

ArcUser

The Magazine for Esri Software Users

LEVERAGE

BUILD

EXTEND

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Increase the Significance of Your GIS 34

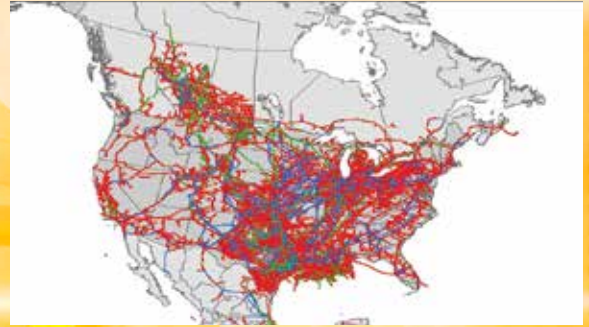


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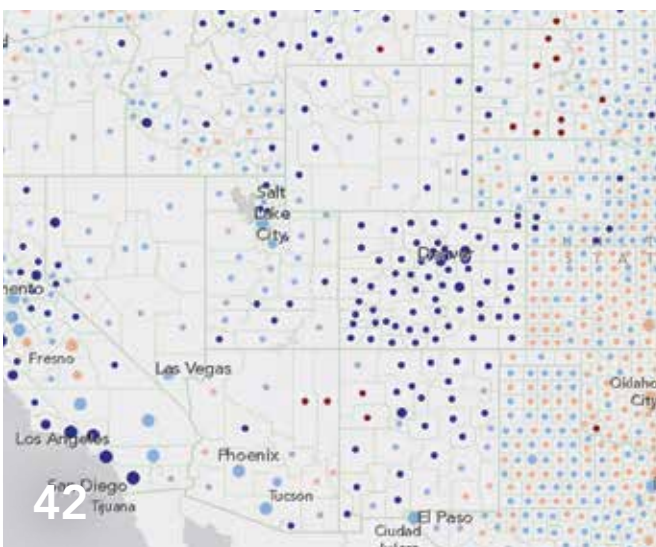
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A Larger Role, A Bigger Impact

The role of the GIS professional has come a long way from “the map guy” in the back room. As a GIS professional, you can empower people throughout an organization to work more efficiently and make better decisions whether or not they know anything about GIS.

That evolution was illustrated by Steve Misterek, GIS coordinator for the City of Minneapolis, and his team members, Nathan Aamot and Phil Holleran, who spoke during the Esri User Conference Plenary Session. Survivors of a city staffing cutback, they realized that since they could no longer try to do everything themselves, they needed a new vision of their role and some new goals.

The team embraced ArcGIS Online and, in 2012, the hugely successful Minneapolis MapIT was born. Focusing on leveraging their expertise and training, they built an infrastructure of maps and apps that would let users benefit directly from GIS. By trusting their users more and letting go of some of the control they previously exercised, the team extended GIS capabilities to the public as well as casual users, knowledge workers, and executives at the city.

This is the future of GIS. Individual systems are becoming part of a larger interconnected platform that enables visualization, analysis, and better decision making by using GIS. This will require geoenabling organizations by

- Building a strong platform.
- Extending the platform across the organization.
- Leveraging your knowledge, training, and existing investments in GIS.

To this list, add another important element—being active in the GIS community. By participating in the profession by attending GIS events such as the Esri User Conference, regional conferences, or workshops, and connecting online through GeoNet or other online forums, you can seek help, give assistance, and gain perspective.



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editor's page

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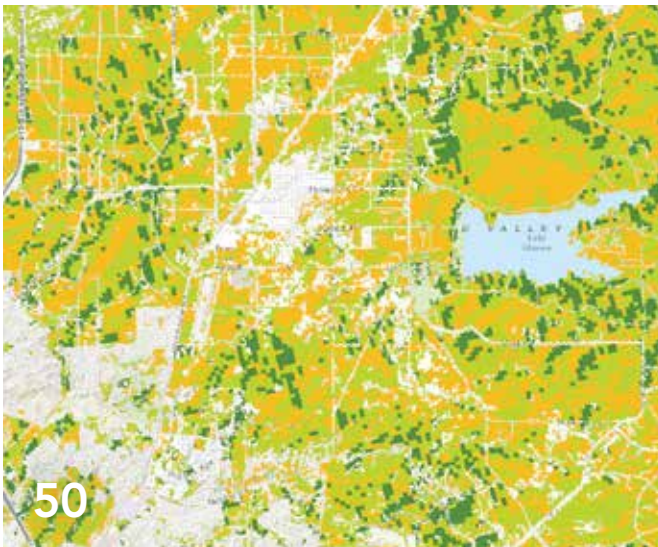
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Armchair Time Travel

Look into bygone landscapes with a new app from the US Geological Survey (USGS) and Esri. The *USGS Historical Topographic Map Explorer* app gives you access to more than 178,000 maps—some dating from 1884—from any digital device.



Topographic maps are indispensable for everyday use in government, science, industry, land management planning, and recreation. These topographic maps are snapshots of the nation's physical and cultural features at a particular time and show how a specific place has changed over time. Scientists, historians, environmentalists, genealogists, and others researching a particular geographic location or area find these maps valuable in their work.

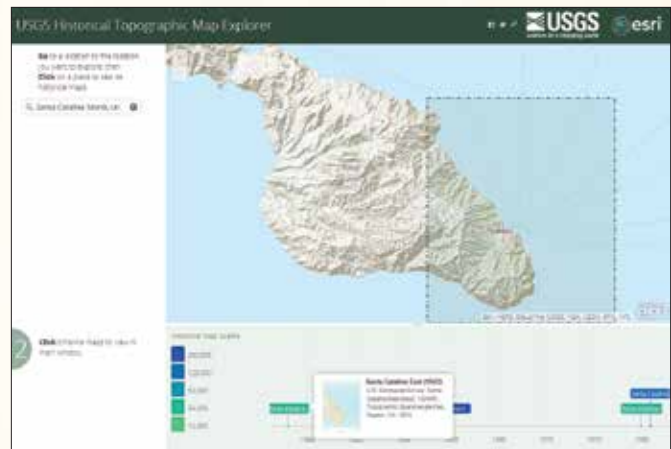
In 2009, USGS began releasing US Topo, a new generation of topographic maps in electronic form. These maps are complemented by the USGS Historical Topographic Map Collection (HTMC), which was officially launched in September 2011. The program's goal was to scan all USGS historic topographic maps published by the USGS since the inception of the topographic mapping program in 1884. Although this goal was met in October 2012, as additional historical maps are discovered, they will be scanned and added. The project has been successful, with more than 6.8 million downloads. In addition to the online collection, HTMC exists as a collection of paper maps in the USGS Clarence King Library in Reston, Virginia.

The ArcGIS platform supports sharing this amazing map collection. With this app hosted in ArcGIS Online, anyone can access any map in HTMC as a high-resolution georeferenced image for use in web mapping applications. The app's time line makes it easy to see the scale and dates of available maps.

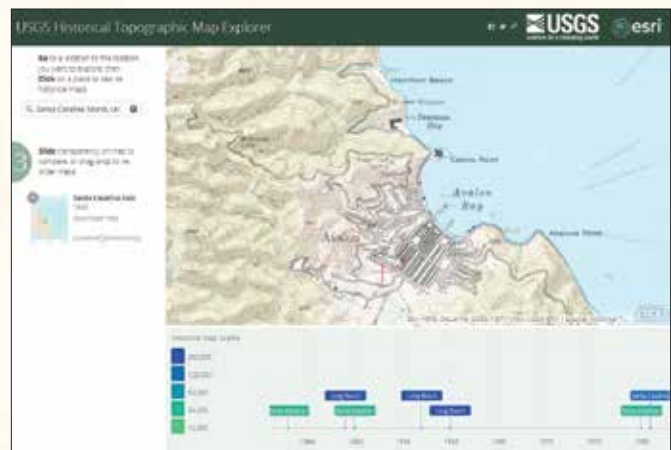
In the past, these maps were available only as printed lithographic copies and more recently, legacy quadrangles were available as free, downloadable GeoPDFs. Now, locating historical maps for a specific area couldn't be easier.

1. Go to the web link historicalmaps.arcgis.com/usgs/. There is no need to download an app.
2. Pan or search for a desired location and click on it.
3. A time line appears showing the maps available for the selected location. In the time line, select a map that is the age and scale desired.
4. The selected map will display in the main window. You can move the slider bar under its thumbnail on the left side of the main window to see the changes over time.
5. You can share this map or save a copy of it to your desktop.

The app is on GitHub, the web-based hosting service for software development, so custom collections of historical maps can be created. For more information, go to nationalmap.gov/historical/index.html.



↑ The time line shows the scales and dates of maps available for the selected area.



↑ With the selected map displayed in the main window, the transparency can be adjusted to see current features in relation to historic ones.

Get Explorer for ArcGIS for Mac, iPad, or iPhone

You can now discover, view, and share maps on your Mac or iOS device using Explorer for ArcGIS, one of the many ready-to-use apps available at no cost from Esri.

Download the Mac app from the Mac App Store or ArcGIS Marketplace to your Mac desktop or laptop. Download the iOS version from the iTunes Store. If you are an ArcGIS Online subscriber and/or have a Portal for ArcGIS account, simply download the app, sign in, and begin exploring your maps and data. You can also try out Explorer for ArcGIS using a trial ArcGIS Online subscription. Sample maps are included.

Explorer for ArcGIS lets you see data in a

geographic context and use maps to make more informed decisions. You can access maps authored by you or others within your organization and share them on Macs or iOS devices. It requires no GIS experience, so others in your organization can begin immediately accessing maps, searching for and visualizing data, and briefing stakeholders.

Tools for interacting with the map are simple and contextual. You can open and view multiple maps at the same time; dock and undock pop-up windows, and go full screen to take advantage of Apple's Retina display. You can search for information about organizational assets, easily share that

information, and use the sketching tool to mark up maps. Use the Explorer for ArcGIS interactive presentation feature to brief stakeholders using map slides that contain visible layers, an extent, and a title. You can interact with a live map during your presentation, viewing pop-up windows and sketching without interrupting your presentation.

An Android version of the Explorer for ArcGIS app will be available later this year. To learn more about Explorer, visit esri.com/explorerapp.

↓ Discover, view, and share ArcGIS Online maps from your Mac desktop or iOS device using Explorer for ArcGIS.



Free Apps with ArcGIS Online Subscriptions



All Esri Location Analytics apps are now available at no extra cost with an ArcGIS Online or Portal for ArcGIS subscription. If your organization uses business intelligence (BI), or customer relationship management (CRM) systems, or productivity systems such as Microsoft Office, your organization can now easily tap into the ArcGIS platform from within them.

- Location Analytics app users can
- Perform self-service mapping and spatial analysis in just a few clicks.
 - Access an amazing library of map layers from Esri and from other ArcGIS Online users, including Esri's exclusive

demographics and lifestyle datasets.

- Create location-enriched information products, including interactive maps and infographics that can be shared with colleagues for more insightful decision making.

The following apps are available to qualified subscribers at no extra cost:

- Esri Maps for Office
- Esri Maps for SharePoint
- Esri Maps for IBM Cognos
- Esri Maps for MicroStrategy
- Esri Maps for SAP BusinessObjects
- Esri Maps for Dynamics CRM
- (Esri Maps for Salesforce will be available later this year.)

To install and configure the apps, you must be an administrator of an ArcGIS Online or Portal for ArcGIS with a paid or trial subscription. US customers with questions can contact Esri Customer Service or call 1-800-447-9778. Non-US customers can contact their local Esri representative. You will also need administrative access to the business system you're using (e.g., Office, SharePoint, Cognos, MicroStrategy, BusinessObjects, Dynamics CRM). If you'd like Esri to install and configure the solution for you, contact your local Esri representative. For a listing of additional apps available with ArcGIS Online, visit ArcGIS Marketplace (marketplace.arcgis.com).

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User Conference— All Year Long



↑ GeoNet is so much more than forums.

What is one of the best things about the Esri User Conference?

It's all the great people you meet, the friends you make, the insights you gain. Wouldn't it be terrific if you could meet and stay connected with other GIS folks from all over the world *all year long*?

Now you can.

All the networking, collaboration, knowledge sharing, and product support you find at the conference is now combined into a single community that spans the globe: GeoNet.

Announced by Esri president Jack Dangermond during the User Conference Plenary Session, GeoNet is not just a collection of forums. It's a tool to help you get your job done more effectively and efficiently (and more enjoyably). At GeoNet, you can create discussions, upload files, collaborate on documents, share videos, write blog posts, and do other things.

Of course, the Geo community is mapped. ArcGIS Online is integrated with GeoNet. You can embed publicly shared maps as a thumbnail that is linked to the live map.

Esri seeded this general platform with spaces focused on industries and products, but you can extend GeoNet to meet your needs immediately by defining a new group. Since its soft launch a couple of months ago, new groups, such as GIS and E911, Cambodia GIS Users, and Facilities GIS User Group, have been added.

It's easy to get started. Just log in with your ArcGIS Online account or create one. Next, update your profile, create custom streams, and begin searching for the topics and people that interest you. Head to geonet.esri.com and keep the party going.

Use ArcGIS Online Imagery to Digitize, Analyze, Contribute

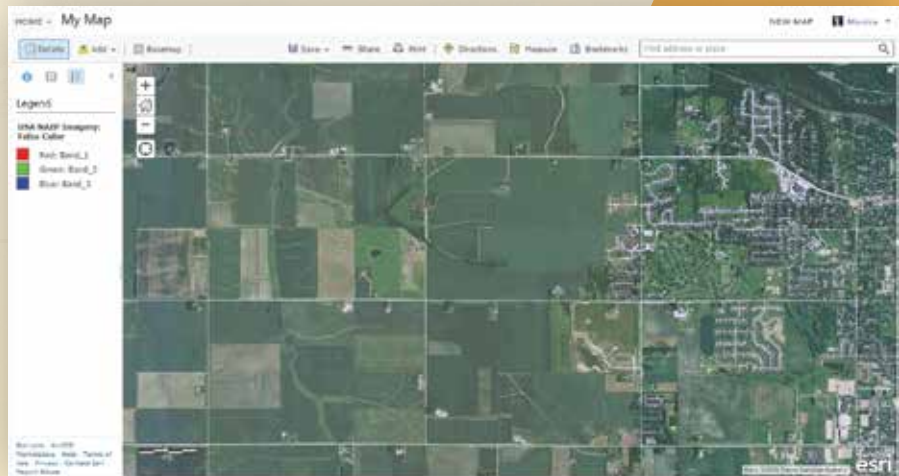
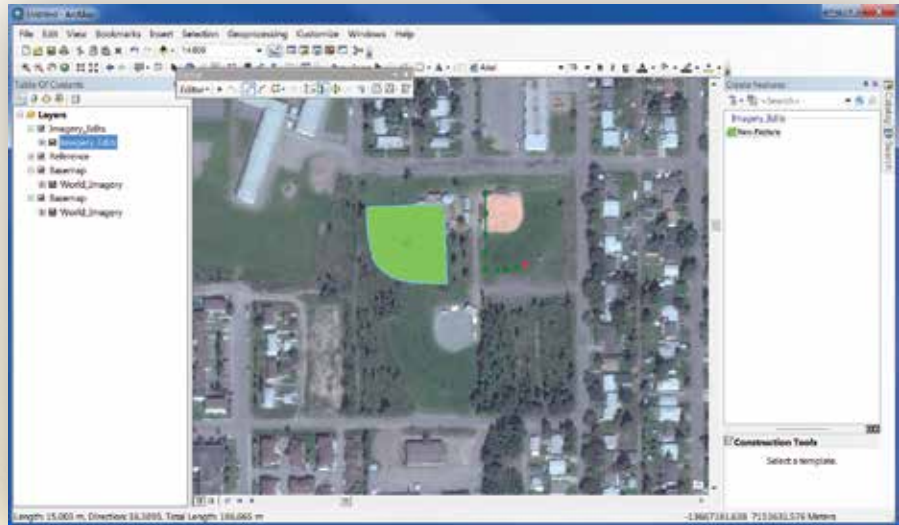
The rich imagery offerings available with your ArcGIS Online subscription can be used for digitization and, in some cases, analysis as well as visualization.

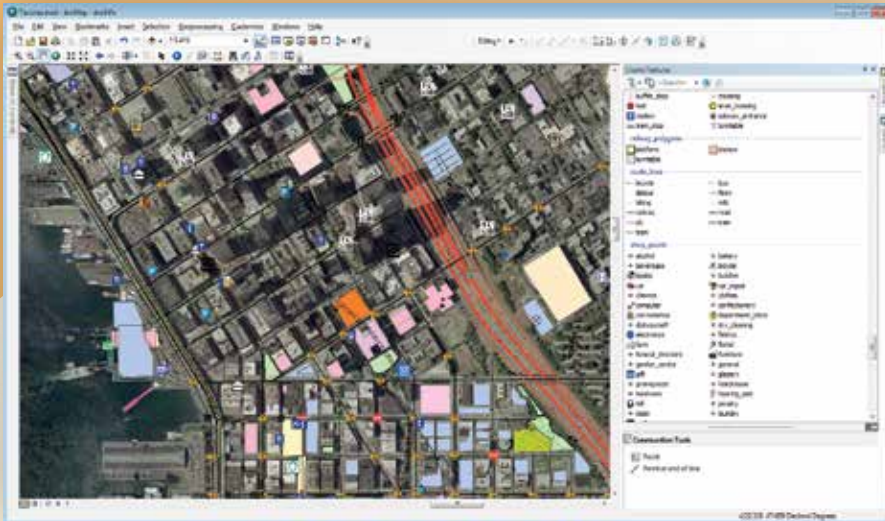
ArcGIS users are entitled to use image layers for digitizing data. Interactive digitizing is one of the most common methods for creating and editing data. With this method, ArcGIS users can display an aerial photograph or satellite image on-screen as a basemap and then draw features, such as roads, buildings, or parcels, on top of it using editing tools. The resultant features can be stored in a local geodatabase or published as a feature layer to share with other users. The image layers can be used to digitize data for your local geodatabase or enhance your contributions to Esri Community Maps.

The World Imagery basemap, available to all GIS users on ArcGIS Online, provides 1 meter (m) or better satellite and aerial imagery in many parts of the world and 15 m or 2.5 m worldwide. It is compiled from a variety of best-available commercial and community sources.

The USA NAIP image service, available to users with an ArcGIS Online subscription, features recent high-resolution (1 m) aerial imagery for the continental United States. NAIP is made available by the US Department of Agriculture Farm Service Agency and updated for several states each year. The multiband NAIP image service can be used for analysis.

If you want to contribute to OpenStreetMap (OSM), an open and freely available database of geographic data, you can use ArcGIS Online image layers with the ArcGIS Editor for OpenStreetMap. This free, open-source add-on for ArcGIS for Desktop helps you participate in the growing OSM community. The ArcGIS Editor for OpenStreetMap makes it easy to download OSM data, make changes to the dataset, and contribute those changes back to the entire OSM community.





↗ Use aerial photography or satellite imagery, available through ArcGIS Online, to digitize features such as roads, buildings, or parcels using ArcMap editing tools. Store the features created in a local geodatabase or publish them as a feature layer that can be shared.

↘ The multiband, high-resolution (1 m) aerial imagery for the continental United States can be used for analysis.

↗ Use the ArcGIS Editor for OpenStreetMap with ArcGIS Online imagery to contribute to OpenStreetMap.

Making Your GIS Relevant to the Community

 A photograph of a person wearing glasses and a plaid shirt, looking at a tablet. The tablet screen displays a reporting interface with the question 'What are you reporting?' and a list of options including 'Abandoned Shopping Cart', 'Abandoned Bicycle', 'Abandoned Vehicle', and 'Animal Service'. The background shows a blurred outdoor setting with some food items.

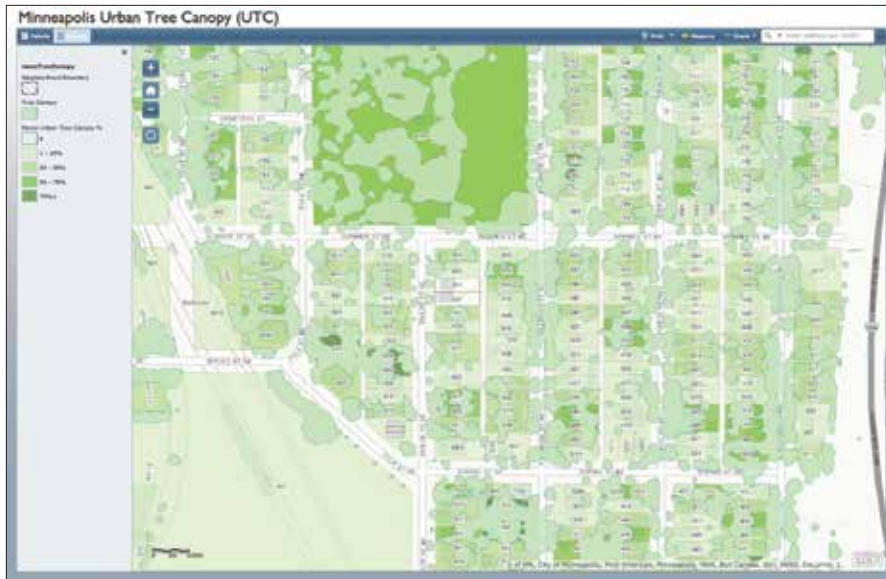
Power Your Community with Best-of-Breed Apps

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Building Resiliency with GIS



↑ The Minneapolis Urban Tree Canopy app helped the city recover from a storm, obtain funding, and streamline repair work.

In his Plenary Session presentation at the 2014 Esri User Conference, Steve Misterek, GIS coordinator for the City of Minneapolis, told how his team's response to adversity led to an approach that used ArcGIS Online to share GIS resources with city staff and citizens. This approach has made the city into a Smart Community—one that efficiently uses resources and can mitigate and bounce back from disasters both natural and man made.

Smart Communities is an overarching term that encompasses concepts and values from other initiatives including sustainable cities, healthy communities, livable communities, and smart grid. The impetus for each of these is the creation of communities that are productive, responsive to citizens, and able to handle economic and environmental challenges.

An early adopter, the City of Minneapolis has been using GIS for decades. It had many experienced users in various departments across the city but, despite the best efforts of the GIS department, it could not realize its vision for an enterprise implementation of its GIS. The strong focus on standards and centralization led to resistance in some departments and the siloing of information.

Then the recession hit, and the city's GIS

team was cut from eight to three. Misterek realized that to succeed or even just survive, they would have to come up with a different approach. Their new priorities were serving the city's core business needs, convincing middle management that GIS could really improve the bottom line, and showing the value of GIS to executive leadership. This meant the team had to change its view of what a GIS professional does, use a relaxed approach that trusted users more, and let go of some of the control they previously held.

The focus changed to building enabling infrastructure, sharing the team's education and expertise with the organization, and promoting their capabilities and agility. Within the city, they had to sell GIS to three separate groups—innovators, traditionalists, and leaders—using three different approaches. They had to teach and support the innovators. For the traditionalists, they needed to show the value of GIS in enhancing existing business workflows. For the leaders, they just had to provide timely answers.

Adopting the Web GIS pattern and embracing ArcGIS Online made it possible for Minneapolis to meet its goals and win over the city's innovators, traditionalists, and leaders. The team launched MapIT

Minneapolis in 2012, the city's ArcGIS Online site, which makes the existing GIS resources available to hundreds of city employees and citizens. It used many of the State and Local Government Solutions maps and apps (esri.com/smartcommunities) to quickly create tools for leveraging Minneapolis's robust existing GIS.

In their plenary presentation, Misterek and fellow team members Nathan Aamot and Phil Holleran shared some of the success stories about their users. One such user, Philip Potyondy, provided a great example of how MapIT Minneapolis has made the city more resilient.

Potyondy, the city's urban forester, was an early and innovative adopter of MapIT who used GIS to enhance the city's resiliency and save the city money. A severe storm in June 2013 downed 1,800 of the city's street trees. Potyondy and other city arborists rapidly inventoried the fallen trees using Collector for ArcGIS on mobile devices. This same data was used not only to manage removal of the tree debris but also schedule the removal of the stumps, apply for Federal Emergency Management Agency (FEMA) reimbursements, and plan the replanting of trees. While he was performing the initial fallen tree inventory, Potyondy recorded any pavement damage near fallen trees and shared that information with the public works department so those repairs could be scheduled and handled expeditiously.

Potyondy's use of ArcGIS helped the city remove hazardous fallen trees, repair infrastructure, gain recovery funds, and streamline the operations of not one but two departments. By answering the *where* question for any project, initiative, or policy, MapIT has succeeded in making Minneapolis much more nimble in responding to the city's needs.

Governments at every level and across the world are struggling with many of the same problems that faced Minneapolis: limited resources, calls for more accountability and transparency, and improved delivery of government services. At the same time, conditions have become more challenging: lingering economic pressures from the Great

Recession; extreme weather events brought on by climate change; and the need to make cities safer, healthier, places to live.

Governments are turning to GIS technology to create information from the data they collect, then analyze that data to understand and develop better strategies for solving problems. Initially, GIS adoption was tied to specific projects or existing workflows. With the development of the ArcGIS platform, governments at all levels are discovering that the power of location and spatial thinking can be applied to nearly every area to realize higher levels of service.

As GIS has moved to the ArcGIS platform, it has taken on an increasingly larger role in creating Smarter Communities. The ArcGIS platform supports geospatial capabilities for four groups: GIS professionals, knowledge workers, decision makers, and software developers. State and Local Government Solutions maps and apps, available to ArcGIS Online subscribers, make the information derived from GIS available to knowledge workers and executives in government. Location analytics such as Esri Maps for SAP BusinessObjects and Esri Maps for IBM Cognos geoenable business intelligence systems by placing all kinds of tabular and enterprise data into a geographic context. Operations Dashboard for ArcGIS uses a geographic framework for monitoring processes throughout the organization.

Data currency is always a challenge. ArcGIS Online supplies constantly updated basemaps, current imagery, and thousands of data layers contributed by the ArcGIS Online community. Instead of having to search for the most recent data, import, and then process it, data is managed by Esri.

Operational data, such as the locations of fallen trees in the MapIT example, can be immediately integrated with these layers using mobile devices, such as smartphones, with Collector for ArcGIS. This streamlines data collection, whether the data describes houses damaged in a fire or fire hydrants inventoried to track their condition.

GIS excels in enhancing intragovernment communication and collaboration. In the

recent Capstone-14 disaster response exercise, ArcGIS Online provided a common operating picture for emergency response teams from eight states in the US Midwest. (See “The Key to Disaster Response: ArcGIS has pivotal role in massive exercise” in this issue.) In public policy development, GIS is helping the US Forest Service develop the national forest plan by giving people inside and outside government the tools and data to ask better questions, explore opinions, and make better decisions, according to Kent Connoughton of the US Forest Service, whose interview, “GIS as a Tool for Building Policy,” appears in this issue.

