ArcNews

Esri | Summer 2018 | Vol. 40, No. 3

Briefly Noted

Esri Launches Africa GeoPortal
Organizations and citizens throughout Africa—from the African Union and national governments to nongovernmental organizations, businesses, and educators—now have access to the Africa GeoPortal, a comprehensive cloud-based platform that provides users with ArcGIS Online and geographic data and imagery related to the continent. This complimentary software-as-a-service technology is offered to all who are addressing the most urgent needs in Africa, including economic development, climate adaptation, conservation, and health care. Get more information at go.esri.com/Africa_geoportal.

Sentinel-2 Image Services Available at No Extra Cost
Users who want to better understand catastrophic events and natural disasters can now access Sentinel-2 image services via their ArcGIS Online subscriptions. Esri makes it easy to employ this multispectral imagery by extracting it with ArcGIS Image Server and publishing an image service through ArcGIS Living Atlas of the World, hosted on Amazon Web Services. Find out more about harnessing the power of Sentinel-2 imagery—part of Copernicus, the world's largest single earth observation program—at go.esri.com/Sentinel-2.

***Forbes* Names Esri a Leading US Employer**
For the third consecutive year, *Forbes* has named Esri to the America's Best Midsize Employers list. The magazine cited work-life balance, outstanding benefits, collaboration with colleagues around the world, and the opportunity to make a difference as some of the primary reasons employees enjoy working at Esri.

Esri Selected to Modernize Cyprus Cadastre

Creating One of the Most Advanced National Systems

Cyprus has a rich, centuries-long history of individual landownership—and now will get one of the most advanced and encompassing digital cadastral systems of the modern age.

In April, the Department of Lands and Surveys, within the Ministry of Interior, signed an agreement with Esri to upgrade its current GIS, called the Cyprus Integrated Land Information System (CILIS). CILIS currently underpins all cadastre and land registration processes and procedures in the Mediterranean island nation and will become a government-wide system based on the ArcGIS platform, covering the whole country.

"Cyprus will become one of the leading places in Europe to have an integrated land registry and taxation system based entirely on Esri technology," said Mark Williams, a senior consultant at Esri and the project manager for this cadastral system upgrade. "At the end of the project, Cyprus will have one of the more sophisticated cadastre systems in the world."

The Department of Lands and Surveys is seen as one of the most important government divisions in Cyprus because everything else depends on it, according to Constantinos Papantoniou, the technical consultant at Esri who is the technical lead on the project.

"If citizens want to buy land, a house, or an apartment, they have to go to the lands and surveys department to get the titles," he said. "Other government entities get data from the Department of Lands and Surveys as well, including the Ministry of Defence, the Ministry of Finance, the Ministry of Interior, and the Ministry of Foreign Affairs."

At the signing ceremony, Minister of Interior Constantinos Petrides stated that the Department of Lands and Surveys is likely the largest provider of property-related data in Cyprus and is certainly the country's primary provider of GIS data. According to him, that makes this upgrade all the more urgent.

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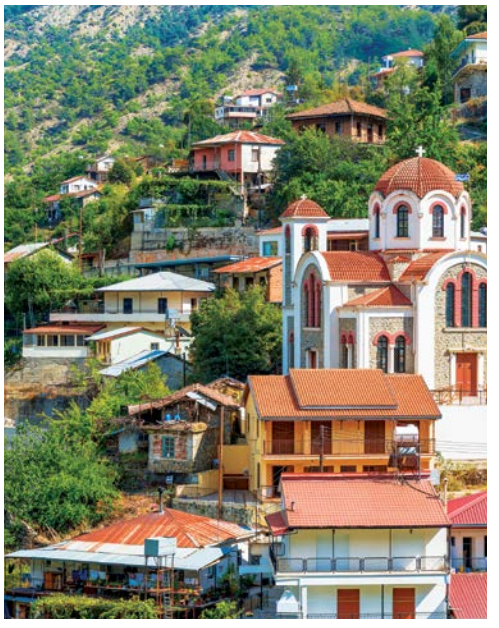

↑ Cyprus has a long, rich history of cadastral record keeping.

At the Forefront of GIS and the Future of Software

Esri Developer Summit 2018

Every year, the theme of the Esri Developer Summit (DevSummit)—held in Palm Springs, California, in March—is By Developers, for Developers. And Esri staff stay true to it. Dozens of technical sessions are geared toward what geospatial app developers want and need to know about building apps using Esri technology, as well as which tech trends—such as artificial intelligence (AI), augmented reality (AR), and virtual reality (VR)—are on the horizon.

"This week is…all about you looking at the technology and getting your hands on it and interacting with it," Jim McKinney, ArcGIS program manager at Esri, said in opening the 2018 Plenary Session. "But it's also about people, and it's also about relationships."

Before the tech presentations started, Esri president Jack Dangermond praised the audience for their app development work.

"You are clearly the people that are making a huge difference in our field and in your organizations," Dangermond said. This, in turn, makes the world a better place.

"You are driving rationality in the way people think," he continued. "*[You're]* not just a collection of developers. *[You're]* a collection of developers with purpose."

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← From left to right (top row first), Esri's Jeremy Bartley, Lauren Bennett, Euan Cameron, Sud Menon, Adrien Meriaux, and Javier Gutierrez and Russell Roberts demonstrated new and improved developer capabilities in the ArcGIS platform at the Plenary Session.

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Although Hurricane Harvey was devastating when it struck Houston, Texas, in August 2017, recent technological advances in GIS made it possible for a research team—led by the University of Texas and supported by Esri—to predict where flooding was likely going to take place and how bad it was going to be.

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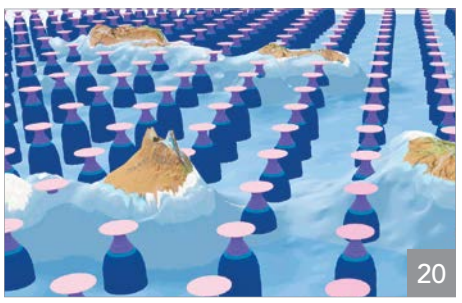

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Esri Selected to Modernize Cyprus Cadastre

continued from cover

"The task and end result is the development of a highly solid product *[that]* will take us forward smoothly in order to cope with all the speedy, changing trends in both technology and…the highly demanding property sector in Cyprus—a sector *[that]* is escalating successfully…after the recent economic crisis due to the hard work, the careful planning, and the setting up of new goals *[for]* the government," he said. "This important sector needs to continuously be supported by fast and friendly, nonbureaucratic procedures; a solid and highly effective land registration and cadastral system; as well as efficient IT technology."

By taking advantage of many of the ArcGIS platform's commercial off-the-shelf (COTS) solutions, the new version of CILIS will enable the Department of Lands and Surveys to benefit from industry best practices and new GIS capabilities as they become available. Cyprus's already-robust cadastral system now has a seamless path forward.

A Long History of Cadastral Record Keeping

According to the Department of Lands and Surveys, the notion of individual landownership had developed in Cyprus by 1400 BC. There is archaeological evidence that, by the fifth century BC, Cypriots had property taxation laws, state-owned (e.g., king-held) and church-owned lands, landholdings in cities, and guarantees of land tenure and ownership.

In the ensuing centuries, as Cyprus slipped in and out of control of the Greeks, the Romans, the Venetians, the Ottomans, and others, patterns of landownership changed, sometimes hinging on feudalism and other times centering on various forms of independent ownership and individual inheritance. By the nineteenth century, Cyprus's economic dependence on agriculture led to a scattered, disunited structure of landownership. Although there was a system for deed and title registration at the time, parcel boundaries were not tied to any sort of reference map or cadastral plan.

By the mid-twentieth century, this had to be fixed. Cyprus passed the immovable property law, which required everyone to register their land via titles with the Department of Lands and Surveys. This ensured that ownership was indisputable and absolute (notwithstanding any errors that the department had to correct) and that all registration is based on cadastral plans that are linked to the island-wide national grid.

With a solid, standardized land registration and cadastral system that's been in place now for more than 50 years, Cyprus is able to cope with the ebbs and flows of land-use practices throughout the island—and keep in step with a property sector that's arguably becoming even more vibrant, complex, and international.

"There is a lot of development going on right now," said Papantoniou. "A lot of foreign companies are coming to Cyprus because of its low corporate taxation rules. They are buying land and properties in urban areas, so there is high demand in all the cities, and there is a lot of growth there—construction, big buildings, hotels, and tourism."

"Cyprus is a highly developed country, and this has happened during tough economic conditions," added Williams. "There's a lot of investment flowing into Cyprus from the West, the Middle East, Europe, Russia, and China."

"Yes, they are building a lot of high buildings right now," explained Papantoniou. "For each new high building, they need to go to the lands and surveys department because of the number of floors they want to build. That department decides what's okay."

With a landownership and cadastral system now grounded in the most innovative GIS, the Department of Lands and Surveys will be able to handle those kinds of property-based transformations with ease—as well as any others that might be on the horizon.

Developing a Stronger, More Powerful GIS

The Cypriot government has been using GIS as the subsystem for its whole cadastral platform since the turn of this century. While that was a cutting-edge system at the time, the Ministry of Interior is now looking to have GIS become a more encompassing part of its day-to-day functions and overarching responsibilities.

"The upgrading of the *[Department of Lands and Surveys']* Land Information System was set as an urgent priority in the last meeting of the Cyprus e-Governance Board," Petrides said at the signing ceremony. "*[It stressed]* not only the importance of the project itself, but the need to provide *[the department]* with the necessary IT tools in order to embrace all new technological trends vital for its operations."

↑ Cyprus's minister of interior, Constantinos Petrides (center), and permanent secretary of the ministry of interior, Kypros Kyprianou (right), signed an agreement with Esri's director of international alliances and partnerships, Dean Angelides (left), to upgrade the Department of Lands and Surveys' GIS.

Cyprus's GIS upgrade will revolve around various components of ArcGIS Desktop, including Esri's parcel fabric. The Department of Lands and Surveys will be able to gain access to a host of ready-to-use apps, such as Collector for ArcGIS and Insights for ArcGIS, and manage its data using the ArcGIS Data Reviewer extension. Esri is planning to implement ArcGIS Enterprise as well to ensure that cadastral data can be accessed within and across departments while remaining secure.

"Cyprus has a strong cadastral system because of its history," said Papantoniou. "Now, the Department of Lands and Surveys is going to have an even stronger system that uses the latest technology. It's a very powerful thing."

At the signing ceremony, the minister of interior expressed his enthusiasm for the upgrade, as well as his expectation that this will be a smooth transition.

"Large-scale IT projects tend to always be complex and quite difficult to implement," he said. "I am very confident, though, that as a ministry, we can rely, on one hand, on Esri's expertise *[in]* the field and global leadership in *[GIS]* and, on the other hand, on the vast know-how *[that the Department of Lands and Surveys and the Department of Information Technology Services]* possess in jointly implementing such projects successfully."

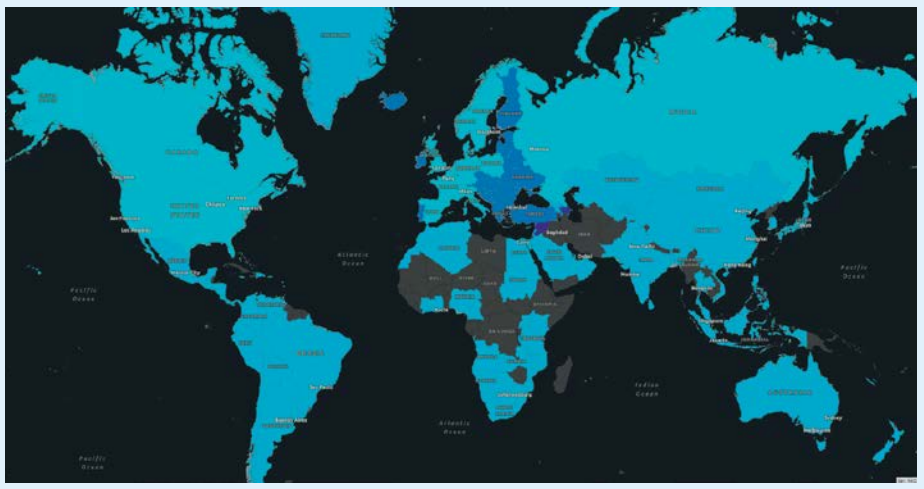
WHAT'S NEW IN ArcGIS Online

The April update to ArcGIS Online brings users more demographic data; an easier way to find maps, scenes, and layers; a new configurable app template; added flexibility in how they update data; and improved 3D experiences. Read on to learn more.

Additional Demographic Data

In the April release, Esri updated the demographic data for 50 countries, which users can access—along with all the other available demographic data—using ArcGIS GeoEnrichment Service; a variety of ready-to-use layers in ArcGIS Living Atlas of the World; and several apps, including ArcGIS Business Analyst and ArcGIS Maps for Office.

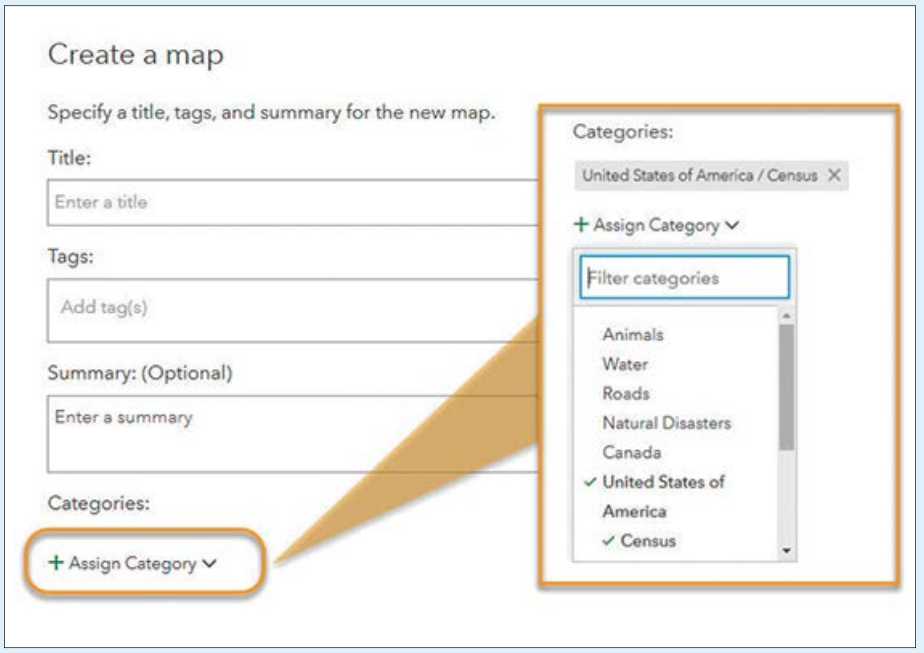
The most notable updates came from Japan and Germany. Demographic data available in ArcGIS Online now includes information from the most recent census in Japan, along with many popular variables such as population density, one-person households, and the population attending or graduated from school. For Germany, the data now includes four additional population attributes—male population, female population, deaths, and births—that span the national to the neighborhood level.



↑ The demographic data for 50 countries was updated in the April release.

Content Categories Improve Search Results

Users can now make their maps, scenes, and layers easier to find by assigning them categories. Administrators and group owners set up the categories and customize them to match the work their organizations do, and then users can employ them. Not only do content categories help users find items when searching through an organization or group's content, but they also allow users to quickly make sense of a lengthy list of search results.



↑ To make maps, scenes, and layers easier to find, users can assign them categories.

REVEAL RELATIONSHIPS, PATTERNS IN Microsoft Power BI

Microsoft Power BI users now have access to a tool that quickly exposes relationships and patterns, freeing them up to focus on the end results of their analyses and make effective decisions. The new, built-in ArcGIS Maps for Power BI visual lets users of both ArcGIS Online and Microsoft Power BI access their own private ArcGIS basemaps and reference layers directly in Microsoft Power BI.

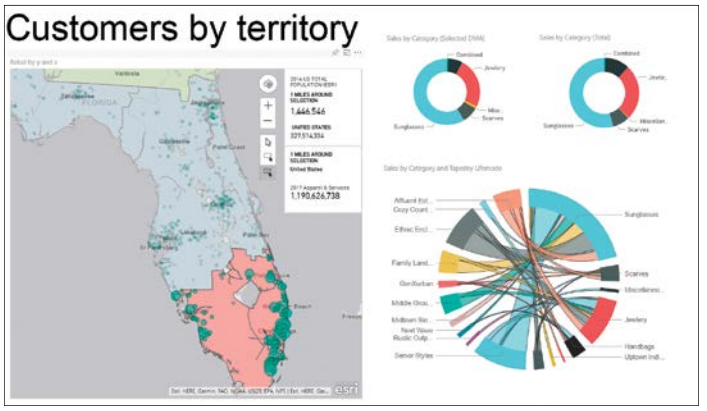
ArcGIS Maps for Power BI makes it easy to create beautiful, accurate map visualizations within Microsoft Power BI. Users can map data from any location value—an address; a city, state, or ZIP code; a place-name or boundary; or latitude and longitude—with a simple drag-and-drop process. Smart mapping defaults guide users to the styles and displays that best fit their data. And users can take advantage of a vast selection of ready-to-use ArcGIS maps and demographic data, as well as simple spatial tools, such as cross-filtering by map selection, heat maps, and drive times.

The new release of ArcGIS Maps for Power BI also allows businesses to purchase Plus subscriptions in one simple transaction and deploy these capabilities across their organizations. Companies can choose from three plans: small for up to 1,000 users, medium for up to 5,000 users, or large for up to 10,000 users.

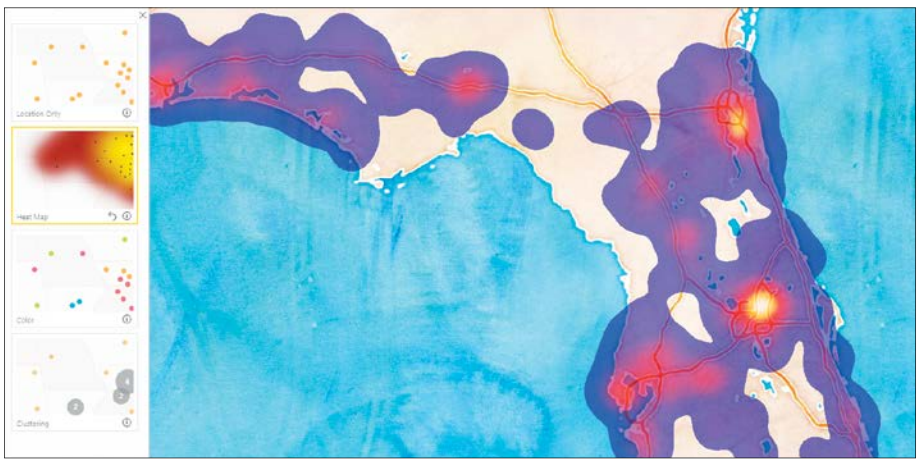
The Plus subscription for ArcGIS Maps for Power BI, launched in late 2017, gives users access to global demographics, expanded data mapping, and more content from ArcGIS Living Atlas of the World. Plus offerings include the following:

- Verified, curated, and ready-to-use authoritative data
- Premium global demographic data, including age, disposable income, and diversity indexes
- 12 basemaps, including satellite imagery, oceans, and terrain
- The ability to plot up to one million points on a map each month

To learn more about ArcGIS Maps for Power BI, visit esri.com/powerbi.



