, in the end, do more with less.

For more information, contact

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## About the Author

**Bob Blackwelder** is the GIS manager for the City of Chula Vista and past chairperson of the San Diego Regional GIS Council. He has a bachelor's degree in city and regional planning from the University of Louisiana-Lafayette.

# Coding Workout for Developers

## New immersive training format

If you are an experienced developer who wants to master the art of geoenabling native Android apps, Esri has something new for you: ArcGIS Runtime SDK for Android Boot Camp.

This boot camp is not for beginners. Over three days, an Esri instructor will whip you into shape with lots and lots of hands-on coding. Course content is driven by classmates. (Hooah!) All the code you build is yours to keep. (Hooah!)

Boot camps are held at Esri US training locations or as private events. They are more immersive, social, and collaborative than other training formats. Participants will have a workout solving real-world problems in small groups during class. Each boot camp covers a focused Esri technology concept. The instructor will discuss recommended workflows and best practices and present software demonstrations. Compared to standard Instructor-Led Training (ILT) courses, boot camps spend significantly more time on hands-on exercises rather than lectures. Students work side by side with the instructor to solve problems presented in the exercises. Students are encouraged to ask questions in this highly interactive training format.

ArcGIS Runtime SDK for Android Boot Camp, the first boot camp being offered, lets you dive into the ArcGIS Runtime SDK and discover how to integrate geospatial data, maps, and GIS capabilities into native Android apps. You will work closely with fellow developers as you learn how to build apps that support connected and disconnected workflows. The course covers

- Preparing to use ArcGIS Runtime SDK for Android
- Accessing local and online data
- Visualizing data on a map
- Navigation using GPS and gestures
- Analyzing data on the server
- Manipulating data in connected and disconnected scenarios
- Distributing ArcGIS Runtime for Android apps

During the class, Esri will provide ArcGIS Runtime SDK 10.2 for Android, Eclipse IDE

for Java Developers, Java SE Development Kit (JDK) 7, and the Android Developer Tools (ADT) Bundle Windows 64 bit.

You will leave knowing how to give mobile users a high-quality app experience that includes interactive mapping, data

visualization and editing, spatial analysis, and querying. A certification of completion is provided. Pricing for all Instructor-Led Training is on a per-day, per-student, or per-class basis. For more information, visit [esri.com/training](http://esri.com/training).

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For more information, visit [esri.com/hardware](http://esri.com/hardware)


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# 10 Open-Source Projects

## Every JavaScript Geo Dev Should Know About

By Allan Laframboise, EDN Program Management

Whether you're a hacker or a well-seasoned developer, writing JavaScript geo apps from scratch takes some serious time, skill, and effort. Thankfully there are a few places you can go to get a head start—like the [esri.github.io](http://esri.github.io) site. There you'll find over 170 geo projects on GitHub that are ready to go. Most of the projects use the ArcGIS APIs and services to do something geo, but many integrate with other technologies as well, and others are pure JavaScript solutions. The other cool thing is that they are all on GitHub, so if there's a feature missing, it's easy to make a pull request or log an issue to get it added.

Here are 10 projects that should help you get your JavaScript mapping apps out the door faster.



↑ Quickstart-map-js shows how to accomplish common mapping tasks with ArcGIS API for JavaScript and ArcGIS Online services with minimal code.

## 1

### quickstart-map-js

Looking for some short JavaScript examples to do things like add points to a map, change basemaps, find places, get directions, or perform spatial analyses? Well, look no further. This project illustrates how to accomplish a bunch of common mapping tasks with ArcGIS API for JavaScript and ArcGIS Online services with minimal code. See live demos. If you are an iOS, Android, or PhoneGap developer, there are other quick starts too.

## 2

### map-tour-storytelling-template-js

Do you like to tell stories with maps and pictures? Well, this repo is for you. If you just want to take it for a test-drive first, just go use the hosted templates to build the app and let ArcGIS Online host it. If you want to make some deeper customizations, fork and clone the code to build a custom version of the template viewer. Either way, you still get a fully responsive app that lets you sync geographic points with images of your choice. There is a live example and a few other storytelling templates that you might want to check out.



## 3

## esri-leaflet

If you like Leaflet, then you'll love esri-leaflet. This project provides the plumbing to consume ArcGIS Online basemaps, services, and your own feature services using the Leaflet JS framework. If you are into geocoding, you should also check out the esri-leaflet-geocoder control. To see some examples of how it works, be sure to check out the live demos.

## 4

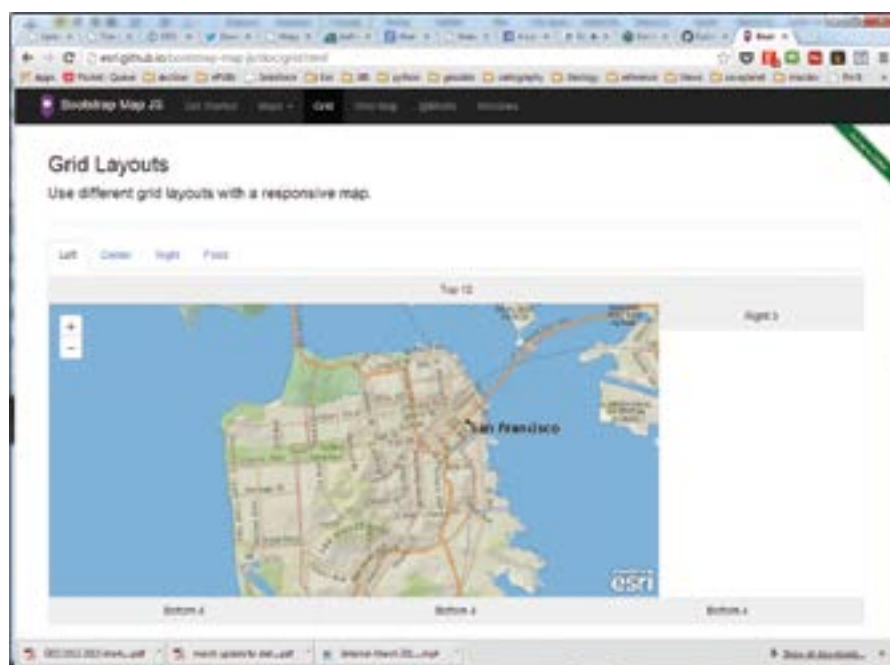
## arcgis-digit-geocoder-js

Ever wonder how to build a context sensitive geosearch widget? A lot of people don't know this, but all the source for the ArcGIS JavaScript Geocoder widget is available on GitHub. Behind the scenes, it uses the ArcGIS World Geocoding Service, and it autodisplays search results as you type. Fork and clone this repo to create custom versions of the geosearch tool.

## 5

## bootstrap-map-js

Looking for a fast way to build a nice-looking, responsive website with a map? Well look no further. This project shows you how to use the new Bootstrap 3.0 framework to build a killer website with a fully responsive map. Just add two files (bootstrapmap.js and bootstrapmap.css), and your maps will magically recenter, resize, and realign and work in the Bootstrap components. The map pop-ups are also uber-responsive too. Check out the live demos. If you are using Bootstrap 2.x and you want to stick with just Dojo, you might want to check out dojo-bootstrap-ui-for-maps-js. ➔



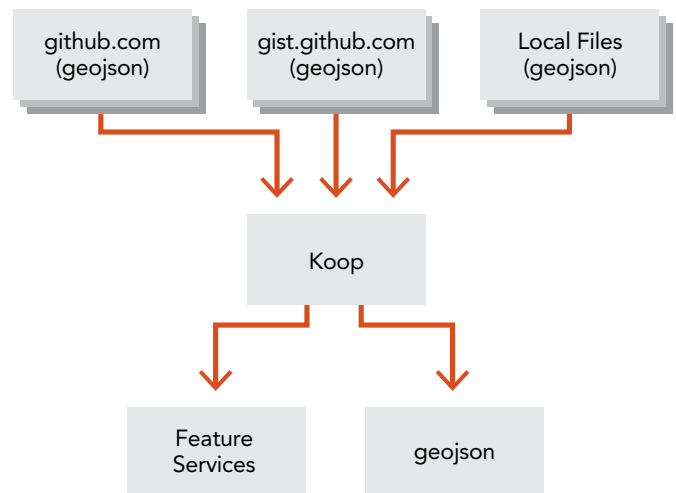
➔ bootstrap-map-js gives you a fast way to build a nice looking, responsive website with a map.



# 9

## koop

Need some help getting your GeoJSON services into ArcGIS apps? This provider makes it super easy to build a NodeJS app to access your own services and expose them as ArcGIS REST feature services so they can be accessed by other ArcGIS apps and APIs. Most of the plumbing is done for you so it is really easy to implement it with your own services. The repo has a few examples that illustrate how to expose feature services from gists, GitHub, ArcGIS Online, and Socrata. Pretty neat.

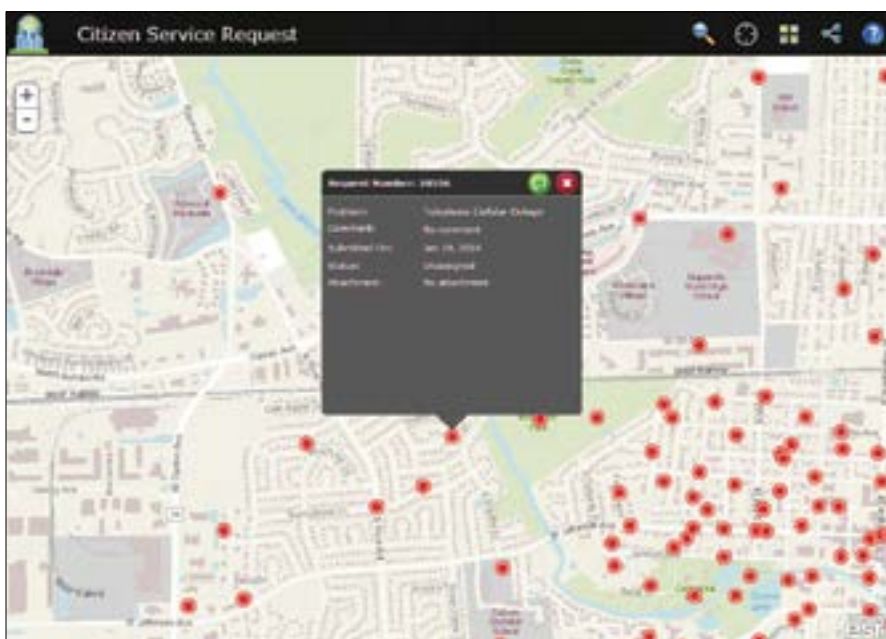


↑ Koop helps you get your GeoJSON services into ArcGIS apps.

# 10

## citizen-service-request

Looking to build an HTML 5 crowdsourcing application for citizens and government workers? If so, be sure to check out this JavaScript app that provides an out-of-the-box solution for just such a task. It allows citizens to submit, comment, and share requests on social media, and it gives government the ability to review them. Give it a try. If you are interested in other government apps and templates, be sure to check the local government repos on the [esri.github.io](http://esri.github.io) site. Visit [esri.github.io](http://esri.github.io) to search for more open-source geo projects.



← This JavaScript app, citizen-service-request, is an out-of-the-box solution HTML 5 crowdsourcing application for citizens and government workers.



# Supporting Agility, Growth, and Rapid Deployment

## ArcGIS for Desktop virtualization

By Dave Peters, Esri Manager for Systems Integration

ArcGIS for Desktop virtualization is not new.

Electric and gas utility companies have been using Remote Desktop Services (RDS) for remote client access to central hosted ArcGIS for Desktop applications (virtual application sessions) since the late 1990s. *[RDS, known as Terminal Services prior to the release of Windows Server 2008 R2, is a server role on a Windows Server that lets a user take control of a computer that the user does not have physical access or a virtual machine (VM) via network connection.]* This enables remote GIS editors to display and control ArcGIS for Desktop applications located in a central data center.

Citrix, building on its close development partnership with Microsoft, has led technology innovation in remote desktop windows application session virtualization over the last 15 years. Application virtualization technology isolates applications from the underlying operating system and other applications, thereby increasing the compatibility and manageability of those applications.

Remote client access to rich interactive mapping applications, such as ArcGIS for Desktop deployed in a centralized terminal server architecture, is an ongoing technical challenge that pushes the limits of both network connectivity and client interactive display performance. Esri has worked closely with Citrix over the years to identify optimum software technology solutions that satisfy customer needs for centrally managed ArcGIS for Desktop terminal services.

Today more than 50 percent of GIS organizations provide some

level of RDS to manage remote ArcGIS for Desktop operations. ArcGIS for Desktop application session virtualization enables server consolidation and thus reduces costs. Moreover, virtualization readily supports business agility, growth, more rapid deployments, and a unified and standardized IT infrastructure. This makes provisioning, securing, and testing systems easier. Centralized application management can also save on ArcGIS licensing costs.

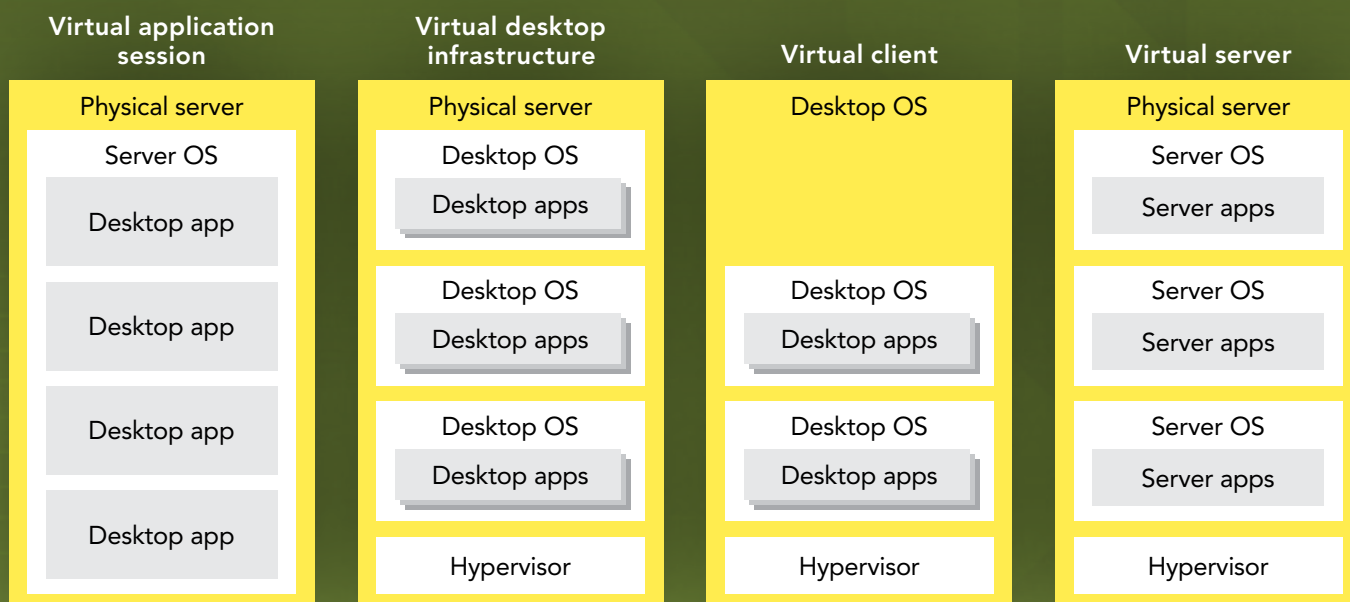
Esri development currently includes the Citrix XenApp virtual application session platform in formal testing and certification for each ArcGIS for Desktop software release, enabling full technical support engagement for customer deployment on the Citrix XenApp platform.