Perhaps even more critical for governments dealing with the effects of climate change is the ability to run prediction models that reveal the effects of trends and help develop long-range plans that mitigate the effects of disasters such as floods on the local populations, infrastructure, and economy. An article in this issue, “Designing for Climate Change with GIS” describes a comprehensive climate change vulnerability assessment conducted by the Massachusetts Army National Guard at Camp Edwards using GIS.

GIS is tremendously useful in distributing resources. Nadika Senadheera, who works for the United Nations World Food Programme, uses GIS to locate vulnerable populations in South Sudan and determine safe and efficient routes for airlifting relief supplies to them. She tells how she does this in “Aid from Above” in this issue.

The tools for enhancing collaboration, communication, and analysis in ArcGIS are based on decades of working with and listening to the needs of users. As part of this ongoing process, Esri began creating a host of apps that support Smart Communities. The goal is to make these State and Local Government Solutions, widely available and accessible to jurisdictions, no matter their size or resources.

The specific apps chosen for development came out of a series of whiteboarding exercises that were held jointly by Esri and the International City/County Management Association (ICMA). Officials from cities and counties—large and small—were asked which apps would make their city or county more resilient. The proposed apps were prioritized and built based on best practices and the experience acquired through years of working one-on-one with users across disciplines and governments.

State and Local Government Solutions help cities, counties, states, and even nations become Smart Communities. The more than 150 solutions can be implemented immediately; configured to enhance use, and, if desired, extended using solutions from Esri partners that are built on these solutions or in-house development resources. These apps help leverage organizational resources, incorporate community knowledge, and enable innovative approaches to the challenges governments face so that communities will be better places to live and work.

↓ City urban forester Phil Potyondy embraced MapIT and saved the city time and money.



When Open Data Isn't Useful Data

Fix four common problems with open data using ArcGIS Online

Organizations create and manage a vast amount of data. Many of these organizations, such as government agencies, desire or are required to share certain data with the public. When this data is freely available for people to obtain, use, and redistribute, it is called open data.

Open data is important for maintaining transparency, fostering innovation, and ensuring data integrity. But just being “open” often isn't enough—open data also needs to be useful data. Open data is most useful when it is discoverable, accessible, explorable, and collaborative. If your data lacks these characteristics, you can use ArcGIS Online to make it more useful.

1 Make Your Data Discoverable

To be useful, people must first be able to find your open data. Open data made available through ArcGIS Online is easily discovered by the public. Not only does ArcGIS Online provide a web interface where people can search for the data they are interested in, it also allows them to discover data through a general web search or by getting recommendations or notifications of new and relevant data.

2 Make Your Data Accessible

People must be able to access your open data to freely reuse and integrate it into their own tools and applications. ArcGIS Online can automatically make your data available in common formats for anyone to use. Data can be made available as APIs, web services, and common file formats that (ideally) conform to open industry standards. The Esri shapefile (SHP) is an open data format and industry standard. Additional open standards for geospatial data, such as KML, are managed by the Open Geospatial Consortium, Inc. Comma-separated value (CSV) is a widely used data format for storing tabular data that is commonly used for sharing geospatial data.

3 Make Your Data Explorable

If people can't filter, visualize, and analyze your open data, as well as combine it with other datasets, they won't be able to use it to answer questions and make discoveries. Open data enhancements in ArcGIS Online are integrated into the ArcGIS platform, which allows people to combine open data with other datasets in ArcGIS Online or to bring the data into ArcGIS for Desktop for advanced geospatial analysis. By adhering to the open standards, additional analysis can be performed on the data in other programs such as spreadsheet or statistics packages.

4 Make Your Data Support Collaboration

For your open data to be truly useful, people must be able to share the results of their exploration and analysis with the public and back to the data provider. The whole point of open data is to make it broadly available so more people have access to it, derive real value from it, and share it back with the community. ArcGIS Online includes capabilities that enable the sharing and disseminating of open data via web and mobile applications. This opens up the results for feedback and improvements that lead to further exploration and analysis, helping organizations and their data to become an important part of the growing open data community.

Conclusion

Open data is not necessarily useful data. Use ArcGIS Online to make data truly useful by making it discoverable, accessible, explorable, and collaborative. An ArcGIS Online subscription also provides access to ArcGIS Open Data, which simplifies the process of making open data available. Build an Open Data website and customize its look and feel in just minutes. Specify which particular items will be shared as open data. The public can use the site to search by topic or location, download data in multiple formats, and view data on an interactive map or table. If you don't have an ArcGIS Online subscription, sign up for a free 30-day trial at esri.com/software/arcgis/arcgisonline/evaluate and see how easy it is to share your organization's open data.

DATA-DRIVEN INNOVATION

In September, the winners of the Esri Global Disaster Resilience App Challenge were recognized at the UN Climate Summit 2014. This contest, held in conjunction with the United Nations (UN) Making Cities Resilient campaign, was one of two this year that asked developers to use Esri technology to create apps that mitigate the effects of climate change.

The contests took advantage of the flood of data being released by governments, businesses, nonprofits, and other organizations that has the potential to address what is arguably the greatest challenge facing the world today: climate change.

The ability to predict, prepare, and respond to extreme weather events and the shifts in temperature and precipitation that affect ecosystems, food supplies, water supplies, and the health of populations is data dependent.

Useful, high-quality data is available through portals such as the Global Earth Observation System of Systems (GEOSS) site and the United States Data.gov, and new sources of data are constantly being released. Esri has released ArcGIS Open Data as a configurable part of every ArcGIS Online organization subscription. With the ArcGIS Open Data application, organizations can quickly set up a website that shares just the data the organization wants to make available.

In addition to being authoritative and current, data must be usable. All the data in the world is useless without the ability to manage and access it efficiently and the tools to create information through analysis. ArcGIS provides those tools across the platform. For decades, Esri has supported open data through open standards, open formats, interoperability tools,

participation in standards organizations, and the constant development of tools that let users incorporate all types of data formats natively or through importing.

Through ArcGIS Online, Esri makes vast stores of data immediately usable. Instead of having to constantly locate, obtain permission, download, and process data from numerous sources on a continuing basis, ArcGIS Online subscribers can quickly search and use data sources that are vetted, continually updated, and supplied as web services that can be added to web maps and apps or desktop analyses. Just one example of the value of this approach: the 30 meter Shuttle Radar Topography Mission (SRTM) elevation data released to the public in September 2014, which is being incorporated in the World Elevation Map on ArcGIS Online so that the most complete high-resolution digital topography database of the earth will be available to users.

Along with this instantly available data, Esri also created an array of developer tools for web, mobile, and desktop that work with cloud services developer APIs and ready to use content. Esri provides SDKs and APIs for Android, iOS, Java, JavaScript, Mac OS X, .NET, Qt, Flex, Silverlight, and WPF.

In the Esri Climate Resilience App Challenge 2014, held earlier in the year, and the more recent Esri Global Disaster Resilience App Challenge, Esri encouraged the use of ArcGIS Online resources and these Esri developer tools to tackle the challenges posed by climate change through two contests.

The Esri Climate Resilience App Challenge 2014 Esri hosted was mounted in support of the White House Climate Data initiative. For this contest governments, businesses, and nonprofit organizations devised apps to help communities bounce back from natural and man-made disasters and cope with the changing conditions that affect the food supply, public safety, infrastructure, and health and human services.

The quality of the apps received was high. Contest results were announced at the Esri User Conference, and the overall winner was Minnesota Solar Suitability Analysis, which lets users identify the suitability of a location for solar panel installations by querying solar analysis data.

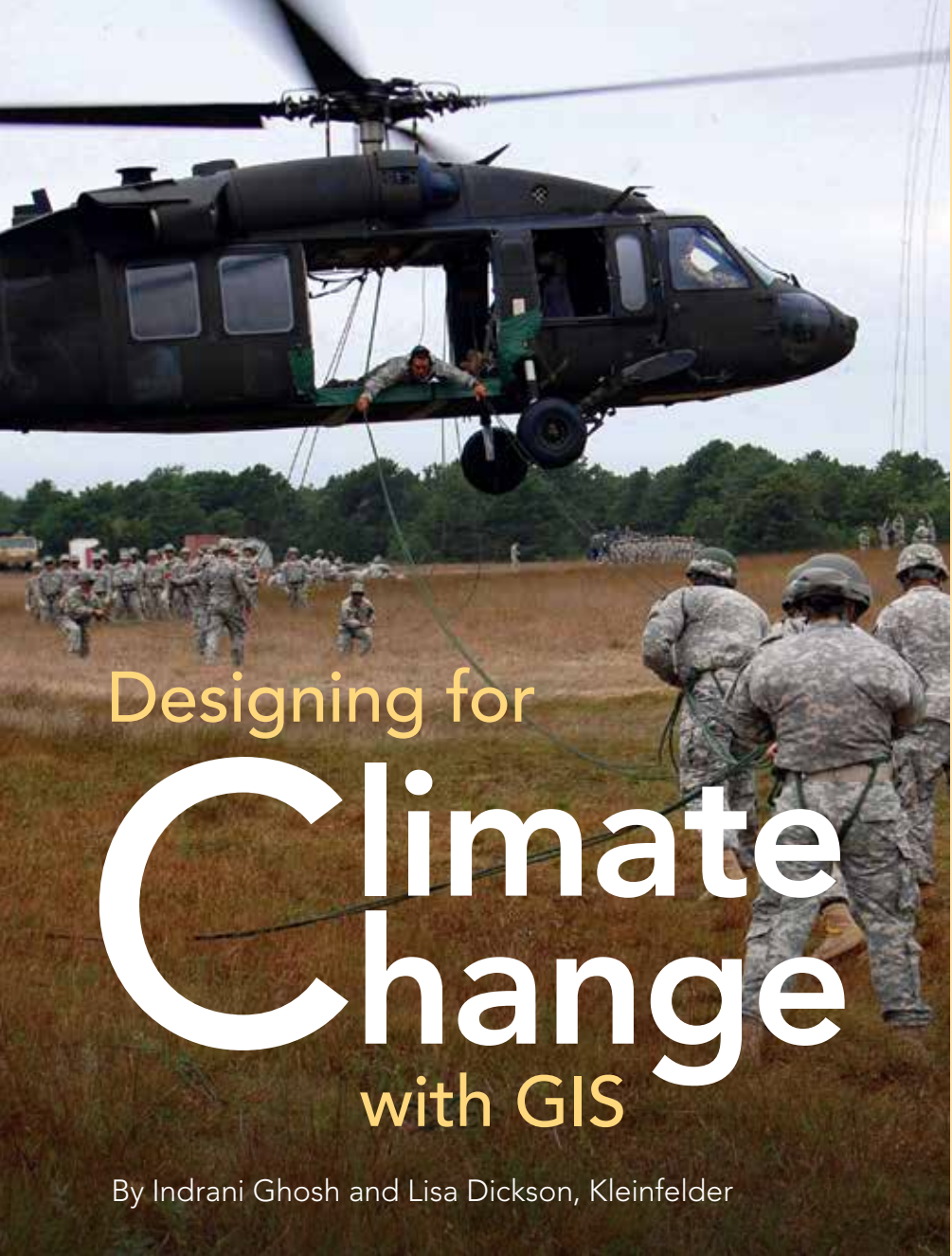
The 22 apps submitted to the Esri Global Disaster Resilience App Challenge addressed many aspects of the climate change effects including measuring the impact of permafrost melt and storm water on infrastructure, providing sea level rise and landslide forecasts and supplying evacuation routes and shelter locations to people affected by natural disasters. Esri will ensure these apps will be widely available to the public.

Esri awarded \$10,000 to winners in the professional/scientific app and citizen/public-facing app categories. The winning app in the professional/scientific category was submitted by The Nature Conservancy. Its Coastal Defense app identifies areas at risk for coastal erosion and inundation from wave and action and storm surge; allows users to interactively explore the role of coastal habitats in attenuating wave height and energy; and identifies appropriate adaptation strategies.

The winning citizen/public-facing app was Guardian Evacuations submitted by Leon Storey and Gareck Packer. This app was designed to extend the capabilities of the Guardian Disaster Management suite, which is in use by 47 local authorities in Australia. It advises users where the closest evacuation shelter is located relative to their current location and provides directions to that center.

Margareta Wahlström, head of the UN Office for Disaster Risk Reduction, said, “Technology and science have a role to play in making the planet a safer and more resilient place. These apps will empower people across the world to manage the risks associated with extreme weather events fueled by climate change, which affects over 100 million people every year.”





← Photo courtesy of U.S. Army/ Spc. Jenna Hergt, 101st Regional Training Institute, Massachusetts National Guard/released

To understand and mitigate the challenges caused by potential extreme events related to climate change, the Massachusetts Army National Guard (MA ARNG) initiated one of the defense industry's first and most comprehensive climate change vulnerability assessments at Camp Edwards in Massachusetts. The effort identified at-risk infrastructure using a state-of-the-art, GIS-based, sea level rise and storm surge inundation model. The GIS model, developed by Kleinfelder based on the methodology used by the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center to map sea level rise inundation, was approved by MA ARNG. It was used to develop a quantitative and qualitative climate risk matrix from which the Guard is able to prioritize planning areas and prepare adaptation and resiliency plans.

Data-Driven Approach

The 22,000-acre Camp Edwards National Guard Base, commonly known as the Massachusetts Military Reservation (MMR), is located on Upper Cape Cod in Barnstable County, a low-lying, coastal peninsula with a fragile connection to the mainland. Sea level rise and storm surge are a primary concern to this area. MA ARNG contracted Kleinfelder, an architecture, engineering, and science consulting firm headquartered in Riverside, California, to conduct a climate change coastal flooding vulnerability assessment and prioritize adaptation solutions to these impacts on MMR infrastructure, training, and operations.

The GIS model includes both current and predicted data. High-resolution digital elevation models (DEMs) built from lidar terrain data with high vertical accuracy and tidal elevation data from the NOAA tidal gage stations surrounding the base provided a basis for mapping existing topography and tidal surface conditions. The team used the Highest Astronomical Tide (HAT) datum, which represents the highest predicted astronomical tide expected to occur at a specific tide station over the National Tidal Datum Epoch. *[The NTDE is a specific 19-year period used by NOAA's*

Designing for Climate Change with GIS

By Indrani Ghosh and Lisa Dickson, Kleinfelder



National Ocean Service as the official time period during which tide observations are taken and reduced to obtain mean values.]

The GIS model also incorporates the predicted sea level rise values for 2020 and 2060. The predicted tidal surface elevation for these future periods is a combination of present tidal elevation and projected sea level rise values as a result of climate change impacts. For the Base assessment, the team used predicted storm surge depths based on a worst-case Category 3 hurricane as predicted by the US National Weather Service's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model to determine the projected water surface elevation at MMR.

The potential impacts of temperature and precipitation on MMR as a result of climate change were based on 2011 Massachusetts Climate Change Adaptation Report projections. *[This report describes the findings of a state advisory board regarding the development and implementation of strategies that would allow Massachusetts to better adapt to climate change.]*

In summary, the important climate change indicators identified included

- Anticipated sea level increase of 4 to 6 inches by 2020 and 12 to 27 inches by 2060
- Potential increase in storm surge events with the current 100-year flooding event (i.e., a flood so large there is a 1 percent chance of it happening every year) recurring once every 35 to 55 years, with an increase in flood elevation
- Extreme precipitation events (i.e., precipitation greater than 2 inches in a 24 hour period), total rainfall associated with five consecutive wettest days of the year, and precipitation intensity are all projected to increase by 2020 and progressively higher by 2060
- Days with extreme temperature (i.e., greater than 90° F) are projected to increase to approximately 20 and 40 days, respectively, by 2020 and 2060.

For the coastal inundation analysis, the team used Esri's ArcGIS for Desktop with the ArcGIS Spatial Analyst and the sea level rise and storm surge GIS datasets to evaluate the extent and depth of inundation of areas in and around the MMR for the two planning horizons. The projected inundation areas were evaluated for hydrological connectivity to the ocean. Hydrologically disconnected

low-lying areas greater than one acre were identified as potential flood areas in case of a breach of higher elevations. The inundation maps were presented in two categories—potential inundation areas from sea level rise, and potential inundation areas from storm surge and sea level rise. The maps further provided the basis for development of a quantitative and qualitative risk-based matrix.

The GIS model also incorporated the extent of flooding from two historic hurricanes, the Great New England Hurricane of 1938 and Hurricane Irene in 2011. Both of these events affected the Base and surrounding areas. The analysis projected that the flooding extent from future sea level rise and storm surge will be greater than from these past hurricanes.

Probable Consequences

The Guard's climate change assessment focused on the estimated risk to infrastructure and facility operations, environmental concerns, training and test ranges, missions, and military training activities, as well as community and regional dependencies.

In this case, risk is equal to the consequence of climate change impact multiplied the probability of occurrence of that impact. Consequence is the impact to the Guard's ability to execute its military objectives. The higher the consequence, the more negative the impact. Probability is the likelihood that a projected climate change impact will occur. Some climate change indicators—such as sea level rise and higher temperatures—are very likely in the Camp Edwards area, whereas more frequent droughts have a lower probability of occurrence.

Linking highest likelihood of occurrence of near-term and long-term quantitative impacts (i.e., sea level rise of 4–6 inches by 2020 and 12–27 inches by 2060) with the potential consequences and implications to the physical infrastructure, training, and operations provides the Guard with a comprehensive, detailed qualitative risk matrix that can be used to prepare a climate change preparedness plan.

For instance, the risk matrix indicates a low risk of significant flooding on the Base. However, the surrounding low-lying areas are at high risk from sea level rise and storm surge impacts. Likely, coastal flooding will have some impact on the area's

transportation and energy infrastructure. Damage to roads could make them inaccessible. Since one of the Guard's missions is to protect the civilian population in times of emergency, damaged infrastructure could hinder the Guard's ability to rescue civilians trapped in inundated areas, especially in case of hurricanes, storm surges, and ice storms. Permanent and temporary inundation of low-lying areas surrounding the Base may cause encroachment from surrounding civilian areas, resulting in potential loss of training areas and competition for existing resources, such as water and electricity.

Adaptation and Prioritization

Once impacts and associated risks were identified and quantified in the risk matrix, the team developed a comprehensive adaptation plan. The Guard's adaptation plan incorporates possible short- and long-term solutions to mitigate impacts from extreme events and will help prioritize climate change adaptation strategies.

Because of its close relationship with the surrounding community, the Guard's infrastructure adaptation plan will likely involve a number of outside stakeholders, such as municipalities, infrastructure owners, and public health officials. A key goal for the Guard moving forward is to outline its expected level of responsibility for each stakeholder and ensure that adequate support is in place from other supporting entities and agencies.

About the Authors

Indrani Ghosh, PhD, is a project professional at Kleinfelder. Her areas of expertise are modeling climate change impacts, conducting climate change vulnerability and risk assessments, GIS data management and modeling, and spatial scaling analysis. She also has significant experience in programming using GIS. She can be contacted at 617-498-4654 or IGhosh@kleinfelder.com.

Lisa Dickson, Professional Geologist (PG), is vice president of sustainability at Kleinfelder and is based in the Cambridge, Massachusetts office. She chairs the company's corporate sustainability initiative and is the firm's technical discipline lead for sustainable practices and solutions. She can be contacted at 617-498-4652 or LDickson@kleinfelder.com.

GIS Helps Farmers See the Big Picture

Landscape-level analysis for climate-smart agriculture

By Asa Strong



↑ Vincent Makiyi (right), a local GIS specialist, collects GPS data on a tablet with the chief of a rural community near Lilongwe, Malawi.

A nonprofit organization in Malawi uses GIS to apply sustainable farming practices that can improve crop yields for smallholder farms in this southeast African country.

The inland nation of Malawi is a small country but is densely populated. Nearly

80 percent of its people are smallholder farmers. On average, farms in sub-Saharan Africa are already the smallest in the world. Malawi's farms averaging fewer than two hectares, are primarily planted with maize, and are dependent on rainfall. Given these

limited resources, farmers are generally able to produce only enough to adequately feed their families.

Farmers' limited capacity for taking on risk, coupled with limited access to sustainable technologies and financial services, further reinforces low agricultural productivity. These limitations produce a yield gap—the difference between potential and realized yields in the same geographic area. Depletion of soil nutrients, loss of trees, and other environmental impacts on agriculture can exacerbate risks to future food production. However, there is potential to reverse these trends and improve economic and environmental conditions in the country.

Agricultural production is directly linked to the well-being of people and the environment in smallholder farming communities in Malawi. Rising rural populations in areas with a fixed amount of cultivatable land are placing unprecedented pressure on environmental resources and ecosystem services and making it more difficult for farmers to derive their livelihoods from the land. To produce the greatest economic and social benefit, efforts to improve this situation must simultaneously address environmental impacts and agricultural productivity.

Nonprofit organizations are heavily involved in the mission to increase food

production and restore natural capital in Malawi. They play a pivotal role in researching local needs, providing new technologies, and identifying novel implementation strategies. The Kusamala Institute of Agriculture and Ecology (hereafter, Kusamala), a non-governmental organization (NGO) located east of Malawi's capital, Lilongwe, focuses on using local resources and knowledge to design climate-smart agriculture (CSA) strategies for central Malawi. CSA has multiple objectives: to increase agricultural productivity and incomes; adapt and build resilience to climate change; and—where possible—reduce or remove greenhouse gas emissions.

Kusamala and affiliated researchers employ GIS technology, acquired through the Esri Conservation Program, to bolster and evaluate the impact of CSA in the country. In 2013, Kusamala received a grant from the Scottish government in partnership with the James Hutton Institute and Climate Futures. Over the next three years, the project will bring climate-smart practices to 1,500 households in the Dowa and Lilongwe districts of central Malawi, ultimately helping 7,500 individuals.

Planting the indigenous *Faidherbia albida* tree in fields, for example, is a climate-smart practice. Known locally as the magic tree, this tree fixes nitrogen in the soil, sequesters carbon from the atmosphere, provides fodder for livestock during droughts, has the unique ability to shed its nitrogen-rich leaves during the growing season (thus not competing with any crops), and retains its leaves during the dry season, providing shade for the bare soil.

The Food and Agriculture Organization (FAO) of the United Nations asserts that a landscape approach is needed to achieve the multiple objectives of CSA. Landscape approaches incorporate farming systems into

landscapes in ways that capitalize on natural biological processes, recycle waste, and diversify farming systems. These approaches put less pressure on natural resources and minimize the need for fertilizers, pesticides, and other external inputs that can be expensive and harmful to the environment. GIS is the preeminent tool for mapping and analyzing natural and human-created processes at the landscape scale and thus is an important technology for CSA evaluation and implementation.

At the district scale, Kusamala used ArcGIS software to create maps for a collaborative workshop with local stakeholders. More than 20 organizations, including local and district governments and private and community groups, met for a three-day workshop focused on improving interorganization collaboration to enhance large-scale social and environmental benefits from CSA in Dowa District.

One of the first questions representatives asked was, "Who is doing what and where?" Rather than having different agencies carrying out similar projects in the same area, organizations could dovetail their efforts if they knew each other's catchment areas (i.e., where each agency was working). Kusamala coordinated a participatory mapping process to collect each organization's catchment area on paper maps. The catchment information was then digitized into ArcMap and the Count Overlapping Polygons tool used to enumerate overlapping catchment areas in the district.

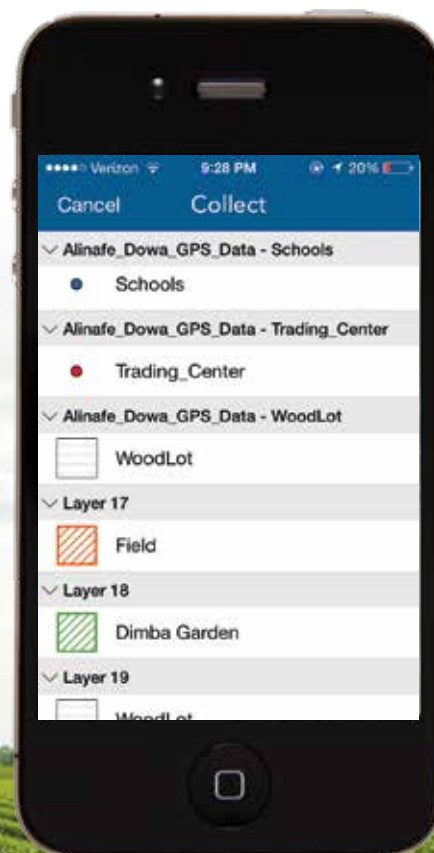
The map illuminated areas that receive significantly more attention as well as areas that receive less attention. Mobilizing collaborative efforts to address problems that are interrelated is an important strategy for meeting the multiple objectives of CSA.

For example, the Farm Income

Diversification Program seeks to sustainably improve the livelihoods of rural Malawian communities by diversifying farmer incomes. Similarly, one of the objectives of CSA is to diversify crops in farming systems. These missions align in purpose and geographic space and could be amplified by synchronizing efforts.

In 2013–2014, researchers at Kusamala explored how field arrangements impact CSA adoption by smallholder farmers. The Esri Collector for ArcGIS app was used on a tablet to collect GPS data for 10 farmers' households, fields, and gardens in a rural community near Lilongwe, Malawi. Maps created from the GPS data illustrate the intentional scattering of farmers' fields across the landscape. →

↓ A form on Collector for ArcGIS that is being used to collect data about the natural and social resources in Dowa District.



The isolation of fields in this area plays an interesting role in smallholder communities. By scattering their fields, farmers minimize the risk that all their crops will be impacted by disturbances such as pests, disease, and fire. The rationale behind this prudent approach is that with many independent fields, some fields will produce even if others do not. With one large field, farmers risk starvation in the event of a low-yield year, even if that occurs infrequently. This diversification strategy used by smallholder farmers ensures that food production stays above a minimum threshold.

farmers give to crops. For example, fields far from a farmer's house will not receive the same number of compost manure applications as nearby fields. Over time, this leads to nutrient depletion in distant fields. Coming to grips with this local heterogeneity and fragmentation of resources is important for planning the future of CSA in Malawi.

The CSA project will be monitored and evaluated using participatory video and mapping and GIS/GPS technology. GPS data will be collected for each of the 1,500 households that receive CSA training. Farmers'

related to natural and social resources in the study area.

This data collection will enable researchers at Kusamala to analyze how perceptions of well-being are related to the proximity of natural and social resources such as forests and schools. "GIS will help us understand the natural and social resources we have in Dowa and Lilongwe districts and how we can best manage them," said Chisomo Kamchacha, a monitoring and evaluation specialist at Kusamala. Ultimately, the analysis will provide a forum for international advocacy and produce information with the potential to influence national decision making.

ArcGIS software on the desktop, online, and on mobile devices provided powerful tools for visualization and analysis of CSA at the landscape scale. Kusamala continues to use geospatial technology for facilitating collaboration, research, and evaluation of the CSA project.