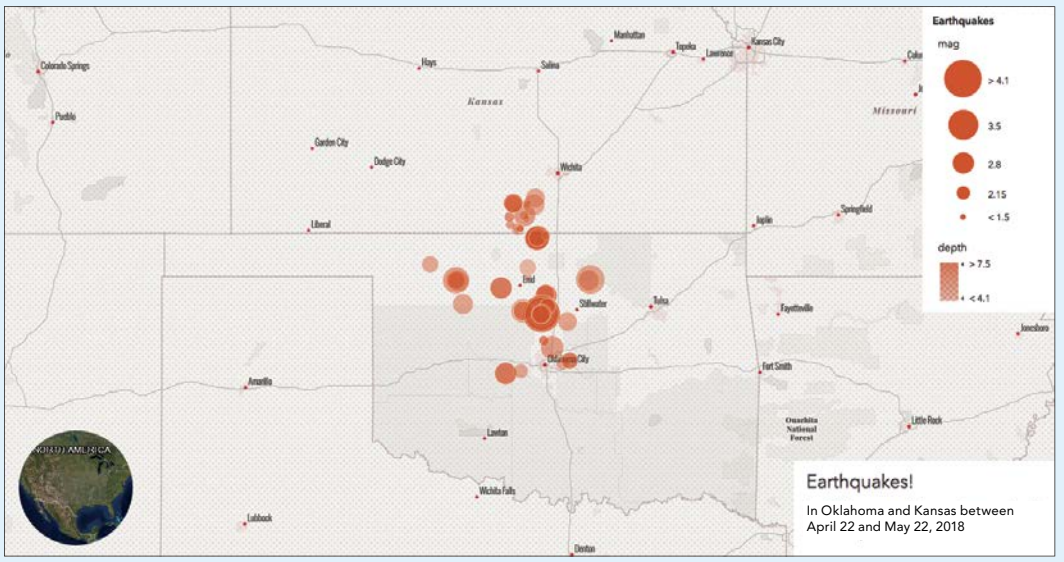
← With ArcGIS Maps for Power BI, as users navigate around a map, the information updates to reflect their current map view.



↑ ArcGIS Maps for Power BI makes it easier for users to visualize their data. With a heat map, for example, an online retailer can see its customer density.

A New Map for News Articles and Blogs

There's a new configurable app template that provides a crisp and simple way to share interactive maps online. Media Map fits perfectly into small spaces on web pages and performs well on mobile devices, making it a great visual aid that can be neatly embedded into news articles and blogs. A splash screen and an information panel introduce the map. To keep viewers within the relevant portion of the map, users set the minimum and maximum zoom levels and lock the extent to which the map can be scrolled. Bookmarks provide shortcuts to interesting places. And a unique circle inset shows an overview map, helping viewers grasp the bigger-picture perspective.



↑ Media Map is a new configurable app template that makes it easy to share interactive maps online.

New Ways to Update Hosted Feature Layers

Users now have more flexibility in how they update their data.

In hosted feature layers, they can apply a new data setting called unique constraints to prevent duplicate entries in fields. When toggled on, this setting ensures that unique values are entered for fields such as parcel ID or customer number. It also helps enforce data integrity by making specific fields the match field, or key, when updating existing data.

Additionally, the ArcGIS Online append functionality, which enables users to update data in their hosted feature layers, now supports two additional file formats—Microsoft Excel and GeoJSON. Being able to use an Excel spreadsheet as the input eliminates the need to export it as a CSV file. And having the capacity to append data in GeoJSON files is advantageous for users who favor more open formats.

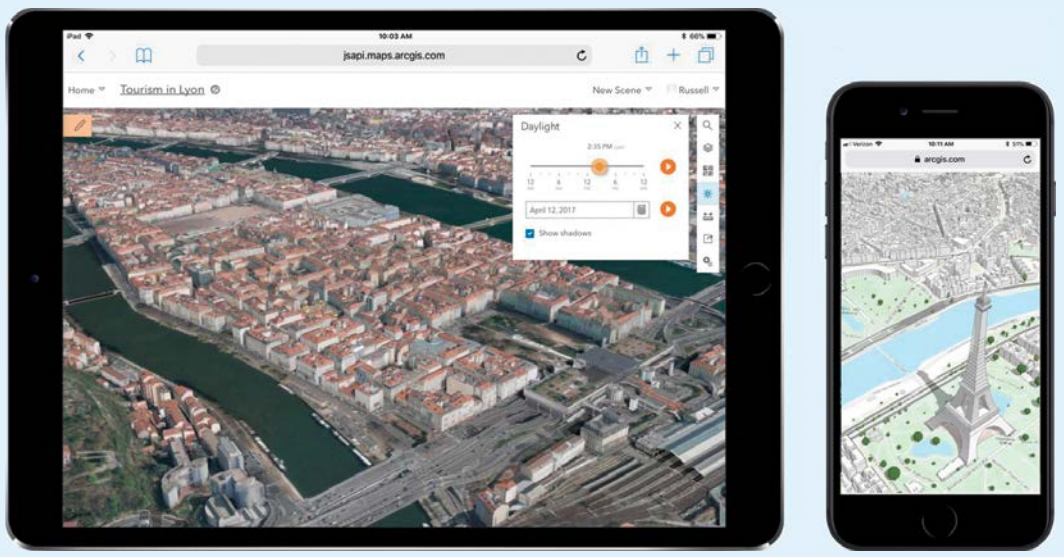
An Elevated 3D Experience

Esri has enhanced the 3D experience in ArcGIS Online considerably with full mobile support, edge rendering, and added functionality in the Measure tool.

For starters, viewing 3D scenes is no longer limited to desktop browsers! Now, users can explore 3D scenes on modern smartphones and tablets. Scenes are easy to navigate using touch gestures to zoom, pan, rotate, and tilt.

Edge rendering is new, too. It adds outlines to building shapes to make 3D scenes really pop. Switching on the Edges toggle within the Configure Layer panel automatically draws the edges onto all the buildings in a 3D scene, improving depth perception and making it easier for viewers to clearly see feature details.

Additionally, while still allowing users to make point-to-point measurements that interactively calculate distance and height, the Measure tool now also supports area measurements. The tool can be used to calculate ground areas and perimeters as well as vertical walls and roofs. Users can easily modify their measurements by clicking or tapping any point in the measurement and dragging it to a new position. The calculated area then automatically updates.



↑ Users can now explore 3D scenes on smartphones and tablets.

Discover more new ArcGIS Online features and reference how-to blogs at **go.esri.com/whatsnew**.

A NEW WAY TO Visualize Microsoft SharePoint Data

Microsoft SharePoint helps organizations all over the world—from government entities to oil companies and retailers—organize their teams, workflows, and data. But native search within SharePoint is heavily reliant on text, so finding a particular file can be frustrating, especially when there is a large amount of data to wade through.

That is why Esri developed a new capability in ArcGIS Maps for SharePoint that lets users map and search SharePoint content more easily. Called ArcGIS Map Search, the app part allows ArcGIS Online and ArcGIS Enterprise users to drag files hosted in SharePoint onto a map to geotag them for easy search later. Now, when an oil company has an emergency at one of its oil wells, for example, employees responding to the incident can open up a map of all the wells in ArcGIS Maps for SharePoint; click on the one where the accident occurred; and immediately find all the documents related to that well, including permits and safety records.

Users have been requesting this tag-and-search capability more frequently in recent years, and it is now available in ArcGIS Maps for SharePoint 5.0—one of the most significant releases since the first version came out in 2010. ArcGIS Map Search, accessible in 30 languages, is supported in Microsoft SharePoint 2010, 2013, 2016, and SharePoint Online.

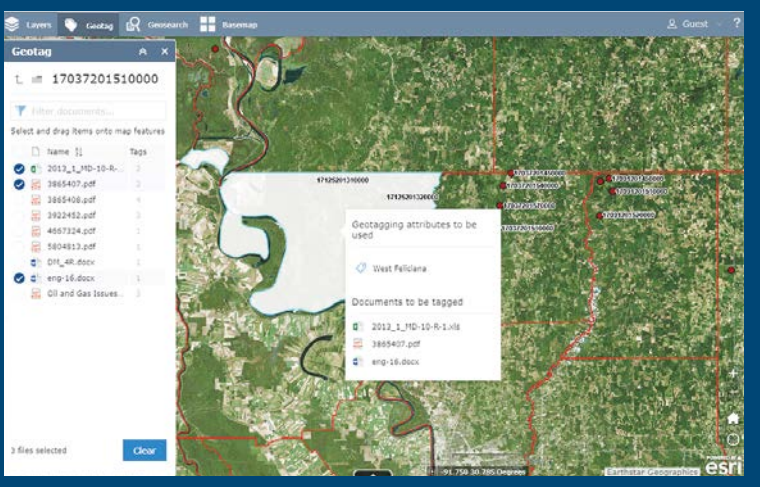
The app part contains two main components: geotag and geosearch. The process starts at geotagging. Users can add a reference layer to an ArcGIS Map Search map and specify which attribute from the layer's data to use for geotagging. When users drag documents onto the configured layer, the attribute generates a geospatial tag, or geotag, for those documents. System administrators can configure systemwide tags as well, which ensures that tagging is uniform across the organization.

Then, when someone needs to look for the data related to a specific location, he or she can open the SharePoint page with the ArcGIS Map Search map, and it will start in geosearch mode. By clicking or tapping a point, line, or polygon on the map, the user can view all the documents that have been tagged with that feature. He or she can also type keywords into the search bar to see the list of documents tagged with those specific location attributes.

This new capability builds on the existing features of ArcGIS Maps for SharePoint that already give users the ability to map and visualize their data in Microsoft SharePoint. With the ArcGIS Maps Locate workflow, for instance, users can view SharePoint lists—such as ones with customer names and addresses on them—on a map, and the map stays current even as new data is added. Additionally, the ArcGIS Maps web part allows users to design maps with their data—and add geographic content from ArcGIS—so they can better visualize their business information on SharePoint site pages.

The latest release of ArcGIS Maps for SharePoint elevates what users can do when they work with ArcGIS and SharePoint together. When organizations can see and arrange their SharePoint data on a map, they save time and energy in their work and, ultimately, make better business decisions.

The on-premises version of ArcGIS Maps for SharePoint 5.0 is available at esri.com/sharepoint, while the online version can be downloaded from the Microsoft App Store.



↑ Users can view all the documents associated with a feature by clicking on a point, line, or polygon on the map.

At the Forefront of GIS and the Future of Software

continued from cover

Dangermond pointed out that while Esri developers create software for millions of people all over the world, they are also in tune with what other developers need to make geospatial apps.

"Their tech…works in a very effective way for developers," he said.

Which is true for Hila Roffman, a geospatial app developer who was in her element at DevSummit, despite being 7,500 miles away from her home in Tel Aviv, Israel. All around her, people were talking about maps, apps, geospatial analytics, ArcGIS API for JavaScript, and the Web Graphics Library (WebGL) API. Roffman, who works for Esri distributor Systematics Technologies R. G. Ltd., smiled and took it all in.

"I am highly interested in the areas of web development and 3D," she said. "The summit includes many diverse sessions, which keep me updated with the latest technology features and tools. Besides, Palm Springs is a cool location."

Software as a Service, Plus Comprehensive GIS

In an overview, Esri director of software development Sud Menon explained that ArcGIS is available as both a software-as-a-service (SaaS) mapping and location platform, via ArcGIS Online, and a comprehensive GIS, via ArcGIS Enterprise.

"ArcGIS," he said, "enables location intelligence everywhere."

More than 45,000 organizations around the world use ArcGIS Online to create maps and visualize and analyze data.

"Mapping, as you know, is at the heart of ArcGIS Online," said Menon. "*[It]* allows you to create compelling user experiences that are interactive, immersive, and analytic."

He also talked about the 2D and 3D smart mapping capabilities in ArcGIS Online.

"We have things like clustering that are available with the categorizations that you have applied to your data," he said. "You can map temporal patterns. And for 3D, we have styles that really bring your data to life in scenes."

Menon underscored several other capabilities in ArcGIS Online, too.

"This mapping platform includes an interactive map viewer and mapmaker that lets you create web maps and web scenes that you can share," he said. "They are declarative specifications of the visualizations that you need, and they can come to life in applications. *[ArcGIS Online]* also includes easily configurable story maps and dashboard apps, as well as a JavaScript API that's built for the modern web."

Smart mapping is available to apps via that API, Menon said. He also touched on the ArcGIS Online suite of mobile field apps for collecting data and navigating from place to place, including its support for high-precision GPS, plus back-office apps for coordinating the work. In addition, Menon spotlighted Insights for ArcGIS for doing location analytics.

"It's for people who may not have used maps before, but they are familiar with charts *[and]* business intelligence," he said.

Menon mentioned, too, that ArcGIS Online includes app builders, such as Web AppBuilder for ArcGIS and AppStudio for ArcGIS, as well as ArcGIS Runtime SDKs for building native apps for iOS and Android devices.

And ArcGIS Enterprise has all the same web-mapping, 3D, data-sharing, and app-building capabilities of ArcGIS Online—with additional capabilities for data management, imagery, and real-time GIS.

"ArcGIS Enterprise is comprehensive GIS in your own infrastructure," Menon said.

Working with Data, Now Easier Than Ever

Jeremy Bartley, from the Esri software product development team, gave a shout-out to the developers in the audience.

"You are building so many great maps and apps," he said.

Bartley then showed improvements to ArcGIS API for JavaScript, such as the ability to opt in to rendering FeatureLayer with WebGL. This capability—along with smart mapping and ArcGIS Arcade, a new scripting language in ArcGIS Online—makes working with your data and building beautiful, meaningful maps easier than ever.

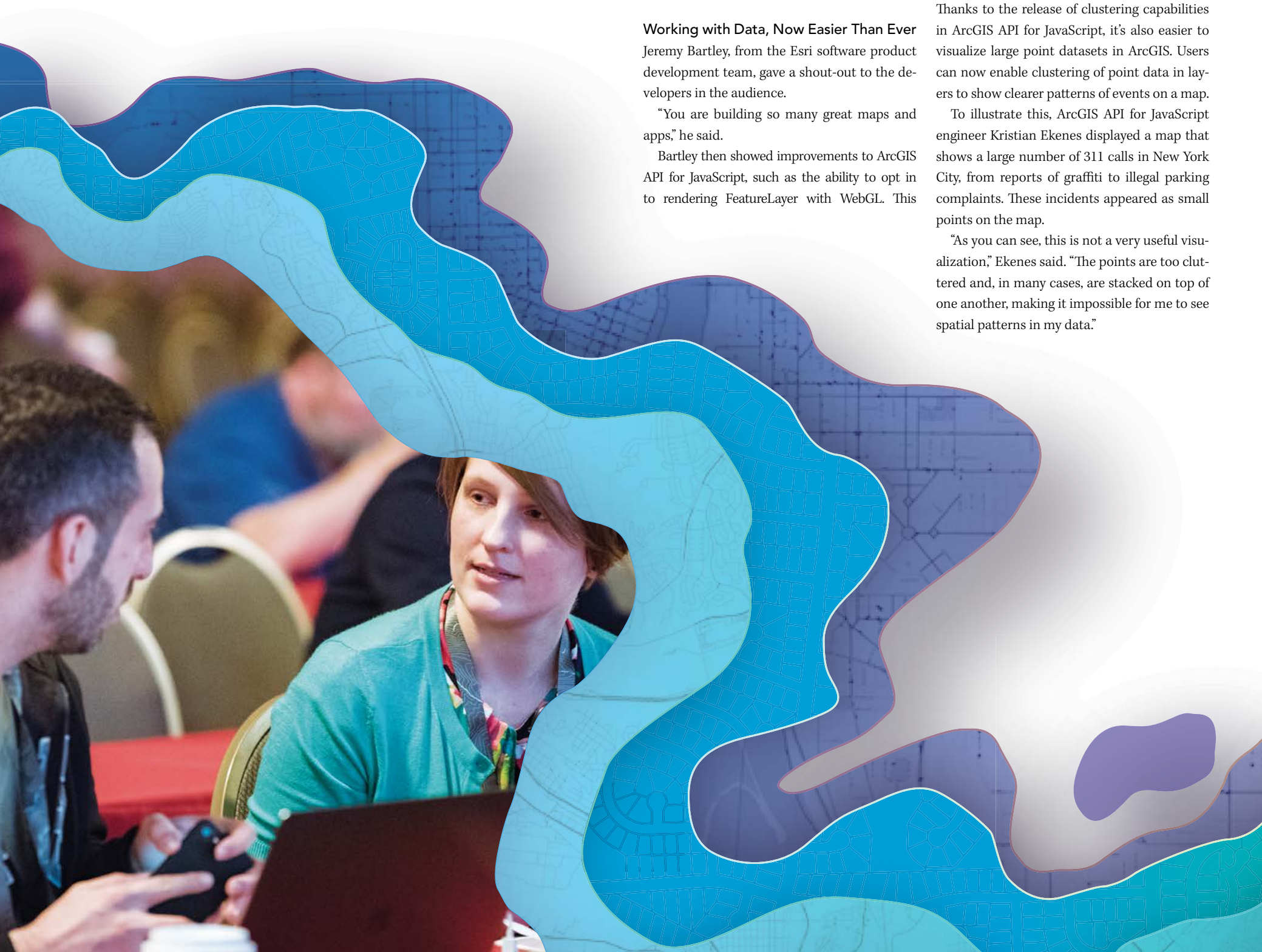
↑ Jim McKinney, ArcGIS program manager, opened the Plenary Session by stressing how crucial people and relationships are to technology development.

Clustering to Reveal More Distinct Spatial Patterns

Thanks to the release of clustering capabilities in ArcGIS API for JavaScript, it's also easier to visualize large point datasets in ArcGIS. Users can now enable clustering of point data in layers to show clearer patterns of events on a map.

To illustrate this, ArcGIS API for JavaScript engineer Kristian Ekenes displayed a map that shows a large number of 311 calls in New York City, from reports of graffiti to illegal parking complaints. These incidents appeared as small points on the map.

"As you can see, this is not a very useful visualization," Ekenes said. "The points are too cluttered and, in many cases, are stacked on top of one another, making it impossible for me to see spatial patterns in my data."



Enabling clustering on the data layer, however, makes all the difference.

"The clutter is removed from the map, and clusters appear, summarizing my data," said Ekenes. "I can gain insight into where more incidents tend to be reported. When I click on a cluster, the total number of features comprising that cluster is displayed in the pop-up. But perhaps my favorite part of the clustering implementation is the fact that the mapped attribute is summarized in the pop-up as well."

3D on Mobile Devices

ArcGIS 3D mapping engineers Javier Gutierrez and Russell Roberts showed the audience that ArcGIS Online now supports 3D web scenes on mobile and tablet browsers.

"This is very exciting," Gutierrez exclaimed, "because just by clicking on a URL, without installing any app, everyone will be able to interact with a 3D scene on their phone."

Roberts displayed a 3D scene on a screen using his iPad. The scene showed thousands of buildings in Raleigh, North Carolina. He then analyzed walk times to metro stations from residential buildings.

"Going into my building scene layer, I just need to pick the walk-time attribute," Roberts said. "Using the Counts and Amounts style *[in ArcGIS Online]*, I am just going to go ahead and pick a new color ramp, and I'm going to adjust the position of the sliders. And you can see, as I make these changes, the scene is updating. So…we see all the buildings that are in yellow have over a 12-minute walk time, and the ones in the shade of blue have less than that."

ArcGIS Pro—A Powerful Analytics Workstation

Spatial analysis product engineer Lauren Bennett showed what ArcGIS Pro can do when it comes to analyzing traffic data.

"ArcGIS Pro is one of the most powerful tools in your toolkit," she said. "It's a fully integrated analytics workstation that makes it easy for you to visualize and explore your data, ask and answer complex questions, and apply The Science of Where."

Bennett demonstrated a new density-based clustering tool in ArcGIS Pro by using it to analyze traffic congestion in the Los Angeles area. The traffic data was provided by Waze.