### What's New in Desktop Virtualization?

Virtualization technology is changing the way IT provisions and manages business operations. Global network bandwidth availability and regional wireless connectivity are improving user mobility. Operations are more fluid and dynamic. Users expect real-time access to GIS applications and data resources from more places and from an expanding variety of mobile client devices (laptops, tablets, and smartphones).

A fully capable virtual desktop infrastructure (VDI)—one that can deliver smooth, real-time remote user display visualization for





↑ Virtualization deployment options

graphics-intensive applications that are centrally hosted—is opening the door to a promising future for enterprise GIS operations. Cloud-based data centers that include both virtual desktop and server infrastructures can effectively integrate and synthesize information from many sources, facilitating communication and collaboration and breaking down communication barriers between institutions, disciplines, and cultures.

Esri is committed to delivering a completely integrated solution that leverages desktop, server, mobile, and cloud computing for

enterprise collaboration and sharing across the full range of physical and virtualized platform environments of the ArcGIS platform. GIS applications, including ArcGIS for Desktop, are an integral part of enterprise business operations.

Esri's performance engineering team works as a part of the ArcGIS development process to provide performance and scalability testing for each ArcGIS software release. The Performance Engineering test suite exercises all major areas of released ArcGIS technology including ArcGIS for Desktop, ArcGIS for Server, ➔

ArcGIS Runtime, and the new ArcGIS Pro application. This test suite benchmarks performance and scalability in a variety of physical and virtual deployment environments and is constantly updated by the performance engineering team and ArcGIS software developers.

Esri is working with key vendor partners—Microsoft, Citrix, VMWare, and NVIDIA—to advance virtualization and cloud technology for enhanced business and community operations.

### Microsoft Desktop Virtualization

Microsoft Windows Server 2012 and Windows 8 include many significant improvements in graphics remoting designed to provide a fast and fluid user experience in remote sessions. Microsoft has redesigned the graphics remoting stack (RemoteFX) from the ground up to adapt to various runtime conditions (such as graphics content types, CPU and network bandwidth availability, and client rendering speed.) New adaptive graphics for RemoteFX adjust to runtime conditions, providing a better balance between responsiveness, scalability, image quality, and bandwidth consumption.

VDI can host personal and pooled virtual machine desktops, session-based desktops, and RemoteApp programs. The Microsoft Remote Desktop App provides easy client access to VDI servers for a variety of client devices including Windows, Windows RT, iOS, Mac OS X, and Android.

### Citrix Desktop Virtualization

Citrix is the market leader in providing comprehensive enterprise desktop virtualization solutions. Citrix desktop virtualization enables businesses of all sizes to deliver the right type of virtual desktop for every user, every time.

With Citrix FlexCast delivery technology, companies can deliver virtual desktops and applications tailored to meet the diverse performance, security, and flexibility requirements of each worker

in an organization. Delivery models include server-based virtual desktops (XenDesktop) and on-demand applications (XenApp).

Citrix HDX technology provides advanced wide area network (WAN) optimization, adaptive protocol acceleration, and deep compression capabilities for superior virtual application and desktop accessibility from any device, over any network. This gives users a desktop experience that rivals that of a local PC. XenDesktop with HDX 3D Pro supports hardware-based graphics processing unit (GPU) sharing of OpenGL and DirectX applications for smooth graphics performance using NVIDIA GRID VGX technology for high-end 3D graphics-intensive user workflows. In addition, Citrix clients are able to leverage Microsoft Windows 2012 (XenApp) and Windows 8 (XenDesktop) RemoteFX capabilities within the Citrix solution.

### VMware Desktop Virtualization

Virtual server market leader VMware is expanding its offerings to include desktop virtualization and mobile computing. VMware delivers personalized virtual desktops (e.g., Horizon View) as a managed service that scales resources up and down to meet changes in demand.

Microsoft VDI, Citrix XenDesktop, and VMware Horizon View virtual desktop deployments leverage NVIDIA GRID VGX for optimum client experience with 3D desktop applications. NVIDIA GRID VGX offloads graphics processing from the CPU to the GPU in hosted virtual environments for optimum display performance. The rich graphic displays that ArcGIS 3D Desktop applications deliver perform best with hardware video card graphics rendering.

NVIDIA joint testing with Microsoft, Citrix, and the Esri performance engineering team is evaluating GRID VGX performance and scalability and promoting VDI solutions for high-demand 3D GIS operations.



## The ArcGIS Vision for Desktop Virtualization

The Esri development and performance engineering teams focus on evaluating and improving ArcGIS performance and scalability in desktop and server virtualization environments. It is a high priority especially because future ArcGIS for Desktop workflows will be more visual and resource demanding.

The new ArcGIS Pro is a 64-bit application that fully integrates 2D and 3D GIS operations and can visualize synchronized map displays in parallel. While placing higher processing demands on VDI services, this will introduce new business workflow opportunities. The ArcGIS Pro application is designed to take advantage of the Microsoft RemoteFX and Citrix HDX software enhancements, including full integration and support for the NVIDIA GRID VGS enhanced VDI processing architecture.

The future of GIS includes 3D, real-time visualization, and

virtualization of the environment. Organizations are building 3D virtual cities and a growing market for 3D visualization exists because 3D delivers a much better representation, and therefore a better understanding, of the world. This has always been what GIS is about. Desktop and server virtualization will continue changing the way GIS technology is both deployed and managed.

## About the Author

**Dave Peters** is author of the Esri Press book *Building a GIS* and the Esri instructor-led course System Architecture Design Strategies for Managers; the content author and principal instructor for Esri System Architecture Design Strategies training; and author of the System Design Strategies wiki site ([wiki.gis.com](http://wiki.gis.com)), which provides online resources for effective system design training and consulting services.

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# Slickrock Rescue

## Testing a multimodal emergency response network

By Mike Price, Entrada/San Juan, Inc.

Learn techniques for modeling time and distance travel on a multimodal network using ArcGIS Network Analyst. This exercise continues the saga of an emergency response team responding to a fictional incident on the Slickrock Bike Trail located just outside Moab, Utah, that began in the fall 2013 issue of *ArcUser* Magazine in “Creating and Deploying a Multimodal Emergency Response Network.”

The previous exercise showed how to create and test a multimodal network dataset that could be used for defining and accumulating emergency response personnel for wildland search and rescue (SAR) and emergency medical services (EMS) response. In this hypothetical incident, the homes of volunteer SAR and EMS personnel were mapped and routes from homes to assembly points were mapped to determine if sufficient personnel were available to effectively initiate and conduct a typical response.

This exercise will show modeling techniques for routing responders and safely transporting an injured mountain biker to appropriate medical treatment. Many of the components developed in the previous exercise will be used in this exercise. The previous Slickrock exercise applied certain assumptions to estimate response times. This exercise will use some of those assumptions and base many of the

procedures in this exercise on actual response data.

However, use the network dataset provided in the sample dataset, which has already been prepared and tuned. A hypothetical dispatch record will guide mapping of the response efforts using the ArcGIS Network Analyst extension.

This exercise begins by routing SAR and EMS responders to their base facilities in and near Moab then along the Slickrock Trail to the hypothetical victim’s location. SAR personnel will be tracked as they respond and transport the subject to a medical facility.

### Reviewing SAR Locations

To begin this exercise, go to the *ArcUser* website and download the sample dataset and unzip it on a local drive in a separate folder from any previous exercises in this series.

1. Start ArcMap 10.2 and open *Slickrock\_Rescue\_2014.mxd*, located in *\SR\_Rescue\*.
2. Inspect data layers and note the data sources. The map initially loads at a scale of approximately 1:40,000, but because it is in data view, not layout view, the actual scale will likely vary.
3. Choose Bookmarks from the Standard menu. There three

### What you will need:

- ArcGIS 10.2 for Desktop (Advanced, Standard, or Basic license level)
- ArcGIS Network Analyst extension
- Intermediate level skills with ArcGIS for Desktop
- Basic understanding of ArcGIS Network Analyst
- An unzipping utility (WinZIP)
- Sample dataset downloaded from the ArcUser website

bookmarks for 1:40,000-, 1:25,000-, and 1:15,000-scale display. (If the data extent does not match exactly, type the proper value in the scale window.) At 1:40,000, the entire study area will be displayed.

4. Right-click on the SAR Locations layer and open its attribute table. There are seven SAR locations, and each includes a short label [Label] and a longer label [LOC\_NAME]. The dispatch logs will reference each point using the [Label] field. Table 1 provides additional information about each point.

### Reviewing Responder Routes

1. Change the table of contents (TOC) display to List by Sources and look at the sources for the point data in the SAR Personnel and EMS Personnel Network Analyst layers.



↑ Open Slickrock\_Rescue\_2014.mxd, located in \SR\_Rescue\ and inspect the data layers.

Dispatch Code	Agency or Place-Name	Description
EOC	Grand County Emergency Management	The Emergency Operations Center (EOC) is located 3.7 miles (5.25 minutes) southeast of downtown Moab, and it is the operations base for Grand County Search and Rescue.
GCSO	Grand County Sheriff's Office	The Sheriff's office is located one block east of downtown Moab and houses law enforcement and emergency communication services for Grand County.
MRH	Moab Regional Hospital	The regional hospital is located 0.6 miles (2.0 minutes) west of downtown Moab. It provides critical and extended care for Grand County and southeast Utah.
BARN	Grand County Emergency Medical Services	The ambulance garage and EMS staging are located two blocks east of downtown Moab, behind the Grand County Courthouse.
PLOT	Slickrock Trail Parking Lot and Trailhead	The Slickrock parking lot and trailhead are located off Sand Flats Road, approximately 3.7 miles (9.6 minutes) east of downtown Moab. These provide the primary access to the Slickrock area for motorized and nonmotorized two-wheel vehicles and hikers.
HRTH	Hell's Revenge Trailhead	Hell's Revenge trailhead is located on Sand Flats Road, approximately 3.0 miles (7.6 minutes) east of downtown Moab. It provides the primary access for four-wheel motorized transportation throughout Slickrock area.
CLASSIC	Classic Lifeguard	Classic Lifeguard base of operations is located behind EOC, 3.7 miles (5.25 minutes) southeast of downtown Moab. It provides immediate short haul and patient transport services throughout the region.

↑ Table 1: SAR Locations



2. Activate the Network Analyst extension. Display the Network Analyst toolbar and dock it.
3. Open the Network Analyst window. Explore the travel routes for each of the SAR and EMS personnel by clicking on each one.
4. The previous exercise used a Closest Facility solver to determine ideal arrival order for eight SAR personnel and six EMTs.

This exercise will use earlier findings and calibrated dispatch logs to establish availability and response times. Get familiar with the call signs in Table 2. They are coded in the [Label] field for all response personnel, and they will be used throughout the exercise.

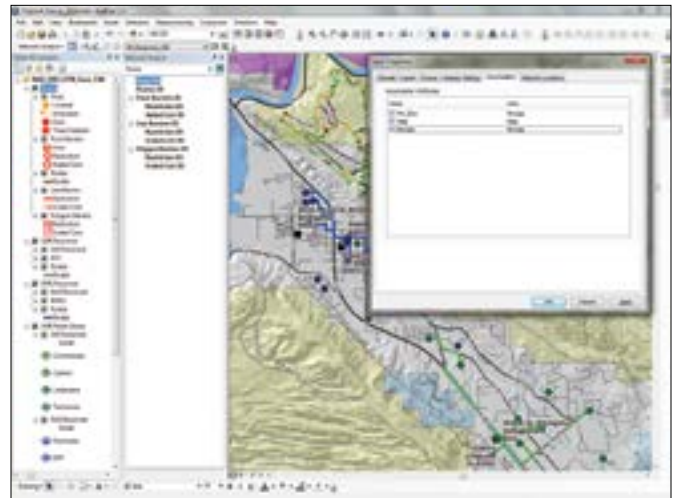
5. Save the project.

Agency	Call Sign	Status
GC SAR	SAR01	Technician
GC SAR	SAR02	Commander
GC SAR	SAR03	Technician
GC SAR	SAR04	Lieutenant
GC SAR	SAR05	Captain
GC SAR	SAR07	Technician
GC SAR	SAR08	Technician
GC SAR	SAR09	Technician
GC SAR	SAR11	Lieutenant
GC SAR	SAR12	Technician
GC SAR	SAR13	Technician
GC SAR	SAR14	Technician
GC SAR	SAR15	Technician
GC SAR	SAR16	Technician
GC EMS	EMS01	Paramedic
GC EMS	EMS02	Paramedic
GC EMS	EMS03	Paramedic
GC EMS	EMS04	EMT Advanced
GC EMS	EMS05	EMT Advanced
GC EMS	EMS06	EMT Advanced
GC EMS	EMS07	EMT
GC EMS	EMS08	EMT
GC EMS	EMS09	EMT
GC EMS	EMS10	EMT

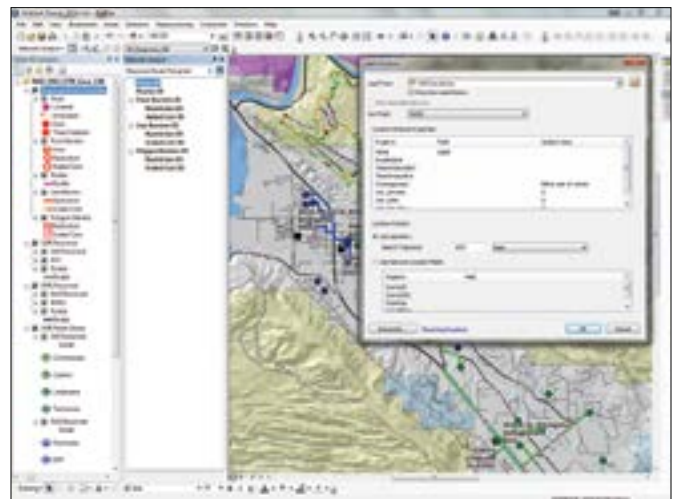
↑ Table 2: SAR and EMS Personnel

## Creating a SAR Locations Response Template

During an emergency, there is never enough time to carefully perform all necessary tasks. Creating a Route template for all SAR locations will improve this situation. This template can be quickly copied and response points added and deleted before calculating routes. Actual Slickrock incident response logs were used to calibrate response times for the Slickrock Trail and Jeep Trails networks. Two times were calculated: one for quick response to a victim (Minutes), and the other for slower return travel while transporting (Min\_Slow) the patient. Both times will be used to model the incident. By analyzing 12 recent Slickrock responses, it was determined that typical



↑ Creating a template that can be copied will speed routing.