Additionally, Kusamala has acquired RapidEye multispectral satellite imagery for landscape-level vegetation mapping. "GIS puts Kusamala in a place where it can be a hub for innovation, research, and development," said Kamchacha. The organization's innovative use of GIS is novel in the Malawi's NGO community. Kusamala's story serves as a powerful demonstration of scalable use of GIS in the developing world that can be replicated.

About the Author

Asa Strong is a GIS intern with the World Resources Institute who is working on the Global Forest Watch and Land and Resource Rights projects. He previously interned with Esri before conducting research in Malawi. He has a bachelor's degree in geography from the University of Iowa. Strong has been using GIS for six years to promote geographic understanding through spatial analysis and geovisualization.



↑ Alinafe Chimongo, the CSA project leader, proudly presents the Collector for ArcGIS app on his smartphone.

Scattering fields, however, reduces average yields relative to what could be obtained if fields were consolidated. Furthermore, the transportation costs associated with each field influence the amount of nurturing

perceptions of well-being, measured before and after the training, will be linked to the GPS data to visualize the impact CSA had in Dowa District. The Collector for ArcGIS app will be used to collect customized GPS data



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The Key to Disaster Response

ArcGIS has pivotal role in massive exercise

By A. J. Mangum



↑ State-level emergency managers from Alabama, Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, and Tennessee participated in Capstone-14, a scripted exercise that tested response to a large-scale natural disaster.

On a morning in mid-June, disaster response managers were summoned to situation rooms across the South and Midwest. A grim scenario awaited them. A 7.7-magnitude earthquake, centered between Memphis, Tennessee, and St. Louis, Missouri, had unleashed unimaginable devastation from Alabama to Illinois. Given the scope of the quake, casualties likely numbered in the tens of thousands, with millions of people facing displacement.

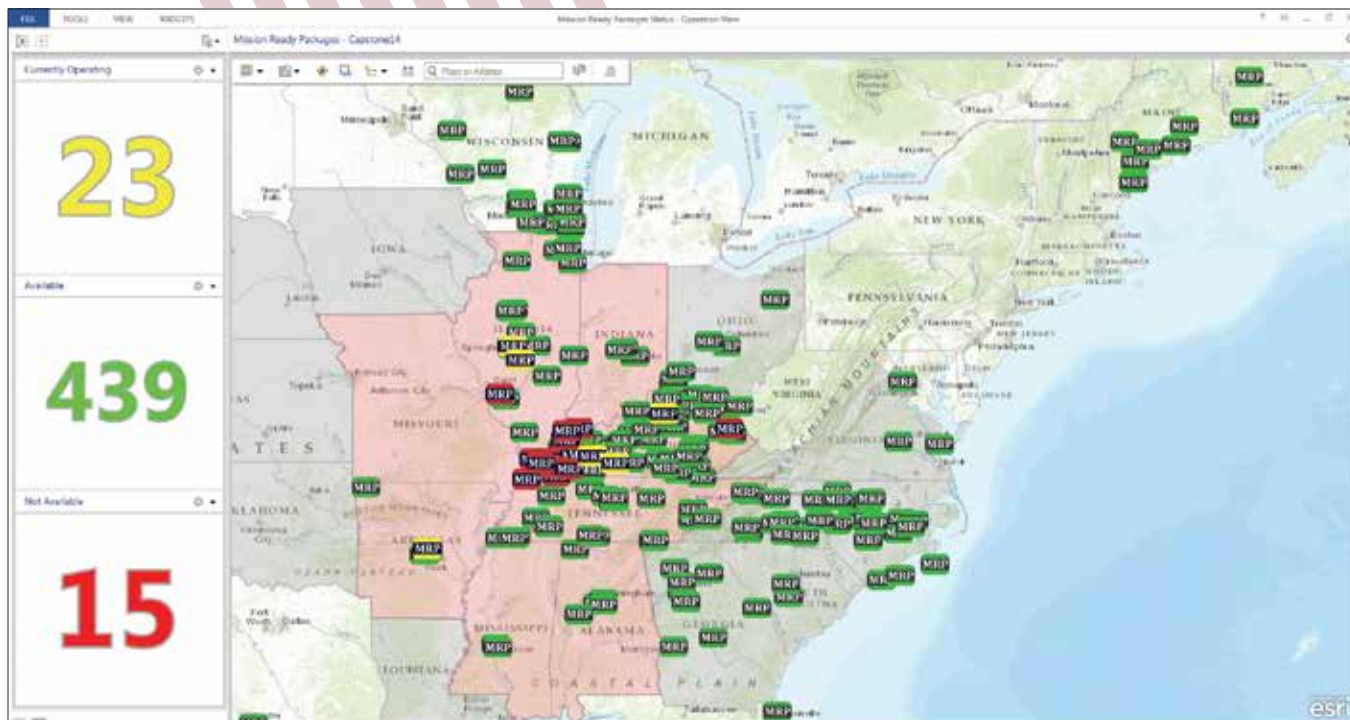
The scene, fortunately, was fictional, a multistate disaster response exercise simulating a megaquake in the New Madrid Seismic Zone, a

network of geologic faults stretching from Arkansas to Illinois. (See the accompanying article, “The New Madrid Seismic Zone.”)

Capstone-14

Officially known as Capstone-14, the scripted exercise, held June 16–20, 2014 was designed and directed by the Central U.S. Earthquake Consortium (CUSEC), a partnership of mid-western and southern states affected by the New Madrid fault system. Participants included state-level emergency managers in CUSEC states Alabama, Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, and Tennessee. Modeled after a 2011 effort, the mock quake served to test states’ levels of preparedness, access to resources, and capabilities for gathering and sharing information. Esri deployed ArcGIS Online in each CUSEC state to facilitate information

sharing and provide a common operating picture (COP) for agencies, emergency managers, and responders. “In an event of that magnitude, you quickly realize you don’t have enough stuff,” said Jonathon Monken, CUSEC chairman and director of the Illinois Emergency Management Agency. “You don’t have the teams or equipment or resources to deal with the problems you’re going to have. It really comes down to how you prioritize—what goes where and who gets what. And without a system in place to share and access information, all we have are spotty field reports. ArcGIS



↑ In each CUSEC state, emergency managers used Operations Dashboard for ArcGIS to monitor unfolding events and response efforts.

is absolutely the essential next step in disaster response.”

Capstone-14 could be described as eight state-specific exercises embedded in a larger regional exercise directed from the Illinois emergency operations center, in the state capital of Springfield. In each CUSEC state, emergency managers—representing a range of agencies, from the National Guard and state police to state forestry and finance departments—used Operations Dashboard for ArcGIS to monitor unfolding events and response efforts.

Initially, participants were challenged with responding to broad-stroke descriptions of the fictional quake’s effects; a lack of specifics mirrored what responders and managers could expect in a real crisis. As the exercise progressed, “injects”—bursts of new information—were introduced to complicate the emerging picture and challenge emergency managers’ priorities. Some injects were state-specific: a particular building in danger of collapsing, for instance. Others were more general, such as suspension or resumption of air or rail travel, or a report of severe damage to a dam that would have region-wide impact and require coordination across state lines.

A multilayered map of all eight CUSEC states reflected continuously updated, county-by-county reports on all manner of data. Regardless of the means by which information was collected in a particular locale, essential elements of information (EEIs)—reports falling within predefined categories of critical data, such as evacuation orders or details on casualties or transport status—were standardized for exercise-wide viewing and consistent interpretation.

State operations centers had access to a COP viewer created in ArcGIS Online for organizations. To broaden access to this information, the viewer was also embedded into WebEOC, a crisis-management platform widely used by emergency operations teams.

“The COP contained layers such as road closures, open shelters, hospital status and emergency service routes, and was enhanced by adding the same layers from adjoining states,” said Mike O’Connell, communications director for the Missouri Department of Public Safety. “Managers *[in Missouri]* had the ability to view *all* the nearest open shelters, for example, not just the ones that were available in Missouri. Emergency service routes extended beyond our borders for better routing.”

The ability to visualize information in a geographic format proved vital in the high-stakes scenario of a major quake, explained Jeremy Heidt, public information officer for the Tennessee Emergency Management Agency. “It’s much easier *[for emergency managers]* to comprehend a complex situation,” he said, “and assimilate *[that data]* with their knowledge of the communities in a state. Knowing where resources can easily reach also informs us of challenges that other communities might face from a lack of resources.”

Crowdsourced Situational Awareness

As the exercise unfolded, Esri developed a mobile app for responders and volunteers to assemble and share field reports quickly. The reporting process was as simple as checking a small set of boxes and required no more technical prowess than that required for sending a text message.

“The *[mobile]* application was used to crowdsource situational awareness data from the field,” O’Connell said. “Volunteers installed the app on their smartphones or tablets and then added points and photos for locations of fires, accidents, road closures, or floods.”

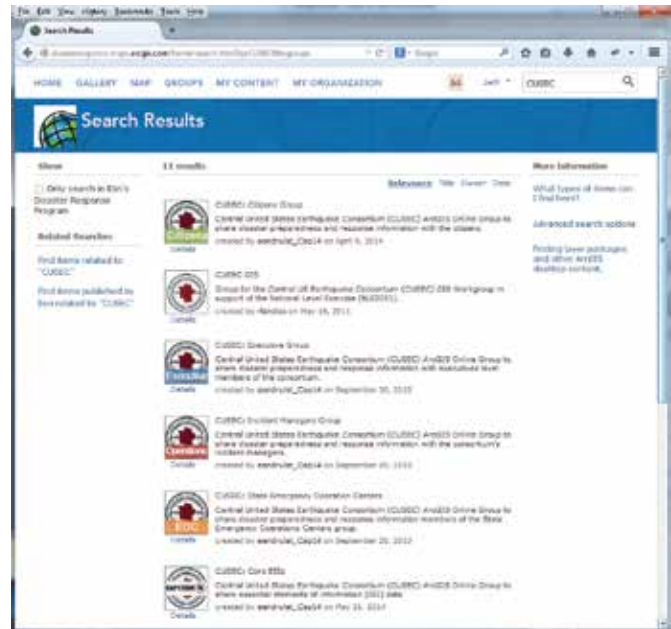
Incoming data from mobile app users was fed into Operations Dashboard so managers in each state’s emergency operations ➔

center could track events in real time. Such field reports, Monken added, couldn't always be expected to provide an abundance of detail but often served to fill in "missing puzzle pieces," to complete emerging pictures of situations on the ground and allow for informed assessments of impact.

"One of the problems we ran into was that a lot of gas stations didn't have power, so they couldn't pump fuel," Monken explained. The lack of fuel access created obvious challenges with evacuation efforts, as well as the mobility of incoming search-and-rescue teams. "That was one of the things we wouldn't have been able to see [without ArcGIS]. We could've only assumed that was happening without actually having good visibility. It was an opportunity to do a targeted prioritization of electricity restoration along an evacuation route we designated based on road information that we also wouldn't have otherwise had."

Other Esri technology came into play. Community Analyst was used to examine demographics in affected areas and refine evacuation strategies; identify potential cold-storage sites for temporary morgues; and locate possible respite sites along evacuation routes. Officials were provided quick updates on high-priority concerns via the Briefing Book. Briefing Book is a configurable ArcGIS app that can be used to create and view map-based briefings and reports that have interactive content. Esri Story Map apps proved a valuable public communications tool. Users could click points on the map to view photos and obtain information on shelters, evacuations, and damage at various locations.

↓ The ability to visualize information in a geographic format proved vital in the high-stakes scenario of a major quake.



↑ Esri deployed ArcGIS Online in each CUSEC state to facilitate information sharing and provide a common operating picture for agencies, emergency managers, and responders.

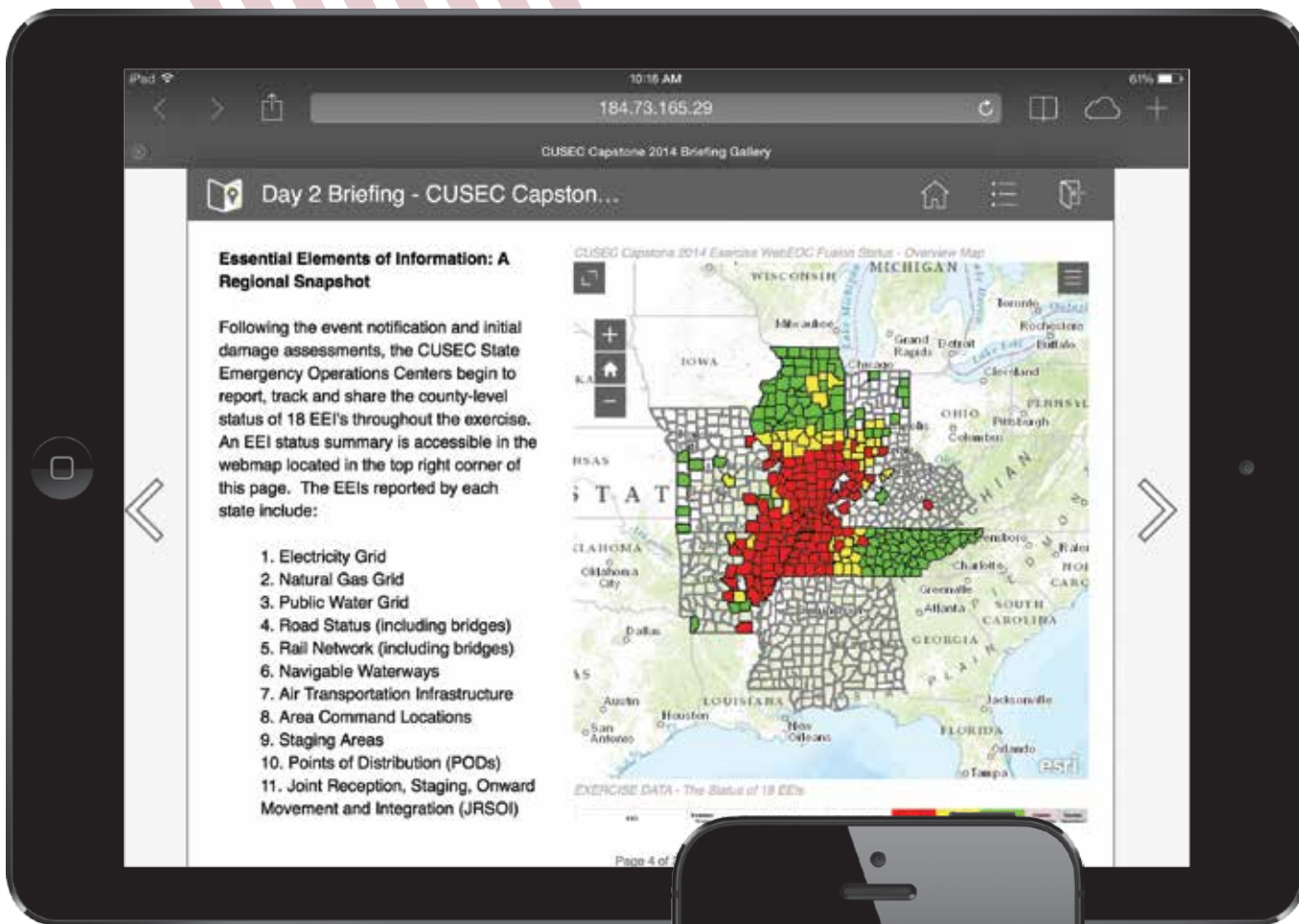
The Future of Exercises and Response

CUSEC is already looking ahead to future exercises, with the goal of partnering with the private sector, as well as other disaster-mitigation consortiums in the West, Northeast, and "hurricane

states" along the eastern and southeastern coasts to develop larger-scale drills. As the geographic scope of a Capstone-like exercise grows, so do the challenges of gathering and sharing information. Monken is convinced ArcGIS—specifically its utility in creating a comprehensive picture out of empirical data—will be the key to managing information in disaster scenarios, real or imagined.

"It's just starting to be meaningfully incorporated into what we do," he said. "Within a couple of years, we'll realize GIS is the fundamental keystone of disaster response."

Challenges may remain, though. Monken observed that emergency managers at all levels will need to become accustomed to managing data in greater volumes. For some Capstone participants, he explained, instant access to vast quantities of actionable information, reflective of real-time events, was initially overwhelming, simply because such access might not have previously been possible. Better situational awareness, he contends, brings with it a requirement that decision makers be prepared to view incoming data in context.



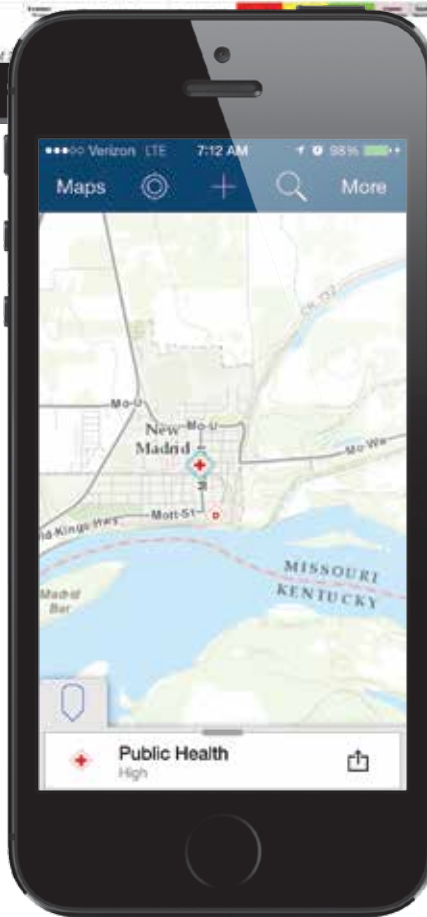
“People are quick to go to the tactical level when the information might really be intended for strategic-level decisions,” Monken explained. “You see information pop up and you want to play whack-a-mole—fix that problem right now—without understanding that you’re seeing a bigger picture in a way you’ve never seen before, and that it’s really serving as a system of strategic prioritization.”

Other Capstone participants and observers add that, in order for ArcGIS to be fully utilized in disaster management, state governments must ensure that managers and in-the-field responders at the county and city levels have access to the platform and the training to use it. Likewise, Monken added, it will become increasingly vital for ArcGIS users, both in government and in the private sector, to recognize the technology’s lifesaving utility in the context of public safety and be prepared to join conversations about deploying the platform in disaster response and management.

“We are light-years ahead, though, of where we were,” Monken said. “In an eight-state area, we had 440 counties reporting real-time, dynamic data into the system, which was unheard of. You can’t help but look down the road and think, the sky’s the limit with this.”

About the Author

A. J. Mangum is a Colorado-based writer, editor, publisher, and film maker.



↑ Officials quickly receive updates on high-priority concerns via the Briefing Book, a configurable ArcGIS app for creating and viewing map-based briefings and reports that have interactive content.

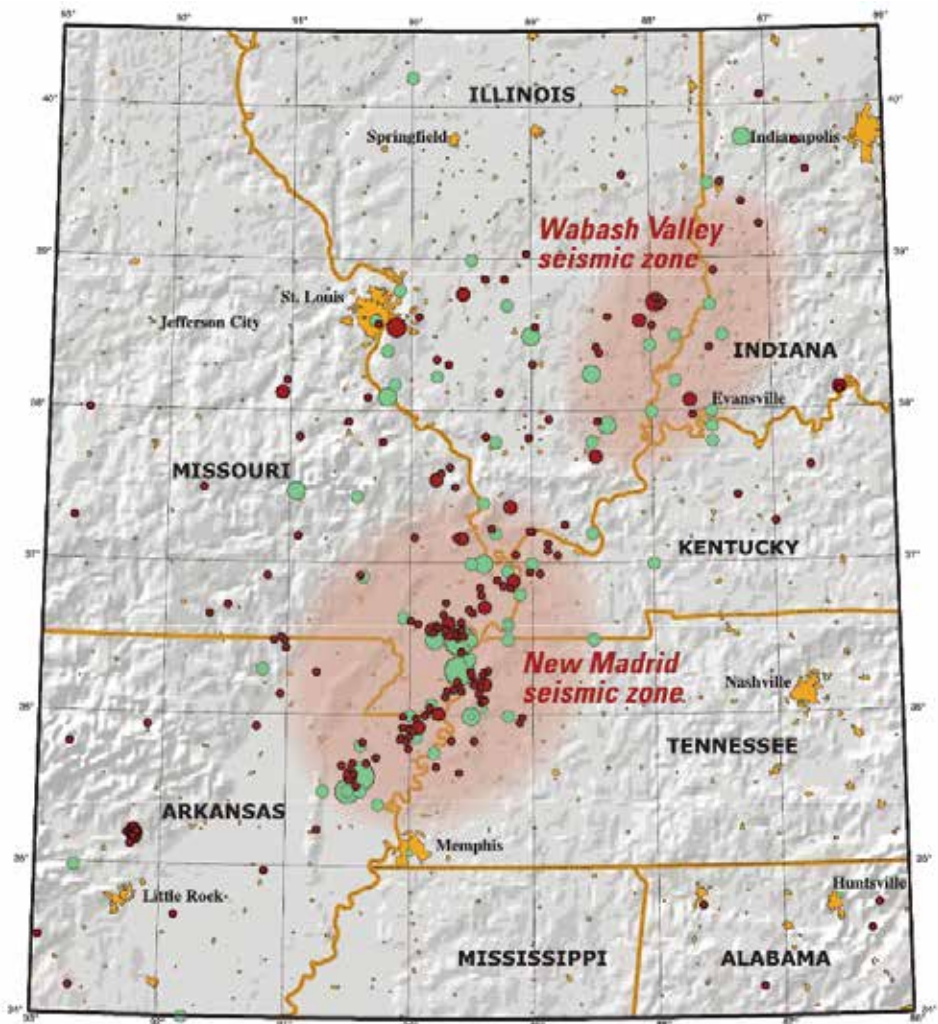
← Volunteers used a simple mobile app developed by Esri for smartphones and tablets to record points and photos for locations of fires, accidents, road closures, or floods.

The New Madrid Seismic Zone

Likely formed in a supercontinent breakup as many as 750 million years ago, the New Madrid zone is, in essence, a crack in North America. This network of geologic faults in the South and Midwest produced the most powerful quakes to strike the eastern United States in recorded history. This series of temblors occurred in 1811 and 1812. With estimated magnitudes between 7.5 and 8.0, they were felt over a 1-million-square-mile area. The seismic zone takes its name from the town of New Madrid, Missouri, which was destroyed in the first of those quakes.

Since 1974, seismic-monitoring instruments in the New Madrid zone have recorded more than 4,000 quakes, most too small to be felt. However, the US Geological Survey and the University of Memphis Center for Earthquake Research estimate there's a 7 to 10 percent chance of a major quake—one with a magnitude between 7.5 and 8.0—occurring in the region in the next 50 years. According to a 2009 study by Virginia Polytechnic Institute and State University (Virginia Tech) and the University of Illinois, such a quake would result in as many as 86,000 injuries and fatalities and the displacement of 7.2 million people.

"The scope is about as big as you could possibly have," said Jonathon Monken, director of the Illinois Emergency Management Agency and chairman of the Central U.S. Earthquake Consortium, a multistate partnership dedicated to reducing damage and loss of life from midcontinent quakes. "We'd expect significant or total destruction of more than 700,000 buildings, displacement of 2.5 million



↑ Red circles indicate earthquakes that occurred from 1974 to 2002 with magnitudes greater than 2.5. Green circles denote earthquakes that occurred prior to 1974. Larger circles indicate earthquakes of greater magnitude. Map: USGS/Joan Gomberg and Eugene Schweig.

people, damage to 3,500 bridges, and a loss of power to not only the central United States, but—for a period of time—a third of the country. Putting it in a purely financial context, Hurricane Katrina was a \$106 billion disaster. We estimate this would be a \$300 billion disaster, the worst in the history of the United States."

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Creating an Offline Lifeline

By Matthew DeMeritt, Esri

An African charity, responding to widespread flooding in Mozambique in 2013, has developed a faster and more accurate way to pinpoint where relief is needed that uses Collector for ArcGIS and its offline capabilities.

Torrential rains caused the waters of the Zambezi and Limpopo Rivers to burst their banks, decimating nearby farmland, destroying bridges and roads, and affecting more than 200,000 people. Humanitarian agencies responded by providing rescue, food relief, and shelter. Many of the region's roads and bridges washed away, so ground-based response was often not an option. Relief needed to come from above, but with airstrips flooded, that meant helicopters. Wings Like Eagles (WLE) was one of only two helicopter relief organizations based in southeast Africa that responded to the disaster.

Much of the population of southeast Africa is scattered across rural areas. Although mobile voice connectivity is available in these areas and much used, there is little or no mobile data connectivity. WLE's team used portable GPS and air maps marked with grease pencil hurriedly written in flight. These notes were then manually transcribed

to notebooks and paper maps on the ground for use by the emergency planning authorities and other aid and rescue pilots.

"The large scale of the disaster made it increasingly clear to us that our survey methods are too slow relative to the criticality of these situations," said pilot Clive Langmead, flight operations coordinator for WLE.

To speed up and improve its surveys, Langmead asked Esri partner Helyx, a GIS firm based in the United Kingdom, to make a data collection app for aerial surveys that could be used offline with a mobile device such as an iPad, iPad mini, or smartphone with a large screen. Data collected would be synced when a helicopter returned to base.

Anneley McMillan, GIS consultant for Helyx, knew the new beta version of Collector for ArcGIS had offline capability and was available for field testing. "I immediately thought of Esri's data collection app when Clive came to us," said McMillan. "Not

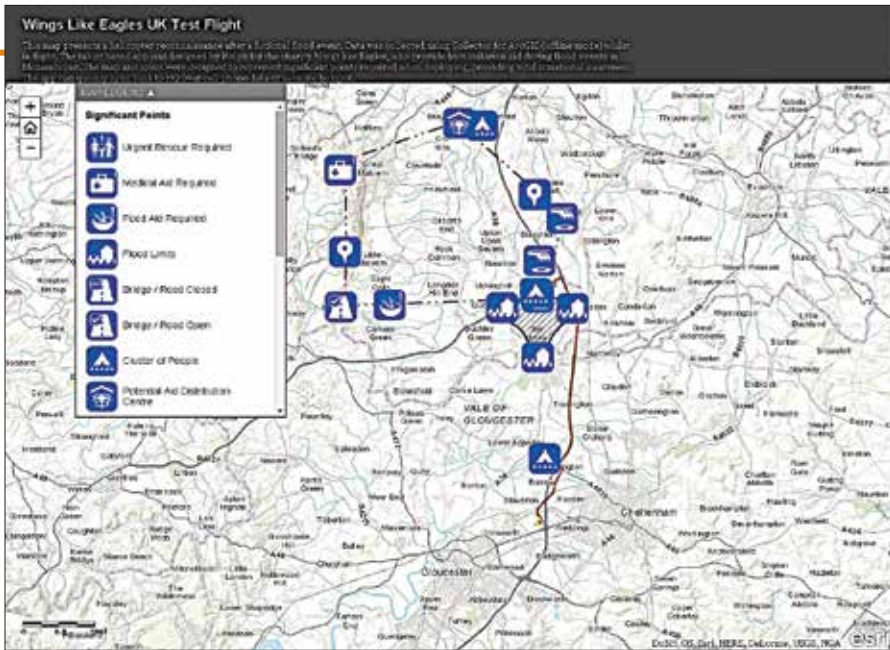
only did it have the disconnected editing feature, but it was also preconfigured, which would save all of us money and time."