"We are looking here at 5:00 p.m., rush hour," she said, referring to a map of the traffic data. "But looking at tens of thousands of points on a map really isn't telling us a whole lot. To find the natural spatial clusters in our data, we will use the new density-based clustering tool," which detects areas where points are concentrated, as well as where they are separated by sparse or empty areas. It's a vast improvement in visualization.

Esri developers have made extensive improvements to the ArcGIS Pro SDK for the Microsoft .NET Framework as well.

"You can configure ArcGIS Pro—its UI and settings and workflows—without writing a line of code," said McKinney, who returned to the stage to talk about extending enterprise deployments of ArcGIS.

With solution configurations, users can "brand the startup experience of ArcGIS Pro, streamline the UI, *[and]* really customize it," he said.

Automation Is Vital, and It's Here

Developers can also automate their enterprise deployments using geoprocessing and Python.

↑ ArcGIS API for JavaScript engineer Kristian Ekenes illustrated how clustering works.

↑ At DevSummit, attendees get up close and personal with Esri technology to see how they can use the ArcGIS platform to help their own organizations make data-driven decisions.

According to Jay Theodore, Esri's chief technology officer for ArcGIS Enterprise, "Automation is no longer an option. It's pretty critical."

ArcGIS API for Python supports automation in ArcGIS Enterprise and time-critical workflows for ArcGIS Online apps. Python scripts can add users, privileges, and roles, as well as create groups, configure the portal, and establish collaborations among ArcGIS Online organizations.

Additionally, the API is integrated with Jupyter Notebook, which facilitates machine-learning and deep-learning workflows through the creation of reproducible research for sharing and collaboration.

Getting Closer to Devices' Native Power

Esri has been maturing its developer framework as well, which now has six ArcGIS Runtime SDKs for native app development and three APIs.

Euan Cameron, who leads Esri's developer programs, emphasized the main reasons to pursue native development: "There's nothing that gets you closer to the native power of the device."

Native app development allows developers to leverage a device's capabilities and access all its peripherals, greatly enhancing performance. Native apps also have the best debugging experience and enable offline use of ArcGIS.

With version 100.x releases of Esri's six ArcGIS Runtime SDKs—Android, iOS, Java, macOS, .NET, and Qt—they can better leverage the Web GIS pattern, meaning developers can use maps, layers, and scenes that have already been created, as well as users, roles, and groups that are already established in an organization.

Sentient Software with AI

The Plenary Session was followed the next day by a Keynote Address from Joseph Sirosh, corporate vice president of the Artificial Intelligence and Research Group at Microsoft. Sirosh said that with the emergence of AI, change is coming to software.

"In the future, with AI, software becomes sentient," Sirosh said. "It develops the ability to understand what the data means. It allows us to build models that predict things. The cloud, with its unlimited computing power and its ability to integrate vast amounts of data across applications—that is the ocean in which AI is being born."

All future software will integrate the cloud, data, and intelligence, according to Sirosh.

"Data from all over—not just from regular applications but *[from new types of]* sensors being invented, and data about all interactions—all of that data is the oxygen that feeds AI," he said. "And algorithms, the incredible advances in AI such as deep learning, and others—that gives us sight, the ability to see into the data and act predictively with it."

ArcGIS technology and the maps and apps that developers build with it are at the forefront of this evolution—which is exactly what this year's DevSummit made abundantly clear.

Esri Collaborates with Alibaba Cloud, Greatly Extending Location Intelligence Capabilities

Esri users now have another compelling option when deploying their ArcGIS technology in the cloud. As of April, Esri and Alibaba Cloud, the cloud computing unit of the Alibaba Group, are collaborating to ensure that their technology is interoperable.

This is an important step forward for Esri in driving the expansion of GIS and The Science of Where throughout the world, especially in the Asia Pacific region. Alibaba Cloud is Mainland China's largest public cloud service provider and the third-largest in the world. The Hangzhou, China-based company currently has 18 data centers worldwide, including ones in Hong Kong, Jakarta, Kuala Lumpur, Mumbai, Singapore, Sydney, and Tokyo.

This collaborative agreement comes as Esri has observed rapid growth in successful ArcGIS implementations in Alibaba Cloud and is a testament to Esri's commitment to its partner ecosystem.

"We've seen our users achieve amazing results already with Esri technology in Alibaba Cloud," said Esri president Jack Dangermond.

He emphasized both companies' shared belief that location intelligence in cloud infrastructure is pivotal to addressing users' needs and solving real-world problems—particularly those that require scalable computing, storage, and networking capabilities.

"This has been made possible as both organizations have engineered interoperable and compatible technology, based on industry standards," Dangermond added. "The agreement will now bring our engineers together to collaborate on shared initiatives that deliver the next wave of location intelligence innovation in the cloud."

↑ Esri's agreement with Alibaba Cloud is an important step forward in supporting the growth of GIS and The Science of Where around the world, especially in the Asia Pacific region.

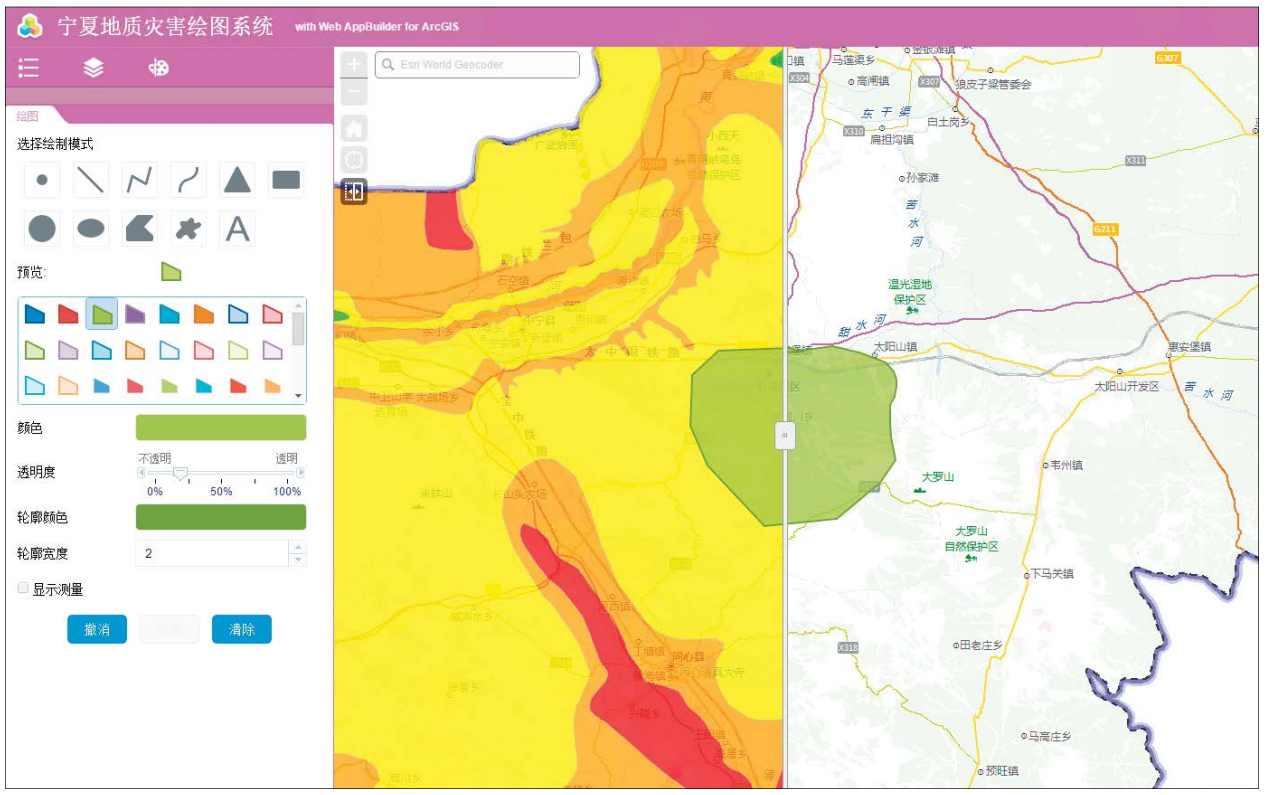
Esri's sole authorized distributor in Mainland China, Esri China, has a proven track record in helping customers implement ArcGIS technology in Alibaba Cloud. For example, the Ningxia Land and Resources Bureau has built its own foundational geospatial data platform using ArcGIS Enterprise in Alibaba Cloud. The department has consolidated its electronic map data, imagery, survey results, and 3D data into a one-stop catalog used by all agencies at all levels of the Ningxia Autonomous Region's government. Since the platform was released in 2016, an unprecedented amount of authoritative data has been made available to government and civilian users alike.

Esri China's president, Francis Ho, has witnessed the rapid migration of location intelligence capabilities to cloud infrastructure—and believes that this will only continue.

"Organizations are rapidly adopting GIS and combining it with the capabilities of cloud technology," said Ho. "Our users already rely on ArcGIS Enterprise and Alibaba Cloud to do this reliably and efficiently, using world-class innovation from our GIS experts in China, the United States, and around the world."

Alibaba Cloud provides robust and licensed images of popular operating systems, such as Windows Server 2016 and RedHat Enterprise Linux, in its Elastic Compute Service (ECS) instances. Several of these available operating systems are already tested, certified, and supported by Esri. This means that organizations can deploy ArcGIS Enterprise technology in Alibaba Cloud ECS immediately.

As Esri's relationship with Alibaba Cloud moves forward, its product engineers and developers will continue to work on adding support for other systems and services.



↑ Using ArcGIS in Alibaba Cloud, the Land and Resources Bureau in Ningxia, China, can now create customized apps with Web AppBuilder for ArcGIS that display interactive versions of its maps, including this geologic disaster map.

Scaling ArcGIS Seamlessly in Alibaba Cloud

The Geographic Center of the Land and Resources Bureau in Ningxia, China, wanted to establish a one-stop, cross-agency geographic information management, processing, and shared cloud services platform for both government and private use. Such a platform would provide authoritative geographic information services and maps to government agencies to help them conduct development programs in a more holistic and integrated manner. It would also give residents of Ningxia access to high-quality geographic data and maps. The shared library would serve as the government's database for basic geographic information.

To meet all these requirements, Ningxia authorities chose to use ArcGIS Enterprise combined with cloud computing services from Alibaba Cloud. Esri China's partner GISUNI helped the bureau set it all up.

Consolidating, Accessing, and Managing Geographic Data

The implementation team discovered early on that there were no consistent inventories of or standards for the large volumes of data that each agency individually held. Consolidating the data was further complicated by the need to adhere to strict data confidentiality policies and ensure that storage and access to sensitive data conformed with all applicable laws.

Engagement with potential users revealed that a majority were unfamiliar with managing and processing geographic information, yet they planned to use the data for advanced analysis and visualization. Furthermore, these potential users had expectations of a flexible, web-based, and easy-to-use system that could adapt to rapidly changing needs and a growing number of users in all agencies.

Setting Up ArcGIS Enterprise in Alibaba Cloud

Each agency was provided with ArcGIS Desktop software and specialist support to inventory and standardize its data holdings. While still retaining ownership and control of their data, the agencies used ArcGIS Server to publish services that were compliant with Open Geospatial Consortium, Inc. (OGC), standards.

A single, unified geographic information portal was then established using ArcGIS Enterprise and hosted in Alibaba Cloud Elastic Compute Services (ECS). GISUNI's GIStack solution monitors and scales the software and services to match users' growing demands.

Once authenticated, all users are provided with distinct permissions to the appropriate and authoritative data services, which can be employed in 2D web maps and 3D web scenes. Users are also provided with access to Web AppBuilder for ArcGIS, which allows them to rapidly author smart and effective web apps without doing any coding.

Automatic Scaling Meets Publishing Needs

The platform, which was implemented in 10 months, has delivered on the promise of giving users real-time, analytical, and visualization tools to help them make effective 2D maps and highly realistic 3D scenes.

Since the platform launched in 2016, the visitor frequency and number of data services published has increased beyond expectations. The growth has been seamlessly addressed by the automatic scaling of Alibaba Cloud, Esri, and GISUNI technology.

The system is now employed by all bureaus and agencies in the Ningxia region and provides standardized data to the national government. Residents and government agency users are rapidly locating and employing the appropriate authoritative geographic information, while each agency is able to confidently protect its confidential and sensitive data.

Utah Involves Public in Redistricting

With the Esri Redistricting Solution, the State Increased Transparency of Revising Legislative Boundaries

Redrawing representative districts in the United States is a contentious process fraught with acrimony. Because of the political influence at stake, the exercise regularly leads to allegations of unfairness. Nevertheless, after each US Census is taken, states must examine—and potentially redraw—their congressional districts.

For the last round of redistricting in 2011, the State of Utah took a novel step toward mitigating criticism: its Redistricting Committee made the process much more transparent to better educate citizens about how it works. Using the Esri Redistricting solution, the committee opened up the proceedings to the public, revealing all the intricacies involved in redistricting and displaying the many genuine obstacles to formulating a solution that satisfies everyone.

Opening Up Redistricting

Following the 2010 US Census, Utah, like all other US states, had to reconsider how its congressional districts were split up. State legislators wanted the public to be involved in the process, but online district mapping tools hadn't been available in prior redistricting years.

Late in the planning stages of its 2011 efforts, the state's Redistricting Committee saw a demonstration of Esri's Redistricting solution and decided to implement it. This would allow citizens in Utah to create and submit their own statewide redistricting plans online.

Working with Esri, legislative staff customized the solution slightly to ensure that users drew their redistricting plans according to the same requirements the state legislature had to meet. Shortly after rolling out the public-facing solution, the committee also created a companion website that allowed citizens to explain their plans and comment on those from others.

As legislators and analysts drew legislative boundaries for the state using Esri partner Citygate GIS's AutoBound extension for ArcGIS Desktop, citizens all over Utah were able to go online to create their own maps for congressional, legislative, and state school board districts.

"This was the perfect citizen engagement opportunity," said Richard Leadbeater, the industry solutions manager for state government at Esri. "Opening up the process of redistricting to citizens helped people realize that redistricting is hard. They got to see that it's difficult to start with a specific idea for your city and then come up with a fair, equitable plan for the entire state."

Creating New Solutions

Citizens accessed the Esri Redistricting app via a web browser, where, with a user name and password, they could either create new plans or collaborate and edit existing ones.

To make a new plan, users first selected census-designated geographic areas of varying sizes, such as counties or groups of neighborhood blocks. Indicators and reports within Esri Redistricting allowed users to visualize the demographic breakdowns in each of their proposed districts and see what would happen if they made changes to their plans.

In addition to mapping out their own redistricting solutions, users could create online groups to share and modify their plans. They could also use the companion website to make public comments about the pros and cons of various plans.

When users considered their plans complete, they locked them to prevent any further revisions and submitted them, via the app, directly to the Redistricting Committee for review.

Legislators also opened up the process to members of the media, since that tends to be where a lot of criticism comes from. Journalists were able to use the same computers and desktop tool that legislators employed to create plans of their own, and legislators were present to answer any questions they had. This way, members of the media were able to get a better understanding of how redistricting works.

Even More Transparency

A thousand citizens registered to use the site and submitted a total of 323 plans. Of those, 271 met the criteria for completeness, which included having each district be as equal as possible in population count, as well as contiguous and relatively compact.

The committee held 17 public meetings throughout the state so legislators could get more public input on redistricting and make the process even more transparent. Citizens who had submitted plans were invited to attend these meetings to discuss their ideas in person.

"If someone who created a plan came to a public hearing, we could bring their plan up online and project it on a screen where everyone could see it," said Jerry Howe, the managing policy analyst for the Utah State Legislature. "They could then discuss their plan and make arguments for it."

A Smoother Process

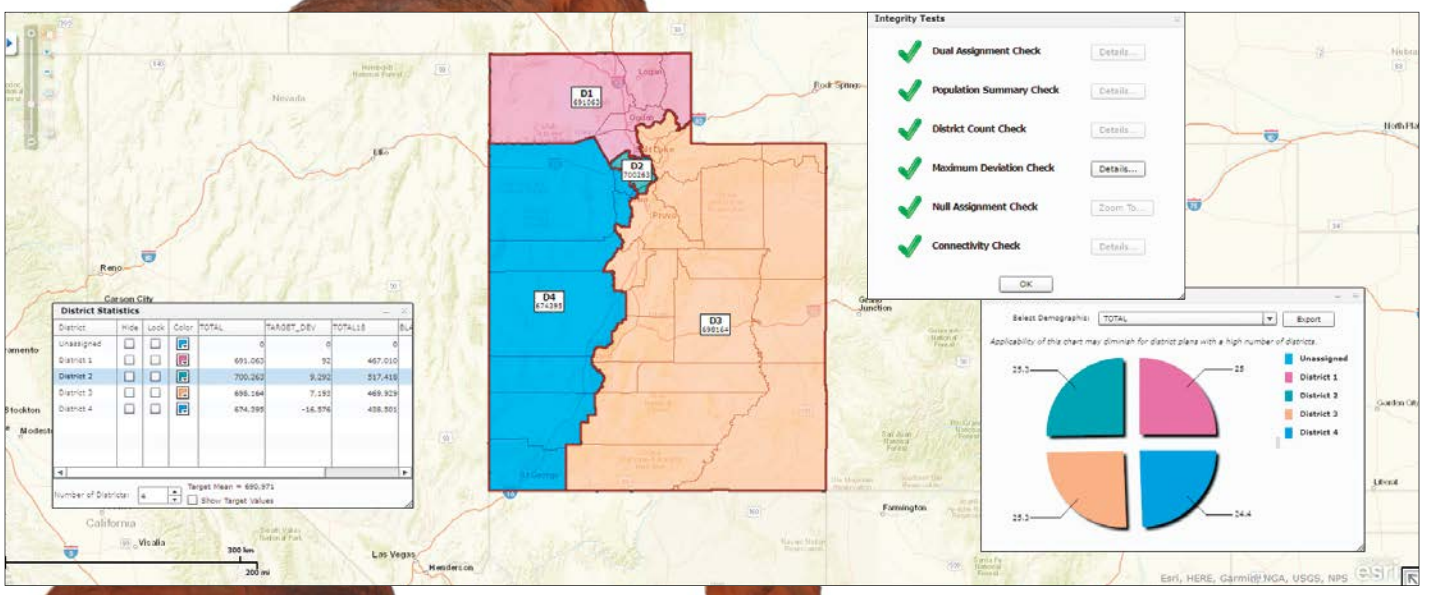
Even though there were still disagreements during the 2011 redistricting process, the Esri Redistricting solution provided the public with unparalleled visibility into how it works, and the Redistricting Committee got unprecedented access to what Utah's citizens wanted. According to Howe, participants not only gained an appreciation of how drawing statewide congressional boundaries works, but legislators also received a variety of options to consider.

"The plans *[citizens]* drew were helpful," Howe commented. "There was a plan for the state school board drawn by a member of the public that, with some minor modifications, was adopted."

Howe believes that public participation in redrawing Utah's state districts was beneficial to the overall redistricting process.

"I think the public and the media understood the problem better after using the Esri tool," he said. "It eliminated some criticism that was unfounded. Everyone who submitted a complete plan learned that it is really easy to draw the first part of the plan—but the real lesson everyone learned was that it gets really difficult to draw the final districts without harming compactness, city and county boundaries, and communities of interest."

For more information about how Utah employed the Esri Redistricting solution in 2011—and how it plans to use the tool after the next US Census—email Howe at jdhowe@le.utah.gov. To learn more about Esri Redistricting, go to esri.com/redistricting.



↑ With the Esri Redistricting app, Utah citizens created new maps for congressional, legislative, and state school board districts.

A New Approach to Flood Mapping

By Dr. David Maidment, University of Texas at Austin

For nearly three decades, we at the University of Texas (UT) have been working with Esri to support the intersection of GIS and water resources, particularly in the areas of hydrology and flood mapping. Recent technological advances—and their proven value in the face of Hurricane Harvey—make this a good point in time to reflect on how we got here, highlight recent developments, and share future initiatives.