↑ Load Stop Locations into the Response Route Template.

travel times out to an incident are approximately 25 percent faster than patient transport times.

1. Click the Network Analyst drop-down in the toolbar and select New Route.
2. Open the Route Layer properties. Under the General tab, rename the Route as Response Route Template.
3. Click the Accumulation tab and check Min\_Slow, Miles, and Minutes. Click Apply.
4. Right-click Routes under the Response Route Template, choose Properties, and click the Symbology tab. Change the route color to a bright color and enlarge it to at least two points.
5. Within Stops, change the Located symbol to a similar bright color. When using copies of the route template, the color of Routes and Stops can be modified to represent specific agencies.
6. Because Network Analyst sets colors by default, they should be updated when using the template. Leave the Response Route Template at the top of the TOC and select it in the Network Analyst window to make it the current Route solver.
7. Right-click Stops and choose Load Locations. In the Load

Locations dialog, set:

Load From: to SAR Locations

Sort Field: to Index

Search Tolerance: to 1,000 Feet

Click OK.

8. If all seven points do not load, create a new Route solver. This is very important so proper indexing is retained and the tolerance distance is increased. (A wildland search tolerance must often be much higher than an urban search tolerance.)
9. Save the project before copying the template.

### Using a Template to Create Many Routes

1. In the TOC, right-click Response Route Template and select Copy from the context menu.
2. Right-click the data frame name (NAD83\_UTM\_Zone\_12) and select Paste Layer(s). Repeat this step at least twice to create a set of four or more routes.
3. When finished, hold the Ctrl key to select all four new copies of the Response Route Template.
4. Right-click any single selected template, choose Group, rename this group Response Route Group, and leave it at the top of the TOC.

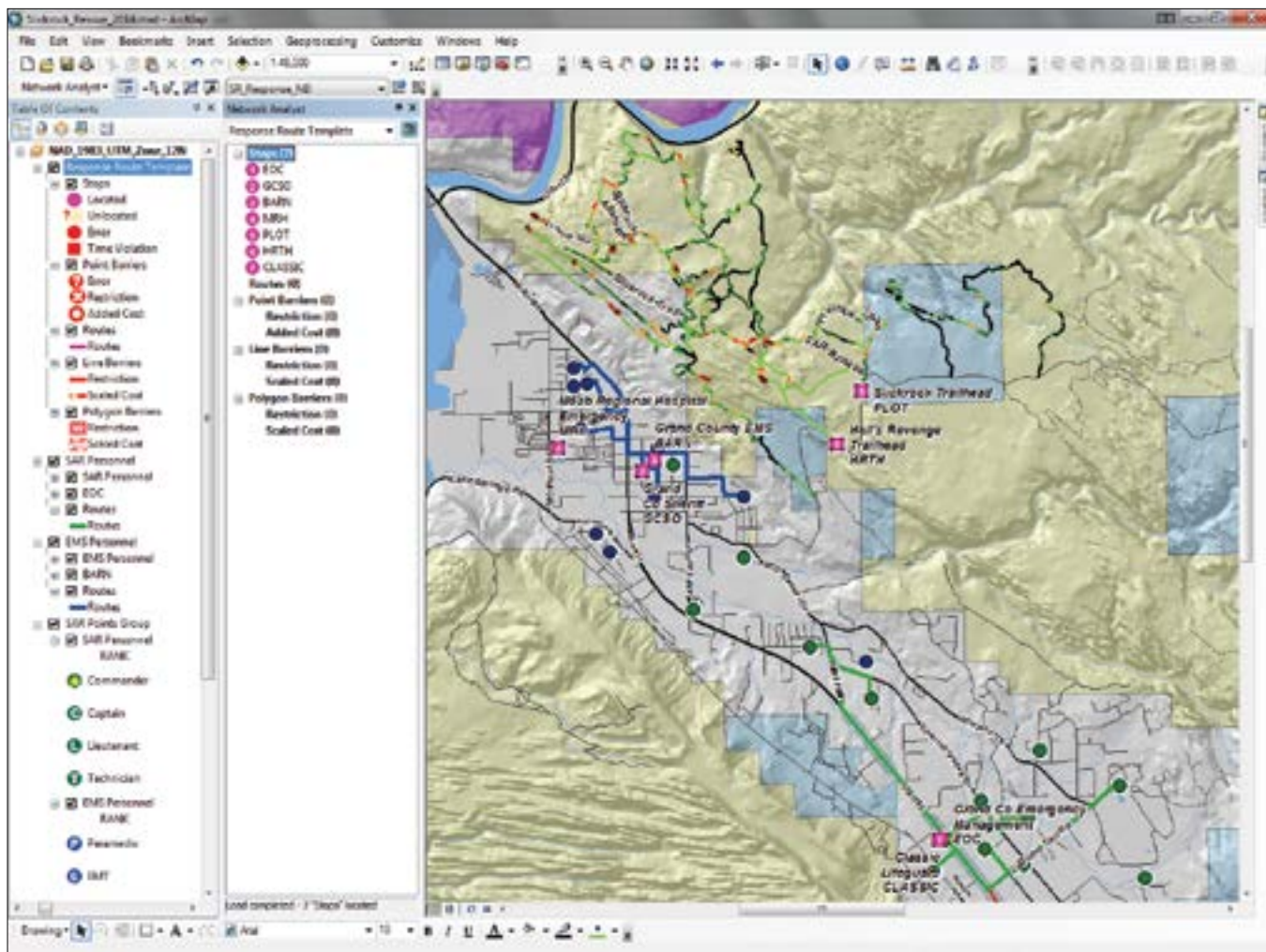
5. Rename the two topmost templates. Call the first on SAR Response to PLOT and the second EMS Response to PLOT. (Remember, PLOT is the dispatch code for the Slickrock Parking Lot.)
6. In the Network Analyst window, make SAR Response to PLOT the active route. Under Stops, hold the Ctrl key and select all points except EOC and PLOT.
7. Right-click any selected point and select Delete. Repeat this process for EMS Response to PLOT route, deleting all points except BARN and PLOT. Save the project to preserve these updated routes.

### The Incident Unfolds

Grand County (GC) Dispatch radio communication will be used to model and map emergency response. Radio logs list time, caller, and the text of information communicated. Table 3 lists the initial communication from GC Dispatch. In this hypothetical scenario, search and rescue personnel were notified that an accident had been reported on the Slickrock Trail and a response was requested.

The incident occurred on a Thursday morning in April. Skies were clear, and the air temperature at the time of the accident was in the high 60s. In the initial communication, Dispatch automatically ➔

↓ Make sure all seven stops load in the SAR Response to PLOT route.







↑ Delete all stops except EOC and PLOT for the SAR Response to PLOT route.

paged search and rescue before providing a preliminary voice description of the incident. The US National Grid coordinates were used to locate the accident and will be used to route to it. The 24-hour clock and Clear Text will also be used for communication. (Clear Text provides a common language to be used by communications centers and field units while responding to emergency incidents.)

Time	Call Sign	Communication Text
10:22	GC DISPATCH	SAR PAGED 1022
10:23	GC DISPATCH	MOUNTAIN BIKE ACCIDENT ON SR TRAIL AT LOCATION USING 12SXH26497426; CELL PHONE REPORT BY PARTY OF 6; REPORTING PARTY: SUBJECT IS MALE, AGE 24, WITH REPORTED ARM AND SHOULDER INJURIES; POSSIBLE CLAVICLE FRACTURE; SUBJECT IS CONSCIOUS AND COHERENT, WITH MODERATE BLEEDING FROM ABRASIONS

↑ Table 3: Initial report of incident

In the first four minutes, five SAR responders called en route, and the SAR Commander also requested an EMS page, which was followed with additional information at 10:26.





↑ Now right-click on SAR Response to PLOT in the TOC and choose Solve.



↑ After solving the SAR Response to PLOT route, use the Identify tool to check the travel times.

10:23	SAR05	SAR05 EN ROUTE TO EOC
10:24	SAR02	SAR02 EN ROUTE TO EOC; PAGE AMBULANCE FOR TRAVEL TO PLOT
10:24	SAR04	SAR04 EN ROUTE TO EOC
10:24	SAR13	SAR13 EN ROUTE TO EOC
10:25	SAR03	SAR03 EN ROUTE TO EOC
10:25	SAR05	SAR05 ARRIVED AT EOC
10:25	GC DISPATCH	AMB PAGED 1025
10:26	GC DISPATCH	AMBULANCE REQUESTED AT SLICKROCK PARKING LOT, WITH TWO EMTS; SINGLE PATIENT IS REPORTED AS MALE, AGE 24, WITH REPORTED ARM AND SHOULDER INJURIES; POSSIBLE CLAVICLE FRACTURE; SUBJECT IS CONSCIOUS AND COHERENT, WITH MODERATE BLEEDING FROM ABRASIONS; OVERLAND TRANSPORT IS LIKELY

↑ Table 4: Initial response by SAR

In the next four minutes, three EMS responders traveled to BARN and prepared AMB01 to respond. SAR personnel continued arriving at EOC, where they prepared for response to the PLOT. Use the resource accumulation Closest Facility analyses to verify the travel times. In the TOC, right-click Routes within the SAR Personnel Closest Facility solver and open the Routes attribute table. Stretch the table to fit and verify that records are sorted in ascending order by [FacilityRank]. Notice that Member SAR16 requires only 0.67 minutes (40 seconds) to travel to the EOC, while SAR01, the sixth responder to arrive, requires 3.18 minutes to travel to the SAR base. Use this procedure to validate response times for EMS responders. Remember that each responder will also require one to three minutes to reach his/her vehicle and begin travel.

Response protocol to this type of incident specifies at least four SAR personnel, traveling with two Polaris Ranger ATVs and at least two EMTs responding with one ambulance. ATVs transport all necessary personnel to the scene.

At 10:30, AMB01 responded from BARN and requested standby from Classic Lifeguard (CLASSIC) for possible air transport because the incident was located some distance along the trail. At 10:35, SAR\_1 departed from EOC, leaving one member at SAR to monitor the response. AMB01 arrives at PLOT, waiting for SAR arrival.

10:26	EMS04	EMS04 EN ROUTE TO BARN
10:26	EMS10	EMS10 EN ROUTE TO BARN
10:26	SAR02	SAR02 ARRIVED AT EOC
10:26	SAR03	SAR03 ARRIVED AT EOC
10:26	SAR04	SAR04 ARRIVED AT EOC
10:27	SAR13	SAR13 ARRIVED AT EOC
10:27	EMS03	EMS03 EN ROUTE TO BARN
10:28	EMS10	EMS10 ARRIVED AT BARN
10:29	EMS03	EMS03 ARRIVED AT BARN
10:29	EMS04	EMS04 ARRIVED AT BARN

↑ Table 5: SAR and EMT responders staging

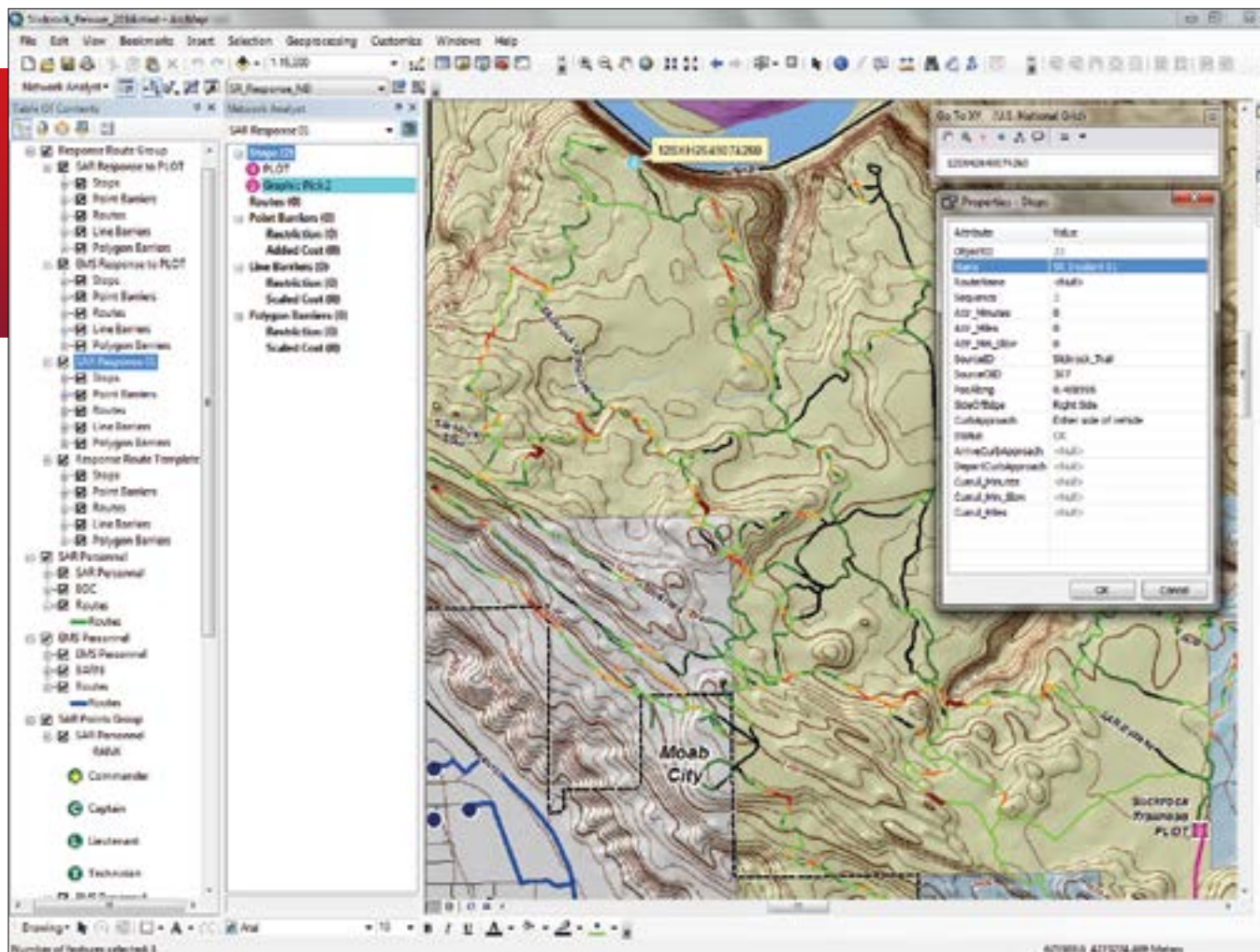
To model EMS and SAR personnel travel times from their respective bases to PLOT, right-click on SAR Response to PLOT and EMS Response to PLOT and choose Solve. After solving, check times by using the Identify tool to select the route. (Alternatively, the attribute table for each route could be opened, but it would take too much time.) Notice that Total\_Minutes and Total\_Min\_Slow are nearly identical for highway travel. Compare the radio log response times to modeled highway response times and note they are quite close.