To test the disconnected editing mode in Collector for ArcGIS, Langmead and McMillan set their tablets to airplane mode and took to the skies over South Worcestershire, England, inputting data into the app as they flew over the region. They identified locations, such as hills where people would take shelter from a deluge, that would be classified as incidents in a flooded rural area.

When they landed, Langmead and McMillan easily synchronized map edits made in flight. Even with the hiccups that typically accompany beta software tests, they noted the digital process was much quicker and more consistent than the handwritten survey. It allowed data collection without cell phone data coverage or Wi-Fi signal and could use a satellite hot spot to synchronize data back to base. The finalized data was presented in an embeddable web map with symbology denoting locations where urgent rescue and medical aid would be needed, flood limits, and bridge condition

↓ Captain John Lane, owner of helicopter rental company Heliflight; Clive Langmead, pilot for WLE; and Anneley McMillan, Helyx GIS consultant getting ready for the test flight in England.





✦ Helyx created an Esri Story Map app to document the success of the test flight.

✧ Helyx and WLE created an ArcGIS Online map that uses a United Nations symbology set created for representing types of relief.

With the application now tested, the WLE has a quick response data strategy for targeting relief delivery. In the future, if flooding in Mozambique makes most bridges and roads inaccessible, WLE will be able to fly over farmland, assess damages, and record the locations where relief is needed. This data can be synced back to headquarters and provide a rapidly updated picture of the situation for the Mozambican disaster response authority and other responding agencies such as the UN and Red Cross/Red Crescent.

“Quick surveys are key to getting emergency aid to the right people,” said Langmead. “A precise overview of a region’s flooded schools or clinics immediately shows the scale of the problem to government and UN aid partners. And, of course, speed and location are essential for flood rescue.”

Collector for ArcGIS allows data to be collected relating to medical aid and food aid requirements, emergency rescue, potential landing sites, and potential aid distribution points. The application could also be used in streaming mode to map flooded areas without manual digitization by the crew.

“This is an amazing leap forward from the way we did surveys before,” said Langmead. “All that scrabbling around with notebooks and paper in the aircraft just disappears.”



status. A stand-alone Esri Story Map app detailed the test flight and displayed pictures from the sortie.

Over the course of a year, Helyx tailored the app specifically to Langmead’s requirements. For instance, the app was configured to use the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) symbology set. This set of 500 free icons relating to humanitarian assistance were designed to be understood by relief workers regardless of language.

“There is huge potential for the online web maps to be further developed,” said McMillan. “For instance, it is a great post-deployment tool to debrief and learn lessons. Using the time element, in particular, allows dissection of postdisaster response in slow time after the event. It can also be used to assess vulnerability and build resilience. If there are common areas that require assistance every time there is a flood, these can be flagged as high-risk areas, and strategies can be developed to mitigate the risk.”



Configuring Sustainable Landscapes

Using native vegetation to support beneficial insects

By Jim Baumann, Esri

To improve grain production, Australian agricultural researchers use GIS to understand how pests can be managed by retaining some of the native vegetation that supports pest predators.

Farm production is a cornerstone of the Australian economy. Australia is one of the world's top exporters of produce and livestock with more than half of the country's agricultural output shipped abroad. Although historically wool was the backbone of the Australian agricultural industry, more recently, grain has become dominant. Wheat, barley, oats, sorghum, maize, triticale, and rice harvests are a significant part of Australia's agricultural production, whether this grain is processed for human consumption or animal fodder.

Because agriculture is so important to the country, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia's national institution for scientific research, along with the Grains Research & Development Corporation

(GRDC), conducts significant research in grain production systems.

Researchers from the CSIRO's Spatial Ecology team in Brisbane investigate insect populations, conduct field surveys, and map the results. Sampling lets the team better understand the dispersal and movement of both pests and predator populations in crop and noncrop habitats. This work helps create predictive models to better understand how specific insect populations interact with their environment and subsequently develop methods to help facilitate pest suppression.

"One of the problems with large-scale ecological surveys is that it's sometimes difficult to visualize spatial and temporal trends in the data," said Andrew Hulthen, GIS analyst and field researcher at CSIRO. "Geographic information system technology allows us to visualize the trends in the data we collect in a spatially explicit way, which makes it much easier for us to interpret our findings and share our results with other researchers."

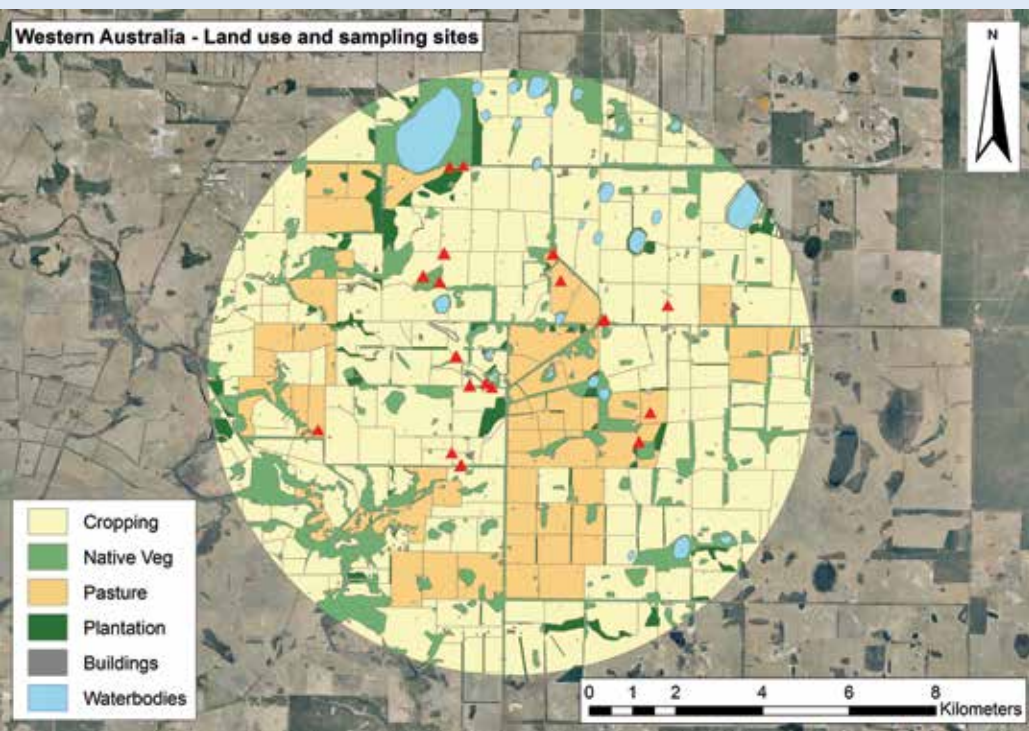
Hulthen recently analyzed the data collected in the field by a CSIRO-led team conducting a study to better understand how population dynamics of pest insects are affected by landscape composition. The team identified the source habitats of both pests and their natural enemies or predators, and then Hulthen used ArcGIS to examine insect movements between habitats and the length of time required for specified insects to establish crop colonization.

Native vegetation can harbor many beneficial insects that eat the destructive pest species attracted to the grain in cultivated fields, so preserving the native vegetation remnants promotes an ecologically sound method of pest control.

The scope of the study included monthly surveys of insect populations at more than 80 sites within six landscapes in Queensland, New South Wales, and Western Australia. The landscapes were selected based on the field crop, the distance from the field to native vegetation

↓ Grain production plays a dominant role in Australia's agriculture.





↑ Sampling sites in Western Australia that were sampled and mapped as part of the project.

remnants, and the proportion of native vegetation to the area being farmed.

In each region, two landscapes were chosen for comparative purposes, one with a low proportion of native vegetation remnant and one with a high proportion. Each was 14 kilometers (8.7 miles) across and at least 20 kilometers (12.5 miles) away from the other. Within each landscape, multiple crops and native remnant sites were chosen. The study was conducted over a two-year period, and the researchers netted more than 100 insect species, 29,000 samples,

and 300,000 individual specimens.

The features in the selected landscapes were digitized and classified as cropland, native vegetation remnant, pasture, forest replantation, or water body. Hulthen used ArcGIS to create multiring buffers of 500, 1,000, 1,500, and 2,000 meters around each native vegetation remnant. The buffers were then intersected with the land-use feature class, as well as the data collected on the insects inhabiting the native vegetation and their travel range.

Hulthen used Python scripting to

automate data processing. The resultant analysis provided him with maps that characterized the landscape features surrounding each survey site and helped to identify the ecosystem benefits provided by these landscape configurations. This work has led to the formulation of guidelines for planting remnant native habitat to support beneficial insect populations and control pests, thus improving grain production.

“We used land-use metrics and highly detailed ecological survey data to visualize and animate insect movement in these habitats and surrounding landscapes,” said Hulthen. “This allowed us to explore those landscape configurations that are less prone to insect pest attacks, which helps us develop pest-suppressive landscapes. This approach works toward reducing reliance on broad-spectrum insecticides and promotes the sustainable management of natural resources.”

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GIS as a Tool for Building Policy

Communicating spatially dramatically improves forest management

Dealing with the effects of catastrophic wildfires in the western United States is a concern for both forest managers and the public. Esri's natural resources writer Barbara Leigh talked with Kent Connoughton of the US Forest Service (USFS) about how GIS is helping him promote policy and plan effective forest restoration strategies.

Connoughton, a veteran of more than 30 years with USFS, was the Associate Deputy Chief for State and Private Forestry in Washington, DC, before assuming his current post as Regional Forester in charge of 17 forests and one grassland located in the Pacific Northwest—Region 6. He is also a fellow of the Society of American Foresters.

Connoughton and his staff are using GIS to measure forest conditions, look for patterns and relationships, and build dialog about forest planning, policy, and legislation.



← Kent Connoughton, Regional Forester for the US Forest Service

I am sure you know that GIS is more powerful than online mapping services because of its capacity for modeling and solving problems. How are you using GIS for analysis in the northwest?

Connoughton: One of our largest concerns is the number of catastrophic wildfires occurring in the west. GIS is helping us to study four national forests in eastern Oregon, one of which is the Wallowa-Whitman Malheur National Forest, where we have been conducting restoration activities. GIS is helping us answer the question, “What do you need to do to conserve those forests in general, and the Malheur Forest specifically?” GIS helped us understand that we not only need to look at forest conditions conducive to large wildfires, but we also had to ascertain the measure of threat this had on communities. Because the west has an arid climate, we know that watersheds are extremely important to forest conditions.

Our forest ecologists have identified some seriously degraded forest conditions. GIS helped us see the relations of five variables impacting forest health: insects, disease, wild

land urban interface, watershed condition, and watershed need. We mapped the prevalence of each of these contributors in Malheur. Upon seeing them displayed in GIS, we were surprised to discover that our restoration efforts did not overlap these problems and therefore our restoration efforts weren't making a huge difference. Instead, natural forces were changing the forests themselves. We realized we were underinvested, a conclusion we could not have drawn without the analysis.

Now we stand on the frontier of forest management as we ask ourselves what the future could look like. What would happen if we changed our restoration priorities? If we increased our restoration investment in other forests, where would we go first, what would we do when we got there, and what would large landscapes look like? GIS provides a way to describe what the public's interest would be. GIS is the only way for us to see these large landscapes.

I think you have probably concluded the GIS capability that we have provides us with the means to describe what the public's interest would be. It shows what tabular data cannot. What GIS is also revealing are public policy concerns. Are we doing what we should be doing, and will our children judge us if we fall short?





↑ Mt. Hood National Forest, Oregon, one of the 17 forests in the USFS Pacific Northwest (Region 6)

One of your duties is to explain national forest concerns, priorities, and needs to various groups in Washington, DC. You have been known to go into meetings with a huge roll of maps under your arm. Wouldn't GIS mobile make it easier to give presentations?

Connoughton: Yes. My problem right now is with hardware issues. But the benefit of mobile GIS is never to be underestimated. Maps are a gateway that facilitates conversation, discussion, and dialog about what public policy will be. Using hard-copy maps is difficult. I am often the only speaker. I put the maps on the wall, point to them, and then take them off the wall. I find it liberating if someone is there to help me.

With mobile technology, I can put into people's hands maps that help them understand by assertion about what the public policies for forestry are and for them to test the assertion themselves. This helps them formulate their own questions.

My objective is to place GIS information into the hands of people who will find uses for it, and those uses I cannot even imagine

myself. People need the electronic capabilities to answer the questions on their own. Furthermore, these capabilities allow them to understand various relationships and project outcomes. People cannot do this type of on the spot analysis using old-style paper maps.

We have talked about the advantages of people using GIS on their personal devices. Let's turn to an even larger venue. What advantages do you see for people who use a GIS platform to collaborate on policy design?

Connoughton: Public policy for each national forest is set by law. The national forest plan follows the procedures of the National Environment Policy Act, the Endangered Species Act, and a few other pieces of legislation. The advantage of collaborating on a GIS platform is that people have data, tools, and maps that give them greater insight and the ability to ask themselves design questions. On the platform, you are in a spatial environment that allows you to display the

"Turning forest information over to people in a way they can understand is empowering."

problem, query one another's ideas, and look at the logical outcome. This type of dialog becomes a mechanism for designing alternatives. Instead of forest service specialists putting together alternatives that are mandatory under the National Environmental Policy Act, they could collaboratively engage in setting public policy and asking design questions.

Boy, what an advance that is. Otherwise, we are drawing public policy from inside the government, and the outcome does not capture people's interest. Why not turn the ability to design public policy over to them. The foundation of policy is spatial, and its design is largely supported by sets of spatial information. This is very liberating to people who otherwise have had to depend on the government to create the forest plan.

Turning forest information over to people in a way they can understand is empowering. The responsibility of government is to be faithful and trusting to the people, and the people are using tools for designing alternative solutions and public policies.

What role do you see GIS playing in the future of public policy?

Connoughton: We have migrated data to probably one of the most meaningful characterizations of the environment that we have ever had. I see three ways GIS will affect us. First, it liberates the imagination to achieve all kinds of things we otherwise may not have even considered. Second, GIS permits anyone, not just specialists and insiders, to find the value in this information. Third, people will formulate powerful questions. The accessibility of geospatial information whenever a person wants on smartphones and other devices means they no longer need an information broker. Because people learn to ask their own questions, GIS becomes an instrument that allows people to converse with their neighbors about issues.

The ability to communicate spatially dramatically improves forest management. People who manage national forests have wonderful instincts about what is occurring in the forest. GIS will reinforce their understanding of the environment and enable them to articulate their concerns to administrators that have responsibility for multiple forests. In addition, GIS helps foresters better interact with local people. GIS is a scientific tool, it is instrumental in helping people let go of unfounded impressions and better understand realities.

I think what you will see during the next 20 years is that more people will become comfortable using these technologies and readily embrace them to understand situations and formulate questions that need to be asked about public policy.

INCREASE THE SIGNIFICANCE OF YOUR GIS

By Wade Kloos, Utah Department of Natural Resources

What can you do to significantly increase the value of your GIS?

It can be difficult for you to determine whether your GIS program is positioned to deliver maximum returns or for top management to fully appreciate the benefits that are delivered. In this article, I will answer this question: What actions can you take that will maximize the value of your organization's GIS and management's appreciation of it?

Organizationally, the GIS team might be under planning, engineering, or other departments that, in turn, report to a higher management level. Because GIS is several levels from top management, a gap exists between the people who truly understand the organization's information and technical capabilities and the people who need that information to address the organization's top priorities.

So the first part of the answer is: Make sure that you, as the GIS leader, are involved with the leadership issues of your organization. Listen for mission-critical challenges or strategic opportunities so you can apply your creative problem-solving skills and GIS know-how. This is not the time to ask for a larger budget. Instead, be resourceful and contribute most effectively to your organization's high priority needs.

By bringing your organization's relevant information (and information from others) to bear on these needs, you ensure that lack of information is not a limiting factor in your organization's decision-making process. Getting recognized by top management costs nothing, removes organizational barriers, and will inspire GIS staff to contribute to the organization priorities.

If you are a GIS manager working for a Fortune 500 company, you are far removed from top management, but there are still levels of management that you can access. Remember, top management focuses on the "what to do" and often delegates the "how" to lower levels of management. Find these managers and convince them that your understanding of the organization's information and spatial tool sets will help them address their most pressing issues and make them look good in the process.

Once you get past this first hurdle, what else can you do? While there is no shortage of work managing your organization's data and GIS resources, you and your staff can spend your careers becoming data experts inside your cubicles. But how often do you

and your staff get out of those cubicles and ask the managers of your organization's numerous programs what their information or work process challenges are? Do you ask them probing questions like, What would you change if you could?

Awareness and understanding of business realities and priorities are organizational currency that you can convert into value. This will help you close the gap between high impact opportunities and information/application know-how. Rather than gain a formal invitation to a leadership meeting, the next goal is to change the behavior of your GIS staff.

You might be familiar with 3M Corporation's 15 percent rule. 3M encourages its employees to spend 15 percent of their time pursuing projects that they believe will advance the company. Thinking along these lines, you should encourage key GIS staff to spend





time discovering new opportunities for GIS problem solving, developing a business case for GIS solutions, and implementing those solutions. Find what's keeping managers up at night and seek solutions that make them successful in their jobs. By enabling GIS staff to create their own projects and solutions, you will see motivation and innovation increase in areas that are meaningful to your organization.

This behavioral change is a two-way street, so make sure management sees its potential and supports it. To succeed, your management must support this freedom and know that failure is just another way to gain organizational insight. Management should not be overly critical of innovative ideas or suggestions that change the status quo. Ask your management if they think 3M regrets granting the freedom to pursue innovative ideas like Post-it Notes given the revenue 3M gained from it.

Because GIS professionals typically do not have MBAs, fiscal matters or business operations are not their first concern. You call the shots on spatial information projects and GIS solutions, but how often are you required to justify them beforehand, or document the project return on investment (ROI) or perform a cost-benefit analysis afterward? This is especially true in government. This behavior, if promoted, has potential to clarify the actual impact GIS is delivering to the organization for the people who fund your GIS program.

The best way to change behavior is to reduce the change and

measure the desired actions. To reduce the change, work with your organization's business analysts or finance people to create a simple template that documents the cost of doing business before and after a GIS solution was put into effect. List direct and indirect benefits to your organization (and others). Include both the qualitative and quantitative dimensions of these benefits. While you shouldn't forget to quantify the cost to create the GIS solution so ROI can be derived, don't emphasize just the ROI percentage. It will get management to appreciate the big picture. The key is to make this documentation simple and something your GIS staff will personally benefit from because it proves their value to your organization.

To measure desired behavior, set expectations (for yourself as the manager and/or your key staff members) that require a business case, cost-benefit assessment, and documentation (that can be the template just discussed). Perhaps you're thinking, I'm too busy, or this is not being asked for, so why do it?

My reply: if you don't do it, who will? Are you really so confident your future budget will be where it should be? You're creative, and this effort is important enough that you should reprioritize your tasks and delegate some of your workload so you can spend time proving your program's value. Make this a habit; it will pay dividends throughout your career.

Ever try getting a job without establishing your value? The significance of your GIS program is not defined by the deployment of the latest software release or wiz-bang product but rather by your organization being open to GIS input at the leadership level, providing for the freedom to discover and solve problems creatively, and setting realistic expectations for documenting actual GIS results.

So there you have it. What is that one resource that if you had more of could dramatically increase the value of your GIS program? It's not more money, people, or time. It's more management attention focused on GIS.

About the Author

Wade Kloos is the GIS director for the Utah Department of Natural Resources. He has more than 25 years of experience working in state and local government and the private sector.





INVEST IN YOUR PEOPLE

As a GIS manager, you must figure out how to prepare your team to leverage new tools and capabilities as the technology evolves. Helping your people develop the skills they need to perform at a high level is part of your job. It's how your organization achieves big-picture business objectives.

Investing in your staff by training them also improves their job satisfaction. Higher job satisfaction is associated with increased productivity, decreased turnover, and higher customer satisfaction. The benefits of training are twofold and bidirectional. It helps you align your employees' capabilities with your organization's mission and strategy. It also helps them because they acquire knowledge and skills that can help them advance in their careers and improve their earning potential.

However, you need to have a plan for training your employees. The planning process documents the strategic value of your staff and the applications they create, manage, and support. Documenting this information can help you communicate to executives the value of GIS throughout the organization.

Esri training consultants can help walk you through the work force development planning process. The process begins with strategic alignment, proceeds to detailed analysis, and results in action.

Strategic Alignment

During the first planning phase, you need to answer the following questions:

- What is your organization's overarching mission?
- What are your organization's strategic objectives?
- What GIS applications are in place that support these strategic objectives?
- What current workflows and work force roles support the GIS applications?

The value of your GIS program is demonstrated by its direct alignment with the organization's mission and strategic objectives. It's possible that some GIS functions are carried out outside the GIS department. For example, geoenabling applications, such as Esri Maps for Office, may be deployed to other business units. It is important to include these roles in the alignment phase to ensure a complete organizational view of GIS applications and workflows. Inviting managers from those other business units to participate in the planning process can help inform the next phase.

Detailed Analysis

The analysis phase focuses on the knowledge and skills required by each work force role. You will determine which learning resources and delivery methods are needed to support each role and discuss timelines, priorities, and budget. Ask yourself:

- What specific knowledge and skills are required for each role?
- Are there skills gaps?
- If there are, what resources are available to fill these gaps?
- When and how should training occur to support ongoing operations, specific projects, and longer-term organizational objectives?
- What is your budget?

Esri training consultants are experienced in preparing this information and working closely with you to document answers to these questions. The analysis phase produces the work force development plan. This is a detailed list of training options organized by role and schedules that will help you track your employees' progress.

Results in Action

The action phase is the culmination of the work you did in the planning process. The work force development plan is executed based on the timelines and priorities identified in the analysis phase. Action is an intrinsic part of the planning process because as the plan is implemented, the manager should periodically review the progress made and ask the following questions:

- Is the plan on schedule?
- Has the organization's strategy shifted?
- Have new roles been created or existing roles modified?

Work force development planning is iterative. Adjustments are made over time as individual roles and organizational priorities change.

Planning Outcomes

The planning process is a tool that helps ensure employees receive the right training at the right time. Beyond that, a work force development plan will help you communicate more effectively with your organization's leaders. Information documented in the plan can be shared during executive briefs, meetings, and presentations and included in budget proposals.

The same information is valuable when communicating with employees. Relating an employee's work to the achievement of strategic organizational objectives boosts positive feelings about the job and increases overall job satisfaction.

Another benefit—one that is becoming increasingly important—is change management support. New technology initiatives can flounder if the human tendency to resist change is not fully addressed. When planning technology changes that will require changes in how your team works, it is critical to gain their acceptance and proactively prepare them for changes ahead.

Demonstrating a commitment to helping your team successfully adopt new workflows and tools will make your employees feel valued and reassured. As they develop new skills and become comfortable with new technology, their resistance will diminish and they will embrace organizational changes.

To learn more about work force development planning, contact GIStraining@esri.com or visit esri.com/workforce-plans.



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Data Visualization with ArcGIS API for JavaScript

By Jerome Yang, Esri Software Product Release Team

In the past year, Esri has added powerful, innovative, and easy-to-use graphic drawing functionality to the ArcGIS API for JavaScript. Now you can easily create effective data visualizations on the map with a few lines of code. This article will walk you through some of the visualization capabilities in the ArcGIS API for JavaScript.

Prerequisites

Before doing this tutorial, you should know how to create a sample map application. If you haven't done this before, see the tutorial on [GitHub](https://github.com/esri/visualization-js/tree/master/basic_simple_map) (github.com/esri/visualization-js/tree/master/basic_simple_map). You should also know how to publish a feature service hosted on ArcGIS.com or using ArcGIS for Server. If you are not familiar with this process, see the ArcGIS help file at doc.arcgis.com/en/arcgis-online/share-maps/add-items.htm.

Getting Started

This tutorial uses samples located on GitHub at github.com/esri/visualization-js. Access this repository to obtain the code and view the live samples referenced in this article.

Add Data as a Feature Layer to a Map

You can create a feature layer with the service URL and add that layer to your map as shown in Listing 1. A feature layer has default drawing properties, which are used to render your data layer on the map.

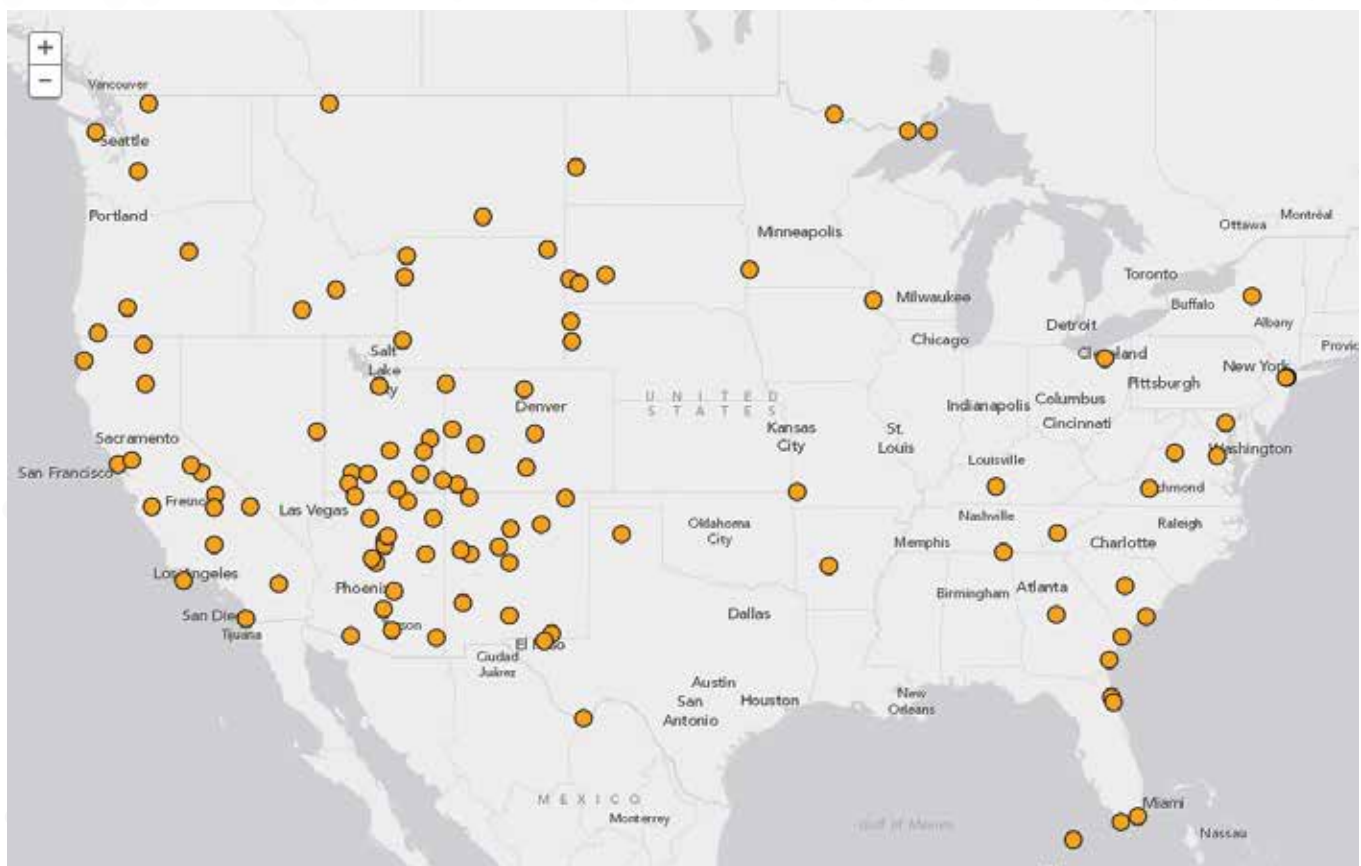
```
var layer = new FeatureLayer("services.arcgis.com/ \
V6ZHF6zdgNZuVG0/ArcGIS/rest/services/ \
NationalParkStats2013/FeatureServer/0");
map.addLayer(layer);
```

↑ Listing 1: Adding a feature layer to the map

Style Data with a Simple Renderer

Renderers determine how a feature layer is drawn on a map. When data was added as a feature layer to a map, the default drawing properties were used to draw the feature layer. However, you are not limited to defaults when representing your data. The ArcGIS API for JavaScript provides different renderers you can implement from the client side so you can create the most effective visualizations for your data.