The History of Flood Mapping

Esri's engagement with the water resources community took off in the early 1990s with the introduction of digital elevation model (DEM) analysis tools for hydrology in ARC/INFO 6.1. This simplified the process of computing watershed variables for hydrologic models. By the late 1990s—challenged by duplicate efforts and a lack of interoperability between systems—our team at UT worked with Esri to organize a group of academic, industry, and government water professionals to design a universal water resources data model. Known as Arc Hydro, there are now many implementations of this data model around the world, all sharing common design properties and patterns that maintain their interoperability.

Over time, what began as a data model evolved into the de facto starter kit for nearly all ArcGIS water resources users—and it continues to progress today. In 2004, our research team created Map2Map, which computes a water surface elevation model and ultimately produces a map of flooded areas by pulling Next Generation Weather Radar (NEXRAD) rainfall data and landscape attributes into two hydrologic modeling systems: the HEC-HMS rainfall runoff model and the HEC-RAS hydraulic model. This important milestone provided a near real-time connection between measured rainfall and flood mapping. Once built, it could even be scheduled to run in an automated form. During this period, the integration of GIS with hydrologic and hydraulic modeling became more formalized. Esri and the US Army Corps of Engineers collaborated in the development of HEC-GeoHMS and HEC-GeoRAS, free ArcGIS extensions for creating model inputs and working with model outputs.

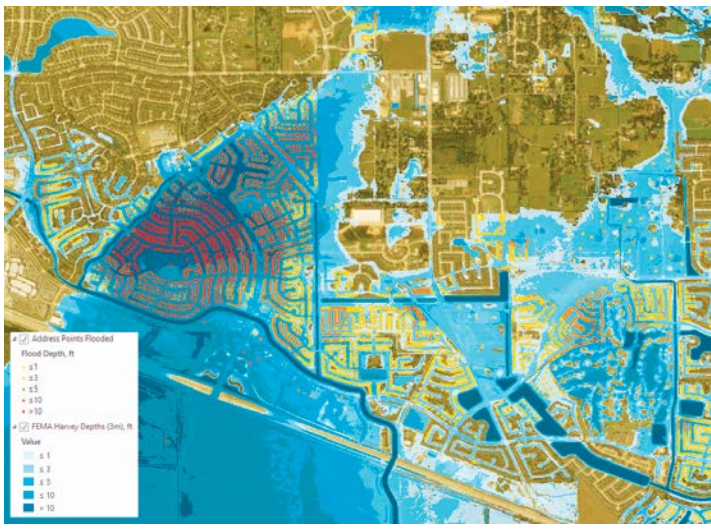
The Need for Improved River Forecasting

Despite these developments, large areas of the United States (and the world) don't have current flood maps—and in other areas, no flood modeling studies have been done at all.

Following a series of catastrophic floods and unfortunate deaths in central Texas in recent years, the UT research group began a renewed focus on flood forecasting, particularly in areas nobody had modeled before. A large part of the initiative centered on providing information to first responders during flood events.

In 2014, we, along with the National Oceanic and Atmospheric Administration (NOAA), initiated the National Flood Interop-

↑ This map shows the water depth of flooded areas along the Brazos River during Hurricane Harvey.



↑ Address point locations approximate where homes and other structures are in Houston, Texas. Hurricane Harvey left 10 feet of floodwater around the addresses in red.

Predicting Flood Levels Everywhere During Hurricane Harvey

On August 22, 2017, weather forecasting centers predicted that a tropical storm or hurricane would make landfall in or near Texas. Three days later, Hurricane Harvey struck and produced record rainfall—the most of any three-to-five-day storm in the history of the United States.

The University of Texas (UT) was ready for this. In 2016, the Texas Division of Emergency Management (TDEM) and the Federal Emergency Management Agency (FEMA) had approved a research project with UT called the Texas Flood Response Project, which Esri was involved in.

"The project had one overarching objective: How do you go from a radar rain map to a flooding inundation map showing impacts on the ground?" explained Harry Evans, the former chief of staff of the Austin Fire Department and a research fellow at UT Austin who now serves as a liaison between the academic and first responder communities. "Because of the work done with TDEM on this project, we were asked by the TDEM leadership to provide any assistance possible as Tropical Storm Harvey was forming in the Gulf of Mexico."

That same day, TDEM activated the State Operations Center to serve as the emergency operations center for Texas's statewide, regional, and local response and recovery efforts during the impending natural disaster. The director of TDEM, Chief Nim Kidd, invited UT to help TDEM's Critical Information Systems (CIS) develop flood inundation maps.

erability Experiment (NFIE), a research collaboration involving the government, academia, and industry (including Esri) to explore and create a prototype of new approaches for national-scale flood forecasting. This resulted in NOAA's 2016 release of the National Water Model for the United States, which combines GIS and numerical modeling tools to transform streamflow forecasts at 7,000 United States Geological Survey (USGS) stream gage locations into forecasts for 2.7 million stream reaches. Today, these forecasts are available as services in ArcGIS Online and on NOAA's Office of Water Prediction website.

Currently, a team of researchers led by Brigham Young University's Jim Nelson is tackling a similar initiative at a global scale. They are downscaling the European Centre for Medium-Range Weather Forecasts' (ECMWF) global runoff forecast onto a global stream network. This will provide access to 15-day streamflow forecasts and 35-year historic flows through an easy-to-use web app.

Using traditional hydraulic modeling techniques to transform streamflow forecasts into flood depth forecasts for a nationwide system is very data- and time-intensive, so the NFIE team has been taking a new approach. Initially developed on a supercomputer, the Height Above Nearest Drainage (HAND) terrain model can now be run for the entire nation at 10-meter resolution as a single job on commercial cloud hardware thanks to the recent advances in ArcGIS—a more-than-500-times improvement in the scalability of the ArcGIS Image Server hydrology tools running in a distributed cloud computing environment. The HAND raster is computed once, then through a custom Python raster function, new runoff forecast tables are dynamically presented as time-aware image services of flood depth.

The Esri water team has been engaged in many aspects of these projects. All the Python scripts created in support of these initiatives are being rolled into the free, open-source Arc Hydro toolset to help others customize their workflows, whether they need to create a custom version of streamflow for a county or country or they want to use a high-resolution DEM to do detailed inundation mapping.

Lessons from Hurricane Harvey

In late summer 2017, as Hurricane Harvey barreled down on the US mainland, various models were predicting that the storm would bring an unprecedented amount of rainfall. But because there was a lack of accurate maps, even though forecasters knew there would be large areas with several to many feet of water, they didn't know where the water would accumulate or when. In the end, the tropical cyclone created the largest areal rainfall quantity ever recorded for the United States, causing $125 billion in damages and resulting in more than 80 fatalities.

The devastation left in the wake of Hurricane Harvey was cause to unite the National Water Model and HAND flood mapping initiatives. Although the National Water Model was still under development and not yet an operational system, and the HAND inundation mapping technique was still a research project, the event was catastrophic enough to justify pulling in these tools to produce a regional view of the impact. More than 40,000 river miles were affected, and over 100,000 homes were flooded.

A map of the flooding over the entire area impacted by Hurricane Harvey was prepared at the Texas governor's request. Subsequent comparison with high-water marks collected by USGS showed that the average difference between the HAND inundation mapping and the observed high-water levels was about 25 centimeters, or 10 inches. At some individual locations, however, larger positive and negative differences between observed and mapped water levels occurred. We hope that by remapping the areas using lidar data, these differences can be reduced.

The Future of Flood Mapping

This is not the end of a journey but rather a new beginning. There are already initiatives planned or in motion to further this work and increase its impact, including the following:

- Improving the numerical models to incorporate the complexities of coastal zone flooding.
- Making data improvements, like more tightly integrating controlled streamflows from dams with higher-resolution terrain for urban flooding and developing countries.

By incorporating other data, such as where people live and work, and coalescing with other modeling domains, like transportation, we can connect flood forecasting models to transportation models. This would improve evacuation planning and first responder deployment, as well as prioritize cleanup and recovery.

Imagine, in the near future, that phone-based routing apps know their users' daily paths home from the office and can alert them to potentially flooded roads before providing them with safe routes home. We are near a time when we can know, with reasonable certainty, the future streamflow anywhere in the world several days in advance. As the accuracy of forecasting continues to improve, we are on the verge of a new era in flood mapping.

About the Author

Dr. David Maidment is a professor of civil engineering at UT Austin, where he has been on the faculty since 1981. He is a specialist in surface water hydrology and focuses in particular on how to apply GIS to hydrology. In 2016, Maidment was elected to the United States National Academy of Engineering for his work in developing GIS applied to hydrologic processes.

Bringing together a group of scientific researchers, GIS professionals from state and federal agencies, and a crew from Esri, UT's group was dubbed the Hydrologic Long-Range Prediction Unit. The team's objective was to coordinate hydrology and river hydraulic information each day from a range of agencies, including the National Weather Service, the West Gulf River Forecast Center, the United States Geological Survey (USGS), the US Army Corps of Engineers, FEMA, Texas river authorities, the Texas Department of Transportation, and more.

"This was done to provide situational awareness for county judges and emergency management coordinators in the dozens of affected communities," said Evans. "We were also asked to provide daily flood inundation maps for ESF 9 (search and rescue) and others as necessary."

Over the next few days, the team provided daily analyses of the water flow levels of 10 sentinel river sites that empty into Texas's Gulf Coast. The monitoring points included the Nueces River at the city of Three Rivers, the San Antonio River at Goliad, the Guadalupe River at Victoria, the Navidad (Lavaca) River near Edna, and the Colorado River near Bay City, along with several others.

In collaboration with the National Weather Service and the West Gulf River Forecast Center, the US Army Corps of Engineers was able to use this information to generate inundation forecasts for the main stems of these major rivers. But this did not take into account all the areas between the main stem rivers and their tributaries. In these places, emergency managers were having to make decisions with little to no data from TDEM. This is where the National Water Model came into play.

Even though the forecasts for these areas were approximate, they at least gave emergency managers something to work with. Knowing if, or when, roadways would be flooded greatly aided agencies in making evacuation plans and ensuring that rescue resources could be moved in to affected areas. The National Water Model also helped the Hydrologic Long-Range Prediction Unit identify high ground where emergency responders could stage rescue resources or care for and shelter evacuees.

When Hurricane Harvey made landfall along the central coast of Texas on August 25, the National Water Center, the US Army Corps of Engineers, USGS, the West Gulf River Forecast Center, and FEMA were all already collaborating to create real-time maximum-predicted-inundation maps.

"All these agencies are amazingly skilled in their areas; however, it was astounding what the group was able to develop when it worked together," said Evans. "For instance, the US Army Corps of Engineers and the West Gulf River Forecast Center were rock solid on the main stem rivers, but there was flooding on thousands of square miles beyond them. This is where the National Water Center, using the National Water Model, filled in the gaps on areas that had no authoritative forecasts. This level of collaboration is the future."

Evans thinks the most impressive part of this project took form even before Harvey hit.

"Probably the most remarkable observations I had prior to landfall were the rainfall predictions coming from the various forecasts," he recalled. "The inches of precipitation on some of the forecasts were unbelievable—40 to 50 inches, and more! So we looked at the prototype Texas Dashboard Impact Calculator we developed with Esri for TDEM and got a rough idea of the number of address points that would be inundated, as well as where they were located in the Houston and southeast Texas area, about 165 miles northeast of where the hurricane made landfall. We were able to assess the inland flood impact of the hurricane several hours before it reached the Texas coast."

It is Evans's sincere belief that the impact calculator, informed by the National Water Model and using any available stream gages and an ensemble of forecasts, can—and will—provide emergency managers with advanced warning of how bad flooding will be prior to a hurricane making landfall.

With his more than 30 years of experience working in emergency response and dealing with large-scale disasters, Evans understands the pressures emergency managers face to make quick decisions to safeguard lives.

"I've been that guy," he said. "Many times, I had no real-time data and made decisions on past history, experience, and intuition. But having worked with the National Water Center, the West Gulf River Forecast Center, the US Army Corps of Engineers, USGS, TDEM, and Esri over the last two years, I couldn't be more optimistic about the future of flood forecasts and predictions. Clearly, when faced with an epic disaster on the scale of Harvey, we are much more powerful and responsive when we all link arms and pull together."

Flexing What's Standard in Parcel Editing

By Corinne Compton, Office of the Commissioner of Revenue, Fauquier County, Virginia

Parcel mappers tend to be detail oriented and have a sense of guardianship over the data they maintain. When it comes to adopting new solutions, it can be hard for parcel mappers to let go of how they previously performed parcel maintenance and fully embrace the benefits of switching to a new system. This was a challenge that GIS staff and other employees at Fauquier County, Virginia, faced when it migrated its file-based legacy mapping system to ArcGIS technology.

Fauquier County, located about 50 miles southwest of Washington, DC, was an early adopter of computerized mapping, dating back to the late 1980s. When it moved to ArcGIS technology several years ago, Esri's initial consultations and assessments indicated that using the Esri parcel fabric would be the most logical method for the county to use to manage its parcel data in the new system. With a land area of 650 square miles and approximately 33,000 tax parcels that encompass the towns of Warrenton, The Plains, and Remington, Fauquier County's tax parcel information was of considerable consequence.

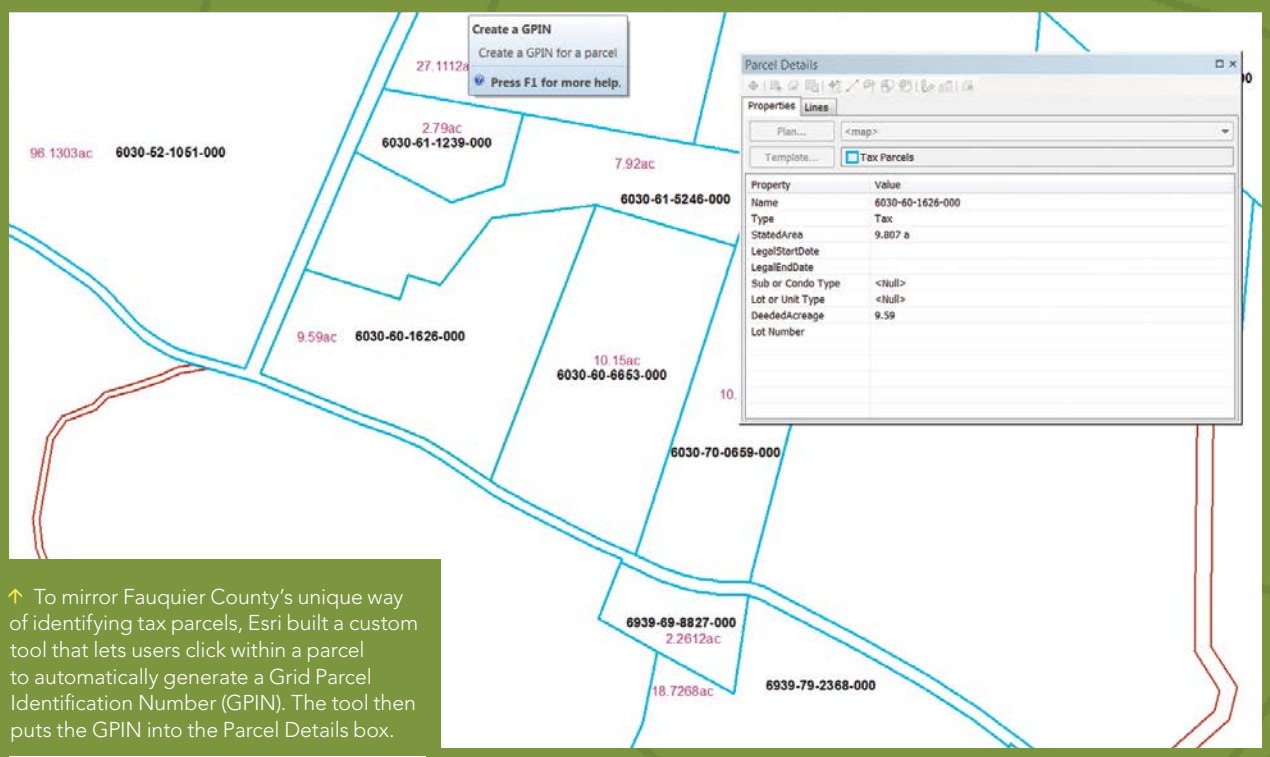
At the time, Esri's parcel fabric was unfamiliar to the county staff members who manage parcel editing, and they were hesitant to start using a system that seemed so complex. But Esri consultants were resolute in their suggestion that the parcel fabric, which stores land record information in a unified data structure and connects parcels in a continuous surface or network, would help Fauquier better maintain and edit its parcels. It could even be flexed to fit some of the county's distinct characteristics. So the migration team—which consisted of four GIS employees, two staff members from the Office of the Commissioner of Revenue, and a few designated IT staff—went for it.

Identifying Parcels

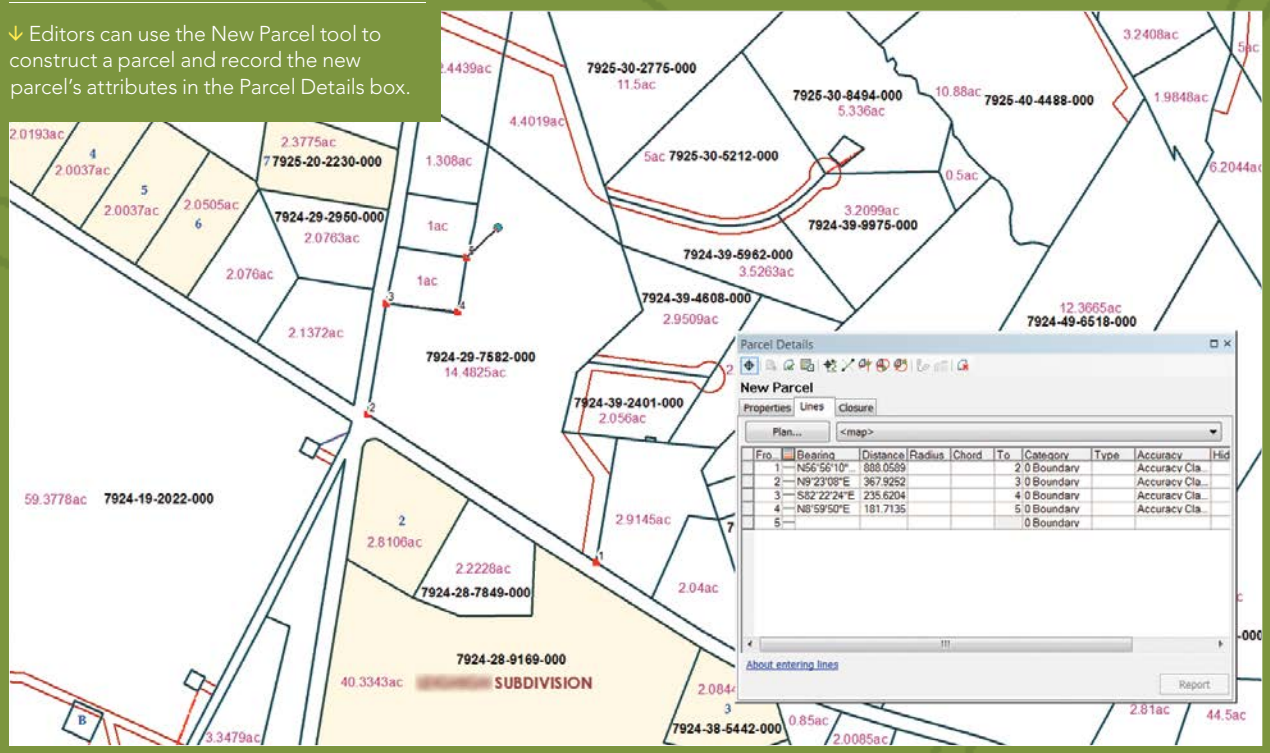
Fauquier County has a unique way of naming parcels. Called the Grid Parcel Identification Number (GPIN), this method generates parcel numbers based on the State Plane Coordinate System grid. GPINs are created by using the approximate center, or centroid, of a parcel's location and a combination of x- and y-coordinate values. The GPIN is a 13-digit identifier that has no relation to any specific attributes of the tax parcel. It is used throughout county departments to index all the records associated with a tax parcel.