10:30	EMS03	AMB01 EN ROUTE TO PLOT WITH PARAMEDIC AND 2 EMTS; REQUEST STAND BY OF CLASSIC LIFEGUARD
10:32	GC DISPATCH	CLASSIC PAGED 1032; CLASSIC STAND BY FOR POSSIBLE FLIGHT TO SLICKROCK TRAIL; POSSIBLE SINGLE PATIENT TRANSPORT TO MRH
10:34	CLASSIC1	CLASSIC IS STANDING BY AT EOC

↑ Table 6: Ambulance and air support

10:35	SAR02	SAR_1 IS EN ROUTE TO PLOT WITH 2 RANGERS AND 4 PERSONNEL; SAR03 REMAINS AT EOC.
10:39	EMS02	AMB1 ARRIVED AT PLOT; SAR_1 IS NOT AT PLOT
10:40	GC DISPATCH	CONFIRM AMB01 IS AT PLOT; STAND BY FOR SAR_1 WITH TWO RANGERS AND FOUR PERSONNEL; SAR ETA AT PLOT 1045

↑ Table 7: Status of responders en route



↑ First use the XY tool to drop a point at the location of the patient and then use the Callout tool to label that point.

SAR\_1 arrived at PLOT at 10:46 and prepared for the trip out on the Slickrock Trail, estimated to take less than 10 minutes. Because it is critical to map the incident, GIS-trained responders take control and use the template previously created.

1. Zoom in to Bookmark SR Response 1:25,000.
2. Right-click the next template in the stack, open its properties, and rename it SAR Response 01.
3. In the Network Analyst window, select and delete all stops for SAR Response 01 except PLOT. Save again.
4. The incident was reported at USNG coordinate 12SXH26497426. (Note the 10-meter precision in this address, which is very helpful.) To plot the incident, select the Go to XY tool on the Tools toolbar and use the tool drop-down to change coordinates to US National Grid. Type in the full coordinate and ArcGIS will change it to all uppercase.
5. Use the Add Callout tool on the XY dialog to display a label for the incident location. It is far out on the trail.

## Routing to the Incident

The simplest way to add the incident point to RS Response 01 route is

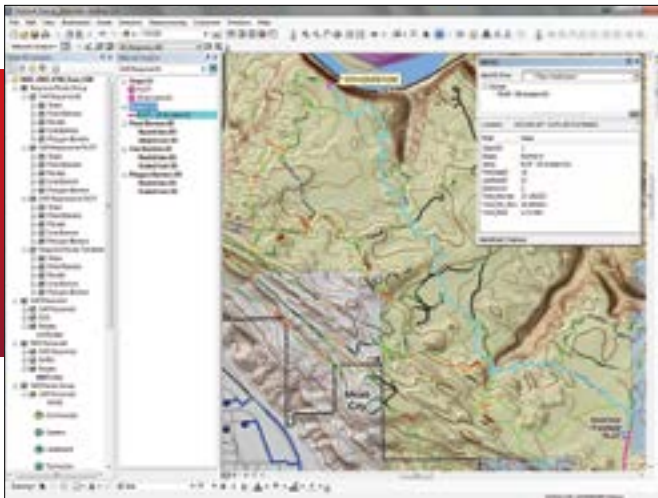
to use the Network Analyst Create Network Location Tool located in the Network Analyst toolbar.

10:46	SAR02	SAR_1 ARRIVED AT PLOT; SAR02 IS COMMAND; SAR_1 AND AMB01 PREPARING TO TRAVEL SLICKROCK TRAIL TO INCIDENT, USING SAR BYPASS
10:56	SAR02	SAR DEPARTING PLOT WITH 2 RANGERS, 4 SAR PERSONNEL, AND 2 EMTS
10:57	GC DISPATCH	AFFIRMATIVE ALL; REPORTING PARTY PROVIDES USING COORDINATES 12SXH26497426; LOCATION IS CONFIRMED AS ON MAIN TRAIL, ABOVE COLORADO RIVER ND BEYOND SHRIMP ROCK
11:00	SAR02	INCIDENT LOCATION VERIFIED ON MAP; ESTIMATED TRAVEL TIME TO LOCATION IS 40 MINUTES

↑ Table 8: Location confirmed and mapped

1. Use the 1:15,000 bookmark to zoom to the incident location and use the Create Network Location tool to drop a point on the Callout arrow.
2. Right-click on an incident point and open its properties. Rename it SR Incident 01. Save the project.
3. In the TOC, right-click on SAR Response 01 and choose Solve.





↑ Use the Identify tool to check the travel time from PLOT to the patient at the point labeled SR Incident 01.

After solving, save the project again.

4. Change the color of the new routes to better identify them. Use the Identify tool to compare travel times for Total\_Minutes and Total\_Min\_Slow. It would take the two responding rangers more than 25 minutes to reach the incident. Incident Commander for SAR02 relayed this information to Dispatch and the EOC.

### On Scene

SAR\_1 passed the Abyss Overlook and arrived on scene at 11:36. The patient was assessed, treated, and prepared for overland transport to PLOT. While EMTs assessed the patient, the SAR GIS technician modeled the best return route. Because the patient will be transported overland, the CLASSIC flight was canceled.

1. To create a return route, copy the current SAR Response 01 route and paste the copy back into the TOC.
2. Rename the copy to SAR Response 02. To reverse the travel direction, in the Network Analyst window under Stops, place SR Incident 01 above PLOT.
3. Right-click on SAR Response 02 in the TOC and choose Solve to create the modified route. Save the project again. Use the Identify tool on the return route. Notice that the travel time (Total\_Min\_Slow) has increased to nearly 50 minutes. ➔





11:11	SAR02	SAR_1 PASSING ABYSS OVERLOOK
11:36	SAR02	SAR_1 ARRIVED AT INCIDENT WITH 2 RANGERS, 4 SAR PERSONNEL, AND 2 EMTS; PERFORMING PATIENT ASSESSMENT
11:42	SAR02	PATIENT IS MALE, AGE 24, CONSCIOUS AND COHERENT WITH EXTREME PAIN IN LEFT SHOULDER AND LEFT ARM; FRACTURED CLAVICLE IS CONFIRMED, WITH NO OTHER DETECTABLE FRACTURES; PATIENT IS CONFIRMED FOR OVER LAND TRANSPORT TO PLOT AND TO MRH
11:43	GC DISPATCH	AFFIRMATIVE; CLASSIC LIFEGUARD IS CANCELED

↑ Table 9: Responders evaluated victim

## Getting to Moab Regional Hospital

At 11:47 SAR02 called in for the return trip to PLOT. SAR\_1 arrived back at PLOT with the patient at 12:37 and began demobilizing and loading the two Rangers. Available personnel quickly transferred the patient to AMB01 and prepared for travel to Moab Regional Hospital (MRH).

1. To calculate travel for AMB01 to MRH, zoom back to SR Incident 1:25,000. Make another copy of Response Route Template and paste it back into the TOC.
2. Rename the copied route EMS Transport from PLOT to MRH.

In the Network Analyst window, delete all stops except PLOT and MRH.

3. Right-click on the EMS Transport from PLOT to MRH layer in the TOC and choose Solve. Using the Identify tool, verify that the trip back to MRH, traveling through southern Moab, should require less than 12 minutes.

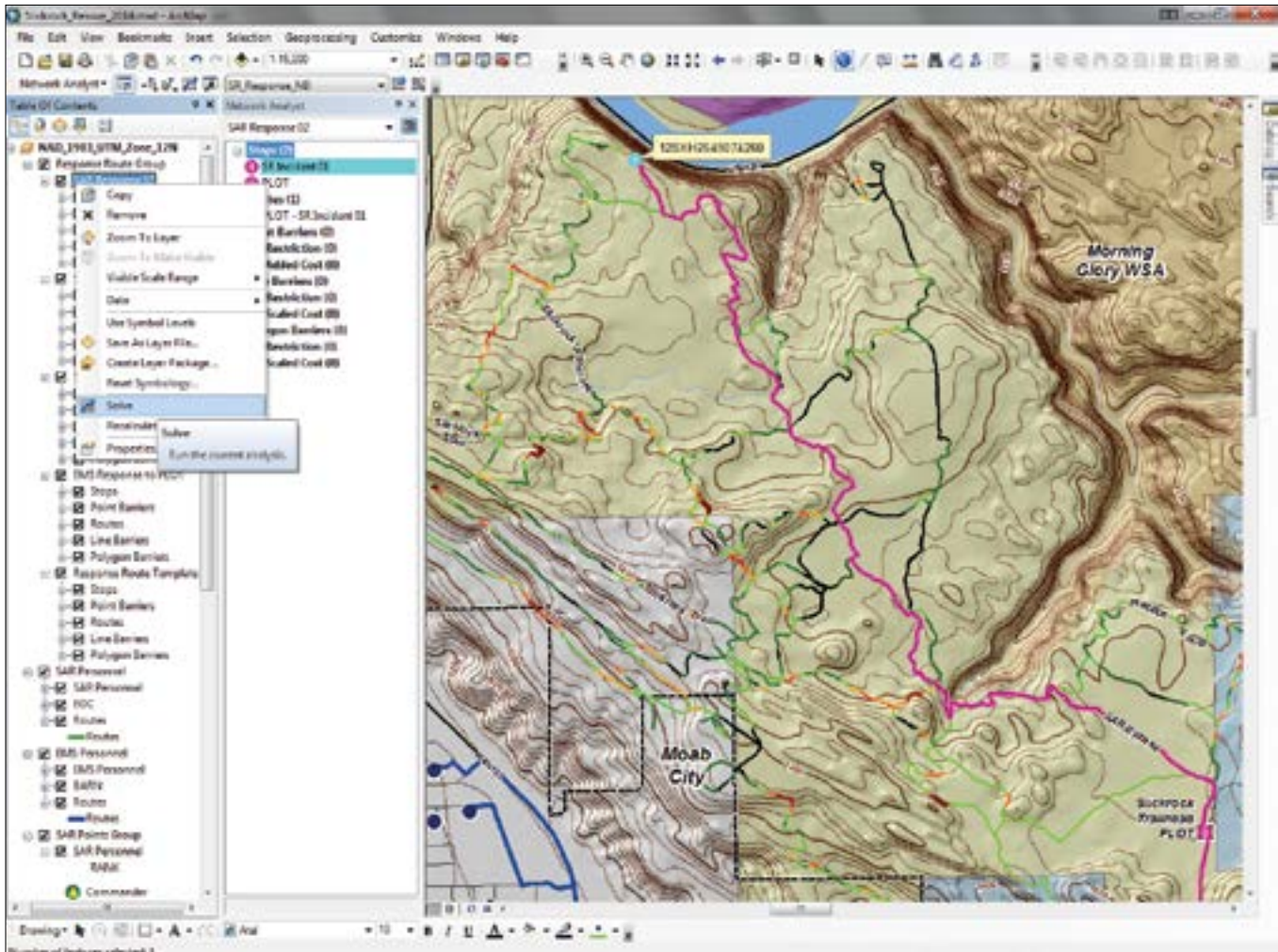
11:47	SAR02	SAR_1 DEPARTING INCIDENT WITH ONE PATIENT; ESTIMATED ARRIVAL AT PLOT AT 1240
12:37	SAR02	SAR_1 ARRIVED AT PLOT; AMB01 IS PREPARING FOR TRANSPORT; SAR_1 IS DEMOBILIZING
12:38	EMS03	AMB01 EN ROUTE TO MRH

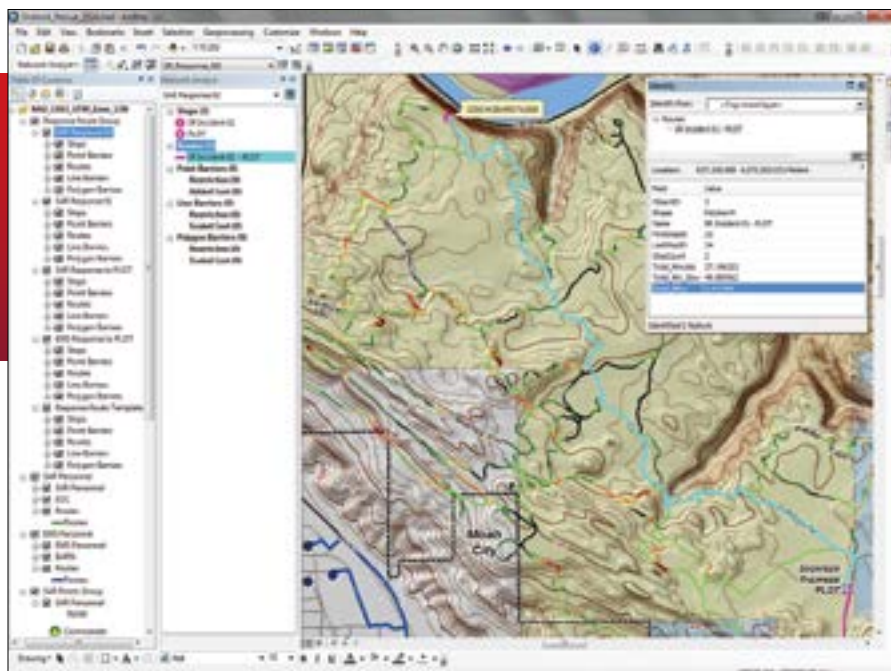
↑ Table 10: SAR departing with patient

## The Story Continues

After AMB01's departure for MRH, SAR\_1 continued to demobilize at PLOT until, at 12:43, an urgent message to all field personnel was relayed from GC Dispatch. A serious accident involving at least one Jeep and multiple casualties was coming in from Hot Tubs, a treacherous part of the Hell's Revenge Jeep Trail. Early information was

↓ Copy SAR Response 01, name it SAR Response 02, and swap the stops to reverse the direction of travel, then solve the route.