↓ The new symbol and the new renderer after they are applied on the map



A good way to determine which renderer to use is to ask yourself what is the purpose of the map. This example uses the National Park Statistics 2013 Feature Layer. To help decide which renderer to use, you could ask questions such as, where in the US are the national parks located? or what type of feature does this layer display? The simple renderer is good for data that answers *where* questions because it draws all features with the same symbol. (See `basic_use_renderer` under `esri/visualization-js` on GitHub for links to code and a live sample.)

To use the simple renderer, first create a symbol. A simple marker symbol is suitable for this point data. For line and polygon geometry types, other symbols are available. See the `Symbolizing graphics with renderers` topic in JavaScript API SDK for more information.

```
var symbol = new SimpleMarkerSymbol();
symbol.setColor(new Color("#ffa500"));
```

Then we pass this symbol into a simple renderer instance and apply this renderer on the layer.

```
var renderer = new SimpleRenderer(symbol);
layer.setRenderer(renderer);
```

↑ Listing 2: Creating a simple marker symbol and passing it to the renderer instance

You can use this approach to make a simple web map application for visualizing your data.

Using the Unique Value Renderer

If your map needs to communicate more than just the location of a feature, you can use other visualization techniques. The Unique Value Renderer is good for answering *what* questions.

The Unique Value Renderer looks at an attribute field in your layer and provides a symbol for each unique value in that field. Again using the National Park Statistics 2013 Feature Layer with the Unique Value Renderer creates a map with each feature displayed by type (i.e., national park, national monument).

Creating a Unique Value Renderer is very similar to creating a Simple Renderer. The key difference is that you must pass an extra argument, a field name, to the `UniqueValueRenderer` constructor. The value of the field chosen will determine which symbol is used for each feature on the map. The sample uses the field `Type`, and the symbol object above is the default symbol for the data. (See the `unique_simple` folder under `esri/visualization-js` on GitHub for links to the code and a live sample.)

```
var symbol = new SimpleMarkerSymbol();
symbol.setColor(new Color("#cccccc"));
var renderer = new UniqueValueRenderer(symbol, "Type");
```

↑ Listing 3: Passing in the field name `Type` to the Unique Value Renderer



↑ The Unique Value Renderer provides a symbol for each unique value in that field.

Define Symbols for Unique Values

The purpose of a map that answers *what* questions is to clearly show features on the map that are logically grouped by a common characteristic that is designated by a unique value in a field. To do this, create symbols that relate to the subject but are different enough from one another that patterns can emerge on the map. Defining symbols is an iterative process. Try a symbol, evaluate its effectiveness, then modify it if necessary. Listing 4 shows how to specify a unique symbol for each unique value in the `Type` field. The `addValue()` method is used to pass each value with its unique symbol.

```
var symbol1 = new SimpleMarkerSymbol();
symbol1.setColor(new Color("#ed5151"));
renderer.addValue("National Park", symbol1);

var symbol2 = new SimpleMarkerSymbol();
symbol2.setColor(new Color("#149ece"));
renderer.addValue("National Monument", symbol2);
```

↑ Listing 4: Specifying a unique symbol for each unique value in the `Type` field

It might not be necessary (or desirable) to provide unique symbols for all values in a field. Because your audience will have difficulty distinguishing more than 10 colors, it is best to only add symbols for the top few categories and place all other categories into a group called `Others`, which will automatically get the default symbol defined in the `UniqueValueRenderer` constructor. (See the `unique_simple` folder under `esri/visualization-js` on GitHub to view the completed sample.)





↑ Converting raw data into two categories on the fly by providing a function to convert values in that field instead of providing a string when creating the renderer.

Convert Raw Data to Predefined Categories On the Fly

Having a field with too many unique values will make it difficult to create good visualization based on that field. One nice trick you can use with the Unique Value Renderer is to convert raw data to a few predefined categories on the fly on the client side. Converting raw values on the fly saves you the step of having to add a field to the data and calculate it, which may be something you don't want to do or cannot do.

In this example, instead of taking raw values in the Address field of the National Park Statistics 2013 Feature Layer, you can group data in a few categories such as Pacific West and Great Plains based on the state name in the address. This magic starts with the creation of the renderer.

```
var renderer = new UniqueValueRenderer(symbol,
function(graphic){
  ...
});
```

↑ Listing 5: Enabling conversion of raw data on the fly

For the second parameter in the renderer, instead of passing the field name, which is a string, you provide a function that converts values in that field. This function gives you access to every graphic in the layer. Each graphic object contains all properties you need to show on the map (geometry, attributes). Based on the Address field, you can convert the address into two categories: Pacific West and Other Areas. You use `graphic.attributes['Address']` to access this field. If an address contains the state abbreviation CA, OR, or WA, it is categorized as Pacific West.

```
var renderer = new UniqueValueRenderer(null,
function(graphic){
  if (graphic.attributes['Address'].indexOf("CA") !== -1 ||
  graphic.attributes['Address'].indexOf("OR") !== -1 ||
  graphic.attributes['Address'].indexOf("WA") !== -1) {
    return "Pacific West";
  } else {
    return "Other Areas";
  }
});
```

↑ Listing 6: Categorizing data as Pacific West or Other Areas

After creating the renderer, you will need to provide symbols for these new categories:

```
var symbol1 = new SimpleMarkerSymbol();
symbol1.setColor(new Color("#7b3578"));
renderer.addValue("Pacific West", symbol1);
```

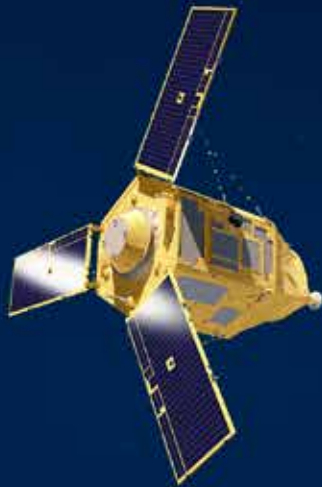
```
var symbol2 = new SimpleMarkerSymbol();
symbol2.setColor(new Color("#cccccc"));
renderer.addValue("Other Areas", symbol2);
```

↑ Listing 7: Symbols for the two new categories

Using a function with the Unique Value Renderer allows you to visualize not only the raw data in your feature layer but also new information calculated from your raw values. See the `unique_conversion` under `esri/visualization-js` on GitHub to look at the finalized application.

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Make Maps That Get Value from Data

By Jim Herries, Esri Cartographic Product Engineer

A great map unlocks value for the reader and makes data understandable by showing what the map's author intended to communicate. Maps are particularly good at unlocking valuable information that is otherwise buried in the data.

They are representations of the interpreted past, present reality, or predicted futures. When we look at a map, we are looking at a representation of reality, not reality itself. Our maps are a subjective view of reality based on data. There's bias in the data. There's bias in how the data was summarized. There's bias in how that data is expressed on the map. Even the colors and shapes on the map introduce additional bias. Whatever truth lies in the data can get lost in this noise, simply because we get intimidated by the subject matter or the software tools (or both). It does not need to be that way.

It's All about Presentation

One reasonable but not so useful reaction to all this potential bias is to "just publish the data" on the map. You can recognize these maps very easily. You look at them, you see some kind of pattern on the map, but you're not sure what you're looking at or how it relates to you.

Think of your map the way you think about your resumé. Viewed one way, a resumé is merely a collection of facts about you such as your name, address, phone, current position, past experience, education, and interests. The facts are one thing, but the *presentation* is everything. It's not just about how the resumé looks, it's about how

it is organized. The successful resumé presents the facts in an attractive manner, made relevant to the reader by the context of the position being sought.

Great maps work the same way. They answer specific questions in a context understood by both the mapmaker and the audience. Who creates that shared context? You do. That's why dumping your data onto a map *doesn't work*: you haven't set the context or expectations on the reader as to what can be learned from that data.

Many thematic maps are made with minimal regard to what the outcome might look like. We obtain the data and make it mappable. We let the GIS software choose how it is classified and symbolized. We deliver the resultant map to the intended audience, and ... nothing. You can almost see the audience thinking, so what?

The data expert blames the mapmaker for not understanding the data. The mapmaker blames the data and says, "The map just shows what the data says." However, the audience just moves on because it found little value in the map. How do we unearth the value in the data and reliably produce meaningful thematic maps? Is it a technical process, or something else?

Three Essential Elements

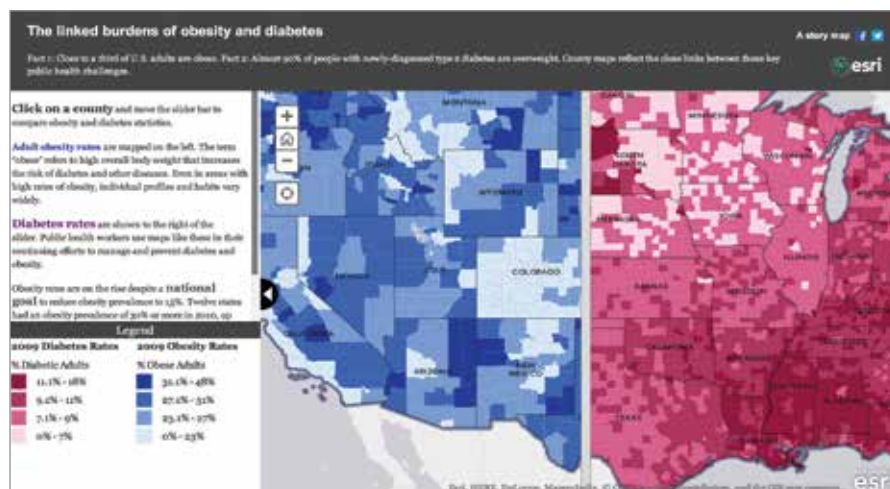
Like building a fire, three things are essential for making a great thematic map: the data that provides fuel to the story, a way to map it that gives it air, and the spark of an interesting storyline to bring it

all alive. What's the intended message of the map and how can we deliver that message as an information product? What's the map reader's first visual impression? What happens when the reader touches the map?

There is a lot of subjectivity at play, even if you don't consciously add any of your own. Subjectivity is infrequently discussed in technical workshops and training classes because it makes sense that we must understand how the software and data work at a technical level before we can introduce subjective decisions about *how* to represent the data most effectively on a map.

Certainly, basic technical knowledge of the software is helpful. These days, I spend equal time working with desktop software like ArcMap and online mapping software like ArcGIS Online as well as working with

↓ Figure 1: This map uses the counts of total population, obese population, and diabetic population in a pop-up to let the reader explore the data in more detail.





↑ Figure 2: This Esri Story Map app depicts the percent of diabetic adults in the population and uses the Swipe tool so the user can compare obesity and diabetes rates.

developers in their languages of choice (such as JavaScript, HTML5). I find that I can accomplish something effective in each of these, so I'm able to focus on what best serves my audience's needs. The tools and APIs I'm attracted to are the ones that allow me as a map author to iterate quickly.

Building a Great Thematic Map

Sometimes we have a great idea for a map, but the data just doesn't support it. Other times, we have a ton of data, and it's mappable, but we put it on the map and are unsure what it says. Or, worse, we infer a pattern that does not exist in reality, a situation that might not be intentional but is still unfortunate.

Sometimes you're handed the data and told to make a map out of it. Other times, you're asked to find data to support a particular story or to find data to support a particular map. No matter where you start, you'll adjust each of the three elements several times before arriving at a great thematic map suited to its story.

When building a thematic map, I look at the data, then talk to people, and look at the data again. I constantly ask myself: does this match the story they're telling me, or do I need to make some changes? I've made maps that revealed patterns beyond the expectations of the data experts. And I've also made maps that clearly did not support the story (which can be a tricky conversation to have with the map requestor). And that's why I enjoy maps. It's a subjective activity that finds balance through iteration and interactions with smart people.

Beyond the Defaults

To get there, we must go beyond just pushing buttons in the mapping software and publishing whatever the GIS chooses. All maps start with a database of features and their attributes. The story emerges when we look at the data critically and choose what to show on the

map in clear and concise visual terms.

For me, it all starts the moment the data arrives. A great story idea is nice, but until the data arrives, there's little to do. Opening that attribute table is like unwrapping a present. It's a moment of truth. Either the attributes needed are there or they are not.

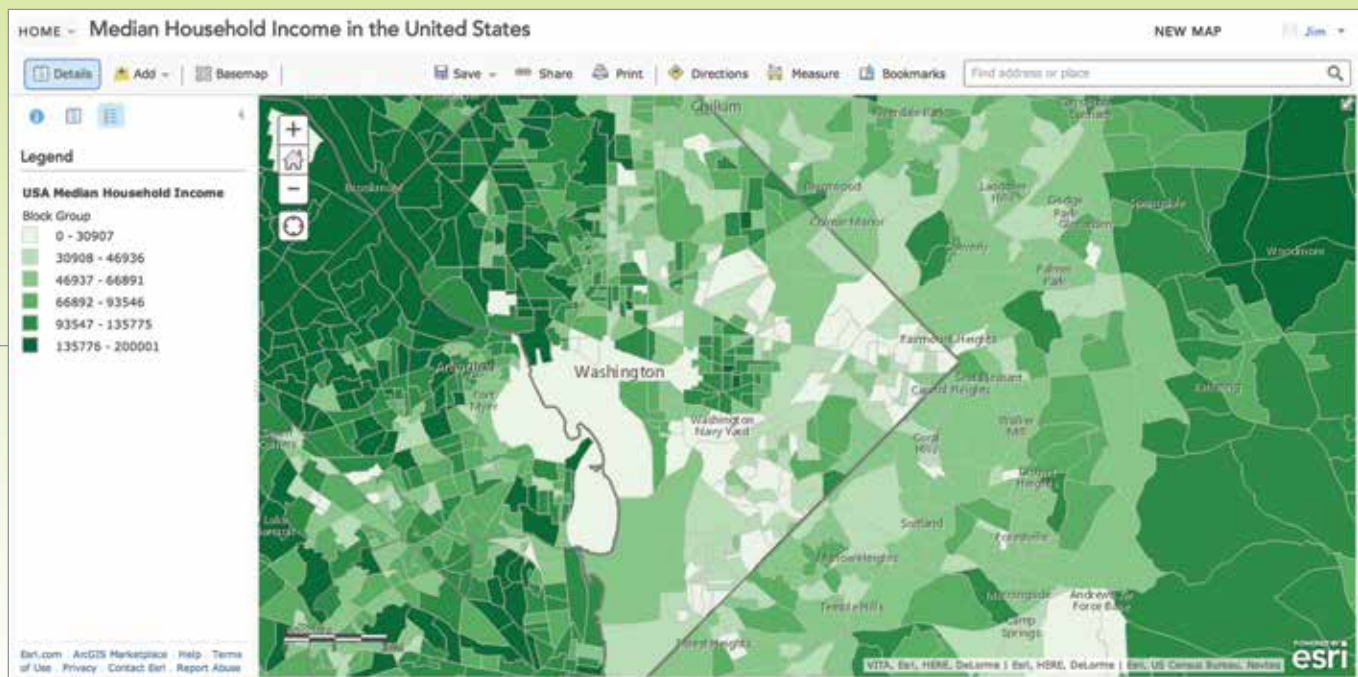
Attribute field aliases help everyone understand cryptic field names. An attributed field displayed as Total Population 2014 is more understandable than a field name such as TOTPOPCY. Some data formats are good about sharing field aliases, while others provide no field aliases. Field aliases help everyone from the data provider to the mapmaker to the application developer, and—most important—the reader.

When you first touch the data, apply easily understood, plain language aliases. Anyone who encounters the data in a database, map service online, or in an app will inherit those aliases and better understand the data. Once the attribute table is open, decide where the most valuable data for your map might be found. Look for a numeric attribute field whose values might tell an interesting story. Numeric values are either counts (e.g., total population) or some kind of normalized value (an average, a median, a percent, an index, or a rate). The normalized values usually contain the most valuable information because they compare things—a fundamental human need.

When staring at the attribute table, you may be confronted with the harsh reality that what is interesting may not be obvious in the data. That's why it's called data rather than information. You have to spend some time with the data to learn how it was collected and processed so you can figure out how much you can trust it.

Telling the Story behind the Data

Looking at the interactive map in Figure 1 that compares the rates of obesity and diabetes in US counties, it is apparent that Los Angeles County has a far lower obesity rate than Hinds County in rural →



↑ Figure 3: This map was created using the data dump approach. It uses the software defaults of Natural Breaks classification, a color ramp in shades of green, and somewhat obtuse precision of default break points.

Mississippi. It's also useful to realize that Los Angeles County has 1.5 million obese adults, while Hinds County has only 62,000. Rather than try to cram all that information into the map's symbology, the mapmaker made that information available in pop-ups so the reader can touch the map to get more detail. The map attracts the eye and communicates one aspect of the data clearly, which becomes a window into more information about the subject.

The data used was obtained from the United States Centers for Disease Control and Prevention (CDC). The story behind it inspired us to unlock the data in different ways. Adult obesity and diabetes are thought to be correlated. Consequently, an increase in the number of adults diagnosed with obesity means that a similar increase in the number of adults diagnosed with diabetes can be expected. To public health officials, these two diagnoses are related and subjects of concern.

The data contained counts of obese adults, counts of diabetics, and total population. We first made a map depicting the percent of obese adults in the population. Then we made another map (Figure 2) depicting the percent of diabetic adults in the population. The Esri Story Map app chosen implements the Swipe tool so the user could go back and forth over a given county or area and get a visual comparison of rates of both diagnoses. Swipe interactivity allows the user to find patterns from two traditional polygon choropleth maps.

As a data person, I always look for ways to reduce the information to a single measure. Knowing that these two conditions are related, I wondered which counties have both high obesity rates and high diabetes rates. I added a field and calculated a combined rate for both conditions based on each county's rates compared to the national average. The dot map in Figure 2 gives an immediate impression of where rates are highest and lowest by county. Given that context, the reader immediately sees regional trends that are otherwise somewhat buried in the two polygon choropleth maps.

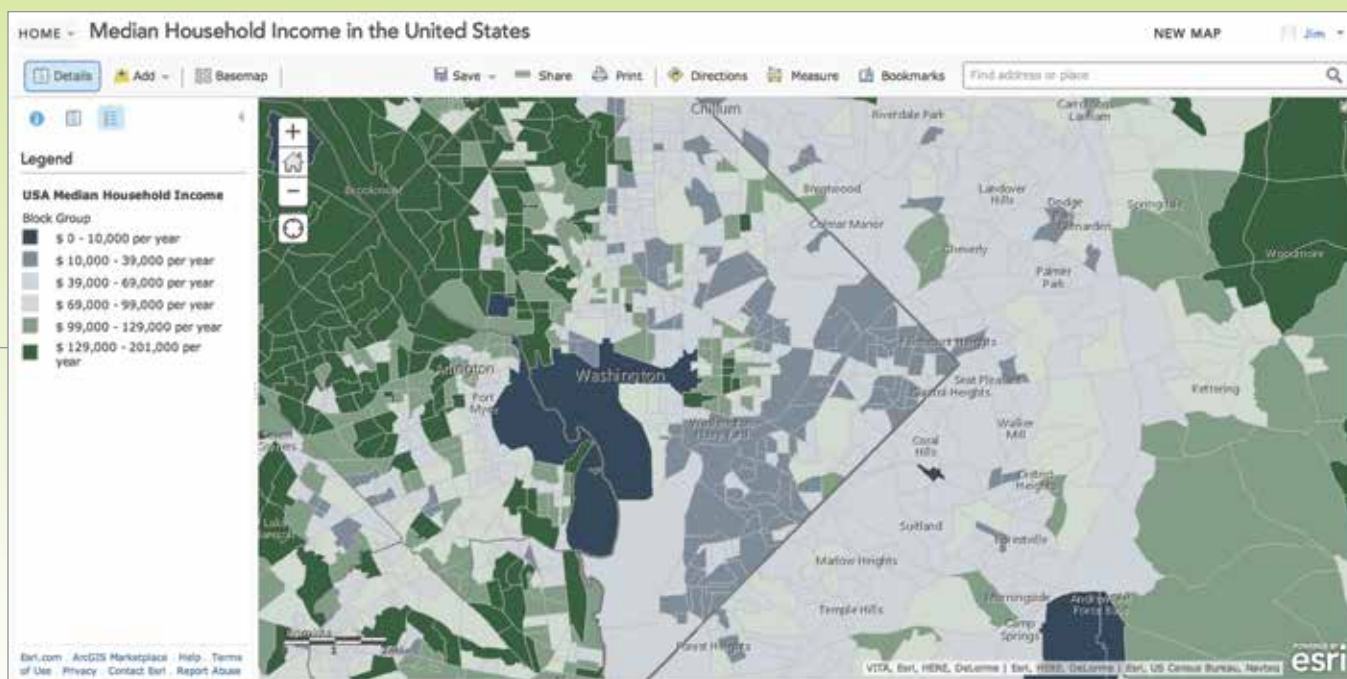
How Do You Create Context?

I consistently find that people who make thematic maps come in two types: those who are comfortable putting the data into a specific, subjective context and those who are not. After having made tens of thousands of thematic maps over the years, I find that maps grounded in a specific context are consistently well received.

It is helpful to assume most people don't know what your data is or how it can help them. Their lives and experiences are their frame of reference. Your job is to relate your map to *them*, not the other way around. To do this, you need to speak their language. Readers may not know exactly what *adult obesity* means, so tell them. They certainly won't know what percentage of all adults are obese. By explicitly telling the reader the national rate of adult obesity, you provide a frame of reference. If your entire map is anchored around that value, you've created a reference point that you and they can understand. You've created a comparison—you told them what the national value is, and the map shows how each county compares to that.

The next example uses US household income data. The Median Household Income in the United States map in Figure 3 is an example of the "data dump" approach. We let the software choose the default Natural Breaks classification, applied a default color ramp in shades of green, and accepted the somewhat obtuse precision of default break points. All we know from this map is some areas are richer than others—something we already knew. The map is not grounded in anything, so I can't really see patterns showing where things are better or worse. The map is true to its own internal logic, but that's the point. This is not a map a person can add to their frame of reference.

Figure 4 shows the same data in a different map. We know that some areas in our community are rich, some are poor, and there's a lot of variety in between. Exactly how we define those terms numerically



↑ Figure 4: This map placed median household income data in context using standard deviation and more reasonable classification break points.

is the challenge because everyone has their own frame of reference.

This map taps into a frame of reference we use when trying to understand unfamiliar numbers associated with a subject. We want to know what's normal and what's not. This map uses standard deviations around the mean to help focus the data. The legend uses values rounded up to better reflect the precision we use when talking about household income. By making these choices, we tell the story in a way that the reader can relate to their own experiences.

This example anchors the map using the US median household income of \$46,533. Areas with close to this income level (i.e., within 1 standard deviation of the mean or SD) are shown in a neutral color. Areas with average income levels more than 1 SD are shown in green. Areas more than 2 SD are shown in dark green. Similarly, areas with lower incomes are shown in shades of blue. The basemap itself is very muted. It contributes no additional colors that might confuse the reader. Rounding break points to the nearest thousand improves readability. Note how the polygons' outline colors are matched to the fill colors, instead of using the default (and visually fatiguing) black outline.

Now it is readily apparent which areas are at, above, and below the national average. Could we use another "anchor" point? Absolutely. You could anchor this map against a state average, the average of a selection of states, an inflation-adjusted average from the previous decade, or let the user choose an anchor point.

An amazing thing happens when you force yourself to anchor your map in a meaningful way. The color symbology reveals patterns more clearly. When applying colors to classifications, first decide what to de-emphasize. If you de-emphasize the normal category first by using a neutral color such as gray, white, or a very muted color, you create more room (color-wise) for the other classifications. The median household income example has a diverging color pattern that uses green for higher than normal income and blue for lower than normal incomes.

Making Great Maps

Why does this work? Your audience probably has no idea what your data is, how reliable it is, or how it relates to them. Even authoritative data sources can have data issues (which you must understand and address in the map). Defining the map around an anchor point, you provide a common point of discussion and understanding with the audience, rather than hoping they understand your map classifications *and* find a detectable pattern in your color ramps.

What's the difference in the maps shown in Figures 3 and 4? It's the same source data, the same software running on the same hardware, the same audience, the same need for answers. The difference is that the data was presented in a way that enhances comparison by anchoring it mathematically during classification and visually when applying color to the map.

This is not simply a data/classification task. Your choices have clearly expressed meaning because you used words your audience can relate to. Great maps don't use jargon that the audience won't understand. Great maps reach out to the map reader in a clear, understandable way so that the reader can easily explain the map to others.

This is an information design activity more than anything else. The data is there, the software is there, the audience has its needs. While there is always a valid use case for just publishing data (e.g., for an audience that has a need to explore and query that data), the true value of the data is always better expressed in a discrete, understandable representation on the map.

That's where you come in.

Increase Efficiency and Avoid Problems

Best practices that improve data management

By Mike Price, Entrada/San Juan, Inc.

My *ArcUser* tutorials on mapping and analytical tasks, often related to natural resources or public safety, always give step-by-step instructions for managing data as well as novel workflows and tips and tricks. Recently my editor asked that I summarize some of the data management best practices I included in these tutorials and that I use in my professional practice.