When Fauquier County's tax parcel data was migrated from the legacy system to ArcGIS Desktop and the parcel fabric, Esri was able to build a custom GPIN tool that mirrored this procedure. The underlying grid is invisible to editors, but once they select the GPIN tool, they can click within a certain parcel to manually indicate its centroid and generate a unique GPIN. The parcel fabric then automatically puts the GPIN into the Parcel Details window and related tables.

If a tax parcel's configuration is changed—it is divided in two, for example, or several parcels are consolidated together—then the original GPIN is permanently retired, and a new GPIN is assigned to the newly created parcel. For boundary line adjustments, which move property lines between two or more lots, and boundary surveys, which determine the property lines of existing parcels, the unique GPIN remains active and is reassigned to the newly adjusted parcel.



↑ To mirror Fauquier County's unique way of identifying tax parcels, Esri built a custom tool that lets users click within a parcel to automatically generate a Grid Parcel Identification Number (GPIN). The tool then puts the GPIN into the Parcel Details box.



↓ Editors can use the New Parcel tool to construct a parcel and record the new parcel's attributes in the Parcel Details box.

Dealing with Complex Geometry

Tax parcels in Fauquier County often contain complex geometry because their boundaries commonly conform to the natural features of the land, including rivers, creeks, and streams. The majority of the parcel divisions, consolidations, and boundary line adjustments recorded in the county are based on current field run surveys (measurements and data collected in the field by a licensed surveyor) and comprise updated perimeter geometry. This means that the entire parent parcel needs to be revised before a child parcel is constructed.

Standard division methods in the parcel fabric, such as Construct From Parent or Parcel Division, were minimally useful, since those tools only allow users to divide existing parent parcels without updating or reconstructing the perimeter boundaries. Thus, it was necessary to customize the editing workflows used to alter parcels in Fauquier.

With help from Esri staff, new workflows were built that fit the county's unique needs and integrated with the other programs it uses to track tax parcel data—all while working in step with the parcel fabric.

Now, to modify a parcel, an editor begins by duplicating the original parcel and marking one of the two parcels as historic to preserve the integrity of its former attributes. Next, the editor creates the new parcel with the New Parcel tool, which allows users to traverse, or construct, a parcel with all new attributes and join it to the fabric. After the new parcel is joined, the editor deletes the original parcel. The new parcel can then be divided or adjusted based on the recorded plat. Finally, the editor assigns GPINs and updates the parcel's attributes manually.

By flexing the out-of-the-box workflows that come with the parcel fabric, Fauquier County was able to design an entirely effective ArcGIS software-based system for updating tax parcels.

Higher Accuracy, More Efficiency

Initially, it took considerable effort from GIS and Office of the Commissioner of Revenue staff—and especially the parcel mapping editor—to learn how to use Esri's parcel fabric and understand its tools. But once they accomplished this, the ingenuity of the parcel fabric became evident.

Having implemented many of the standard features of Esri's parcel fabric, as well as extending some tools to fit its needs, Fauquier County now maintains its tax parcel data at a much higher level of accuracy than it did with its legacy system. With all the refinements Esri makes to the parcel fabric at each new release, Fauquier continues to significantly improve its parcel editing techniques and create more efficient processes.

For more information on how Fauquier County extended the Esri parcel fabric, email Corinne Compton at corinne.compton@fauquiercounty.gov or visit fauquiercounty.gov.

About the Author

Corinne Compton is a parcel mapping specialist in the Office of the Commissioner of Revenue for Fauquier County, Virginia. She has a bachelor's degree in geography from Mary Washington College.

Mapping Open Spaces and Extending Conservation's Reach

↑ Larry Orman

As a white-water rafting guide in California in the early 1970s, Larry Orman gained a profound understanding of how environmental activism works—and sometimes doesn't.

Well before he built up the Greenbelt Alliance or founded GreenInfo Network, he fell into this adventuresome job at the suggestion of a roommate.

"We were trained in brutally cold weather," Orman recalled. "It was the best thing ever."

But one of Orman's routes, along the Stanislaus River, was being threatened by a dam. A spectacular stretch of rapids was going to be inundated. As construction on the dam started, a new breed of environmentalists was taking form—and Orman was one of them.

"We fought the building of that dam, but we lost" he said. Nevertheless, "it gave me a huge collection of friends and political understanding"—both of which Orman has relied on throughout his influential career in mapping and protecting open spaces.

A Visceral Dynamic

Orman grew up in Mission Valley, California, an area just outside San Diego proper (at the time) that was known for its dairy farms. He played in the valley's open spaces and enjoyed visiting downtown San Diego, which was actually cohesive in the 1950s.

But then, the city put a shopping center in Mission Valley. According to Orman, this gave the valley its own core, which caused downtown San Diego to fall into disrepair.

"It completely destroyed Mission Valley, from my point of view, as a natural area," he said. "And downtown San Diego was an absolute wreck. That dynamic was visceral for me."

After high school, Orman moved north to attend UC Berkeley. While studying environmental design and architecture, he spent a year in Germany living in a relatively small city that was surrounded by farmland. He marveled at being able to walk all over town and then step straight into the greenbelt.

"That alternative to what San Diego had done got really imprinted in my brain," he said.

When Orman returned to Berkeley, he took a class that required students to work on one project for the whole term. Orman chose to help a group of local citizens fight a development down at the waterfront.

"We held off development proposals tooth and nail," he recalled. While it took 20 years of community activism, that development site—which was slated to become a shopping center—is now a state park.

"I ended up learning a lot," Orman said. "I have a background that was ripe to be catalyzed by something like that shopping center, and that thrust me into city planning."

Orman got his master's degree in city and regional planning from UC Berkeley. He then forged a career that centered on setting the agenda for regional planning and conservation—first in the San Francisco Bay Area, next throughout California, and now for many places around the United States.

Creating the Geography of an Issue

After graduate school, the People for Open Space hired Orman as its first paid employee. Over the next 19 years, Orman built that organization—which became the Greenbelt Alliance—into a force for open space and land conservation in and around the Bay Area.

"When I started with this very small organization, we wanted to take on the big question of how to define a whole greenbelt for the Bay Area," Orman said.

The organization didn't get all the funding it needed for that, so Orman and his colleagues took on agricultural land instead.

"We said, we're going to give that use of open space a voice and talk about what should be done to protect it," he recalled.

They spent two years learning about farmland—including where it was.

"Nobody had a clue!" Orman exclaimed. "We had to draw our own maps. We had to create the geography of the issue to show people its extent."

The Greenbelt Alliance also devised the idea of identifying land that was at risk of development.

"We decided to talk about all the lands that are unprotected and under pressure of being developed," Orman said.

The organization started doing risk mapping. This is when Orman began using GIS.

"Our map ended up showing areas of high and medium risk over large parts of the Bay Area," he said. "Our point was, this isn't all going to be developed, but until we take away some of these risks, any of it could be."

This project, which showed that the Bay Area had too much land up for grabs, got media coverage. According to Orman, it helped constrict development around San Francisco. Although the area has been booming in recent years, it hasn't seen much massive sprawl.

"The mapping helped with that," said Orman. It also made him realize how important it was to have competent, compelling visuals to tell a story.

"I taught myself GIS. I'm not an expert by any means," he said. "The thing I learned is, you can have the best technical understanding in the world, but if you don't know how to communicate in the public-interest realm, you're never going to make an impact."

A Long Arc of Work

This thinking inspired Orman's next project: founding GreenInfo Network to help nonprofit organizations use GIS. The technology was becoming more democratic, moving from workstations onto personal computers, and data was more widely available.

"My thought was that I'd get nonprofits going with GIS, and then they'd take it and run," said Orman. But nonprofits didn't have the resources to get great at GIS. So GreenInfo Network became a consulting organization that helps a range of public-interest groups better visualize and communicate their ideas.

"The timing was great," said Orman. "People were extremely interested in visualizations."

While at the helm of GreenInfo Network, Orman and his team developed the California Protected Areas Database (CPAD), a GIS inventory of all the protected open space in California that's owned by various agencies and nonprofits. The project was part of a long arc of work for Orman, evolving out of his efforts to create a database of all public lands in the Bay Area and ending up as a major impetus for the United States Geological Survey's (USGS) Protected Areas Database of the United States (PAD-US), which Orman helped develop. (Read more about PAD-US in *ArcNews* at p.ctx.ly/r/7lh6.)

"That whole trajectory shows how Larry has worked, and led others to work, incrementally," reflected Dan Rademacher, the current executive director of GreenInfo Network. "Thirty years ago, people might have wanted a national database of parks, but that was really hard to do then. One of the ways to get there, though, was to make tangible progress where you could. He led the creation of the Bay Area Protected Areas Database. It wasn't ever perfect, but it amassed data and got jurisdictions talking to each other. And it always got more useful over time. Then that grew into CPAD"—and beyond.

Reveling in Old Open Spaces

In his 20 years as executive director of GreenInfo Network, Orman worked on countless projects that helped shape conservation all over California and the United States. At the end of 2015, he decided to step down as executive director and hand the organization over to Rademacher to foster continued growth in the digital age.

Orman is now a senior fellow at GreenInfo Network, working on projects of his choosing, including PAD-US.

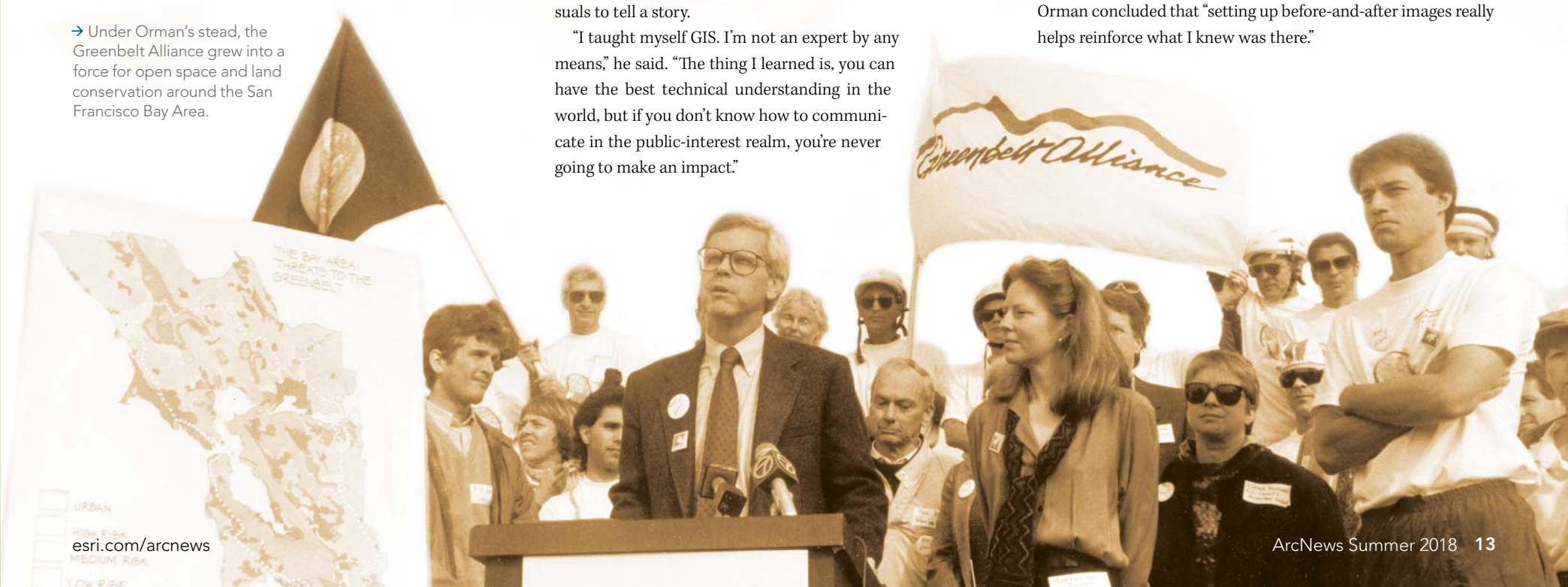
"One of the other projects I'm working on is an archive site for the Stanislaus River," he said, referring to the river that was dammed when he was younger. "I'm working with people I knew from those days to develop a really wonderful website that's going to be an archive to remember what it was like."

While he's never been back to the river itself, he revels in his memories of that open space.

"It was really one of the more exceptional places in California that we just couldn't save," he reflected.

Although it has been a bit of a tough project to work on, Orman concluded that "setting up before-and-after images really helps reinforce what I knew was there."

→ Under Orman's stead, the Greenbelt Alliance grew into a force for open space and land conservation around the San Francisco Bay Area.



Digital Elevation Models Bring Mining History to Life

With Lidar and ArcGIS Spatial Analyst, Company Accurately Documents Archaeological Elements at Colorado Gold Mining Town

By Connor C. Johnen and Michael J. Prouty
Alpine Archaeological Consultants, Inc.

For about two decades from the late 1890s to the late 1910s, the Frances Townsite, in western Boulder County, Colorado, was a mining town. Located by a natural spring in a moderately high-elevation mountain gulch, the community served miners from a number of local gold mines within the immediate vicinity.

Built around a mill, the town was formally established in 1897 when a railroad constructed a station there. While large-scale mining diminished by the early 1900s, Frances continued to serve independent miners and a burgeoning tourism industry until 1919, when the railroad closed and the town was abandoned.

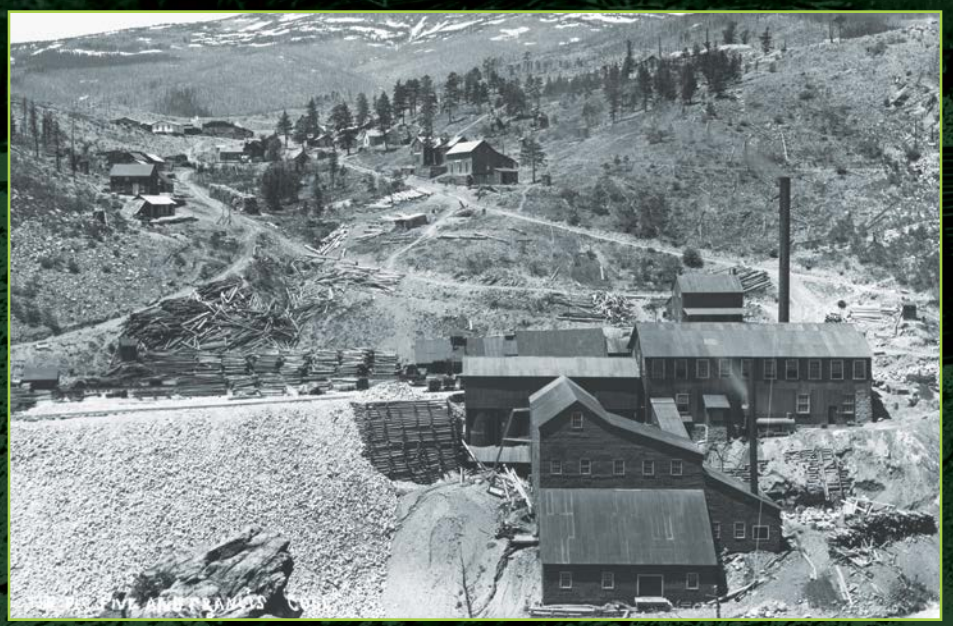
The neglected buildings in Frances slowly began deteriorating. People removed some of the building materials, and the town became an archaeological site. It now sits on a combination of federal, county, and privately held lands.

In 1997, archaeologists documented 52 former structures, or elements, in Frances, including leveled platforms, privy (outhouse) depressions, stone building foundations, and root cellars. Based on historical photographs, the archaeologists suspected that there were other elements in the area but that they had been obscured by natural processes.

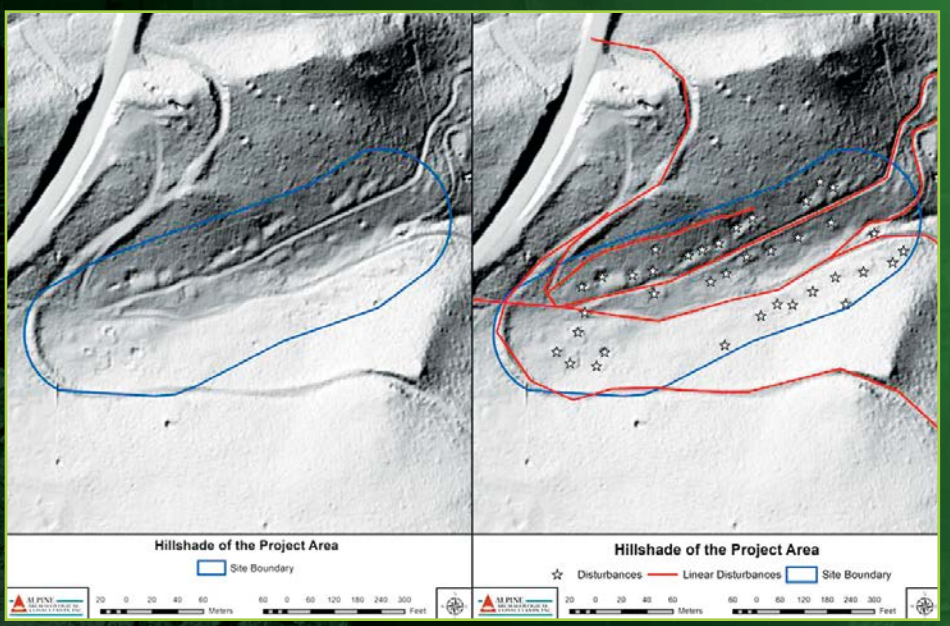
Not too far away, the Colorado Department of Public Health and Environment (CDPHE) and the Environmental Protection Agency (EPA) have been cleaning up the Captain Jack Mill Superfund site, where the soil and surface waters remain contaminated with metals and other hazardous materials, largely from mining. As part of the cleanup's mandate, the Bureau of Land Management's Royal Gorge Field Office (BLM-RGFO) requested that nearby historical resources, such as the Frances Townsite, be shielded from any associated impacts.

To that end, in the fall of 2016, CDPHE hired Alpine Archaeological Consultants, Inc., to conduct an intensive site recordation of Frances and to update the site map. The objectives were to better understand the town's spatial organization and to provide the BLM-RGFO with an accurate map so it could more carefully manage this significant archaeological resource.

The BLM-RGFO requested that the site be documented using high-precision technology and modern GIS. By collecting lidar data from *The National Map*, hosted by the United States Geological Survey (USGS), and employing the ArcGIS 3D Analyst extension for ArcGIS Desktop, Alpine was able to create a precise composite digital elevation model (DEM) of the townsite's modern surface. In addition, the company used highly accurate



↑ The general layout of the Frances Townsite, circa 1900. (Photo courtesy of the Boulder Historical Society Collection of the Carnegie Branch Library for Local History.)



↑ A hillshade of the site area (circled in blue) highlights depressions, which could indicate elements of the town, such as former buildings and rail lines or roads.

on-the-ground robotic survey technology to detail all the elements at the site.