↑ Use the Identify tool to compare the travel time to the patient to the time required to transport him back to PLOT.

sketchy, and GC Dispatch advised all personnel to stand by and prepare to redeploy if necessary.

At 12:50, AMB01 arrived at MRH and transferred the patient to staff. Unfortunately, these responders were offline and not immediately available to respond to the new incident.

12:43	GC DISPATCH	GC DISPATCH TO ALL SAR AND EMS UNITS NOW IN THE FIELD: DISPATCH IS RECEIVING REPORTS OF A MULTI-CASUALTY JEEP ACCIDENT ON THE HELLS REVENGE TRAIL BEYOND THE HOT TUBS; HOLD POSITION AND AWAIT FURTHER INSTRUCTIONS
12:44	SAR02	SAR_1 IS AT PLOT; SAT_1 WILL PREPARE TO REDEPLOY ON SLICKROCK AND AWAIT FURTHER INSTRUCTIONS
12:44	EMS03	AMB01 IS TRANSPORTING TO MRH; ETA 12:50; AMB01 WILL MONITOR TACTICAL FREQUENCY WHILE EN ROUTE
12:45	GC DISPATCH	PRELIMINARY REPORTS INDICATE MULTIPLE CASUALTIES, POSSIBLY FOUR TO SIX SUBJECTS; CONTINUE TO STAND BY AND PREPARE TO REDEPLOY
12:50	EMS03	AMB01 ARRIVED AT MRH; TRANSFERRING PATIENT

↑ Table 11: As patient was transferred, a new incident was reported

## Summary and Acknowledgments

Again, the author thanks the agencies in Grand County that have supported the development of this response scenario and training set: the Sheriff's Office (including the Search and Rescue and Grand County Dispatch), Emergency Management, Emergency Medical Services, the Sand Flats Recreation Area team, and the Road Department. Their assistance contributed significantly to the overall quality and reliability of the network. The response protocol presented in this exercise was derived from actual search and rescue incident and dispatch logs.

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# Instantly More Productive with ArcMap

## 10 tips you can use today

These tips will help you accomplish common tasks more quickly.

	Description	Shortcut
1	Activate a data frame	Hold down the Alt key and click the data frame name.
2	Create a copy of a layer within the same data frame	Hold down the Ctrl key and drag the layer up or down. Select multiple layers and Ctrl-drag them all at the same time.
3	Move a layer to a different data frame	Hold down the Ctrl key while dragging it to the new data frame.
4	Zoom to the extent of a layer	Hold down the Alt key and click a layer name.
5	Open a layer's properties dialog box	Select the layer and press Enter.
6	Pan the map	Hold down the C key while any tool is active.
7	Zoom in	Hold down the X key.
8	Quickly open a table	Hold down the Ctrl key and double-click a layer or table in the table of contents or select the layer or table and press Ctrl+T.
9	Invert a selection in a table	Press Ctrl+U.
10	Toggle field sorting in a table between ascending and descending	Double-click a field name.

You can find these tips and many others in the ArcGIS for Desktop Help.





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# GIS Bookshelf



## Programming ArcGIS 10.1 with Python Cookbook

By Eric Pimpler

This is a Python book for GIS professionals who have a basic knowledge of Python or another programming language and want to optimize their workflows with Python. The recipes in *Programming ArcGIS 10.1 with Python Cookbook* will teach them how to create geoprocessing scripts with ArcPy, customize, create time-saving tools and scripts for ArcGIS, and modify ArcGIS with Python. Using these techniques will make GIS professionals more effective and efficient by automating geoprocessing tasks, better managing map documents and layers, finding and fixing broken data links, and editing data in feature classes and tables.

After introducing the fundamentals of Python programming using ArcPy in the ArcGIS environment, the book covers specific ArcGIS scripting for managing map document layers, automating map production and printing, finding and fixing broken data sources, and working with feature classes and tables. The next chapters deal with executing geoprocessing tools from scripts; creating custom geoprocessing tools; querying and selecting data; manipulating tables; and describing GIS data. The final chapters introduce customizing ArcGIS with add-ins and error handling and troubleshooting.

This is a practical book about getting things done. Numerous hands-on recipes will help save time and effort by using Python to turbocharge ArcGIS with scripts, tools, and customizations. Sections for each task follow a format that makes it easy to understand and remember. Each section explains not only what to do to accomplish a task but also why it is done and how it works. Warnings and tips are sprinkled throughout the book. Two helpful appendixes are included: "Automating Python Scripts" and "Five Things Every GIS Programmer Should Know." Packt Publishing, 2013, 304 pp., ISBN: 978-1849694445

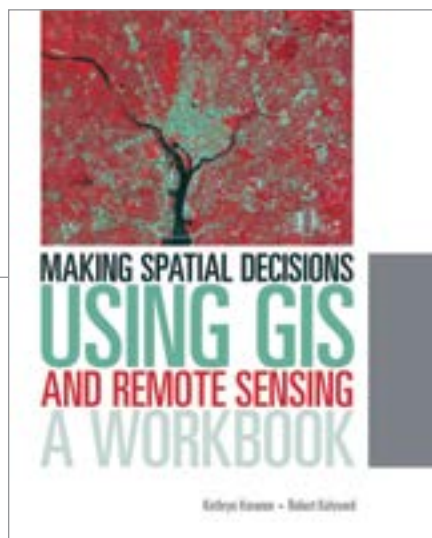


## Geospatial Technologies and Advancing Geographic Decision Making: Issues and Trends

By Donald Patrick Albert

*Geospatial Technologies and Advancing Geographic Decision Making: Issues and Trends* has policy analysts, academicians, and geospatial practitioners as its target audiences. This book, authored primarily by academics, is divided into two sections. The first presents an overview of the philosophy, education, training, and prospects for those in or entering the applied geospatial industries. The second section provides examples of application domains within applied geospatial research. The examples cited focus on the calculation of statistical and spatial analytic measures that benefit decision making in the areas of emergency response, transportation planning, epidemiology, retail site selection, and urban planning. IGI Global, 2012, 423 pp., ISBN: 978-1466602588

# Making Spatial Decisions Using GIS and Remote Sensing: A Workbook



This college-level textbook gives students skills and knowledge that will help them incorporate GIS and remote sensing into decision making as they pursue careers in government, business, and other organizations. With that in mind, exercises are presented as scenarios. These lessons focus on employing a GIS workflow that documents the process and systematically approaches solving the problem.

*Making Spatial Decisions Using GIS and Remote Sensing: A Workbook* is the first workbook to highlight the image processing capabilities in ArcGIS software. Designed to complement remote-sensing textbooks in an undergraduate curriculum, this workbook teaches students image processing and analysis skills with ArcGIS 10.1 for Desktop. It assumes some prior knowledge of GIS but will teach how those capabilities are used with remotely sensed data.

The modules move from exercises that provide a better understanding of various types of imagery to ones that use imagery in GIS to measure change caused by urban development and drought. Each module contains two scripted projects and a third “On your own” project that requires students to select a problem and study area and apply the techniques learned in the previous projects.

An accompanying DVD contains the Landsat imagery, maps, and worksheets required for the projects. Students can download a trial version of ArcGIS 10.1 for Desktop Advanced software that is good for 180 days. Instructor resources are available.

The authors Kathryn Keranen and Robert Kolvoord are both educators and previously authored another Esri Press book, *Making Spatial Decisions Using GIS*, which was published in 2011. Keranen is an instructor at James Madison University, the cofounder of the dual enrollment Geospatial Semester, and a curriculum writer. Kolvoord is a professor at James Madison University, where he also serves as the interim dean of the College of Integrated Science and Engineering. He is a researcher and curriculum developer. Esri Press, 2014, 263 pp., ISBN: 978-1589483361





# Geoempowering Design

Creating an ideal relationship between man and nature

By Carla Wheeler, Esri Writer

Kongjian Yu, the keynote speaker at the 2014 Geodesign Summit, January 29–30, 2014, in Redlands, California, is the son of a Chinese farmer. He grew up on a commune working in the fields with his father until he left for college at age 17. Today Yu, 50, is a well-respected, award-winning urban designer and landscape architect. His firm, Turenscape, turns neglected land and polluted waterways into wetland parks filled with flowers and teeming with fish and birds.

Yu showed photographs of these lush parks during his address. He urged adoption of a fresh way of thinking about landscape architecture and design. He advocated using geodesign, which incorporates design, geography, and geospatial technologies such as GIS, to help create an ecological infrastructure for communities.

An ecological infrastructure reflects the natural environment rather than something built out of concrete and steel. Many of Turenscape's park projects in China let nature take its course. Rather than diverting storm water from a river during the rainy season with pipes or channels, it's captured and filtered in ponds in a terraced wetland system. Areas that flooded historically are allowed to flood again. Nature takes hold and reeds and flowers

spring to life. Birds flock to these wetlands again and so do the bird watchers, Yu said.

"Design for an ecological infrastructure to create an ideal relationship between man and nature," said Yu. "It's a new way to make a beautiful landscape."

## Geoempowering Design

Yu and a roster of other speakers gave presentations to nearly 300 people from diverse fields such as architecture, urban design, ecology, health, banking, biology, mining, and marine science. Nearly half were new to the event, now in its fifth year. Geodesign Summit organizers believe this reflects a deepening interest in geodesign.

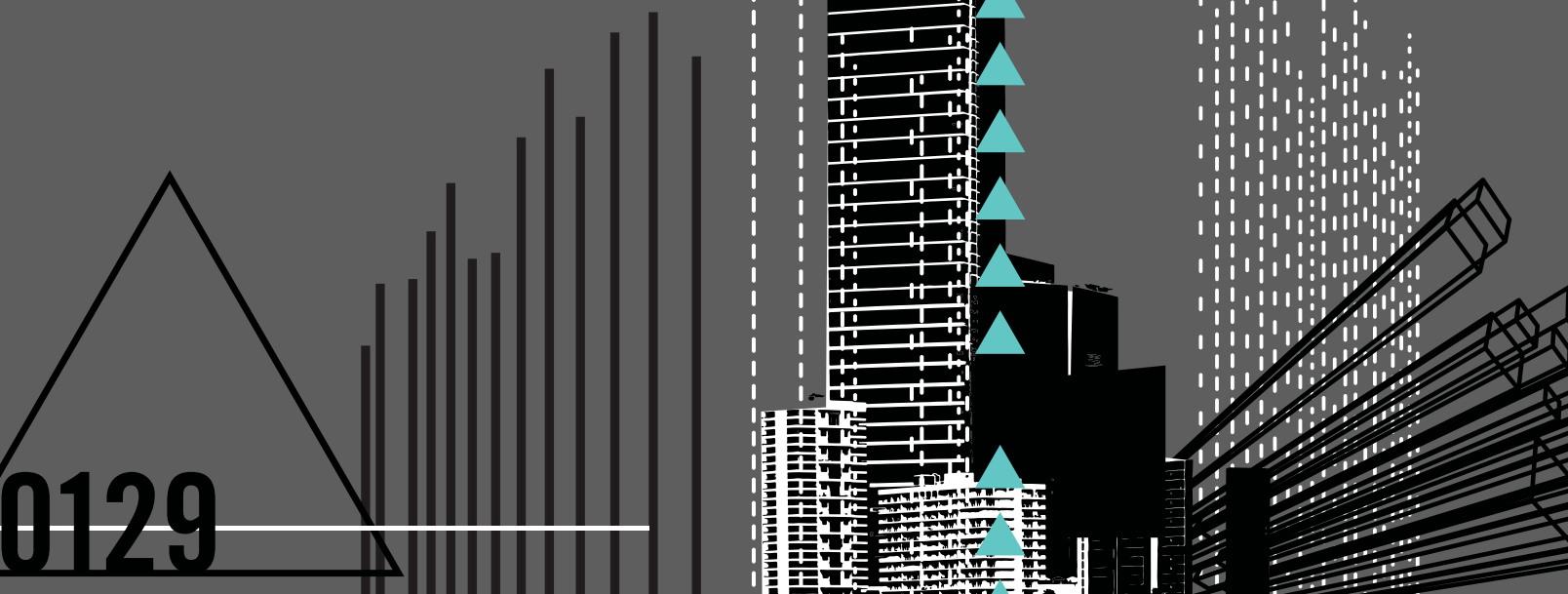
Emcee Thomas Fisher, dean of the College of Design at the University of Minnesota, said the definition of geodesign continues to evolve but offered one of his favorites. "It's a marriage of the incredible spatial power of GIS, geography, and design. It marries the data-rich analytical power of GIS with the creative synthesizing methods of design. GIS helps us understand what is and design what could be."



↓ Kongjian Yu, the keynote speaker at the 2014 Geodesign Summit, urged his audience to work with nature using geodesign techniques. His firm has used geodesign to transform neglected and polluted areas into wetland parks.



"Design for an ecological infrastructure to create an ideal relationship between man and nature."



Esri president Jack Dangermond spent about 30 minutes outlining why he thinks using geodesign—whether in urban planning or other fields—will be a linchpin in solving sustainability issues including the effects population growth are having on land use and climate. “What is the counterbalance to these trends?” he asked. “I think it’s in this emerging world of geodesign. Collectively, we need to create a better future.”

Dangermond said GIS technology is essential to geodesign. “GIS provides a platform for the integration of science, providing the practical means for geoempowering design.”

Esri staff gave a short demo of the geodesign tools in Esri CityEngine, which creates 3D models of buildings and entire urban landscapes using procedural rules. Eric Wittner, Esri 3D technology evangelist, and the 3D team also previewed the 64-bit ArcGIS Pro, a powerful 2D and 3D visualization, editing, and analysis application that will be part of ArcGIS for Desktop. The first release of ArcGIS Pro is slated for later this year and will mainly offer 2D and 3D visualization, support for analysis, and simple feature editing. Subsequent releases will offer additional capabilities.

Esri technology evangelist Bern Szukalski demonstrated a new browser-based web app called Esri Landscape Planner that will be available soon in ArcGIS Marketplace. This ArcGIS Online powered app contains sketching and analysis tools and gives

designers the ability to bring in landscape and demographic layers and imagery. The app also lets them collaborate and edit designs. Szukalski used the app’s tools to sketch a park and a proposed light-rail line in a town. “I think this will be an exciting piece of technology to add to your geodesign portfolio,” he said. “Landscape Planner helps put all the pieces together to create a true, open geodesign platform.”