What Are Best Practices Anyway?

The phrase *best practices* is commonly used in business, industry, and education to describe methods, procedures, and workflows designed to obtain desirable results in a safe, cost/time efficient, and (when applicable) an environmentally friendly manner. In a practical sense, best practices are formally or informally implemented within industries and organizations to achieve consistent, reliable results. Within GIS and spatial analysis, best practices have evolved through the interaction between the technology's users and its developers to continually enhance mapping and cartographic tasks.

In this article, I will explain the best practices I use whenever I start a new tutorial or mapping activity. These practices are applicable to both industry and academics and include new and traditional steps to help GIS users design and produce solid mapping projects.

I find that one of the biggest issues confronting GIS professionals is data management, which includes understanding and documenting coordinate systems. Using a well-designed file system that identifies when and from whom files were obtained and the coordinate systems used with those files, along with obtaining, updating, or creating quality metadata, will help you avoid many problems and makes most project tasks a breeze.

A Real-World Example

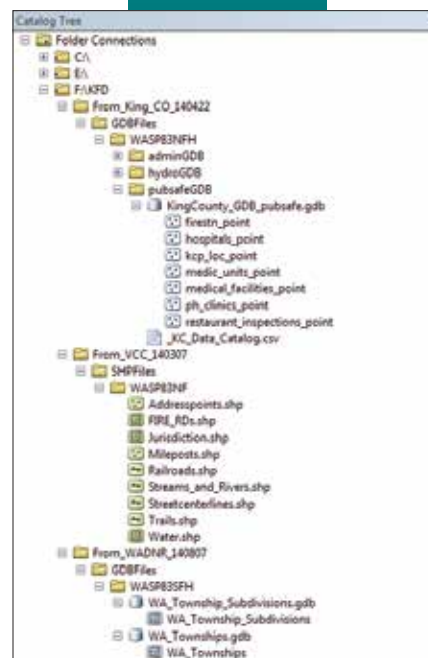
The illustrations in this article come from a public safety map book project undertaken by the Kent Fire Department (KFD) in Kent, Washington. Kent, a growing community located less than 20 miles south of Seattle, is a hub for commerce and industry and has one of the largest warehouse districts on the west coast. KFD uses digital and printed map books to guide emergency response and assist with planning. The KFD map book uses Esri's Data Driven Pages to publish data from federal, state, and local providers.

Data Acquisition and Management

All projects begin with an idea and proceed directly to data acquisition. In public safety, mappers often rely on agency and industry providers. Whenever I obtain project data, whether downloaded from the Internet, copied from a CD or DVD, or transferred interactively from a portable drive, I always create an archive folder to store a copy of the data so that it will remain safe, secure, and unchanged. I copy project data from this archive and store it in project folders.

Coordinate Systems and Metadata

When I receive data, I immediately open it and review it in ArcCatalog. I look for



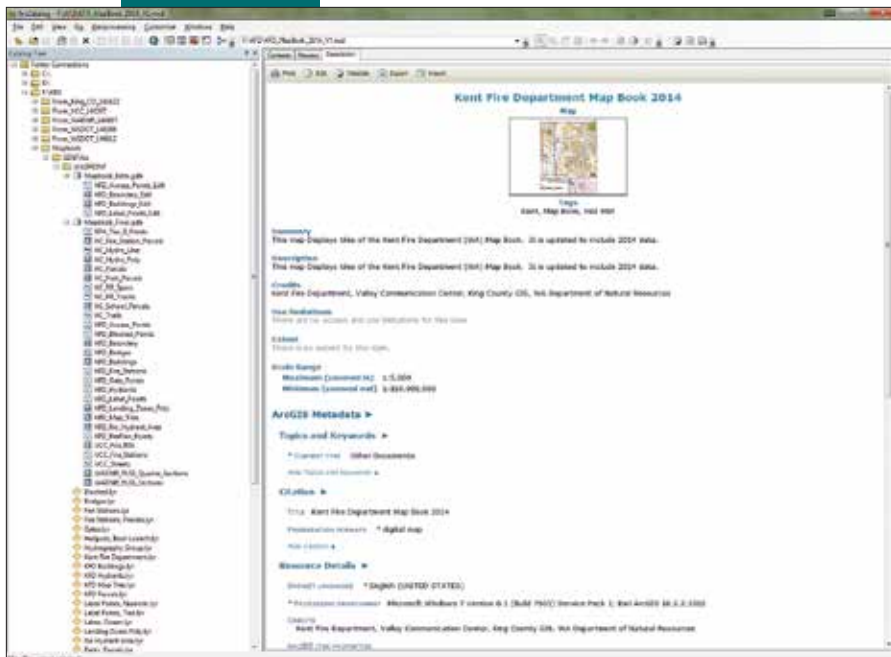
↑ Organize project data (including updates) in a carefully structured and named master project folder.

↓ When you receive data, immediately open it in ArcCatalog and review the metadata created by the provider.

↓ ↓ Set Geoprocessing Extents by choosing a layer that completely covers the analysis area or set the extent manually by inputting coordinates or interactively using Same as Display.

metadata created by the provider. If adequate metadata is not available, I use ArcCatalog to create new metadata or to validate and edit a minimal set. If metadata is available separately from the provider, I download the file and import it or manually merge it into the source data. Sometimes, I return to a provider's site several times to ensure I have all available supporting information.

the data type and a subfolder with an abbreviation for the coordinate system (e.g., SHPFiles > WASP83NF for Shapefiles > North Zone U.S. Feet). If these parameters are not known, I unzip the new data in the root of the master folder, determine its format and coordinate system, create appropriately named folders, and move the data to these folders. Using this naming convention is especially important if source data is available in several different coordinate systems.



Integrating Data into Projects

After downloading and storing archived data, I employ strategies for extracting, standardizing, and editing or updating data that I may already have in my project. Typically, I open source data in ArcMap, review its geometry and attributes, and export it to the project's database.

If the data comes in a coordinate system that differs from my project's coordinate system, I convert the data to the desired system and apply appropriate datum transformations as needed. Because most of my data is stored in a file geodatabase, the full path is the same for all project data.

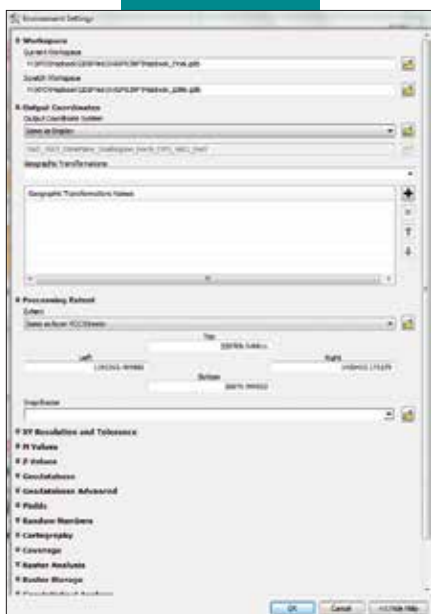
By reprojecting data from a single well-defined conversion data frame, I can control the output coordinate system of all imported and interpreted data.

As I import project data, I verify that the provider metadata is included with any new datasets. If I modify imported data, I note the changes I made. If geoprocessing tools are used to modify data, I confirm that those geoprocessing events are described in the output metadata.

Data acquisition and management practices vary by project based on your needs, the sources you used, and your preferences. In addition to carefully storing data on your local computer and keeping a secure archive copy of the source files in logical folders, also be sure to reference the organizations that supplied that data and let them know you appreciate their efforts.

Starting or Updating an ArcMap Document

When you start a new ArcMap session, the software prompts you to open a new



You will often use data from many sources, and it will come to you in many ways: downloaded from the web, on DVD, or copied over the network from another department. Sometimes that data will be periodically updated.

To organize project data (including updates) I create a master project folder. Data in this archive folder will remain unchanged. The master project folder contains separate subfolders for each data source. Each folder name begins with From_ which is followed by an abbreviation for the agency providing the data, and a date string in YYMMDD format denoting when I acquired that data.

If the data type and coordinate systems are known when the data is acquired, I create a subfolder with a name that denotes

template called Normal.mxt and allows you to set a default geodatabase. Too often we “lose” data because we fail to specify a location, and the computer stores it in a location based on another project.

If you specify a default for your new project, the chance your data will be properly stored increases significantly. You can use more than one geodatabase for a project. One geodatabase can contain finalized data, while the other one contains only layers that will be edited. This approach decreases the chances of experiencing editing disasters.

Setting the Coordinate System

When you initially add data to a new map document, ArcMap reads the projection information for that data (if it is available) and sets the data frame coordinate system to match it. Therefore, it is a best practice to add a feature class or shapefile with a known (and the desired) coordinate system to a newly created data frame. If you are not sure which coordinate system that data frame is using, open the data frame properties, select the Coordinate System tab, and verify or (if necessary) set the coordinate system manually.

Setting Map Document Properties

In a new or existing map document, it is very important to set several Map Document Properties as soon as possible. To set document properties in ArcMap, go to File in the Standard menu and choose Map Document Properties. In the dialog box, fill in the Title field and as many fields as possible.

ArcMap uses the Title field to assign a default title to the map layout. You can change the title later if you wish. The other fields populate the map document’s metadata. Take your time completing this task. If you plan to use hyperlinks in the map and all photos or other objects to be linked will reside in a single folder, you can set the hyperlink base using the Map Document Properties.

Controlling Data Storage

Still in the Map Document Properties, look at the Default Geodatabase specified. If you set a default geodatabase when you opened the Normal.mxt template, you might not

need to do anything. If you didn’t set it or realize you need to change the default geodatabase, do it now.

Next, locate the Pathnames box in the dialog. If your data is organized so that all data for the layers in your map resides in folders that are organized in a hierarchy, you can check the box to apply relative paths to search for the data in the map using that structure. If you store the ArcMap document at the base of the folder structure, ArcMap will search out folders located in this structure to find the data used in the map.

By default, ArcMap does not retain the relative path setting for all documents. If you prefer relative paths as your default, click Customize in the text menu, select ArcMap Options, click the General tab, and check the option Make relative paths the default for new map documents.

Save your project after verifying or manually setting the coordinate system and setting the Map Document Properties.

Before considering geoprocessing options, make certain that Maplex, Esri’s powerful labeling engine, is available. With ArcGIS 10.1 for Desktop, it became part of the core software and is available to all ArcGIS for Desktop users.

By default, new ArcMap documents use the Standard Label Engine, so change this returning to the Standard ArcMap menu. Choose Customize > ArcMap Options and open the Data View tab. Near the bottom of the dialog, set the Label Engine to Maplex Label Engine.

Now is also a good time to consider a different font name and size for labeling. I recommend using a simple, sans serif font such as Arial for default labeling. Consider increasing the default size to 10 points.

Remember, updating these properties for the current map will not change the label engine and font for existing map documents. Set Maplex as the labeling engine for existing maps by right-clicking on the data frame, opening Properties, selecting the General tab, and changing the Label Engine to Maplex.

While in Customize > ArcMap Options > Data View, you can also change how the coordinates display in the status bar by modifying the number of numeric characters to the



↑↑ In the Geoprocessing Options dialog box, make sure geoprocessing results will be written to a log file.

↑ Use Customize > ArcMap Options > Data View to change the number of numeric characters to the right of the decimal point that are displayed for coordinates in the status bar.

- ↓ Make sure you set Maplex as the labeling engine.
- ↓ ↓ In Map Document Properties, fill in as many fields as you can.



right of a decimal point. If you display decimal degree units derived from GPS, you might want to limit the number of places shown.

If you want to obtain one-meter precision with decimal degree coordinates in the middle latitudes, specify five characters to the right of the decimal point. With label engine and coordinate display set, save the map document.

Setting Geoprocessing Options

ArcToolbox provides powerful and highly efficient geoprocessing tools, but to use them properly, you must set certain geoprocessing options and environment variables.

In the ArcMap Standard menu, choose Geoprocessing > Geoprocessing Options. Check the box so geoprocessing results will be written to a log file. It may be desirable to overwrite the output files from intermediate geoprocessing operations. By default, ArcMap will not overwrite existing geoprocessing output, so eliminate lots of intermediate files by checking the Overwrite box.

If you want to run geoprocessing tasks in the background, check the Background Processing Enable box. You can also turn geoprocessing notification on and off and change the length of time a message displays on your screen. *Always* display all error messages so you can figure out how to fix errors.

Experiment with these options and decide what works best for you. Keep final geoprocessing results for at least two weeks. For most processes, add the results to the map.

If you elect geoprocessing in the background and you are unsure of the status of a process, you can choose Geoprocessing > Results in the Standard menu to check it. Look at the top item in the Current Session. A small hourglass indicates that the process is running.

Next, let's consider some default geoprocessing environment settings. These settings allow you to manage and redirect geoprocessing output, define output coordinate systems, and set the processing extent.

Open the Environments dialog box by choosing Geoprocessing > Environments in the ArcMap Standard menu or by right-clicking an open Toolbox area in the Catalog window. In the dialog box, expand the Workspace, Output Coordinates, and

Processing Extent items. Verify that the Current Workspace is set to the desired geodatabase or other output location. If you are using a second output location such as a geodatabase you will use for editing, consider setting the Scratch Workspace to that location. The Scratch Workspace is used primarily by ModelBuilder to store intermediate datasets. I occasionally use it for layers that I wish to edit before they are finalized.

If you have properly defined the coordinate system of your data frame, you can use Same as Display to set the preferred Output Coordinates for all geoprocessing tasks, but make sure you verify that the listed coordinate system is correct.

To set Geoprocessing Extents, identify the layer in your map that completely covers your proposed analysis area and select it from the drop-down. Alternatively you could carefully enter the maximum and minimum bounding coordinates for the desired extent. You can also set the extents visually by zooming the display to the desired maximum extent, resizing the active mapping area if necessary, and selecting Same as Display.

Remember your Geoprocessing Options and all task parameters will be stored in the output metadata.

Summary

In this article, I shared some of my favorite data management practices. I find that GIS best practices are a moving target. I continually develop new and better ways to perform mapping and analysis tasks. The best new procedures make it onto my best practices list. The data management best practices in this article have proved valuable over time. Try them and incorporate them into your workflows as you see fit.

Acknowledgments

Special thanks to my Washington-based data providers, including Washington State Department of Transportation, Washington Department of Natural Resources, Valley Communications Center, King County GIS, and especially to the Kent Fire Department/City of Kent for their continued support and innovative approach to mapping and analysis in public safety.



What You Will Need

- An ArcGIS Online organizational subscription and access to administrator rights
- Access to the GeoPlanner for ArcGIS app (a trial version will work)
- An Internet connection

Modeling Suitability

Finding the best site with GeoPlanner

By Rob Stauder, Esri Professional Services

Spero Vineyards is a small winery in Temecula, California, with a special mission. It teaches adults with developmental disabilities to work in the viticulture industry. The winery wants to expand its viticulture education program, so it needs to identify land that is suitable for growing wine grapes. In this exercise, you will learn how to use GeoPlanner for ArcGIS, a new web-based premium app hosted on ArcGIS Online, to find areas that will allow Spero Vineyards to enlarge its operations.

Focused on land-based planning and design activities, GeoPlanner helps you create, analyze, and report on planning alternatives. All data and reclassification functionality is available within the application. This makes the common GIS task of modeling suitability using weighted overlay easy by including data and tools you can learn to use quickly in a web application. *[See the accompanying article "Understanding Weighted Overlay."]*

The New Weighted Overlay Model tool in GeoPlanner uses 24 Esri-curated landscape layers. These layers represent the physical

structure of the United States, including hydrography, soil characteristics, geologic units, and land surface forms. These data layers are maintained and updated by Esri so your analyses execute against current data.

Powerful server-side processing frees up local computing resources so you can use GeoPlanner from nearly any device at any time. By providing the data, analytical tools, and a hosted environment, GeoPlanner gives you access to sophisticated analysis without requiring a high level of expertise or investments in time and money to acquire and maintain data.

Processing the weighted overlay is done by ArcGIS Online. The resultant suitability model is a new hosted image layer that can be viewed at any scale for the continental United States. Because the output image layer is stored in the ArcGIS cloud, it can be accessed from many connected devices.

Establishing Criteria

By identifying and rating areas based on criteria that you have determined will reveal

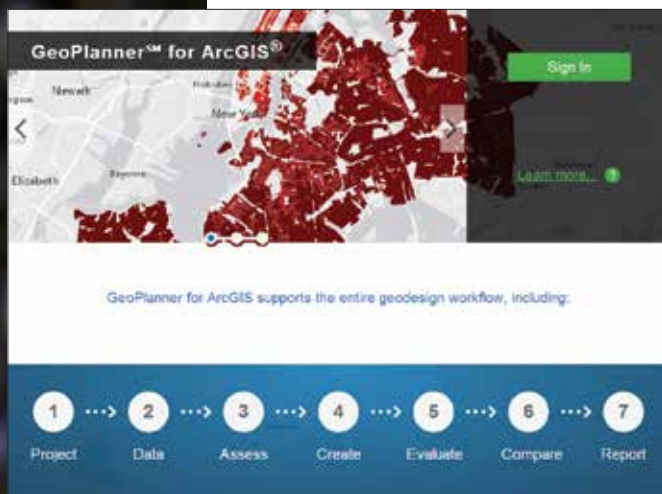
opportunities, risks, and constraints, suitability models help answer questions such as, Where are the greatest fire risks? or Where are optimal locations for a new housing development? The answers generated depend on the data you use and criteria you define.

Spero Vineyards has defined four criteria to identify land suitable for additional vineyards.

- To receive the correct amount of sun, the aspect of the land should be east or west.
- For ideal growing conditions, the elevation should be approximately 1,400 to 1,600 feet.
- To enable circulation of colder air, land should be on a 5 to 10 percent slope.
- In addition, Native American lands, areas of open water, and areas of residential development should be excluded from consideration.

Accessing GeoPlanner

With the criteria for analysis chosen, the next step is accessing GeoPlanner. If you have an ArcGIS organizational subscription, you can sign up for a trial of the GeoPlanner app and add it to your ArcGIS



↑ GeoPlanner is a new web-based premium app hosted on ArcGIS Online.

and the members of the group created in step 3. Sign in to GeoPlanner using your ArcGIS Online credentials.

Getting Started with a Template

To perform weighted overlay analysis in GeoPlanner, you will choose a template when you create a new project and then open the New Weighted Overlay Model widget.

1. In the Getting started screen, choose Create a New Project.
2. In the template gallery, click the Select button for the GeoPlanner Template for Land Use Planning.
3. In the Create Project dialog box, type

- “Spero Vineyards” for Title. Add a summary, description, and a tag and click Create.
4. When the project opens, click the Find tool in the button bar and type “Temecula CA” to zoom the map extent into the area of interest.
5. Click the big blue action button in the upper left corner labeled Project and choose Assess from the drop-down.
6. Click the Modeler button on the far right of the button bar. The New Weighted Overlay Model widget appears on the right side of the browser containing a list of layers.

Performing Suitability Analysis

Next let’s choose the layers, set the weights, and reclassify raster values to a common suitability scale using the criteria previously determined.

Check the boxes beside the Aspect, Elevation, Landcover GAP, Native American Lands, and Slope layers to turn them on. Click the Design Model button.

Click Color Ramp and set the color ramp to Low (Red) to High (Green).

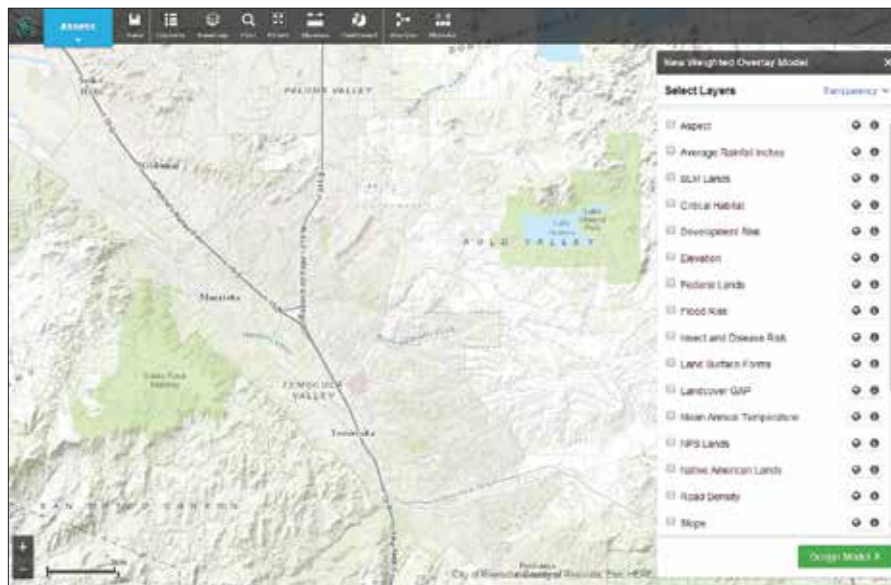
For Elevation, assign a weight of 25. Click the > symbol. The values in the widget are given in meters, rather than feet. The ideal elevation of 1400–1600 feet is 426–487 meters and falls into the 300–800 range, so set Medium (300–800) to 8 either by moving the slider or typing in the value. Set all other elevation values to 1. Setting these values represents the ➔

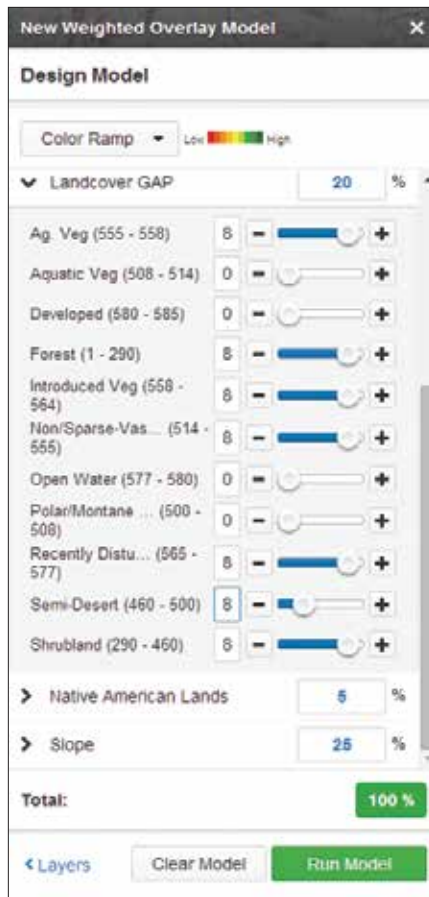
← In this tutorial, you will perform a suitability analysis to identify potential sites for more vineyards in Temecula, California.

organizational subscription.

1. Sign in to ArcGIS.com with administrator credentials.
2. Click Groups at the top of the site.
3. Click Create A Group. Name it GeoPlanner App. Add information about this group under Summary and Description. Add a tag and set status to Organization. Optionally, add to this group some ArcGIS Online members to whom you want to give access to the GeoPlanner app.
4. Go to ArcGIS Marketplace and search for GeoPlanner. Click the item listing. Click Try it Now and enter your ArcGIS Online administrator credentials. Fill out the form, agree to terms and conditions, and click Submit.
5. In the Thank you page, click the link to your console.
6. In the My Console page, click View Item and share it with the group you created in step 3. Click OK.
7. Click Open and choose View Application from the drop-down menu.
8. GeoPlanner is now ready to use for you

↓ The New Weighted Overlay Model widget contains 24 Esri-curated landscape layers.





←← Use the New Weighted Overlay Model widget to evaluate suitability based on the chosen criteria.

← Remove lakes, residential development, and other land uses that would not be useful from the analysis by setting these parameters for Landcover GAP.

Click the Run Model button. In the Save Model dialog box, name the model Spero Vineyards Potential Sites and click Save.

Looking at the Results

When you click Save, the information you just entered is submitted to ArcGIS Online. The suitability values are computed for overlaying raster cells and written to a new output image layer. This layer is added to the GeoPlanner project as a suitability map. On this suitability map, you'll see a few areas of red, more areas of orange, and areas with several shades of green. Dark green cells denote the areas most suitable for wine production based on the input criteria. Areas without shading were those excluded from the analysis. Based on this analysis, the area southeast of Lake Skinner looks like a promising area for Spero to expand its operations.

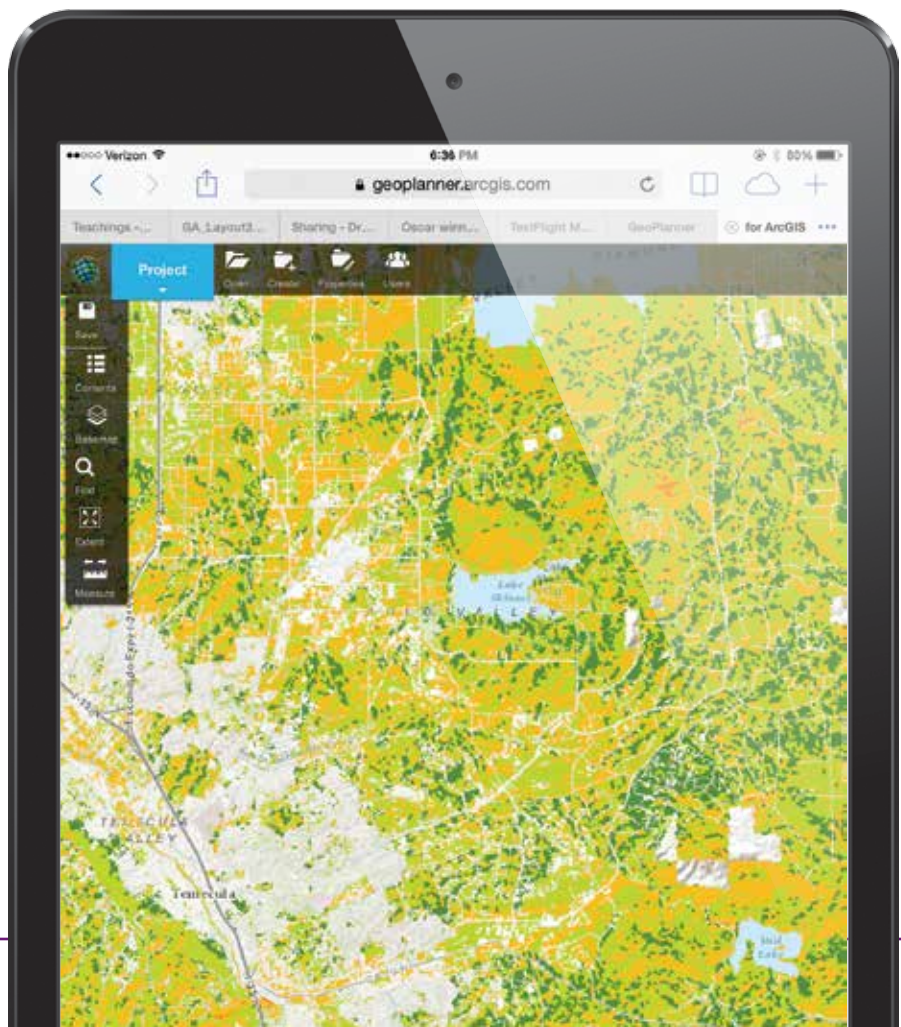
reclassification of the input raster cell values to a common suitability scale. (Read the accompanying article “Understanding Weighted Overlay” for more information.)