Identifying Elements with Lidar

The team at Alpine assumed there were going to be difficulties in rediscovering and re-recording the Frances Townsite. When the BLM-RGFO did the original site recordation in 1997, it didn't use a GPS receiver, and a local archaeologist hand mapped the townsite. While the map did detail all 52 elements' locations and was a fantastic resource for Alpine, the team wasn't sure how accurate it was, since hand-drawn maps are prone to scaling mistakes. Furthermore, the team at Alpine thought that other elements in the townsite might have been obscured by environmental processes, such as erosion or infilling.

Focusing its analysis on the map's original site boundary, the team planned to use the lidar dataset from *The National Map* to identify additional elements in the townsite, such as platforms, depressions, roads, and railroad grades. The first step was to process the collection of LAS files using a geoprocessing tool in ArcGIS Desktop called Create a LAS Dataset. This allowed the team to work with the collection of LAS files as if they were one and to do so directly on the LAS files without converting them.

Alpine only wanted the ground data, so once the multipoint dataset was ready, the team filtered out disturbances—such as canopy and water structures—using the Filter tab on the Layer Properties dialog box of the LAS dataset. When it had a clean dataset, the team used the LAS Dataset To Raster tool to create the DEM.

The most common DEMs available in the United States and North America are taken at 10-meter resolution. But *The National Map* dataset that Alpine was using had point spacing of 0.411 meters, which is excellent considering that the availability of 1-meter resolution DEMs in the United States is sparse. This high-resolution lidar data was able to differentiate among ground surfaces; low, medium, and high vegetation; buildings; water; rail and road surfaces; and more, making it relatively simple for the team to filter out any surfaces it didn't need.

Once the raster was ready, the team used the Hillshade tool in the ArcGIS Spatial Analyst toolbox to create a hillshade so it could begin identifying potential elements in the Frances Townsite. The Hillshade tool produced a gray-scale 3D representation of the area, putting shadows in stark relief. This enabled the Alpine team to zero in on areas that looked like depressions both in and immediately around the original site boundary. These depressions were potential evidence of buildings and other elements associated with the townsite.

With the hillshade map, the team identified 37 depressions and/or platforms, as well as 5 linear elements that were interpreted as roads. The findings were a mix of previously recorded elements and newly identified ones—including 16 new platforms—and they were found both within and outside the original site boundary.

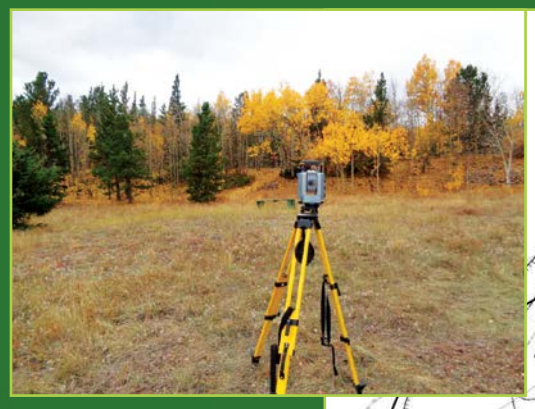
Verifying Analysis in the Field

The next step was to go out into the field to look for these elements. The team created a new map of the townsite with all the elements on it and then uploaded the elements' points into a Trimble GeoXT handheld GPS receiver. Knowing exactly where the elements were made it much easier to find them in the real world.

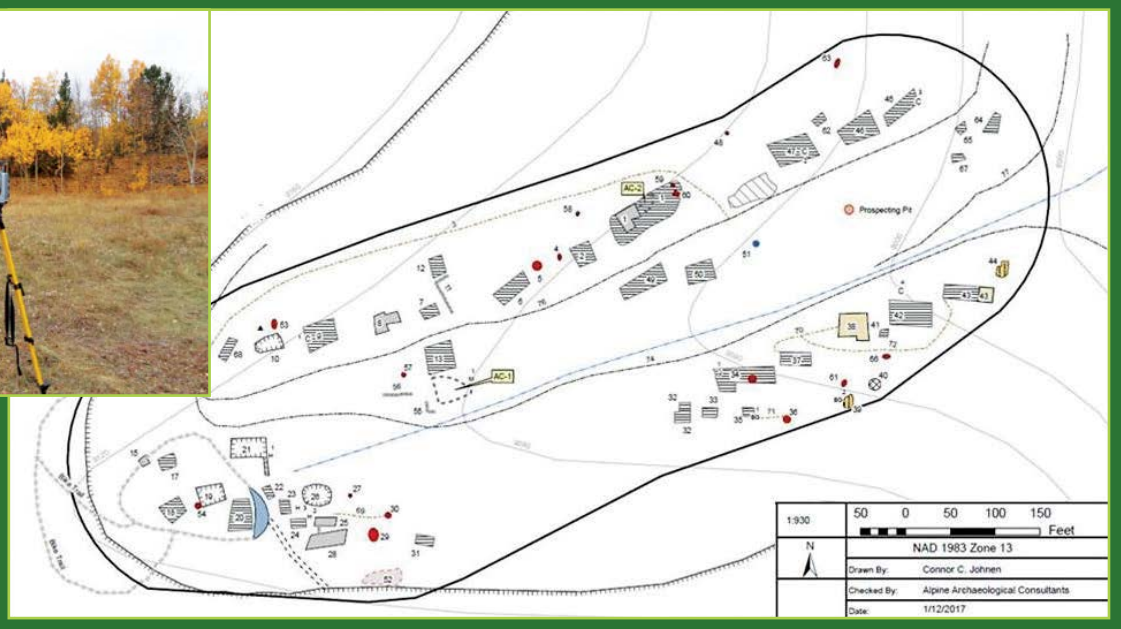
Once on-site, the team used the results of its analyses to verify where the elements were located. They then used Trimble's S7 Total Station—a piece of surveying, imaging, and 3D scanning equipment capable of subcentimeter accuracy—along with a GPS unit capable of submeter accuracy (for redundancy), to record the details of each element.

Thirty-two of the depressions and platforms found in the hillshade turned out to be historic elements of the townsite itself. While the remaining five depressions were not specifically associated with Frances, they did reveal other ways in which the landscape was historically used. Some ended up being prospecting pits dug up during the mining boom, while others had to do with modifying the landscape.

Back at the office, the team processed the resultant data using ArcGIS Desktop 10.4 and created a new, highly accurate map of the Frances Townsite. The BLM-RGFO now uses it to better manage this significant Colorado gold mining site, which will ultimately help protect it.



↑ The team used a Trimble S7 Total Station to record railroad grades within the townsite.



↑ The final, highly accurate site map, which was produced with ArcGIS Desktop 10.4, shows all the elements and disturbances in the Frances Townsite.

About the Authors

Connor C. Johnen is a GIS specialist at Alpine Archaeological Consultants, Inc., and Michael J. Prouty is a senior project archaeologist for the company. For more information, contact Johnen at connor_johnen@alpinearchaeology.com or 970-249-6761, or email Prouty at mike_prouty@alpinearchaeology.com.

Grad Students Reenvision Neighborhood's Future Using 3D GIS

In central Atlanta, Georgia, the Old Fourth Ward has been the site of several lagging and fruitless redevelopment projects since the mid-twentieth century. As such, it is an ideal neighborhood for urban design and architecture students to use as a case study to explore modern urban design techniques and learn new technology.

Last spring, a group of graduate students in the urban design program in the School of Architecture at the University of North Carolina at Charlotte took on the challenge of reenvisioning the old urban renewal site's future. The main idea for this academic project was to learn about the design principles that were key to the City of Savannah, Georgia's effective redevelopment of its historic district—something Atlanta was unsuccessful with decades ago when it built its civic center (now itself a subject of demolition) in the Old Fourth Ward, displacing more than 1,000 largely African-American households, wiping out existing street grids, and disrupting not only the physical structure of the land but also the social fabric of the community.

In addition, the class used this project to explore the potential of using modern geospatial technologies—including ArcGIS Pro, the Local Government 3D Basemaps solution, Esri CityEngine, and ArcGIS Online—to study the existing urban form, understand the current socioeconomic conditions of the Atlanta neighborhood, propose and examine design alternatives, and eventually help visualize potential scenarios for the future of the Old Fourth Ward.

"To propose good urban design solutions, students need to first have a good understanding of the contexts of the project site and then have proper tools to allow them to develop and evaluate their proposals," said Dr. Ming-Chun Lee, an assistant professor at the University of North Carolina at Charlotte's School of Architecture and the instructor of this urban design studio course. "Many modern geospatial tools serve well for all these purposes."

3D Models, Virtual Reality, and Sharing

Students began the project by collecting GIS data about both the Old Fourth Ward and Savannah's historic district from online, open-source databases. To create a digital representation of the existing urban structures for the two areas, the students built a series of basemaps by combining datasets into layers in both ArcMap and ArcGIS Pro. They then generated detailed 3D models for the two sites that displayed existing buildings and trees and contained accurate terrain.

To construct the 3D models, the students used ArcGIS Pro to extract 3D features from lidar point cloud data, which came from the United States Geological Survey's (USGS) EarthExplorer. They then employed the Local Government 3D Basemaps project package in ArcGIS Pro to process all the reclassified lidar tiles and extract the buildings and trees in 3D. This produced digital terrain models (DTMs) as TIFF files, which represented the bare, ground-level terrain for the Old Fourth Ward and Savannah's historic district.

The class then used CityEngine to enhance the visual quality of the resultant 3D models. They added details such as architectural structures and textures, landscape features, street markings and pavement, transportation features, vehicles, and human figures. The students implemented additional light effects as well to augment the level of realism in the models.

To do all this, the students first used ArcGIS Pro to package the needed GIS datasets—the lidar-extracted 3D buildings and tree points, the DTMs (as TIFF heightmap files), streets, building footprints, and aerial photos of the sites—in a file geodatabase. After importing the GIS datasets into CityEngine, the students used its Polygonal Street Creation tool to generate streets based on the types of streets they had identified at both sites, including major thoroughfares and local roads. All the data associated with the streets—such as vegetation, signs, pavement, vehicles, and human figures—were added using Esri's Complete Street Rule Package, which is available via ArcGIS Online. The class then employed Esri's Building Construction rule set to generate 3D buildings with architectural details and textures.

"Having all this in CityEngine, as well as the data preparations done in ArcGIS Pro, allowed the students to create large-scale city models to visualize existing urban structures, in addition to proposed urban design solutions," said Lee. "These models also helped students examine and compare the spatial qualities of the Old Fourth Ward and Savannah's historic district."

But there's more to modern geospatial technology that the students aspired to discover. So they explored their urban design solutions using virtual reality (VR). To do this, they had to export their CityEngine models as FBX files before

↑ In their detailed 3D models, students created pedestrian-oriented neighborhood designs.

↓ A CityEngine model, viewed from CityEngine Web Viewer, shows a future development scenario for the Old Fourth Ward.

→ The urban design students from the University of North Carolina at Charlotte used modern geospatial technology to reenvision how the City of Atlanta could revamp the Old Fourth Ward.

importing them into a game engine called Unity to create their VR scenes. Unity allows users to implement additional light effects and has a number of environment-rendering options—such as movement speeds and view angles and heights—to enhance the appearance of the models even more. It also has VR settings that let users use a typical game controller, such as an Xbox controller, to walk virtually around the 3D scenes originally generated in CityEngine.

Finally, to conclude the project, the students took advantage of ArcGIS Online to share their data and graphic contents with each other. They generated web maps and 3D web scenes—which included detailed streetscapes, buildings, and spatial analysis results—to visualize and explore various urban structures and design solutions. Once they had everything in ArcGIS Online, the students also used Esri Story Maps app templates to present their project outcomes. The story maps contain various forms of media—such as photos, graphs, diagrams, text, interactive maps, and 3D scenes—that reveal, in a narrative way, the urban structures of Atlanta's Old Fourth Ward and the historic district in Savannah.

Riding the Wave of New Geospatial Trends

This class exercise offered students an opportunity to explore new geospatial tools and visualization media while studying urban design in a more encompassing, engaging way.

"I believe that being able to get a better handle on location-based knowledge and further incorporate it into actual physical design strategies will really help urban designers connect to the place and the people of the place and, in turn, develop solutions that will have real impacts and generate satisfying results," Lee added.

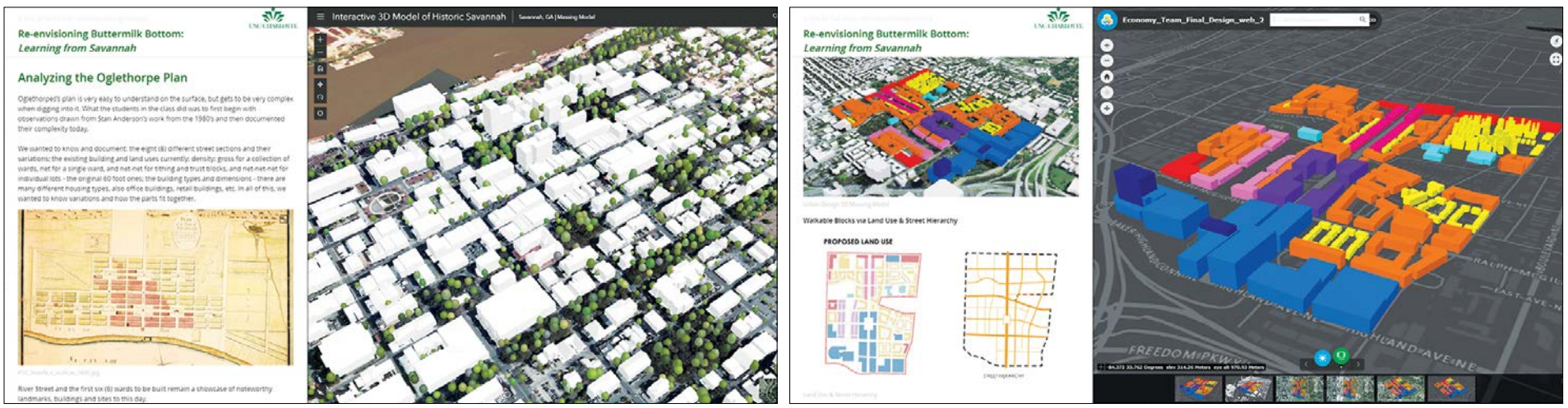
By employing 3D GIS modeling, lidar data processing, cloud-based GIS, and VR to real-world contexts, urban design students at the University of North Carolina at Charlotte got to ride the wave of many major trends in geospatial development early on in their careers.

As these digital tools continue to advance, urban planners, designers, and researchers will need to fully understand them so they can establish workflows that move their ideas forward and promote pioneering solutions to city planning problems. By even just improving the integration of mapping, modeling, and visualization capabilities, modern geospatial technologies are effective tools for envisioning the future of local neighborhoods.

For more information about this project, email Lee at Ming-Chun.Lee@uncc.edu or call 704-687-0137.

"To propose good urban design solutions, students need to first have a good understanding of the contexts of the project site and then have proper tools to allow them to develop and evaluate their proposals."

Dr. Ming-Chun Lee, Assistant Professor at the University of North Carolina at Charlotte's School of Architecture



↑ The students created a series of Esri Story Maps apps to present their project outcomes in a narrative style.

←↑ The class created virtual reality (VR) scenes to experience the CityEngine models in a more immersive way.

City of Brampton, Canada, Saves Time, Money with GeoHub

Residents, Students, and Businesses Now Have Easy Access to Public Information

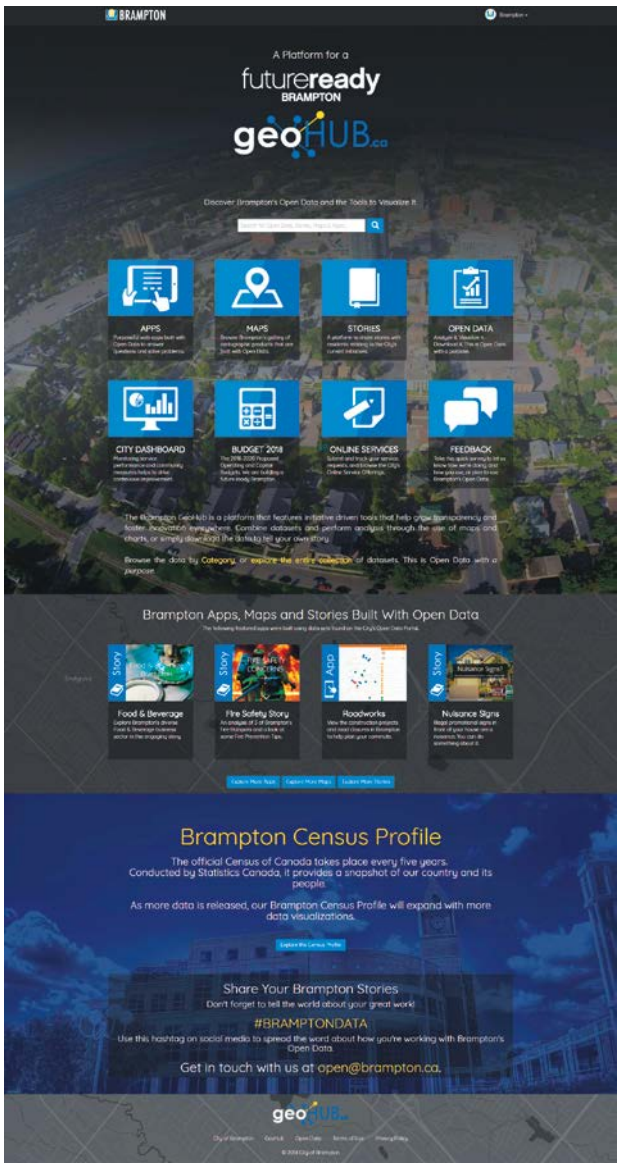
Brampton, a diverse and fast-growing city in Ontario's Greater Toronto Area, boasts a population of just over 600,000, with residents working in key industries such as retail and business services, aerospace technology, and telecommunications equipment manufacturing. Known as the "flower city" due to its historical success in horticulture, the City of Brampton now has ambitious plans to become a connected city that is innovative, inclusive, and bold.

To get this effort off the ground, Brampton launched its first iteration of an open data portal in 2011. This was in response to the Ontario provincial government's new requirement that all municipalities release their facilities' energy consumption and greenhouse gas emissions data. In 2015, Brampton upgraded the portal to ArcGIS Open Data, where it initially hosted 15 datasets online. At the end of 2016, the city rebranded its open data portal as the Brampton GeoHub (accessible at geohub.brampton.ca), which is now a comprehensive open data portal based on ArcGIS Hub technology.

Employees in Brampton's information technology division understood that the city's data was useful for residents, developers, and city employees and wanted to improve services through transparency and community engagement. The GeoHub quickly became the one place where anyone could view and acquire the city's datasets—from asset, land-use, and infrastructure data to orthoimagery—as well as public data from the open data catalog.

"If you're going through the effort to open data, make it useful, make it purposeful, and build awareness—not only to the public, external agencies, and business but also to staff," said Matt Pietryszyn, the City of Brampton's information technology team lead of GIS and open data. "It's a great way to share authoritative information throughout the organization."

In the first year of use, the city saved 588 hours of staff time by decreasing the number of data requests it received both from internal departments and members of the public. Given that the GeoHub now has almost 300 datasets (a big jump compared to the 15 it started with), Brampton has virtually eliminated the need to process data requests, saving staff exponentially more time.



↑ The City of Brampton's GeoHub is a comprehensive open data portal that employs ArcGIS Hub technology.

Providing Transparency, Interacting with Citizens

Before GeoHub, Brampton city staff and residents struggled to find and use data. In most cases, the city's internal teams or members of the public looked for data, downloaded a file, and then uploaded it into a system before they could view or analyze it—sometimes only then finding out that the data was not what they needed.