## Designing with Nature in Mind

Though technology was front and center at the conference, the idea of designing with nature in mind was omnipresent. Renowned biologist and natural sciences writer Janine Benyus took the stage to talk about biomimicry, the science that studies how nature can provide inspiration for innovation. It can provide a model for landscape and urban design.

“I live in the Bitterroot Valley in western Montana,” she said, showing pictures of the bucolic rural countryside. “It’s so healthy . . . when I walk back there, I see what we could be,” she said.

Benyus said much can be learned from nature about how to design for urban areas. “It’s nature as mentor,” said the author of the book *Biomimicry: Innovation Inspired by Nature*. “What would it take for a city to function as elegantly as a forest?”

She spoke about how plants and animals adapt to a changing



↑ GIS provides a platform for the integration of science, providing the practical means for geoempowering design.





and often harsh environment, using a 1,500-year-old tree with strong, deep roots and branches that are designed to shed as an example of the resiliency in nature. “That 1,500-year-old tree—it has seen many hurricanes,” she said. “Generosity is one of the standards of nature. How does nature create more and more opportunities for life?”

In a follow-up conversation with Dangermond and Fisher, Benyus said that metrics need to be collected to create ecological performance standards for designing sustainable cities. She envisions the creation of a biological information repository that inventors, designers, and others involved in biomimicry could access to obtain information about their areas of interest. Benyus said she looked forward to learning more about GIS and the role it could play in developing and hosting such a repository.

### The Art of Survival

Keynote speaker Yu learned to use GIS two decades ago. Today his staff at Turenscape uses ArcGIS for topographic modeling and analysis. Before he founded Turenscape in 1997 and became professor and dean of the College of Architecture and Landscape Architecture at Peking University, Yu attended Harvard University, where he earned a doctor of design degree at the Harvard Graduate School of Design. He also interned at Esri, where he

worked in the prototype lab.

Yu said geodesign using GIS technology is essential to the work of his company, which has completed 1,300 projects in 200 cities including China Town Park in Boston. But he credits his early years working on the commune with providing him a grounding in geography, topology, and soil. The words *Tu Ren* in his company’s name, Turenscape, mean “earth man.”

The man did not really wander far from the farm. “Many of these designs are inspired by my experience on the farm,” said Yu. “In the city, you don’t know how to grow rice. You don’t know how to work with dirt, you don’t know how to irrigate.”

He said he and Dangermond are sympatico when it comes to believing that geodesign will change the world for the better and our survival depends upon it. For example, geodesign was used for the Shuicheng River and Minhu Wetland Park project his company worked on in Liupanshui City, China. There, storm water is no longer diverted away from the river. Water no longer goes to waste. A once-polluted waterway is fishable again. People stroll along walkways that wind around terraced ponds. Beautiful orange flowers blossom around the wetland’s perimeter.

“Now, it’s become a beautiful place,” said Yu. “People love it. The biodiversity has increased. It has now become a national wetland.”



↑ An angler fishes in the Shuicheng River in Liupanshui City, China. As a result of a restoration project by Yu’s firm, the once-polluted river was cleaned up and the waterway and the Minhu Wetland Park were restored. Photo courtesy of Kongjian Yu/Turenscape.

# GIS AND Genealogy

## Teaching GIS while learning about the past

By Robbyn J. F. Abbitt and Glenn M. Julian, Miami University, Oxford, Ohio

This article describes how GIS students helped one of the authors with a genealogy project to trace the movements of his ancestors during the 19th century. Genealogists like to track the movement of ancestors across the land. Identifying when these people lived in specific places can reveal much about their daily lives. GIS techniques can provide a powerful tool for locating these places in space and time.

After retiring from teaching physics at Miami University in Oxford, Ohio, Glenn Julian (one of the authors) took up his father's hobby of researching family history. Julian spent nearly 10 years in researching family records, history, and land records in county libraries and deeds recorded in county court houses. He learned that his great-great grandfather Isom Julian (1795–1885) and great-grandfather George Julian (1812–1906) moved from Rutherford County, North Carolina, to Blount County, Tennessee, about 1816.

Tennessee was formed in 1796 from the western part of North

Carolina. Blount County was surveyed beginning about 1806 using metes and bounds. Julian learned that Isom and George continued moving southward into McMinn, Hamilton, and Bradley Counties as those counties were formed.

### Adding GIS to the Search

Julian thought he knew approximately where the farms owned by his forebears were located (although that turned out to not always be true). He was intrigued by the thought of actually standing on the land. Because the land has not changed greatly in the intervening two centuries, he wanted to see the view that his great-great-grandma saw when she stepped out of the cabin door in the morning to feed her chickens.

At the suggestion of a faculty colleague, Julian contacted Robbyn J. F. Abbitt for assistance in locating the farmlands of his forebears. Abbitt advises Miami University's GISci certificate program and teaches entry- and advanced-level GIS courses with a focus on real-world applications. In these courses, students use the most current version of Esri's ArcGIS for Desktop software (Advanced license level). For advanced students,

she provides instruction and coaches students in two types of assignments: semester-long GIS projects undertaken by an individual student or by a team of three or four students, who advise a client's major GIS project. Over a period of three semesters, individuals and teams helped trace Julian ancestors in three Tennessee counties.

### Historical Background

A series of treaties with the Cherokee opened up east Tennessee lands for legal settlement by people of European descent. Settlers were allowed to enter a claim for a tract. Upon paying an entry fee and occupying the tract, they were subsequently granted title to the claim by the state.

With the 1819 signing of the Calhoun Treaty, the US federal government bought a vast block of land known as the Hiwassee Purchase. The boundaries of the Hiwassee District included the Hiwassee, Big Tennessee, and Little Tennessee Rivers and enclosed McMinn and other counties.

Following the 1836 Treaty of New Echota,



Isom and Betsey Julian





↑ Claims of the Julians, Smiths, and Bonds in McMinn County (circa 1840) located by creating a fishnet grid to replicate the Hiwassee district and overlaid on the Esri World Imagery basemap.

the Cherokee were removed from their last major block of lands in Tennessee. This area, known as the Ocoee District, extended to the border with Georgia and included Hamilton, Bradley, and other counties.

Both districts were surveyed in a public domain grid of six-mile-square townships that were further subdivided into 36 one-mile-square sections of 640 acres. Sections were further divided into tracts. A quarter section consisted of 160 acres.

The grid lines of the Hiwassee District paralleled lines of latitude and longitude. However—apparently to align somewhat with the Tennessee River—the Ocoee District was surveyed with a grid tilted at 20 degrees from the lines of latitude and longitude.

## McMinn County Julians

A team of three GIS students worked with Julian to locate his ancestors' claims in McMinn County, which is located in the southeast corner of Tennessee.

Julian's great-great grandfather, Isom Julian, a circuit-riding Methodist Episcopal minister, was sent out as the first missionary from his church in Blount County. In 1833, Isom, his wife Betsey, two daughters, and four of their five sons moved to McMinn County. This was also the county where his father-in-law, Robert Patterson, had already entered a claim in 1825.

Isom's claim was described in terms of the Hiwassee Survey as the southwest quarter of Section 32 of Township 4, Range 1 East (Section 32, T4 R1E) of the north-south Principal Meridian of the Hiwassee District, which passes about three miles east of Athens, Tennessee.

Julian identified the claim for the farm of Isom's son George, who was also a circuit-riding minister. George established the claim when he married Mourning Smith in 1836. George's son, Robert Patterson Julian,

married a woman named Bond. Julian found earlier claims for both the Smith and Bond farms but could not find where they were located.

The only map he found that showed both the Hiwassee Survey grid and features on the ground today was a Cherokee National Forest map of 1994. This map was based on an 1851 hand-drawn map of the Hiwassee District. At the GIS office in the McMinn County courthouse, Julian was told that no accurate record existed of the location of the Hiwassee grid lines.

However, studying aerial images, such as Esri's Online World Imagery basemap, revealed that the old survey lines are still visible on the ground as the borders of fields and woodlands. Although interrupted by later subdivisions, they extend for many miles in a checkerboard pattern. Pinpointing his forebears' claims would require identifying these squares.

Abbitt's GIS students worked with him to locate these claims. They used the Create Fishnet tool in ArcMap 10.1 to create a uniform grid of polygons that were one mile square. The students then adjusted this fishnet to match the section lines on the 1994 Cherokee National Forest map. By looking at current aerial images, students could infer the locations of claims in particular sections and townships as they were numbered in 1851. This led to the inference that Isom's claim was located where, today, the town of Etowah, Tennessee, stands. However, this would have meant that his ancestors farmed on the side of a mountain—not a good place for subsistence farming.

Then Julian noticed that the 1825 claim by Isom's father-in-law Robert Patterson was in T6 R1W. There was no T6 on the 1851 map. From the Tennessee State Library and Archives, Julian obtained a copy of the 1836 Tax Map for McMinn County. It showed that the numbering of townships in 1836 was different from the numbering in 1851 that was shown on the 1994 National Forest map.



After allowing for this discrepancy, students could identify the actual locations of the claims by Isom and George as well as those of James Smith and Peter Bond (whose children had married into the Julian family). All claims were six miles north of the previously identified sites. The claims were actually located on land suitable for farming and were laid out one to three miles apart, well within courting distance. Julian realized that he would not be here if Isom had chosen a different location for his farm.

### Hamilton County Julians

A student used georeferencing and aerial imagery to locate land claims owned by George Julian and his brothers that were located in and near Tyner, Tennessee.

Between 1839 and 1842, George and his brothers, Samuel and Marsena, moved from McMinn County and entered claims for land newly opened for settlement in Hamilton County. These claims were in Fractional Township 5N, R3W of the Ocoee District meridian, which passed near Cleveland, Tennessee. As towns were formed in this area, Julian lands adjoined the towns of Tyner and Chattanooga.

Julian's father inherited one of George's original grant documents. At the Cleveland and Chattanooga libraries in Tennessee, Julian found microfilmed records of these land grants. From the Tennessee State Library and Archives, he obtained a map (circa 1842) of the grants, but unfortunately it did not show features on the ground.

However a huge, rare 1928 plat book found in the Chattanooga Public Library included both the Ocoee Survey grid and modern features on the ground in the area. It is dramatically clear from the plats that today's roads in Tyner follow the 20-degree tilt of the Ocoee District survey. A GIS student used ArcMap to georeference the old grant map to current road intersections in a digitized image from the plat book.

By 1850, George had sold his original grants north of Tyner and moved west of the Tennessee River. Most of the records of these transactions were lost after federal troops passed through the area following the nearby Battle of Missionary Ridge in November 1863. In 1858, George returned to the Tyner area. He bought land in downtown Tyner, where he lived during the war, moving to Bradley County in 1870.

The georeferenced reconstruction of George's land in and near Tyner, superimposed on a current aerial image of the area, shows that the original grants of George and his brothers were located at the site of the new Chattanooga Volkswagen plant.

### Bradley County Julians

A student team re-created portions of a survey grid in ArcMap to georeference the deeds owned by Julians who moved to Bradley county.

In about 1848, Isom and his son Robert Patterson Julian moved with their families from McMinn County to Bradley County in the Ocoee



George and Mourning Smith Julian

District. They settled in the Chatata Creek Valley northeast of Cleveland, Tennessee. Isom continued preaching, and his son, R. P., operated a water-powered sawmill. By 1870, both George and his brother, Samuel, had moved from Hamilton County to join them in Bradley County.

A team of three students read the locations of the Julian farms from copies or transcriptions of original deeds. An important lesson they learned is the deeds contained errors (a wrong quarter-section) and omissions (missing section numbers) that had to be corrected before the farms could be located. Bradley County tax maps from 1966 still noted the corners of Ocoee Survey Sections. The team used the Create Fishnet tool to re-create portions of the Ocoee District survey grid and georeference the deeds. They noticed that many modern property boundaries still reflect the Ocoee Survey grid lines.

### Pedagogy

The Hamilton County study was the first one performed. It was carried out by an individual undergraduate student who was a botany major. The other two studies of McMinn and Bradley Counties used a team approach. Abbitt formed each team a few weeks into the semester after assessing the students' GIS skills. Each team had at least one graduate student.

She had students play the role of professional consultants to a GIS client. Although she did not interact directly with the client, that did not necessarily save her time. The client understood that students were



learning GIS techniques, but she also gave him an idea what the students were capable of doing.

The client, Julian, was a genealogist with no previous GIS experience. He attended some progress report oral presentations by the student working on the Hamilton County study to learn what the student could do with Esri software and gauge how well the student understood data on his family.

Students held one inaugural meeting with the client, worked out how they would share tasks, maintained e-mail contact with the client, and held a summary meeting with the client near the end of the semester before the final report and presentation to an audience. As with any team effort, students vary in motivation and participation, so Abbitt allowed both the client and teammates to provide some input on students' grades.

This approach offers considerable promise because students will need to work in teams after graduation. GIS has grown tremendously over the past 10 years. Using these approaches exposes students to GIS techniques that they may not learn within a structured classroom setting. Thus far, the experience has been very positive for both students and clients. Many clients, like Julian, have been repeat customers.

## Acknowledgments

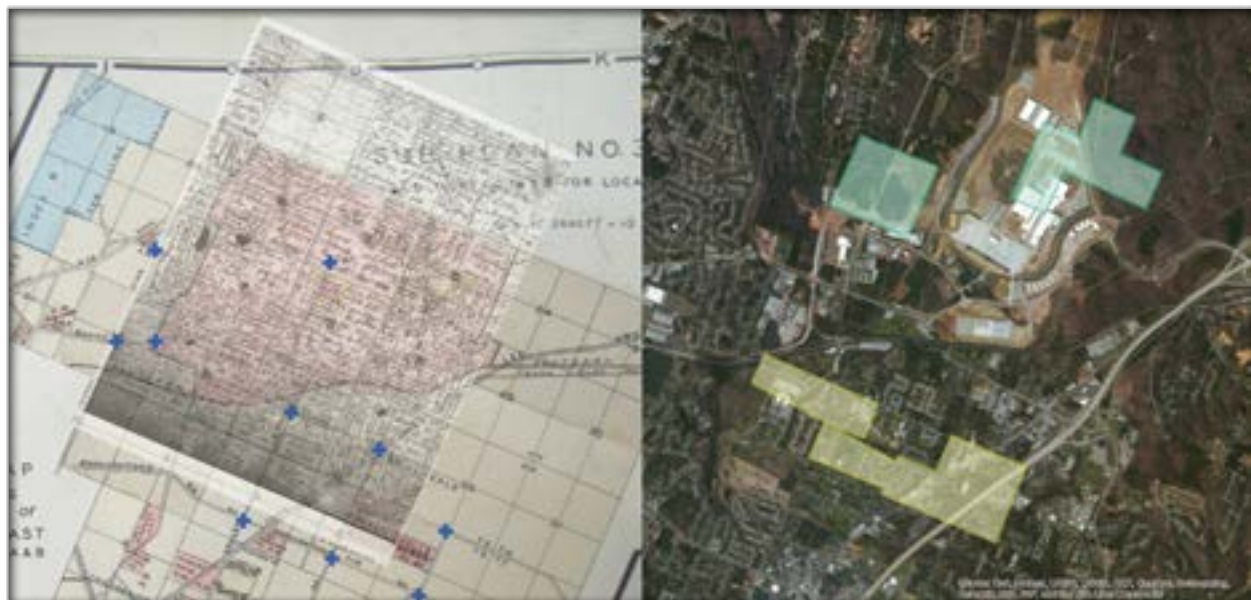
Special thanks to the Miami University GIS students who worked on these projects: Joseph F. Lawrie, Lori Kelly, Daniel Pearlman, Jacob E. Young, Kelly Adelman, Michael Dennis, and Emma Troesch.