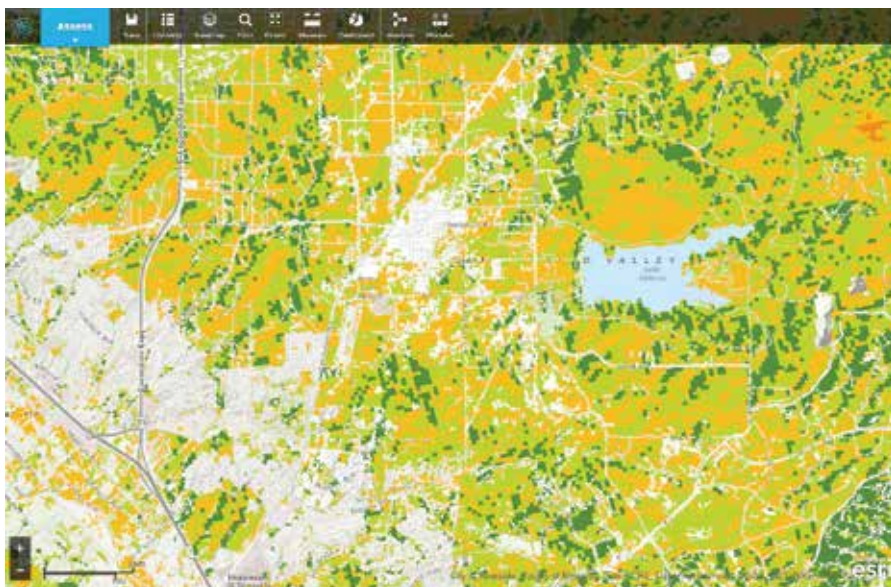
For Aspect, assign a weight of 25. Click the > symbol and set NE, E, W, and NW to 8 and all other Aspect values to 1.

For Landcover GAP, type “20” in the % text box and set Aquatic Veg, Developed, Open Water, and Polar/Montane to 0 and set the other parameters to 9. This will remove lakes, residential development, and other unsuitable land uses from the analysis.

For Native American Lands, type “5” in the % text box. Click the > symbol next to Native American Lands and set Native American lands to 0 and Non-Native American lands to 8.

For Slope, type “25” in the % text box. This assigns a value of 25 percent for the weight of Slope in the weighted overlay analysis. Click the > symbol next to Slope. Set the Slope value for Low (3–8) as 8 and all others to 1. This will map all values of 0–2, and 9–82 to a suitability value of 1. Values of 3–8 will be reclassified to a value of 8.





↶↷ The results of this analysis, showing an area southeast of Lake Skinner is suitable, can be viewed on tablet or desktop browsers without the need for additional software or plug-ins.

Using GeoPlanner

GeoPlanner was originally designed as a planning tool that incorporates many geodesign concepts and includes online data, spatial analysis tools, GeoEnrichment services,

raster geospatial landscape variables, and sketching tools. This tutorial showed how it can be used for agriculture, but it can also be applied to problems in utilities (route planning and facilities siting), the oil and

gas industry, emergency response planning, and other uses that require GIS information integration and evaluation. GeoPlanner is a touch-enabled web application that runs on desktop and tablet browsers without the need for additional software or plug-ins.

Understanding Weighted Overlay

Weighted overlay is one method of modeling suitability. ArcGIS uses the following process for this analysis.

- Each raster layer is assigned a weight in the suitability analysis.
- Values in the rasters are reclassified to a common suitability scale.
- Raster layers are overlaid, multiplying each raster cell's suitability value by its layer weight and totaling the values to derive a suitability value.
- These values are written to new cells in an output layer.
- The symbology in the output layer is based on these values.

Assigning a weight to each raster in the overlay process allows you to control the influence of different criteria in the suitability model. In the Spero model, you could weight slope more than aspect. Table 1 shows the result of overlaying two raster cells, one slope, and one aspect. Multiplying each layer's weight by each cell's suitability value produces a weighted suitability value. Weighted suitability values are totaled for each overlaying cell and then written to an output layer.

↓ Table 1: Totaling weighted suitability values

Layer	Weight (as percent)	Cell suitability value	Weighted suitability value
Slope	80	5	4
Aspect	20	5	1
Total suitability value			5



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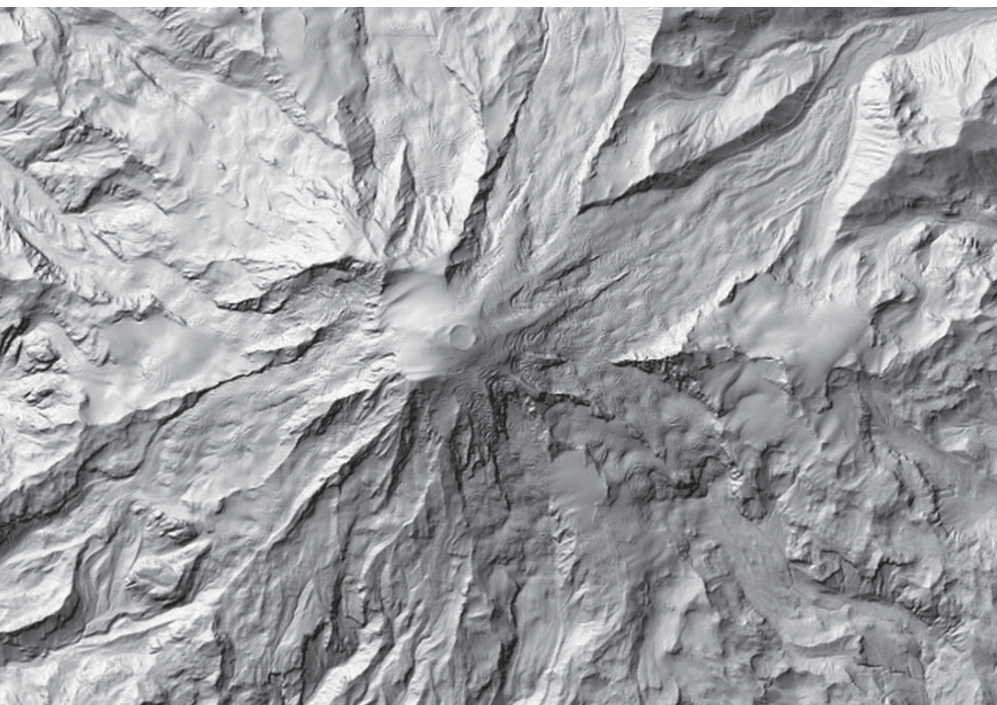
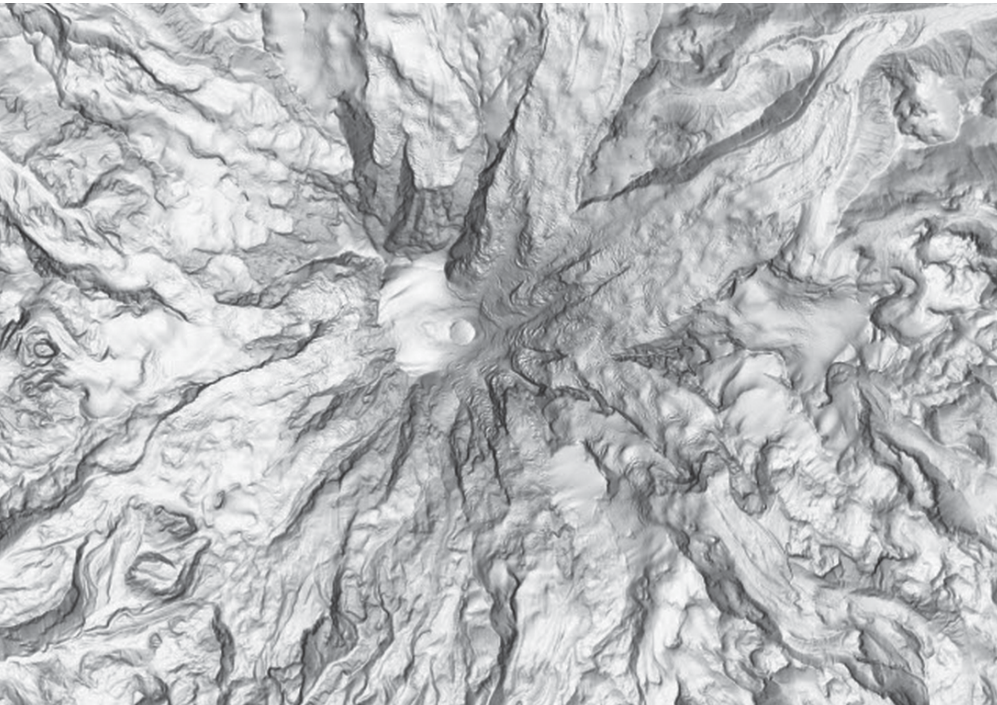
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Multi-Directional Hillshade Makes Your Maps Pop

By Rajinder Nagi, Esri Product Engineer



In July 2014, Esri released the next generation hillshade, the Multi-Directional Hillshade image service. This hillshade was inspired by the work of the legendary Swiss artist and cartographer Eduard Imhof. The Multi-Directional Hillshade provides an excellent representation of the world's topography and the perfect relief backdrop to support your work.

Unlike a default hillshade (i.e., light source with an azimuth angle of 315 degrees and an altitude angle above the horizon of 45 degrees), the Multi-Directional Hillshade presents an unparalleled view of the world's mountains, plateaus, valleys, and canyons by using an algorithm that computes hillshade from six different directions as opposed to the single direction used in a default hillshade. The result is a stunning visualization in both high slope and expressionless areas.

The Multi-Directional Hillshade, available on ArcGIS Online, can be easily added to maps created with ArcGIS for Desktop or web apps. It is currently implemented as a custom raster function on the World Elevation Service and requires an ArcGIS Online organizational account to access. This live service renders results dynamically on the fly for every pan/zoom request. Because the Multi-Directional Hillshade is a dynamic service, Esri can quickly update it as additional high-resolution datasets become available.

Two images of the iconic Mount Rainier in Washington. With the Multi-Directional Hillshade on the top, you can almost feel the glacial remains on the surface of the mountain, whereas the default hillshade on the bottom lacks clarity and realism.

Traditional hillshades are created by illuminating light from the northwest direction. This often produces results in which the illuminated sides are overexposed and terrain details on nonilluminated sides are obscured. This problem is more pronounced in hillshades that have areas of medium to high slopes. However, by varying the direction of the light from six different sources, terrain depicted by the Multi-Directional Hillshade is more realistically represented, and overexposed and nonilluminated areas of the map are balanced.

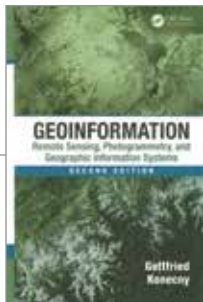
The Multi-Directional Hillshade provides a perfect backdrop for topographical, soil, water resources, or outdoor recreational maps. This service includes global elevation data from multiple sources and resolutions ranging from 230 meters (m) globally to 3 m partially covering the United States obtained from US Geological Survey (USGS) National Elevation Dataset (NED); Federal Emergency Management Agency (FEMA); and community contributed content from Denmark, Finland, and the United Kingdom. The ongoing data contributions by the ArcGIS user community continually improve the resolution, coverage, and quality of the data available. For more details and a list of current data sources, refer to the Item Description for the Terrain layer, available from ArcGIS Online.



➤ Using the Multi-Directional Hillshade to visualize land cover in the Alps in Europe.

➤ Using the Multi-Directional Hillshade as a backdrop for Utah earthquake fault data supplied by the USGS.

GIS Bookshelf



Geoinformation: Remote Sensing, Photogrammetry, and Geographic Information Systems, Second Edition

By Gottfried Konecny

Gottfried Konecny gives readers a comprehensive overview of the evolving field of geoinformation in *Geoinformation: Remote Sensing, Photogrammetry, and Geographic Information Systems*, Second Edition. This book recognizes the transformation of the discipline-oriented technologies of geodesy, surveying, photogrammetry, and cartography into the “methodology-oriented integrated discipline of geoinformation.”

In addition to providing fundamental information about how remote sensing, photogrammetry, and GIS work together, Konecny outlines the history of their development. He discusses the theoretical principles that underpin them. He furnishes extensive examples of how applications using remote sensing, photogrammetry, and GIS increase understanding of the world and improve decision making.

With nearly 70 years of experience in the field, Konecny is uniquely qualified to write this book. In 1945, he began working in surveying, photogrammetry, and mapping and is one of the leading authorities in the field of geoinformation. He is emeritus professor at Leibniz University of Hannover in Germany and the former president of the International Society of Photogrammetry and Remote Sensing. He holds honorary doctor of science degrees from the University of Tucuman, Argentina; the University of New Brunswick, Canada; Anna University in Chennai, India; and MIIGAiK, Moscow, Russian Federation, as well as numerous awards and distinctions from universities and professional organizations around the world.

The second edition was updated to reflect technology advances in remote sensing, photogrammetry, and GIS that have occurred in the intervening 12 years since the publication of the first edition. The examples of the use of remote sensing in the study of meteorology and climatology, oceanography, environment, nonrenewable and renewable resources, and natural hazards are new with this edition. The GIS section has been greatly expanded also.

With its emphasis on the fundamentals of geospatial technology and its current applications, *Geoinformation: Remote Sensing, Photogrammetry, and Geographic Information Systems*, Second Edition, is an excellent resource for students and professionals involved in any area of geoinformation. CRC Press, 2014, 472 pp., ISBN: 978-1420068566



Learning Geospatial Analysis with Python (Community Experience Distilled)

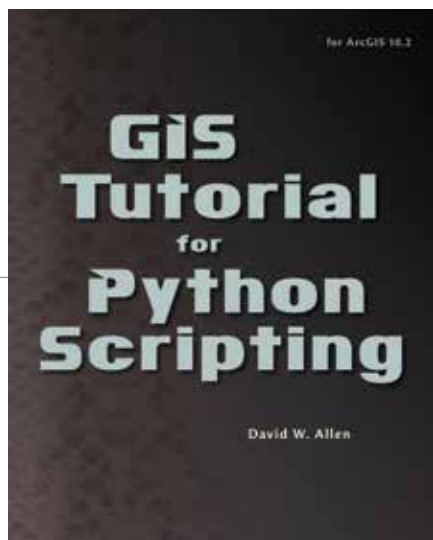
By Joel Lawhead

This book is predicated on a Python-centric approach to the use of Python with GIS as one of the components of its focus on geospatial analysis. This hands-on guide to geospatial analysis assumes basic proficiency with Python. It teaches the reader how to use Python to construct applications as well as use it with GIS software packages including ArcGIS.

The author, Joel Lawhead, posits several reasons for performing geospatial tasks with Python. These include having complete control of the underlying algorithms, data, and execution; minimizing overhead when performing specific, repetitive analyses; creating programs that are easily shared; and—possibly the most compelling for GIS practitioners—obtaining a more profound understanding of geospatial analysis. Of special interest are Chapter 4, which introduces Python libraries for working with geospatial data; Chapter 8 on advanced geospatial Python modeling; and Chapter 9 on using real-time data.

Lawhead has served as the lead architect, project manager, and codeveloper for geospatial applications used by government agencies such as the National Aeronautics and Space Administration (NASA) as well as commercial and nonprofit organizations. He received an Esri Special Achievement in GIS Award in 2002 for his work on the Real-time Emergency Action Coordination Technology (REACT). Lawhead, who began using Python in 1997, started combining it with geospatial software development in 2000. He maintains the geospatial technical blog *GeospatialPython.com* and Twitter feed @SpatialPython on using Python in the geospatial industry. Packt Publishing, 2013, 364 pp., ISBN-13: 978-1783281138

GIS Tutorial for Python Scripting



← By David W. Allen

This practical, hands-on workbook will show you how to immediately become more productive with ArcGIS by using Python to streamline and automate tasks. Python, the scripting language for ArcGIS, is tightly integrated with ArcMap and ArcCatalog.

This book is designed for the GIS professional with limited programming experience. The author shares strategies for learning how to get things done more efficiently. Exercise data for all 24 tutorials is included as well as access to ArcGIS for Desktop via a trial copy. Learning objectives for each tutorial are supplied as well as materials the student should become familiar with before attempting the tutorial. Each exercise includes a scenario and information on the data to be used as well as step-by-step directions and tips on scripting. Instructor resources are also available.

The first tutorial in the first chapter provides a brief introduction to Python. The remaining tutorials show how you can get a lot more done in the ArcMap interface using Python to create label expressions and change data formatting in the Field Calculator. The remaining chapters cover writing stand-alone Python scripts, understanding and using the ArcPy mapping module, creating Python toolboxes, and creating Python add-ins.

The author, David W. Allen, is the GIS manager for the City of Euless, Texas. Since 1999, he has taught at Tarrant County College where he helped found one of the first GIS degree programs in Texas and establish a state standard for GIS degree programs. He is the author of *GIS Tutorial 2: Spatial Analysis Workbook* and *Getting to Know ArcGIS ModelBuilder* (Esri Press 2011) and the coauthor of *GIS Tutorial 3: Advanced Workbook*, all published by Esri Press. Esri Press, 2014, 288 pp., ISBN: 978-1-58948-356-9

ESRI USER CONFERENCE HIGHLIGHTS

WHERE GIS IS GOING

“GIS is integrating geography into virtually everything we do. GIS is changing the way we see things in our organizations and also at the planetary level. And it’s also changing how we act,” said Esri president Jack Dangermond, opening the 2014 Esri User Conference (Esri UC) and highlighting the event’s theme, *GIS: Creating Our Future*.

He noted that we are facing serious challenges—population growth, urbanization, pollution, natural resource depletion, and climate change—that impact on individual and societal levels because the world is both complex and interconnected. Geography is the science and GIS is the framework that can help us better understand the world and the effects our actions have on it.

GIS is integrating geographic knowledge into virtually everything we do. It’s changing the way we think by helping us to see and understand things differently, within our own organizations as well as at the planetary level. And it’s also changing how we act. As Richard Saul Wurman says, “Understanding precedes action.”

As part of the ongoing evolution of GIS, individual systems are becoming part of a larger interconnected platform that enables visualization, analysis, and better decision making. As we deal with severe climate events, drought, and other threats, the work done by GIS professionals to inform policy and improve disaster response is becoming more critical.

SHOWCASING THE MANY ROLES OF GIS

The increasingly pervasive nature of GIS is playing an important role in many areas: how businesses operate, how governments provide services, how transportation is managed, how disease outbreaks are handled, and how children are taught. All these roles played by GIS were illustrated by speakers who addressed the nearly 16,000 attendees to the conference held July 14–18 in San Diego, California.

Laurence Norton, director of business intelligence strategy and solutions at Starbucks, took the plenary stage to explain how Atlas, the company’s market planning and store development application powered by GIS, is helping Starbucks grow responsibly. Atlas lets Starbucks partners evaluate local trade areas, retail clusters, demographics, traffic, and transportation nodes to find the most promising sites for new locations. GIS not only helps Starbucks select new store locations, but by analyzing its customers’ spending habits, it can help tailor the placement of Starbucks products such as its upscale Clover brewing system and imminent wine and beer offerings.

A longtime GIS user, the City of Minneapolis is serving its customers—its citizens—better with GIS. The city made the benefits of its enterprise implementation available to more people with its ArcGIS Online website. The MapIT Minneapolis site helps citizens locate services, amenities, and information. Staff use it to work

↓ Rikki Vaughan and Kylie Miller, two fourth graders, and their teacher, Josh Worthy, told how ArcGIS was being used by students to solve problems in their community and explore science.



more effectively. According to Steve Misterek, the city's GIS coordinator, "Answering the 'where' question for any project initiative or important decision is now easy for everyone!"


Through its simple-to-use GIS application, the complex operations and systems of the Port of Rotterdam in the Netherlands can be accessed from a single platform. Erwin Rademaker, project manager for PortMaps, described how the application has reduced redundancies and made the port more efficient. PortMaps includes SAP, SharePoint, and ArcGIS. "We used SAP for administrative and financial information," said Rademaker. "We used SharePoint to store all our documents and technical drawings. And in the center, connecting everything with geographic information, there is ArcGIS."

While PortMaps eliminates redundancies, Dr. Bruce Aylward, from the World Health Organization (WHO), and Dr. Vincent Seaman, from the Bill & Melinda Gates Foundation, are using GIS to eliminate polio. The conference's keynote speakers demonstrated how mapping technology helps them locate children in developing countries who need to be vaccinated. "Over one billion children now in total have been vaccinated multiple times through this initiative," said Aylward.

GIS is being used to foster the well-being of children in another way. As part of the ConnectEd initiative of US President Barack Obama, Esri has pledged \$1 billion of software to the effort by making ArcGIS Online organizational accounts available for free to all K-12 schools in the United States.

Two students from Sonora Elementary School in Springdale, Arkansas, demonstrated just what students, even very young ones, can do with these tools. Rikki Vaughan and Kylie Miller, two fourth graders, and their teacher, Josh Worthy, told how ArcGIS was being used by students to solve problems in their community and explore science. Vaughan demonstrated a project that mapped where veterans live in relation to Walmart stores as part of a campaign by a nonprofit to benefit those veterans. Miller told how she and fellow students tracked a weather balloon they launched. They animated the balloon's travels in 3D. The girls received a standing ovation from the crowd as they cartwheeled off the stage.

RECOGNIZING GREAT WORK

The many achievements of GIS users are celebrated at Esri UC. During the Plenary Session, several organizations and individuals received special recognition. Royal Dutch Shell received the 



Enterprise GIS Award for its GIS integration, which benefits people throughout the company from experts to casual users. Making a Difference Awards went to Haru Hyashi, from the Research Center for Disaster Reduction Systems at Kyoto University, and Daniel Eriksson, head of information management at the Geneva International Centre for Humanitarian Demining. The City of Rancho Cucamonga, California, received the President's Award for its use of GIS to promote sustainable growth. In a separate ceremony later in the week, more than 150 organizations, chosen from the more than 300,000 that use Esri software, received Special Achievement in GIS Awards.

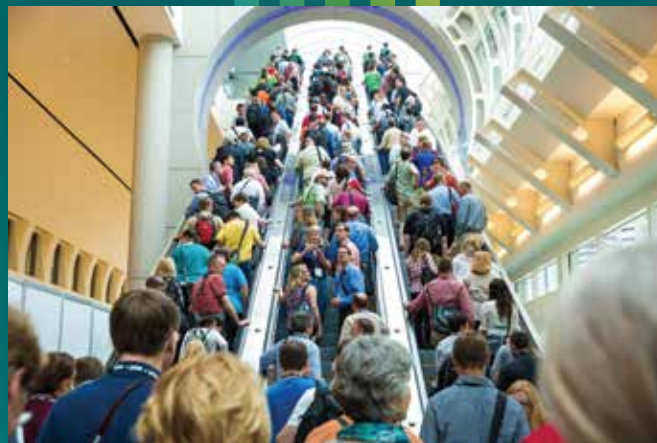
MAKING DATA ACCESSIBLE

The importance of data was a recurring theme during the Plenary Session. US Secretary of Commerce Penny Pritzker underlined the importance of data including open data. "Data is a key pillar of our department's open-for-business agenda," Pritzker told the audience. "For the first time, we have made it a department-wide, strategic priority to unleash more of our data to strengthen our economic growth; to make our data easier to access, understand, and use; and to maximize the return for businesses, entrepreneurs, government, taxpayers, and communities."

Esri supports open data with the ArcGIS Open Data application, which is included as part of ArcGIS Online subscriptions for organizations. With it, organizations can quickly set up a website that shares just the data the organization wants to make available.

Dr. Kathryn Sullivan, administrator for the National Oceanic and Atmospheric Administration (NOAA) and former astronaut, expanded on Pritzker's open data message. NOAA is one of the agencies under the Department of Commerce. Sullivan said her agency strives to provide authoritative and timely data. Environmental intelligence coupled with GIS tools can "provide us [with] powerful situational awareness, insight, and perspective we could never gain otherwise."

Hurricane Sandy, said Sullivan, drove home the point that communities and agencies need to do more than just respond and rebuild after a natural disaster. "It reminded us that what we need to focus on is not just being prepared but becoming resilient," Sullivan said. "As we factor into our rebuilding decisions, we need to not think just about building back to what we were before a storm. We need to think about building for what's coming ahead."



A Marketing Student in a GEOGEEK'S WORLD

Katherine Desy was one of 105 summer interns at Esri. She worked on the strategic marketing team at Esri's headquarters in Redlands, California. She is currently finishing her bachelor's degree in marketing and entrepreneurship at Syracuse University in New York. In this article, she shares her impressions of two days she spent at the Esri User Conference (Esri UC).

To sum up my internship, all I can say is... incredible.

Interns were given the opportunity to travel for a day down to the Esri User Conference, which is probably something we were most looking forward to. I was lucky enough to spend two days in San Diego taking pictures, interviewing conference student assistants, and just enjoying what Esri UC has to offer. Obviously, having started at Esri a month and a half before the conference, I heard a significant amount about what it was like. I had an idea of what to expect, but I didn't quite realize the magnitude until I got to San Diego. Here are a few of my observations.

Even if you know next to nothing about GIS, the conference is still wicked cool. I sat in on a technical session that talked about using Esri Maps for Office. Even with little working knowledge of ArcGIS, I will now be able to use maps in my Word documents, Excel spreadsheets, and presentations. And let me say, I do a *lot* of presentations at school, so now I can blow people away with my interactive maps!

Just walking around the conference, especially in the exhibit halls, you get a real sense of how cool GIS is. I saw flying drones, a giant display of sea-level temperature, 3D adventures using the Oculus Rift, and so much more. Coming into Esri, I had no idea of the kind of impact GIS had on the world. But seeing everything at the conference made me realize GIS is pretty much everywhere you look, and that's pretty neat.

As someone who wants to be in the



↑ Katherine Desy with Mapgirl at the Esri UC.

marketing field, I found the Tapestry Segmentation booth to be fascinating. The location analytics team at Esri has classified US neighborhoods into 67 unique segments based on demographic and socioeconomic characteristics. For someone in marketing, sales, retail, or virtually any business that deals with customers, this package is the epitome of usefulness. There's even an app that breaks down the types of people based on ZIP code (and by street block if you have an ArcGIS subscription). You can literally receive data down to the block level for anywhere in the country. To me, that's mind-blowing. Whether or not I end up at Esri full time in a year, I will certainly be using Tapestry for the rest of my life.

I hope everyone else had a great time at Esri UC! Maybe I'll be back again next year to write another guest post but as a full-time employee.