Since GeoHub's launch, staff no longer have to respond to public requests for information on topics that range from health and safety to infrastructure, since residents, business owners, and students can now get what they need through the open data catalog. In addition, members of the public can leverage high-quality and authoritative datasets to make their own apps. Such access to data not only gives the community a chance to be part of the process, but it also helps the municipal government identify the types of data users want to see.

"We are not only providing transparency in service; it is also our aim to foster innovation and transformation in how we interact with our citizens," said Joseph Pittari, commissioner of corporate services for the City of Brampton. "Through the GeoHub stories and mapping features, our residents can get a better understanding of their community and its surroundings."

A Rising Star in Open Data

Brampton's profile is rising as it sees increasing success with its open government efforts. It is already the second most open city in Ontario, beating out other Canadian stalwarts like Ottawa and Vancouver, according to Open Cities Index Results published by *Public Sector Digest* last year. Brampton also won the Canadian Open Data Rising Star 2017 award in the Canadian Open Data Awards.

Its success can be attributed to the city's hardworking GIS and open data team, supportive leadership, and collaborative internal departments. Brampton's GIS and open data team is made up of 14 forward-thinking GIS professionals working toward the shared goal of distributing the city's data and GIS tools to a wide audience so that city employees, local businesses, and residents can employ business intelligence and GIS services as typical capabilities.

"Promote your location platform everywhere—in every meeting and every hallway discussion," advised Gaea Oake, the program manager for the GIS and open data team. "Meet new people in the organization and talk about data with staff you haven't worked with in the past. Engage with the public. Data-driven governance and citizenship is gaining importance because it's a quick way to begin connecting citizens to strategic initiatives and show them that cities are aware of where they've come from, have a strategy in place, and will be held accountable for moving forward."

Brampton's GIS and open data team has also worked tirelessly to educate city staff about what is available in GeoHub—from data and maps to visualizations and collaboration opportunities. Letting teams know that there is a central, authoritative location to find content for better decision-making has made a "really big impact," said Pietryszyn.

It hasn't been an easy journey to get departments to share their data. But things are changing, according to Pietryszyn.

"Through initiatives like the Smart City Challenge, hackathons, and other activities that aim to modernize how cities run their business, awareness is growing," he said. "Municipal leaders are beginning to understand that when you make good, purposeful data available publicly, it's easier for businesses to make the decision to locate in their city. Students have access to accurate and real-world data to analyze and understand their city. Small businesses benefit and are able to better grow the local economy."

Pietryszyn said that the GIS and open data team is constantly working on adding more datasets to its open data catalog—influencing departments to release business data along with location data while also making sure that what's being released is accurate, current, humanized, and purposeful.

Becoming Future Ready

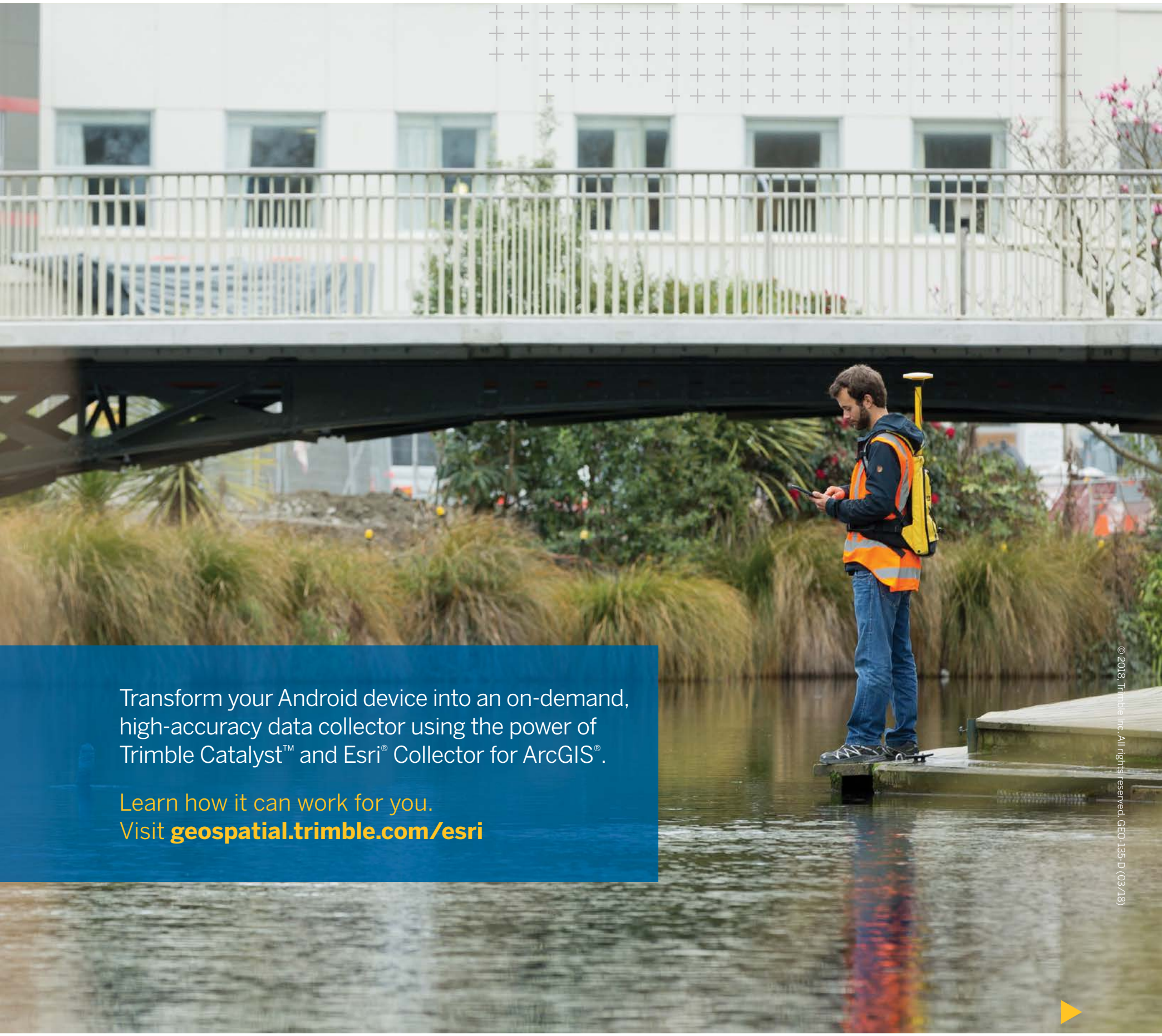
Next on Brampton's journey to becoming a smart community is putting its recently finished City Dashboard to good use. A public-facing performance dashboard, this online tool helps members of the community understand how the city's day-to-day undertakings produce positive outcomes. Residents can monitor categories such as Finances and Assets, Community Well-Being, and Livability and see whether the city is meeting its targets or needs improvement. In the Economy section, for example, users can see that Brampton is working to improve the jobs-to-population ratio, while under Customer Service, residents can find out that the city is providing good-quality transit service, since it is meeting its target of only receiving one complaint per 10,700 rides.

Pietryszyn said that cities striving to become "future ready" through open data and more transparency need to embrace their GIS departments.

"Municipalities struggle to understand what their GIS can do for them, or just what it is exactly," he said. "Recently, we've spent less time explaining to people what GIS is and more time showcasing apps and how we can partner to solve problems and make their data more purposeful through quick dashboards and visualizations to tell their business units' stories. This is the biggest win across the organization for GIS. It doesn't have to be complicated or time-consuming."

Learn more about how the City of Brampton is thinking bigger at brampton.ca or by following @CityBrampton on Twitter and checking out its Facebook page at facebook.com/CityBrampton.

↑ Brampton's GIS and open data team is made up of forward-thinking GIS professionals who are committed to distributing the city's data and GIS tools widely.



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Deoxygenation of the Ocean Affects Everyone, So Act Now

By Dawn J. Wright, Esri, and Sylvia A. Earle, National Geographic Explorer-in-Residence

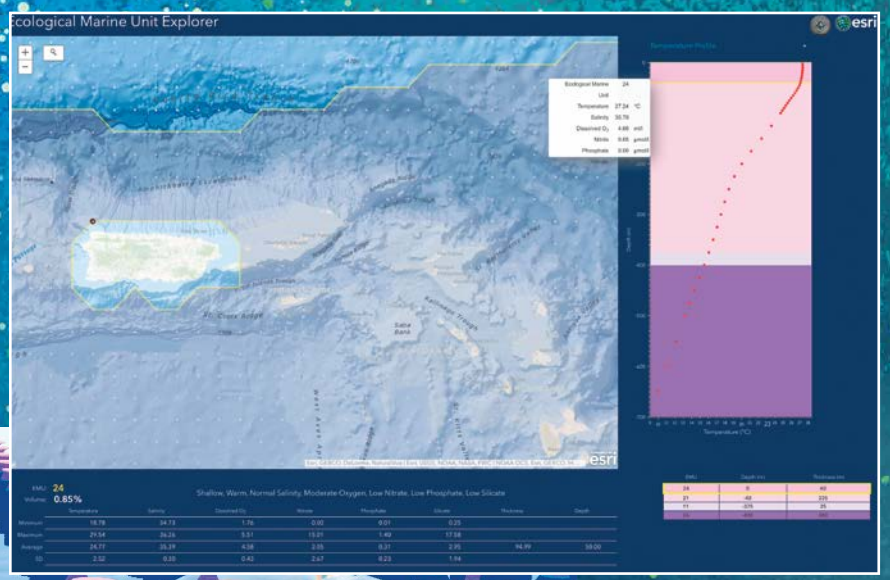
Did you know that more than half of the oxygen we breathe comes from the ocean? This oxygen is produced in large part by the photosynthesis of billions and trillions of small plants in the ocean called phytoplankton, as well as the blending of seawater with the atmosphere right at the ocean's surface.

But the ocean is facing unprecedented pressures that are causing massive disruptions in the ecosystem and nutrient cycle of phytoplankton and countless other species—the result of an extensive, commercially driven depletion of ocean wildlife; industrial-scale pollution; and other human activities. This oceanic turmoil occurs on the seafloor via trawling, dredging, drilling, and mining. It also happens in the water column with nets, long lines, fish-aggregating devices, and other techniques.

Fishing methods like these were introduced over the last few decades to extract marine life with unprecedented speed and scale from ecosystems that were hundreds of millions of years in the making. As a result, they are contributing to the accelerated reduction of oxygen levels in the ocean, as well as in the air and on land all around it.

Indeed, overfishing of the ocean biomass has tremendous effects on the earth's climate and carbon cycle. Restoring marine life, then, could have a huge impact not just on ocean health but on life on land as well. That is why the decline of oxygen in the ocean concerns absolutely everyone, no matter where we live.

Editor's note: This article is based on a letter published in the March issue of *Science* called "Ocean deoxygenation: Time for action," by Sylvia A. Earle, Dawn J. Wright, Samantha Joye, Dan Laffoley, John Baxter, Carl Safina, and Patricia J. Elkus.



↑ The EMU Explorer apps let users study oxygen and other parameters throughout the ocean.

↑ The Ecological Marine Units (EMUs) provide 3D visualizations of dissolved oxygen near Cape Verde in the Atlantic Ocean.

Raising Awareness

There is comprehensive evidence that oxygen levels in open ocean and coastal waters have declined precipitously over the last half-century. According to a recent review article in *Science* entitled "Declining oxygen in the global ocean and coastal waters," by Breitburg et al., oxygen in the ocean is currently dropping faster than can be accounted for by physics. This suggests that respiration—the intake of oxygen followed by the release of carbon dioxide—must be increasing. However, a good portion of this decline in oxygen may, in fact, be due to the disruption or destruction of tiny microbes in the ocean.

Scientists definitely need new insight into how changes in oxygen within the ocean are affecting the pathways and processes of these microbes at all depths. The extent to which the system is out of balance is becoming clear, and the pace of this change—as well as how widespread the impacts are—is alarming. We humans cannot afford to wait to take action.

Fortunately, ocean science has many integrated frameworks that combine observations, experiments, modeling, and GIS mapping from scientists, local governments, intergovernmental bodies, and business sectors. These are raising people's awareness of the pervasiveness of issues such as ocean warming and acidification, as well as the ever-increasing presence of microplastics in the water.

Now, scientists need to raise awareness about how quickly the oxygen is dissipating. But such awareness must spread beyond the pages of scientific journals so it permeates all facets of society. Web maps and visualizations that are intuitive, interactive, and dynamic have the power to do this, driving the point home to a variety of audiences.

The Ecological Marine Units (EMUs) digital ocean project, for example, gives anyone access to millions of observations of the oxygen dissolved in water all over the ocean. Accessible at esri.com/ecological-marine-units, the EMUs also show each body of water's temperature; salinity; and nitrate, silicate, and phosphate concentrations—the likely drivers of many marine ecosystem changes. Some major goals of this project are to support marine biodiversity conservation assessments; aid in research about the economic valuation of marine ecosystem goods and services; and contribute to studies on ocean deoxygenation, acidification, and other environmental impacts.

Another great resource for raising awareness is the Marine Conservation Institute's interactive Atlas of Marine Protection, also known as the MPAtlas, available at mpatlas.org/map/mpas. Momentum is accelerating to designate very large marine protected areas (MPAs) throughout the ocean, and research suggests that sizable MPAs are much more cost-effective to implement and manage compared to smaller ones. Furthermore, larger MPAs generally provide better protection from activities that occur outside of them, since, even though they safeguard a great number of organisms, so many marine animals—especially fish—are constantly on the move across large sections of the ocean. If those organisms can find shelter and stability within large MPAs, they stand a better chance of enduring once they leave them.

These online resources will be key to generating the societal and political will to effectively manage marine habitats in ways that will ultimately reverse the declining levels of oxygen in the ocean and mitigate the serious consequences this has for ocean life and ecosystems. Additionally, the International Union for Conservation of Nature (IUCN), in collaboration with world experts, is coordinating the production of a comprehensive report called *Ocean Deoxygenation—Everyone's Problem: Causes, Impacts, Consequences and Solutions* that will further summarize the challenges and implications we face. The IUCN plans to distribute this report far and wide—to government agencies, conservation organizations, citizen groups, and universities.

We must connect important discoveries about the nature of the world with public perception and current policies that shape the habitability of the earth. The global trend by countries all over the world to secure large areas of the ocean within national exclusive economic zones (EEZs) and create "blue parks" as safe havens for ocean life are also reasons to be optimistic, since protecting nature protects human existence.

What to Do Now

So what can you do to stem the tide of ocean deoxygenation? How can you connect the dots and take action to reverse some of the present destructive trends? Consider some of the following options:

- This summer, visit a blue park in person to gain a fuller appreciation of the life-giving resources the ocean provides—including oxygen!
- Join forces with the Sylvia Earle Alliance's Mission Blue movement (mission-blue.org) and other similar causes that showcase many of these blue parks. With Mission Blue, anyone can nominate a section of the ocean to become a blue park, also known as a Hope Spot, for protection and preservation. Soon, GIS content, such as the EMUs, will be included in this process.
- Use the EMU Explorer apps, accessible at esriurl.com/emuapps, to study oxygen levels and other parameters throughout the ocean.
- Use the MPAtlas to see other current areas of protection.
- Watch episodes of the BBC's *Blue Planet II* (bbcearth.com/blueplanet2) series, which wonderfully educates viewers about the nature of the ocean, including scientific evidence of the many ways our ocean is declining due to human activity.
- Take simple steps to recycle or greatly reduce plastic use—especially straws; this affects the ocean *no matter where you live* because it all starts upstream with wind and water flows. Plastic pollution of waterways is intimately connected to declining oxygen levels in the ocean. Organizations such as Algalita Marine Research & Education (algalita.org), the Save the Albatross Coalition (albatrosscoalition.org), the Aquarium of the Pacific (AOP.maps.arcgis.com), and the Marine Conservation Institute (marine-conservation.org) all provide excellent tips and resources.

There's plenty to do to assist with marine conservation and help reverse the deoxygenation of our ocean. But we need to act now—because if there's no blue, there's no green, which means there will eventually be no humans. No kidding!

About the Authors

Dawn J. Wright is the chief scientist at Esri and a full professor of geography and oceanography at Oregon State University. Sylvia A. Earle is a National Geographic Explorer-in-Residence and the founder of the Sylvia Earle Alliance, an organization dedicated to safeguarding the ocean, and Deep Ocean Exploration and Research, which builds remotely operated vehicles used in ocean exploration.

Taking the Next Technological Steps in Eradicating Land Mines

> the farmer pushed the slow earth into teats • primed
> with water • worried with seed. still the rice
> wandered into shrapnel • stalks ripen into flame.
>
> Dennis Schmitz, "Vietnamese"

By the time the Vietnam War ended in 1975, 7.5 million tons of ordnance—including cluster bombs, grenades, and land mines—had been dropped on Vietnam, Laos, and Cambodia. The Vietnamese government has estimated that 10–30 percent of it failed to detonate. Over the last 40-plus years, about 105,000 Vietnamese have died from or been injured by these explosive remnants of war (ERW).

Throughout the world, there are more than 60 countries contaminated with ERW. According to some estimates, more than two billion square meters of land are currently lost to the threat of ERW. These munitions can sit for decades underground, primed and ready to explode when disturbed by agriculture, construction, or curiosity.

To help curb the widespread incidence and broad impact of ERW, the nonprofit Geneva International Centre for Humanitarian Demining (GICHD) was established in Switzerland in 1998. The organization works in close partnership with national authorities and international and regional organizations all over the world to reduce the magnitude of ERW and their effects.

"Our ultimate goal is to save lives, return decontaminated land to productive use, and promote development," said Olivier Cottray, head of information management at the GICHD. "We do this through various initiatives that focus on mine removal, strategic planning, and information management."

As part of its efforts, the GICHD provides the Information Management System for Mine Action (IMSMA), an information management tool that gives the mine action community enhanced decision support, spatial analysis, coordination, and reporting capabilities to increase the efficiency of demining activities. Recently, the GICHD developed the newest iteration of the system as a web-based GIS environment. Called IMSMA Core, this system is rooted in ArcGIS Pro and ArcGIS Enterprise.

While getting the web-based functionality was important, it was going to be difficult for the GICHD to keep IMSMA operating smoothly during the transition. So the organization contracted Esri's Professional Services to help develop the newest generation of its system.

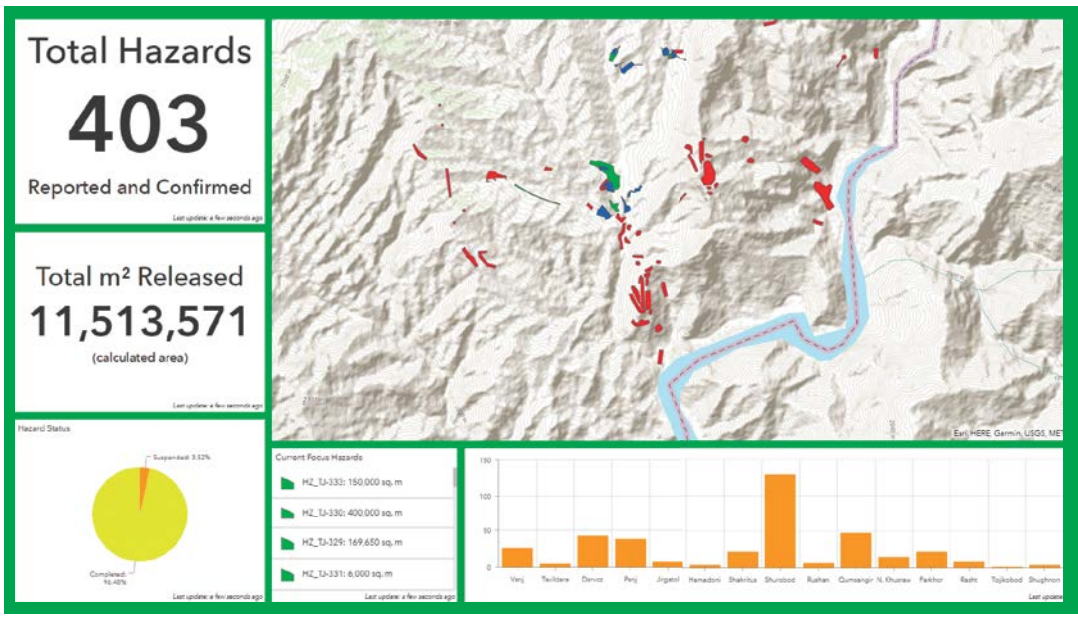
Managing Mine Action with GIS

IMSMA is key to much of the GICHD's work and has become the de facto standard for information management systems in the mine action sector, according to Cottray. The GICHD provides the system to governments and nonprofit organizations all over the world that are involved with the removal of ERW.