## About the Authors

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✦ A grant map (circa 1842) (left) overlaid on a 1928 plat book map, with grid corners marked for georeferencing. The reconstructed tracts (right) owned by George Julian in Tyner, Tennessee. Grants circa 1842 are shown in green, and grants from 1858–1879 are shown in



# Seven Best Practices

## For georeferencing historic maps and data

By Robbyn J. F. Abbitt and Joseph F. Lawrie, Miami University, Oxford, Ohio

Often, when locating historic places, we have either a paper with a location description (road name, township and range, acreage, owner) or an old (typically hand-drawn) map of the area with owners' names written inside property outlines. In either case, to locate and map the historic information, we must match the description or map with georeferenced digital information.

Scale is a consistent concern with all data. Georeferencing a large-scale dataset (e.g., 1:1,000) to a GIS dataset created at a smaller scale (e.g., 1:2,000,000) will cause problems with feature

locations. In this case, placing and replacing ground control points (GCPs) will be important to obtain an overall sufficient georeferencing. When the reverse is the case (e.g., historic data is at a small scale), you probably will not be able to represent exact feature locations. With a high-quality GIS dataset to georeference from, you can spread out GCPs across the historic map to obtain a georeferenced dataset suitable for more general location purposes.

Here are seven best practices for successfully georeferencing historic data and maps.

# 1

If you have historic maps, scan them at a high resolution (300 dpi or greater) in a format compatible with ArcGIS such as JPEG or TIFF.

High resolution will allow you to still see features on the map when zooming in and out in ArcMap. Many local, county, and state libraries have historic maps and settlement records available in paper and/or microfilm format.

# 2

Identify significant physical features on your historic map such as buildings, roads, section lines, streams, and rivers.

These features are often found in existing GIS datasets and can be used as GCPs. Knowing what identifiable features you have on your historic map will determine what type(s) of GIS data you can use for georeferencing.

# 3

If you are locating historic landholdings that refer to township and range, determine if your study area is included within the Public Land Survey System (PLSS).

PLSS data is available in GIS format from the US Geological Survey (USGS) and will often coincide nicely with township and range information found in hand-drawn maps and written accounts. Using the PLSS data, you may be able to quickly locate historic properties and identify GCPs for georeferencing historic maps based on PLSS boundaries. (If your area was not included in the PLSS, you will have to rely on other information on your map as GCPs or find historic paper maps with your survey system included.)

# 4

Obtain GIS roads data from local municipalities, counties, states, or Esri to use as a primary georeferencing source.

Many old roads still exist and road intersections or corners work well as GCPs. In the United States, counties typically have the most accurate and up-to-date GIS road data. If the local government is



unwilling or unable to provide detailed local road data, major state and US roadways can often be obtained through a state department of transportation (either through an online GIS clearinghouse or by contacting the agency). Esri data can also be used as a road data source. If you have a subscription to Esri's StreetMap dataset, this works well to find most local streets. Other ArcGIS Online resources that show roads on a basemap (e.g., Imagery with labels, Streets or OpenStreetMap) are useful, but you need to remember that you are geocoding to an image pixel and not an exact road crossing intersection as with roads vector data.

## 5

### Obtain digital/georeferenced aerial photography to use as a primary georeferencing source.

Some counties and state agencies also have databases of historic air photos that have been georeferenced. If the local county government for your study area does not maintain its own aerial photography, the US Department of Agriculture Farm Service Agency (FSA) also collects aerial photography for the entire United States through the National Agriculture Imagery Program (NAIP). Current NAIP imagery is flown on a three-year cycle at a 1-meter resolution. (Reference the FSA's Aerial Photography Field Office [APO] GIS Data Viewer for an interactive map of available NAIP products at [gis.apfo.usda.gov/gisviewer/](http://gis.apfo.usda.gov/gisviewer/)). One difference with NAIP imagery is that it is flown during the summer months (i.e., leaf-on) as opposed to during the late winter (i.e., leaf-off) when county and state imagery is flown. NAIP imagery can be downloaded for free from [datagateway.nrcs.usda.gov/](http://datagateway.nrcs.usda.gov/), or you can access it via an ArcGIS for Server connection ([gis.apfo.usda.gov/arcgis/services](http://gis.apfo.usda.gov/arcgis/services)). ArcGIS Online imagery base-maps are also a good source for high-quality aerial photography. Click the credits to see the source of the imagery you are viewing through the ArcGIS Online World Imagery service.

## 6

### Obtain digital raster graphics (DRGs) of USGS topographic quadrangle maps to use as a primary georeferencing source.

USGS topographic maps include roads, buildings, hydrography, and other physical features. These map features are a good source of GCPs. Many areas have multiple years of the 1:24,000-scale

topographic maps. Many online data servers provide access to the DRGs, such as state GIS web services and USGS online data servers. Additionally, 7.5-minute quadrangle maps (1864–present) will soon be available from USGS via the online USGS Store. *[In 2009, USGS began releasing high-resolution scans of more than 178,000 historical topographic maps of the United States.]*

## 7

### Obtain GIS railroad data, typically from a state transportation agency.

Many rail lines were built long ago, and since they are not often moved, railroad data can be a great asset to the georeferencing process, especially in areas with few roads. Rail crossings work very well as GCPs.

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# Casualties in a Labor War

By Scott Doody

In April of 1922, the United Mine Workers of America (UMWA) went on a nationwide coal strike. Eight weeks into the strike, W. J. Lester, owner of the Southern Illinois Coal Company, Williamson County, Illinois, having already released the union workers from their duties, hired nonunion labor and heavily armed guards from Chicago. (Whether these men knew they were strike-breakers or not is still a matter of debate.)

Union miners from as far as Kansas, Indiana, and Ohio had arrived to protest earlier in the week. By June 21, a steady stream of gunfire had been exchanged between the two factions. By nightfall, two UMWA men had been killed.

Miners, farmers, and other locals were infuriated. By the morning of June 22, it was estimated that 1,000 armed men had advanced on the mine. Realizing there was no alternative, the nonunion men raised a white flag of surrender. With promise of safe passage out of the county, the men were led from the Lester Strip Pit to a wooded area about two miles away, known as the Power House Woods, where the killing spree began.

Over the next two days, 23 men were killed in Williamson County and on the streets of Herrin, Illinois. It was the largest mass murder of nonunion labor in the history of America in an event that would become known around the world as the Herrin Massacre.

“The unknown dead of Herrin’s labor war went to their graves today. Sixteen of them were buried in the potter’s field . . .”

From the *St. Louis Globe Democrat*  
June 26, 1922

↓ Union men digging the graves and preparing wood vaults on June 25, 1922. Photo courtesy of Williamson County Historical Society. This photo originally appeared in the *Chicago Tribune*.





# Finding the Victims of the Herrin Massacre

Mystery dating from 1922 solved

By Steven M. Di Naso and Scott Doody



When he happened upon Scott Doody in the Herrin City Cemetery in Illinois in March 2010, geospatial scientist Steven Di Naso could not have known that this chance event would lead to one of the greatest challenges of his life.

Doody, a historian, had been looking for the better part of a year for the grave site of a decorated World War I veteran who was killed in the infamous but now largely forgotten Herrin Massacre of 1922. He was searching for a single marker erected by the Veterans of Foreign Wars post in Chicago to honor Anton Malkovich, but it had vanished.

The search for Malkovich's grave site eventually became a four-year-long, interdisciplinary project that would locate the unmarked graves of the other men killed in the Herrin Massacre. It was the first attempt to find these grave sites using GIS. (For information on the Herrin Massacre, see the accompanying article, "Casualties in a Labor War.")

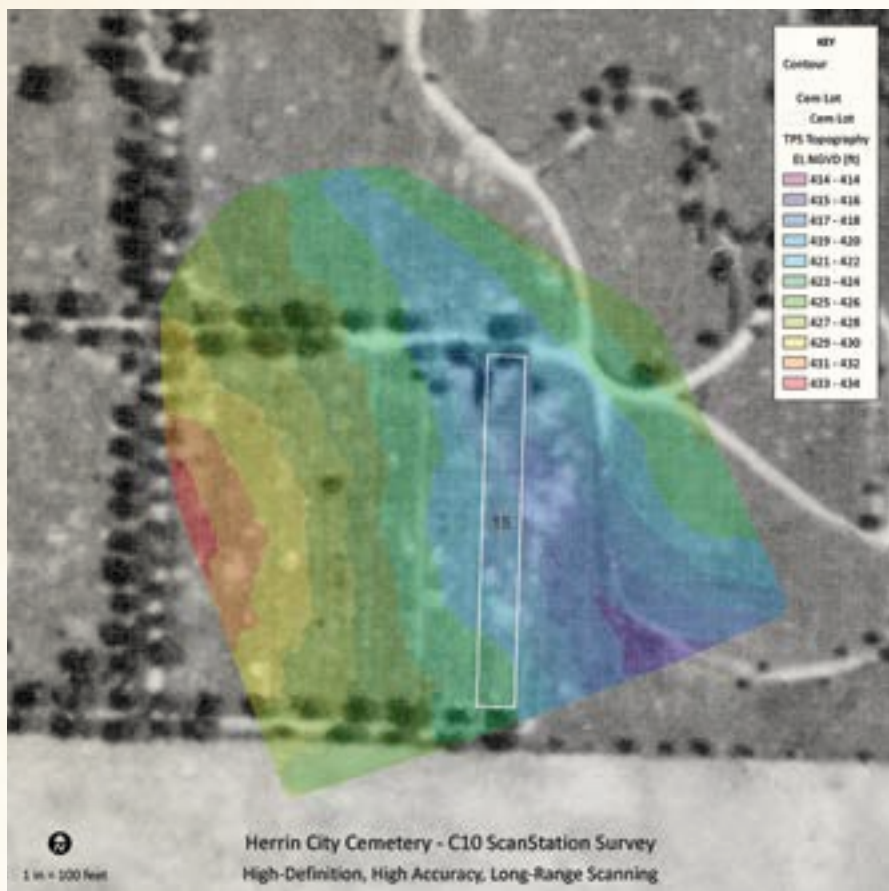
↑ Herrin Mayor A. T. Pace (foreground) flanked by United Mine Workers of America officials as they move the body of the first victim. Note the coffin's beveled and chamfered corners. Photo courtesy of Williamson County Historical Society. This photo originally appeared in the *Chicago Tribune*.

Although the story of the Herrin Massacre was well documented, the event was so atrocious that it was not spoken of for generations. In time, the locations of the unmarked graves of the men killed were forgotten.

Twenty-three men were killed in the massacre. Seven bodies were immediately claimed by relatives. The bodies of the remaining 16 men were buried in the potter's field, an area of the cemetery reserved for the indigent, the unknown, and the unidentified.

Within four months, five of the bodies in the potter's field were disinterred and claimed by relatives. On October 3, 1922, Ignatz Kubinetz, who had been injured in the massacre, died of his wounds and was buried in the potter's field. This brought the total of unmarked grave sites from the Herrin Massacre to 12. ➔





↑ High-definition, high-accuracy, long-range C10 ScanStation survey being used in Herrin City Cemetery

## A Missing Potter's Field

Nearly a century later, a team of geospatial scientists, historians, and forensic anthropologists came together in an attempt to locate these lost burial sites. Could the long-forgotten graves of the victims of the Herrin Massacre be found by applying GIS techniques?

Di Naso, a geospatial scientist, was confident the mystery would be solved with geographic information science. The cemetery's long-held secret would be revealed not by mapping what was *on* the surface, but what lay *beneath* the surface.

Members joined the multidisciplinary, integrative research team as additional expertise was required. The team eventually consisted of principal investigator Doody; Di Naso; geographers Dr. Vincent Gutowski and Grant Woods; Dr. Robert Corruccini, a forensic anthropologist; and John Foster, a former United Mine Workers of America (UMWA) coal miner and retired Washington County sheriff. Most of the team worked daily on the project, which was completely funded by the team. No external grants were sought.

The team relied on hundreds of maps, animations, 3D renderings, charts, graphs, and figures. For the first time, the integrative methods and geospatial technology would be used to find the massacre victims' locations.

Additional help was offered to the team. Some local residents claimed the men were buried in a location outside the cemetery. Others said they could find the graves by "witching." Psychics even offered to speak to the dead on the team's behalf. All these offers were politely declined.

## An Archive of Life and Death

To create, store, manage, analyze, and distribute the data the team had assembled, a custom enterprise geodatabase model was implemented and deployed on Microsoft SQL Server 2008. By versioning the data, the team could work on the model and the attribution of the many sections, blocks, lots, spaces, and markers. Data and maps were shared by publishing numerous services via ArcGIS for Server.

Taking an old, hand-drawn paper map, they built a GIS model of the cemetery's parcel fabric from known dimensions. It was the conceptual design or ideal layout of the cemetery. Initially it acted as a template for analysis and modeling of interment and other data and was used to produce a single animation that would reveal the location of the potter's field as a function of the behavior of its sextons over the cemetery's long history.

The team produced the first accurate GIS inventory of the sections, blocks, lots, spaces, headstones, and associated interment records for the 25-acre cemetery. More than 9,600 interment records were modified from an existing genealogical database made available by the Williamson County Historical Society. This comprehensive repository of geographic data, empowered by ArcGIS, became the driving force behind the research.

Thousands of news articles from the period were reviewed. These account descriptions offered geographic clues and supported location hypotheses. The city's cemetery records were studied; county recorder's office records reviewed; and representative photogrammetry for every decade from 1938 to present, as



↑ ArcScene rendering of Herrin City Cemetery and block 15 detail, viewed from the southeast



well as period photographs, were obtained and scrutinized. From these resources, the team produced an accurate compilation of historical data for conducting research.