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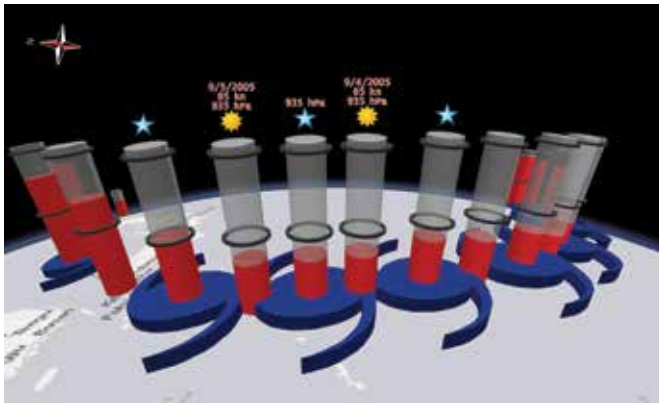
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3D Mapping Has Arrived

In his Keynote Address at the Esri 3D Mapping Forum, Nathan Shephard announced that 3D GIS has officially emerged and pervades across the Esri platform. Shephard, who leads Esri's 3D visualization team, kicked off the conference, which was held July 12–13, 2014, in San Diego, California. In this interview, Shephard explains the distinction between 3D mapping and cartography and why Esri dedicated an entire forum to this technology.



Why did Esri dedicate a forum to 3D mapping?

3D is important for GIS users because our world isn't flat, and some problems can only be solved when you include the z-coordinate. You can also generate excitement and improve communication by presenting your message with 3D scenes. Many of our users have been asking for more guidance and insight on working with 3D, so it made sense to start a community that can discuss and learn about this technology together.

What does 3D's pervasiveness across the Esri platform mean for 3D content creators and GIS users?

Basically it means that 3D capabilities are more accessible across the platform than ever before. When you need to do 3D work, you can, regardless of where you happen to be in the platform. And for those who are unsure about 3D or have been worried about getting into it, having it available in places where you're already comfortable will make it less imposing. The goal is that 3D will be more attractive to people, regardless of their GIS expertise or where they happen to fit into the platform.

↑ Some kinds of information, such as the trajectory, wind speed, and barometric pressure of a typhoon, can be more effectively communicated in 3D rather than 2D.

→ The project by SmarterBetterCities and Eiko Kumakura from Tokyo Institute of Technology to rebuild parts of Japan following the 2011 Tohoku earthquake and tsunami combined ArcGIS Online 2D maps, CityEngine, and SmarterBetterCities's CloudCities interactive 3D viewer.

In the Plenary Session, you also talked about Esri's 3D City Information Model (3DCIM) and standardization. What are some of the benefits of working with that model?

The attraction of standard data models, like the 3D City Information Model, is the reward users get by following it. They get preauthored maps, preauthored scenes, well-defined analytical and data management tools, and all just by modeling their data with the 3DCIM. And because it's built on information and knowledge gathered from previous projects, it has significantly reduced risk when diving into new projects.

Where do you see 3D mapping headed now that it has emerged and what does the market look like?

There's no stopping it. It used to be that some people would add 3D as a differentiator or kind of gimmick. But now it's more a case of it being expected. This means that, in general, people are rolling more and more 3D into their general workflows, even if they were only 2D just a few years ago. There are billions of dollars in projected growth coming from this technology. I think that kind of speaks for itself. The pieces are in place to start doing this work without the obstacles and impositions that existed before.

There was a lot of talk about web scenes at the forum and what's next. Can you tell me how they've evolved?

The primary new addition to the web scenes is the ability to consume services, which means we can have web scenes of any size. Web scenes are also becoming a larger part of our story across the platform. You can author them in ArcGIS Pro, or you can author them on the web. Then you can consume them in ArcGIS for Desktop, ArcGIS Runtime, or the web. Basically the delivery mechanism for 3D content centers on the web scene. You author, host, and manage web scenes and the services that they're displaying, and then you use that across the platform as needed. Whether it's for data management or analysis or just communication, web scenes are becoming a focused integration point for sharing 3D.



In your plenary talk, you distinguish between the 3D photorealistic scene, such as the kind you'd see in the web scene of a city, and the cartographic, thematic view. Will we see more of these 3D cartographic views to communicate information in the near future?

I really hope so. In my talk I used the adage, "An aerial image is not a map." Certainly, an aerial image has a purpose; it can show you where things are right now, and there are use cases for this. The same applies to a photorealistic 3D scene. It can show you what the city looks like right now. You can swap out a building and see what it'll look like after a new building comes in. That's a valid and useful reason to create a photorealistic scene.

But there are many other cases where a thematic view can engage and provide a lot more information to an audience. Crime statistics, typhoon dynamics, subsurface geology—all of these things need different ways of being presented because of their inherent complexity. Right now, I think using thematic and cartographic representations of 3D to help understand things such as natural phenomena and social problems is the least exploited aspect of 3D mapping. I hope more and more users take advantage of this in the future.



Esri 3D Mapping Forum Highlights

ArcGIS Pro was the biggest news at the 3D Mapping Forum held July 12–13, 2014, in San Diego, California, in conjunction with the Esri User Conference. Esri's new simplified GIS will have CityEngine procedural capabilities baked into ArcGIS Pro. Keynote speaker Nathan Shephard demonstrated the fluidity of ArcGIS Pro's semiautomated design workflow and showed how easy it is to build 3D urban environments from 2D data using familiar tools in the ArcGIS Pro ribbon interface.

Forum sponsor and Esri partner Leica Geosystems demonstrated the huge advances in mobile mapping that have improved the creation of street-level imagery records. When Leica's lidar- and imagery-based mobile mapping system Pegasus:One was introduced at last year's forum, the audience was blown away by a mobile sensor package that could capture the built environment in great detail relatively cheaply. At this year's forum Plenary Session, Leica's Brad Adams introduced its vastly superior sequel, Pegasus:Two. Pegasus:Two calibrates imagery and lidar point cloud data and includes semiautomated feature extraction for near real-time processing and upload into ArcGIS.

The forum's most inspiring story came from Jan Halatsch of Esri partner SmarterBetterCities's and Eiko Kumakura of Tokyo Metropolitan University. Their presentation was on their project to rebuild parts of Japan following the 2011 Tohoku earthquake and tsunami. The project combined ArcGIS Online 2D maps, CityEngine procedural design, and SmarterBetterCities's CloudCities interactive 3D viewer to guide reconstruction.

Survivors of the disaster from the stricken regions of Ainokama, Fujisone, Ninokura, Hasegama, Kabasaki, and Niihama wanted to re-create destroyed villages in their pre-disaster state to honor the victims and assist in relocation efforts. Because information on those villages was not available, Halatsch and Kumakura, in collaboration with Akinobu Murakami from the University of Tsukuba and Mikiko Ishikawa from Chuo University, conducted workshops with surviving residents. Through these workshops, they learned about the landscapes, housing styles, and culture prior to the earthquake. They incorporated the feedback from those workshops in a detailed reconstruction of the six stricken villages in CityEngine. Using these models, SmarterBetterCities created 3D scenes of the six villages in CloudCities, enabling sharing and discussion of 3D design scenarios between all stakeholders, including residents. The viewer displays 2D ArcGIS Online maps next to the 3D scene for convenient comparison.

CloudCities, powered by Esri CityEngine, became an invaluable resource for planning and reconstruction, helping affected communities honor fallen residents and preserve Tohoku regional culture.

Supporting Digital Learning and STEM Education

Esri is helping more students use ArcGIS Online to learn about STEM (*science, technology, engineering, and mathematics*) subjects and become geospatially aware through free school subscriptions and support for curriculum development.

GIS activities almost always involve thinking scientifically, analyzing mathematically, breaking problems down into manageable steps, and determining a solution using technology. Introducing ArcGIS Online into STEM-related courses reinforces the scientific method and provides students with an effective way to present their findings.

Problem solving, critical thinking, data analysis, communication, and collaboration are hallmarks of GIS professionals. These are also proficiencies sought by employers everywhere. Introducing ArcGIS Online can help students build these skills and get a head start preparing for careers. Map-based classroom activities and service learning projects also foster collaboration between students.

Schools like Clark Magnet High School in La Crescenta, California, have discovered that ArcGIS Online enhances STEM subject education. The achievements of Clark Magnet High School were highlighted during the Plenary Session of the 2014 Esri Education GIS Conference. Dominique Evans-Bye, a science teacher at Clark Magnet High School, and her student Yeprem Chavdarian described how he and fellow

students have used ArcGIS Online and ArcGIS for Desktop for projects. In one project, students analyzed organic and inorganic contamination in California's spiny lobster and mapped their results. They won the grand prize in the Lexus Eco Challenge and received more than \$70,000 in student scholarships and grants to their school.

During this year's White House Science Fair, which celebrates student winners of STEM competitions, Esri president Jack Dangermond announced Esri's offer of a free ArcGIS Online account to every one of the roughly 115,000 elementary, middle, and high schools in the United States. This offer, valued at \$1 billion, was made to support President Barack Obama's ConnectED initiative to provide K–12 students with more digital learning opportunities,

"We are honored to be part of President Obama's ConnectED initiative to provide a better learning environment and future for students throughout the United States," said Dangermond. "By leveraging the power of geospatial technology, students can truly understand how the world is interconnected and help create solutions for the challenges that lay ahead."

To increase the impact of this gift, Esri has created resources that help educators take advantage of ArcGIS Online organizational accounts. Because ArcGIS Online is cloud based, students can use it

Make It Stick

The science of successful learning and GIS

By Joseph Kerski, Esri Education Team

In their wonderful book about the science of successful learning, *Make It Stick*, Peter Brown, Henry Roediger, and Mark McDaniel spell out some truths that I believe are instructive as to how we should approach teaching with GIS.

The authors claim that "learning is deeper and more durable when it's *effortful*. Learning that's easy is like writing in sand, here today and gone tomorrow." Despite the fact that teaching and learning with GIS are far easier than it was a decade ago, I think we as educators do a disservice to our colleagues in education or to students when we say, "it's easy."

Teaching and learning are difficult tasks and not for the faint-hearted. Think of everything that goes into teaching with GIS. Content knowledge, skills, and the geographic perspective must all

be balanced. Yes, it may be easier technically to bring a CSV file into ArcGIS Online than it was to bring a spreadsheet into ArcInfo back in the 1990s, but even this relies on some key foundations. You must still know

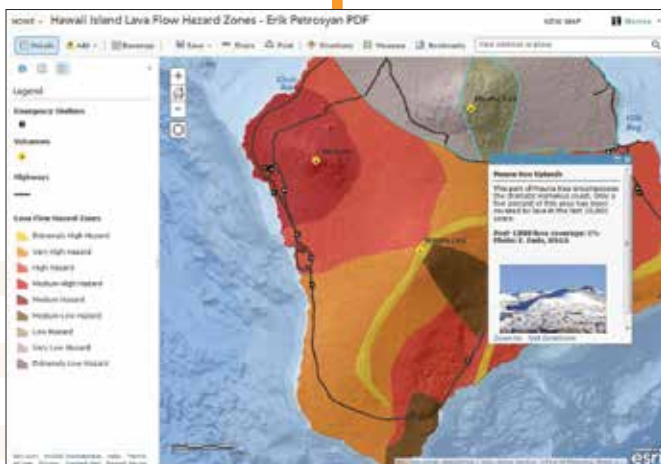
- What a database is and how to create one.
- How locations are mapped.
- How to work with latitude and longitude pairs or street addresses.
- What the pros and cons are of choosing a certain map projection over another.

Recall a time when working in GIS when you tenaciously stuck to a problem you were grappling with and finally figured it out. That shouldn't take long—you are not likely to forget those times nor the skills that you gained by the experience.



During the Plenary Session at the 2014 Esri User Conference, Dominique Evans-Bye, a science teacher at Clark Magnet High School, and her student Yeprem Chavdarian described how students are using ArcGIS.

This web map showing lava flow hazard zones on Hawaii Island was created by Clark Magnet High School student Erik Petrosyan.



on computers at school, tablets at home, and smartphones on the go—anywhere they can connect to the Internet.

This donation is part of an ongoing commitment to K–12 education that has spanned more than 20 years during which Esri has offered special educational licenses to schools, districts, and states; held the Esri Education GIS Conference; conducted numerous classroom and conference presentations; and held educator institutes.

In July 2014, Esri’s assistance to students was expanded through the signing of a memorandum of understanding (MOU) with European Schoolnet, an organization that works with multiple ministries of education to bring innovation to teaching and learning throughout Europe. During the three years the MOU is in effect, Esri will advise the European Schoolnet team members on the use of ArcGIS Online and help them develop a series of related lesson plans. ArcGIS Online will be implemented in European Schoolnet’s Future Classroom Lab, a state-of-the-art project that supports changing styles and learning.

“The cloud-based capabilities of ArcGIS Online align very well with the other technologies we are using in the Future Classroom Lab,” said Benjamin Hertz, project coordinator for European Schoolnet. “Lessons with ArcGIS Online bring STEM education to a higher level.”

If everything was easy, according to these authors, and confirmed by our own experiences in using GIS, we certainly wouldn’t remember it as well. By implication, we wouldn’t be building a foundation for new knowledge.

The authors claim that “all new learning requires a *foundation of prior knowledge*.” How often do we—either as educators or students—want to skip right to an advanced task without understanding the knowledge and skills that must be in place first?

For example, when teaching a recent workshop on mapping field data, many of the workshop participants wanted to skip to the last item on the agenda—citizen science mapping with live web mapping services—before understanding how data can be mapped and what a mapping service is in the first place.

According to these authors, “Putting new knowledge into a larger context helps learning.” The purpose of the Esri Education blog, webinars, the Teachers Teaching Teachers GIS (T3G) institute, ConnectEd, and other initiatives is to ground the use of GIS in the larger context of educational best practices within the content of a specific discipline and the context of other geospatial skills. For example, even the tried-and-true lesson of using GIS to teach about plate tectonics should take place in a larger context of the physical processes of the earth and the relationship between earthquakes, volcanoes, and plate boundaries.

There are other instructive gems for teaching and learning with GIS, such as “learning is an acquired skill, and the most effective strategies are often counterintuitive,” but I will leave it to you to read *Make It Stick*.



Aid from Above

ArcGIS helps airlift food in South Sudan

By Nadika Senadheera, United Nations World Food Programme

The author, a GIS consultant who works for the United Nations World Food Programme (WFP), provides geospatial services that enable WFP and coordinating relief organizations to deliver aid to vulnerable populations. In 2013, she received the Esri Making a Difference Award for her work in Afghanistan, which was described in “Her Years of Living Dangerously: Fighting hunger in perilous places” in the Fall 2013 issue of *ArcUser*.

WFP, the largest humanitarian organization fighting hunger worldwide, has a primary mission to provide food to those who are unable to obtain it for themselves. On average, WFP delivers food to more than 90 million people each year. Of that number, 58 million are children.

Since December 2013, WFP has been providing food and nutritional assistance to more than 90,000 people in many areas of South Sudan. Continued insecurity and fighting along the supply corridors in addition to the effects of the rainy season often

prevent WFP from conducting regular deliveries of critical food supplies by road to South Sudanese refugees and internally displaced persons (IDPs) nationwide. Consequently, WFP has been providing food supplies to the IDP camps and maintaining food distribution to refugee camps in conflict regions through a combination of airlifts and airdrops.

Aircraft loaded with lifesaving supplies fly in from Asosa and Gambella in neighboring Ethiopia and from Juba in South Sudan. Following encouraging discussions with the

Sudanese government, it may be possible to conduct an air operation from Khartoum, the capital of Sudan, to assist villagers displaced in Upper Nile and Unity. In addition to air operations, plans are under way for the movement of barges along the Nile River from Juba to transport food commodities to Upper Nile state of South Sudan.

Mapping Improves Delivery of Assistance

A mapping component was introduced by the United Nations Joint Logistics Centre (UNJLC) in Sudan following the humanitarian crisis in Darfur in 2008. Insecurity in this area has continued and has limited the ability of UNJLC to deliver humanitarian assistance, leaving IDPs and vulnerable populations exposed to life-threatening risks.

To mitigate the effects poverty, limited infrastructure, malaria, and recurring natural disasters, such as floods and drought,

← WFP has been providing food supplies to camps in conflict regions through a combination of airlifts and airdrops.

↓ WFP provides assistance immediately for the needy and vulnerable population affected by the civil conflict.

Photos courtesy of George Fominyen, WFP South Sudan.

has required a robust disaster preparedness plan. UNJLC continued to ensure coordination of logistics and information management to facilitate the timely and cost-effective delivery of assistance. GIS, including mapping services and logistics for emergency preparedness, was provided for key areas during the interventions in 2008. Following independence in 2011, the South Sudan WFP Country Office (CO) based in Juba continued to support the core concept of WFP through its eight sub and four field offices.

Humanitarian access is the main challenge for operations in South Sudan. During the civil unrest, WFP's prepositioning of supplies was ongoing, moving food

to strategic locations ahead of the rainy season, particularly for refugee operations in Unity (Yida) and Upper Nile (Maban) states. However, civil unrest, insecurity, and road closures due to the rainy season presented major challenges to both road and river transportation and storage facilities throughout the country.

After years of internal conflict, the world's youngest nation had high levels of malnutrition. Much of the population was living below the poverty line. The country was again divided along ethnic lines. More than 100,000 of the 1.5 million people displaced by the fighting were living in UN peacekeeping bases. The only option the WFP had to reach these vulnerable groups who were in areas inaccessible by ground transport was using the United Nations Humanitarian Air Service (UNHAS) air assets. A combination of airlift/air bridge and airdrops worked for these areas, especially during the rainy season and periods of security instability.

Since GIS tools were introduced to the WFP CO in 2008, they have been used to support decision making for each unit within WFP and the Logistics, Food Security and Livelihood Clusters. *[Clusters have become a standard business model for coordinating agencies and organizations providing humanitarian responses to sudden disasters and protracted crises.]* These capabilities have been especially important to humanitarian access between South Sudan and Sudan. It is required for the emergency operational plan composed by WFP and nongovernmental organization (NGO) counterpart staff to distribute food commodities along with nonfood items (NFIs) for IDPs (items such as plastic sheets, mosquito nets, and jerry cans) within conflict affected states in South Sudan.

Maps were one of the key documents exchanged during bilateral discussions with the governments of Sudan and South Sudan to emphasize the importance of border crossing to reach IDPs in the conflict states of Jonglie, Unity, and Upper Nile in South Sudan.

All feature classes saved in a geodatabase could be extracted and analyzed easily using the data management tools in ArcToolbox. WFP CO purchased ArcGIS 10.2 with the ArcGIS Network Analyst extension for all spatial analysis →



and mapping tasks. The new built-in-tools made compiling the required maps fast and simple.

Due to the conflict situation in the country, the WFP headquarters in Rome declared South Sudan as a Level 3 emergency, its highest level emergency. All outputs from WFP contained maps. Maps were required for running the operation in South Sudan as well as keeping the regional office in Nairobi, Kenya, informed of the situation. Maps showed the location of IDPs; the road and river access constraints; the distance to each location from the food storage facility; any possible corridors for food supply and NFIs; and where organizations were present on the ground. Maps also showed the security situation and land use, helping WFP provide assistance immediately for the needy and vulnerable population affected by the civil conflict.

Almost all WFP sub and field offices were looted or destroyed. Staff continued to

support food distribution based in United Nations Mission in South Sudan (UNMISS) compounds where they lived in cramped accommodations with limited access to Internet and e-mail.

If staff could have used their smartphones, they could have shared KMZ or KML files with the mapping unit by importing these files into a map document using the Import From KML tool in ArcGIS. However, due to government regulations, photographs, observation equipment, and smartphones could not be used without requesting permission from the government. That permission became more difficult to gain during the conflict. Access to governmental statistical data for IDPs became impossible to obtain, and satellite imagery was infrequently updated.

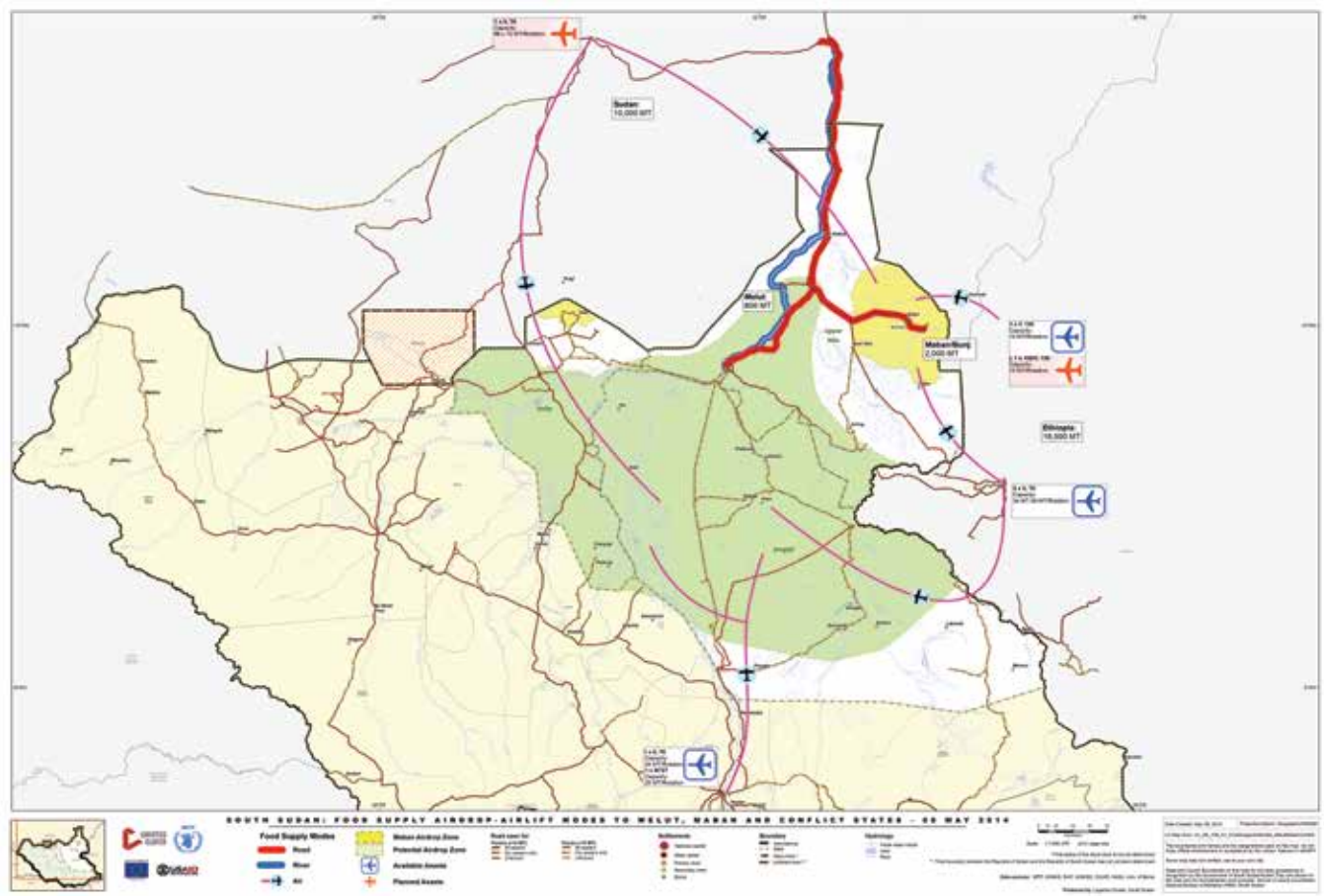
Using ArcGIS 10.2, staff could access the OpenStreetMap (OSM) basemap, which was especially useful where ground and detailed transportation data was not available.

Using OSM as background data with the available spatial data helped make the ground situation understandable. This was especially important when deploying field staff for airdrop/air bridge food distribution. If the fighting resumed, it helped identify safe locations for staff and the security personnel who were monitoring the situation.

When the WFP CO received operational specific data from the field, that data was most often provided in Microsoft Excel spreadsheets. With ArcGIS 10.2, information in Excel spreadsheets could be dragged and dropped onto a map document and, within a few minutes, a map needed for planning and decision making was complete.

WFP partners, especially those who provide logistical support, need to act immediately. GIS is the key to identifying locations. GIS tools and UNHAS air asset data are used to create detailed maps that helped partners understand and plan air

↓ GIS tools and UNHAS air asset data are used to create detailed maps that helped partners understand and plan air operations.



operations. Nautical miles were calculated within a couple of minutes to identify the type of aircraft, payload that could be carried, the distance to each drop location, and how many rotations that each aircraft could do based on the weather.

In addition to assisting in the effective use of air resources, GIS helps determine where aid is delivered by locating all IDP camps that require aid from WFP and its partner NGOs. It also identifies which WFP/Logistics Cluster service locations used by partners are free and which locations require a fee.

Logistics Cluster partners and NGOs have access to maps with the help of WFP, and the Logistics Cluster staff have provided better, more efficient service, in a timely manner based on needs and requirements. As the concept operation plan for the Logistics Cluster was created, a map was compiled that showed partners where common storage facilities and services were provided.

Easy-to-use maps have been shared by partners who use the facilities available at each location. During this emergency, ArcGIS tools provided tremendous support for WFP operations as well as the Logistics Cluster, Food Security and Livelihoods Cluster, and the Emergency Telecommunication Cluster in South Sudan.

For more information, contact Peter Schaller, head of logistics, WFP South Sudan at Peter.Schaller@wfp.org or the GIS officer of the WFP Logistics Cluster at southsudan.logs@logcluster.org.

Civil Unrest in South Sudan

South Sudan, a landlocked country in northeast Africa, is the youngest nation in the world. In 1982, after a decade-long pause in the country's civil war between the north and south, conflict reignited. Following the death of more than 1.5 million people, a peace agreement between the two sides was signed on July 9, 2011, creating the Republic of South Sudan. With an estimated population of 10.3 million, 90 percent of South Sudanese households depend on crop farming, animal husbandry, fishing, or forestry for their livelihoods, but productivity across all these sectors remains minimal.

Peace didn't last long in South Sudan. On the evening of December 15, 2013, fighting erupted between the two main ethnic groups spreading beyond the capital city of Juba to Bor and Akobo in Jonglei State, where two Indian United Nations Mission in South Sudan (UNMISS) peacekeepers were killed when a UN house was stormed. By the end of December 2013, civil unrest was reported in almost all regions, and as a result, tens of thousands of people fled from their homes to seek shelter in UN-based compounds. By December 22, 2013, the UN confirmed hundreds of people had been killed in the conflict and approximately 62,000 people have been forced to flee their homes in 5 of South Sudan's 10 states. Of those, 42,000 sought refuge at UN bases. The United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) reports indicated that the looting of humanitarian compounds and theft of vehicles impacted UN agencies nationwide.

↓ By the end of December 2013, civil unrest was reported in most regions of South Sudan, and thousands had fled their homes to seek shelter in UN-based compounds.

Photo courtesy of Patrick Noonan, WFP, South Sudan.



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