### Field Surveys

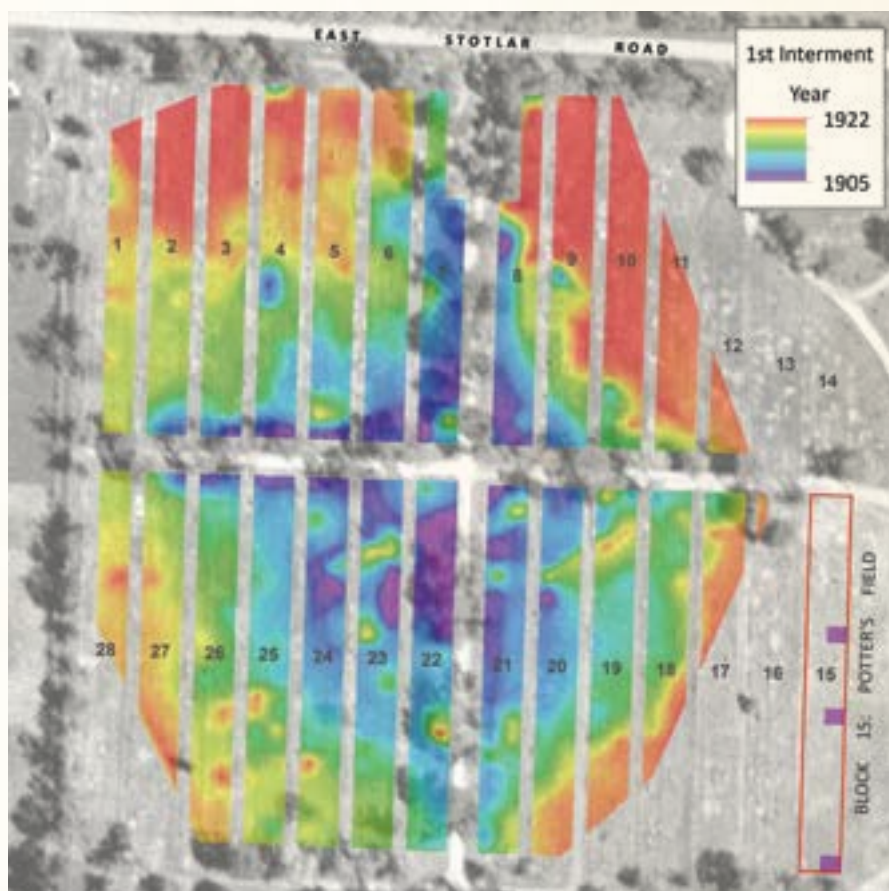
In the field, accurate horizontal and vertical control was established using static GPS techniques. The data was processed through the National Geodetic Survey (NGS) Online Positioning User Interface (OPUS), which enabled positional precision on the order of millimeters—well above the accuracy and precision required. *[OPUS provides access to high-accuracy National Spatial Reference System (NSRS) coordinates by upload of a data file collected with a survey-grade GPS receiver. The NSRS position for that file is returned via e-mail.]* The team used real-time kinematic (RTK) GPS with a multiple-baseline solution and differential corrections provided by the Kara Company ReIL-Net on the NGS Continuously Operating Reference Stations (CORS) data to map headstones and acquire photographs of them contemporaneously.

In practice, although use of NAVSTAR *[GPS satellite network operated by the US Air Force]* generally requires signal acquisition from a minimum of four satellites on any given day to attain a position, there are specific intervals of time throughout the day during which satellite geometry and other factors permit recovery of precise positioning at survey-grade accuracies (i.e., centimeter level) when using RTK GPS.

By taking photographs and positions contemporaneously within these short intervals, during which survey-grade positions could be acquired, ensured collection of all headstones and attribute data. This strategy permitted the team to include attributes such as first name, last name, and date of death (when these were legible in photographs) back at the lab after processing the data.

The surface inventory allowed interment records tied to the conceptual model of the cemetery to be compared to actual interment locations in the field. Often, these locations did not agree. Conceptual designs seldom match reality, and the Herrin City Cemetery was no different.

Using a high-definition, high-accuracy, long-range 3D scanner from multiple setups, an area encompassing 6.5 acres was scanned and detailed topography, headstone outlines, and imagery extrapolated from millions of cloud points obtained. This “microtopography,” processed using tools in ArcGIS 3D Analyst and visualized in ArcScene, offered insights into the locations of unmarked burial sites by illustrating small changes in slope and highlighting subtle surface depressions. Using this data, dynamic, virtual walk-throughs of the cemetery were created and made available using a simple web browser so the team could visit the cemetery virtually without having to physically go there.



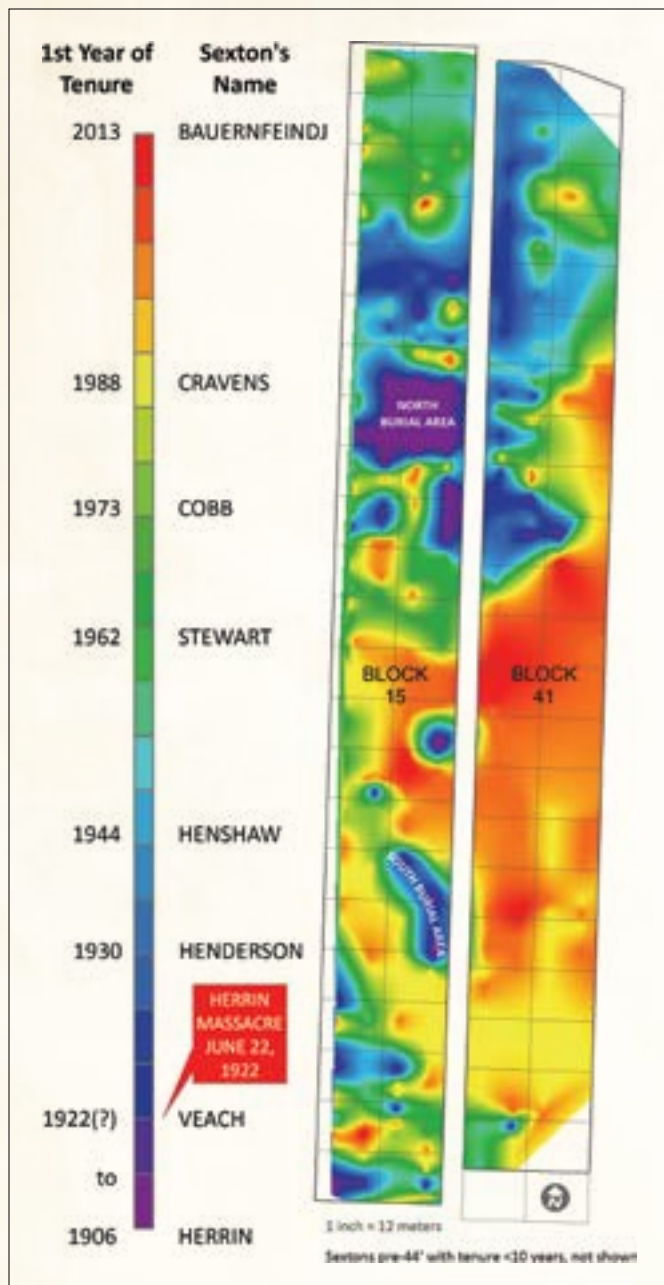
↑ Spatiotemporal model of the Herrin City Cemetery, 1905 to present. Note radial interment pattern spreading from top of hill at center and the sporadic interments in block 15.

### A Cemetery Brought to Life

The GIS model offered a unique opportunity to locate the potter's field through an animation of interments over the cemetery's 108-year history. For example, one lot, 16 feet by 20 feet, held 8 grave spaces. Each grave space was 4 feet by 10 feet. Despite having interment data that was explicit to the grave-space level, the team decided to create an animation using the first record of interment for each lot to visualize the exponential growth of the cemetery with higher fidelity and without the hyperspecificity of space-level data. The grave spec for any one lot could be used independently over the lifetime of its availability. The simplified animation of the year of first interment in each lot demonstrated a less ambiguous patterning of the cemetery's growth. The animation was supplemented with a continuous surface model of interments created using an Empirical Bayesian kriging interpolation model on the same variable.

An animation of interments between 1905 and the present revealed a predictable pattern of burial practices in blocks 1 through 28 with the exception of one block—block 15. The earliest burials (circa 1905) were at the top of a hill in the center of the cemetery. As new interments followed, these burials were located down-slope and radiating away from the center, continuing until all blocks were occupied. Block 15 however, was utilized irregularly, with contemporaneous and seemingly dispersed interments throughout its long history in a pattern typical of a potter's field.

While the headstone survey provided information above ➔



↑ Spatiotemporal model of block 15 that illustrates the activities of individual sextons over a period of 108 years

ground, research of interment records provided information below ground for numerous unmarked burials, found mostly in block 15.

### The Nail in the Coffin

After identifying block 15 as the potter's field, a more explicit model could be produced for visualizing the activities of individual sextons in a manner that was not possible by simply looking at old interment record books. Although the city has a cemetery archive, the records for 1905 to 1929, the first 24 years of interment history, were missing.

To predict the location and associated years for these burials, the team compiled all known records of death and records of lot sales

throughout block 15 and adjacent blocks 41 and 42. After creating a continuous surface model of this data, first by year, and then again resampled by decade, yielded a map of the hypothetical pre-1929 interments—and hence the probable location of the Herrin Massacre victims within a 30-year time interval. The team identified two distinct areas—one at the northern end of the potter's field and another on the southern end—that were likely sites.

Geographically speaking, the GIS model indicated the historical burial array represented an area of one part in 58,000, relative to the 25-acre extent of the cemetery. The team's work, based upon techniques of applied geography and GIScience, was sufficient to warrant excavation. It was time to propose this location hypothesis to city officials. After four years of intensive research, the team received approval from city council and began excavating the site.

### Distinctive Interments

On November 12, 2013, the team discovered the first vault and coffin. Potter's field interments in the Herrin City Cemetery were typical for the period: wood vaults, few coffins, scarcely any hardware, and no markers. However, the Herrin Massacre interments proved to be atypical.

Period photos and the observations of numerous reporters documenting the burial on June 25, 1922, played a key role in identifying the graves. In his Record of Funeral for the massacred men, the undertaker, Albert G. Storme, omitted any description of the bodies other than their number but noted the make, model, and other details of the coffins.

He ordered all the caskets from the Belleville Casket Company with the same specifications. Each was 6 feet 3 inches long and 2 feet wide, oval-topped with chamfered corners and eight sides, and painted black. The coffins had three pairs of opposing brass handles and cloth-lined interiors, and each was enclosed by a wooden vault—not typical paupers' burials. Affixed to each was a plate reading At Rest. These plates were described in many news accounts of the period. According to news accounts of the burial, the men were buried in four rows of four, in an area roughly 16 feet wide by 40 feet long.

### Vindication

The field excavations in November 2013 uncovered eight of the 12 victims. Excavations are scheduled to continue in the summer of 2014. The team's hypothesis had passed the test—the graves of massacre victims had been located using GIScience and ArcGIS. A group of scientists and historians formed a research team that formulated several hypotheses, performed analyses, identified the likely location, and found exactly what they were looking for.

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## About the Team

**Robert Corruccini** is a forensic anthropologist and distinguished faculty emeritus of the department of anthropology at Southern Illinois University.

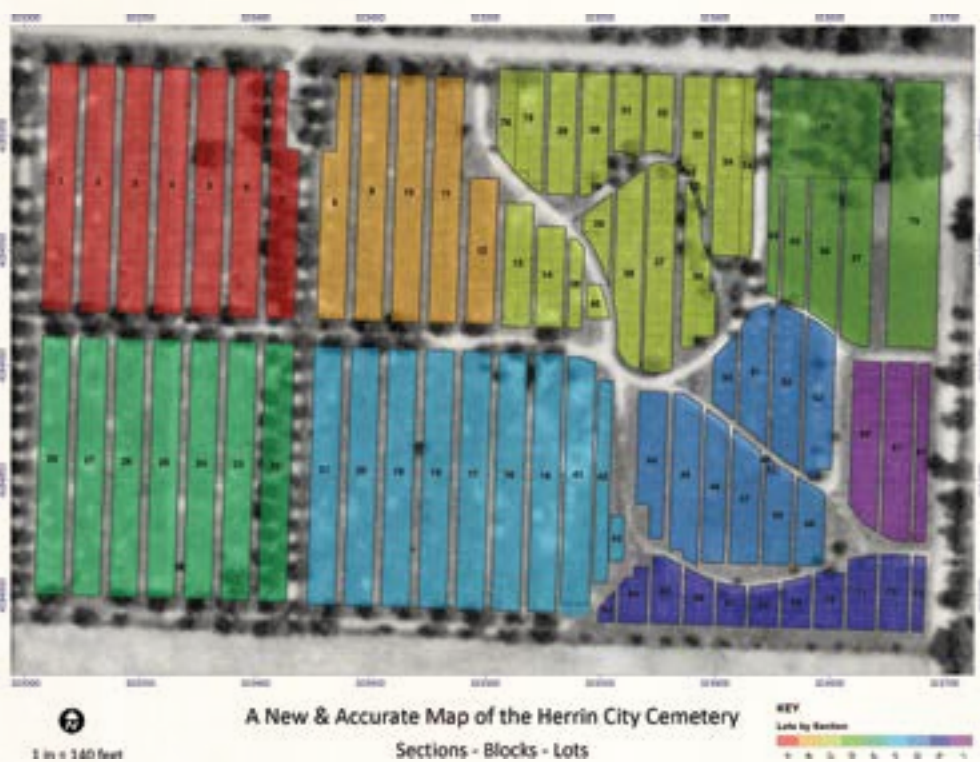
**John Foster** is a United Mine Workers of America pensioner and a retired Washington County sheriff.

**Vincent Gutowski** is a geographer and distinguished faculty emeritus of the Department of Geography and Geology, Eastern Illinois University.

**Grant Woods** is a geography graduate student at the Department of Geography and Geology, Eastern Illinois University.

## Acknowledgment

These individuals also helped with the project: Trevor Barham, operating engineer for the city, ran the backhoe at the site. John Bauernfeindj is the Herrin City Cemetery sexton. City Councilman Bill Sizemore was instrumental in gaining access to the cemetery.



↑ A new, accurate map of the Herrin City Cemetery

↓ (Front row) Vincent Gutowski, Steven Di Naso, Grant Woods. (Back row) Roy Music, Scott Doody, Bill Sizemore, Trevor Barham, John Bauernfeindj, Robert Corruccini, and John Foster. Photo courtesy of Steven M. Di Naso.



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