"We do not maintain the data for the various national entities and other agencies that use the system, as often that is a matter of national security for them," said Cottray. "But we do provide training and support for their use of the system."

The GICHD has used Esri technology for all the system's iterations from the very beginning.

"The first generation of IMSMA was implemented using ArcView with a MySQL database," recalled Cottray. "The next generation, IMSMA NG—which is still in use in over 40 countries today—uses a Java-customized client/server app on top of PostgreSQL, and runs ArcGIS Engine."



← Operations Dashboard for ArcGIS, available via IMSMA Core, shows open and closed hazardous areas across Tajikistan, including total released land area and hazardous area count by administrative district. (Data courtesy of the Tajikistan Mine Action Centre.)

← IMSMA Core puts all the ArcGIS capabilities to the service of mine action so organizations can visualize hazardous areas and previously completed hazard reduction activities, using satellite imagery and elevation for context. (Data courtesy of the Tajikistan Mine Action Centre.)

Now, for this latest iteration, IMSMA Core can put all the ArcGIS capabilities to the service of mine action, including route analysis, terrain modeling, predictive modeling, buffer zones for suspected ERW, automated reporting, and drones for imagery collection.

"We are also creating a complement of web apps that allow various users easy access to the specific information they need for their work," said Cottray. "The updated system will open up all sorts of new possibilities in terms of what we can do with mine action data."

> "Our ultimate goal is to save lives, return decontaminated land to productive use, and promote development."
>
> **Olivier Cottray**, Head of Information Management at the GICHD

A New Modular System to Meet Changing Needs

The GICHD contracted Esri's Professional Services team in 2016 to implement IMSMA Core.

"It has been a complex task to support existing IMSMA workflows while bringing in the new functionality offered by a web-based GIS environment, made easier by providing access for pilot programs and testing using cloud-based hosting during the development process," said Sam Libby, the technical lead from Esri on the project. "We developed the system architecture through close collaboration with the GICHD and have built IMSMA Core based on ArcGIS Enterprise and ArcGIS Pro, with heavy usage of Survey123 for ArcGIS for structured data collection. We also helped convert existing information management workflows for use with ArcGIS Pro and provided web-based applications for data review, editing, and approval."

Professional Services collaborated with Esri Switzerland for local support. And in 2017, the team successfully piloted the system with several partners in different countries.

IMSMA Core is modular and allows the GICHD's partners to easily access those components specifically related to their work. What's more, many United Nations (UN) agencies and departments, as well as nongovernmental organizations (NGOs), use the ArcGIS platform for different aspects of humanitarian work, including human rights monitoring, refugee support, food distribution, education, finance, agriculture, peacekeeping, and disarmament. IMSMA Core is therefore completely compatible with these systems and allows those in the mine action community, as well as in the wider human security realm, to more easily share vital operational information with one another.

Simplifying the Training Process

Because the GICHD works with so many countries at varied stages of ERW removal, it was important to have a simple training process. Thus, the GICHD standardized the roles required to manage the information associated with mine action and specified the levels of IMSMA expertise needed to perform those roles. It then created the Mine Action Information Management Qualification Scheme.

With that, "we can now keep track of who is qualified and at what level, whether they are administrators, specialists, developers, or end users," said Cottray. "It helps us determine, country by country, what the level of skill is and helps us target those countries that require further capacity development."

From there, the GICHD relies heavily on ArcGIS training materials to build people's skills and keep them up to speed.

"With IMSMA Core and because of the many training modules that Esri has developed for ArcGIS, we can now spend less time and energy on creating material," said Cottray. "We can simply tailor training tracks using existing Esri materials to meet the needs of particular user groups in their local language. This *[allows]* us to focus more on understanding their information requirements and on translating those requirements into processes and tools for implementation in their IMSMA."

The Workflow's Digital Transformation

National governments are responsible for mine action, but it is implemented by a variety of agencies, including commercial companies, NGOs, the military, UN agencies, and community-based organizations. It is generally a combination of these entities that works to eradicate ERW.

"The standard workflow starts with a nontechnical survey with local populations to understand from their witness accounts what the extent of the ERW hazard might be in that area," explained Cottray. "This is followed by technical surveys to identify more precisely the areas actually contaminated. These surveys generate an enormous amount of field data. Currently, these are captured through paper-based forms, but with the implementation of IMSMA Core, the field surveyors are now able to make use of Survey123 and Collector for ArcGIS. The submitted data goes through a number of validation processes to ensure the best possible quality before it is committed to the national database. It can then be used to provide the overall picture of the contamination problem in that country and analyzed to determine land clearance priorities. Clearance tasks are then assigned to operators who go out and perform the actual demining. As they start clearing an area, the revised contamination status of the land flows back up to the national database so that decision-makers can keep track of the progress being made. This entire process is supported in IMSMA Core by the use of mobile and web applications that each performs specific tasks along the way."

To facilitate the process, the GICHD has also developed a multicriteria prioritization tool called PriSMA that allows mine action stakeholders in any community to express their priorities. Minefields can be fast-tracked for demining if they are located near areas and facilities that local residents are required to visit, such as hospitals, schools, and agricultural land.

"The impact of clearing each of these hazardous areas will vary according to the overall needs of the community," said Cottray. "PriSMA provides a very interactive way for stakeholders to set their criteria for demining priorities, and then it determines an impact score for clearing each specified area."

The Next Technological Steps

Employing remote sensing to a greater extent is the next big technological step in mine action, according to Cottray.

"We are carefully watching the research being done with multispectral analysis to see whether or not we can find spectral signatures that are characteristic of contaminated areas," said Cottray. "A few studies, for example, use the Normalized Difference Vegetation Index, which looks at the health of vegetation. The theory is that when the nitrates in explosives leak out, it can actually boost vegetation growth. So these sorts of anomalies in vegetation in postconflict areas might provide clues to the presence of unexploded ordnance there. The problem is that there's too much noise and ambiguity in the spectral analysis at the moment, which produces false positive readings."

Mounting ground-penetrating radar on vehicles to detect the location of hard objects underground may have some potential as well.

"This is also promising, but we are again seeing too many false positives at the moment," explained Cottray. "The mine action sector is fairly conservative in adopting new tools because of the risks involved in getting it wrong."

One Month, Thousands of Assets, and Two People

How a Small Arizona Electric Cooperative Completed a Large Data Collection Project Quickly and Efficiently

Gathering data in remote, rugged areas can be very challenging. In typical situations, this requires a large team to put in lots of time and effort. But in 2017, Sulphur Springs Valley Electric Cooperative (SSVEC), based in southeastern Arizona, managed to collect data on more than 7,000 locations in 32 days—with only two staff members. The secret to this success? Collector for ArcGIS.

↓ Electricity poles are made up of a combination of assets, from transformers and crossarms to insulators and secondary voltage support structures.

How to Gather Lots of Data, Fast

SSVEC is a rural electric cooperative with 190 employees, more than 4,000 miles of power lines, and a service region roughly the size of Connecticut. Much of the terrain in SSVEC's service area is mountainous with high-desert valleys.

In early 2017, the operations office at SSVEC issued an urgent request: it needed an inventory of all the asset records from a particular substation and its associated feeders. An audit had indicated missing or inaccurate data on poles, underground equipment, vaults, and service meters. The operations office needed field staff to correct the errors in the data and fill in any gaps.

In the past, SSVEC's data collection methods were manual, slow, and GIS-intensive.

"We collected high-accuracy data in the field and downloaded it when back in the office," said Kurt Towler, SSVEC GIS supervisor and the lead on this data collection project. "It then required GPS postprocessing, converting the data into shapefiles, and importing it into ArcGIS. That was time-consuming and very GIS heavy."

For this project, Towler knew that field staff would have to collect a lot of data. For example, one pole is not one asset. Poles are made up of a combination of assets: transformers, crossarms, insulators, and secondary voltage support structures. Towler calculated that there were 87 different combinations of assets that could make up a single pole—and that doesn't even take into consideration the data that had to be collected on other pieces of equipment.

Speed and accuracy were going to be high priorities for this project. The work needed to target more than 7,600 locations and had to be completed against a tight, six-month timeline. What's more, the operations office was hoping that what it learned while fixing these data collection mistakes could be applied across the organization.

Towler realized that leveraging mobile technology would be the fastest and most accurate way to hit the deadline. Since the project was going to involve SSVEC staff working separately in the field, he also knew that data collection had to be simple and streamlined, negating the need for careful coordination. Usability, scalability, and user independence were going to be key.

SSVEC already stored its existing data in ArcGIS, so Towler naturally looked first for an Esri-powered solution. With its intuitive interface and easy-to-use workflows, Collector fit the bill. Towler's team decided to store pole data as point features in ArcGIS Online and any other associated asset data as related records.

"GIS staff needed to acquire GPS, or GNSS, technology; design the field data collection process; and publish to a mobile app within six weeks," said Towler. "Having in place all that is required for project success—and hiding complexity from those in the field actually doing the data collection—was critical. We needed to make data collection fast and efficient."

Increasing Productivity While Improving Accuracy

To configure Collector quickly and get it out to line workers on iPad Minis on short notice, GIS employees first created reference and editable map layers in ArcGIS Online. Since much of the work would need to be done in places that lacked wireless connectivity, they also prepared tile packages for basemaps and side loaded them into Collector through iTunes so the basemaps could be used in the app's offline mode.

Towler was concerned about precision, since decimeter accuracy was critical to the project. By coincidence, the previous release of Collector had introduced support for GNSS receivers via Bluetooth. So Towler decided to pair the iPad Minis with the Arrow Gold GNSS receiver from Esri partner Eos Positioning Systems. The receiver connects to Arizona's Real-Time Kinematic (RTK) satellite navigation network, which enabled field staff to use the Eos Tools Pro app to monitor position accuracy in real time.

GIS staff decided to keep all the project data in ArcGIS Online, where it is easier to access, via the cloud, without adding to SSVEC's on-premises infrastructure. Towler and his team spent time up front creating the maps, uploading data to ArcGIS Online, configuring the app, and training the line workers before they headed out to collect data. While in the field, the line workers could see which locations needed to be checked; at the same time, staff back at the office could easily monitor their progress.

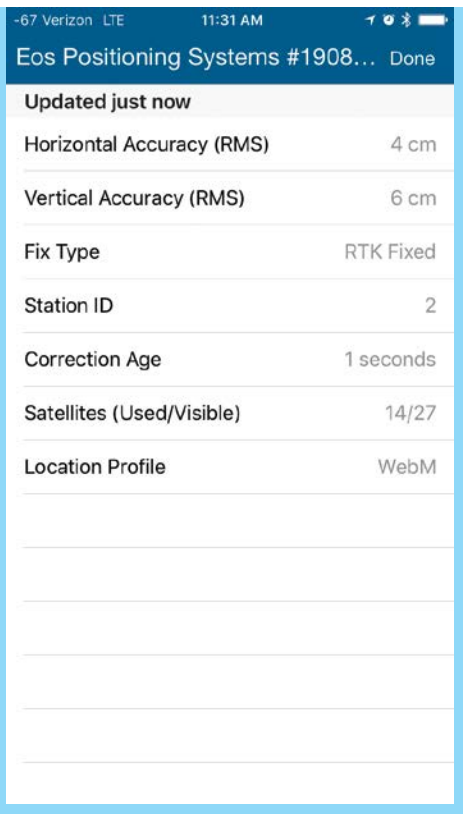
"We can send high-accuracy positions and inventory data from Collector directly to the cloud geodatabase," said Towler. "That means the line workers can now do their jobs without software or hardware getting in the way."

The results were impressive. Just two linemen inspected 7,640 locations in 32 days. On the most productive days, the linemen collected over 600 data points. Overall, they entered more than 25,000 related asset records. And the accuracy of most locations was four centimeters or less.

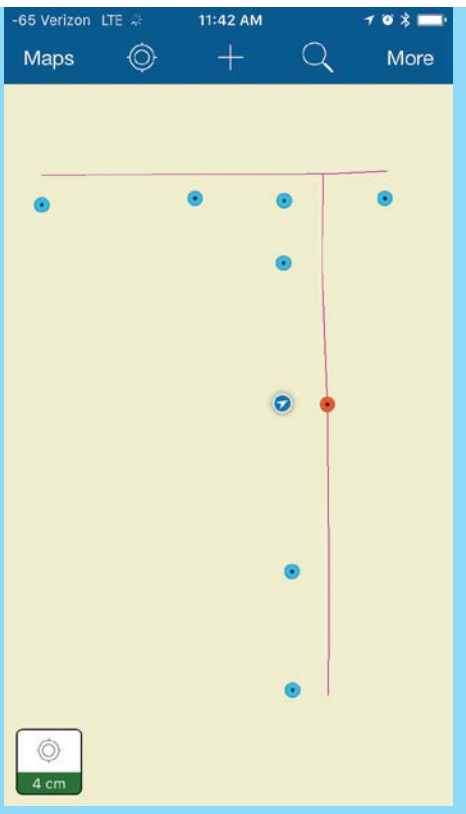
"Productivity was proved, as was scalability and reliability," reflected Towler. "This project showed me that high-quality location and asset data is easier and much less expensive to collect than in the past."

SSVEC is now looking to apply the same approach and methodology to similar projects in other parts of the organization.

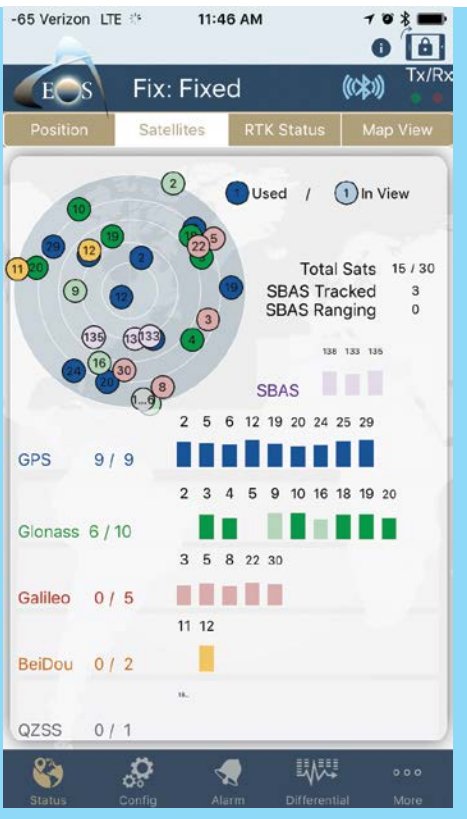
For more information on how SSVEC implemented Collector with ArcGIS Online, email Towler at ktowler@ssvec.com or listen to his podcast, *Speaking of GIS* (speakingofgis.com), in which he discusses similar topics.



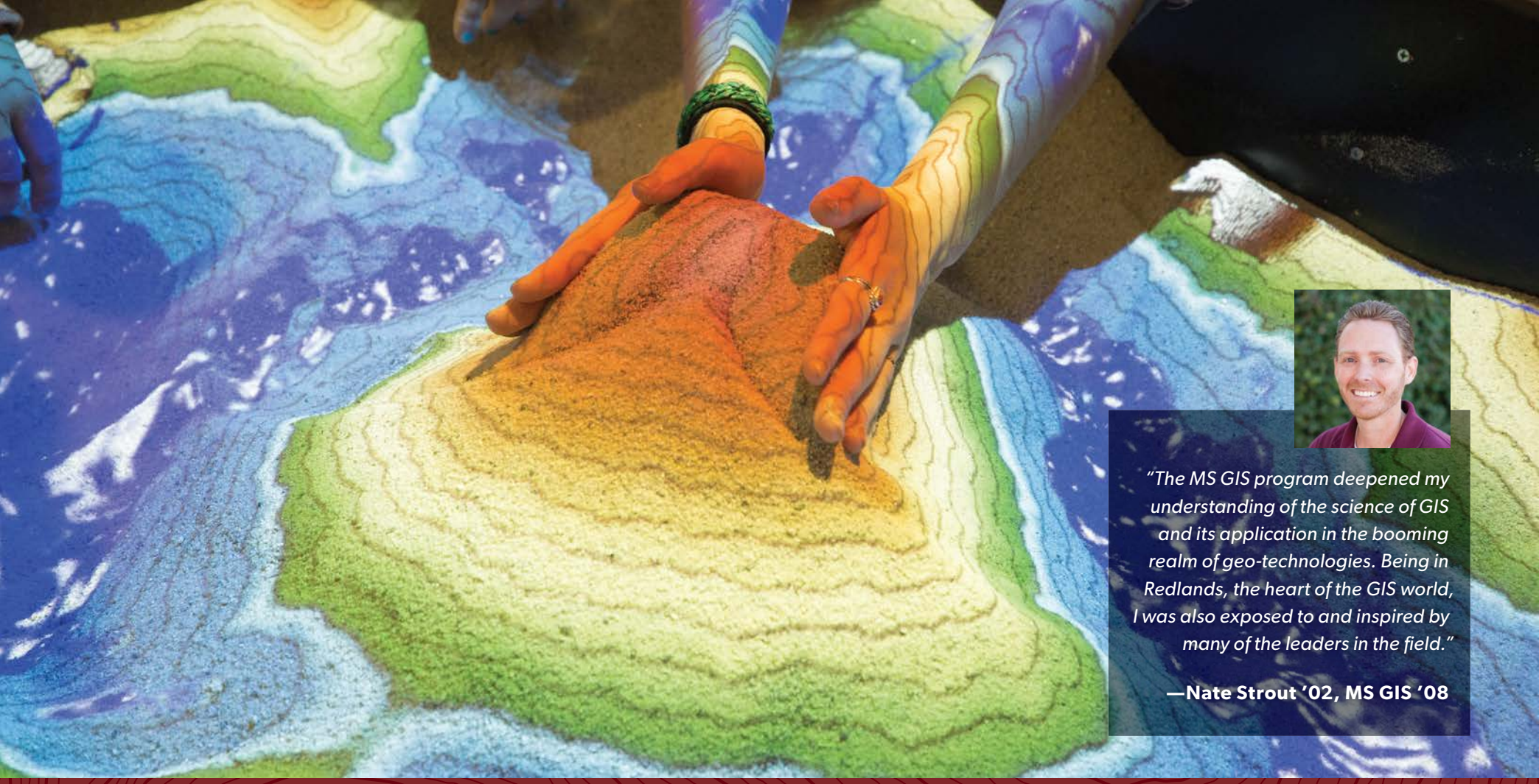
↑ Field staff at Sulphur Springs Valley Electric Cooperative (SSVEC) collected a lot of data fast using Collector for ArcGIS.



↑ The two linemen conducting the inspection entered over 25,000 related asset records into Collector.



↑ The GIS team also used the Arrow Gold GNSS receiver from Eos Positioning Systems to monitor position accuracy in real time.



"The MS GIS program deepened my understanding of the science of GIS and its application in the booming realm of geo-technologies. Being in Redlands, the heart of the GIS world, I was also exposed to and inspired by many of the leaders in the field."

—Nate Strout '02, MS GIS '08

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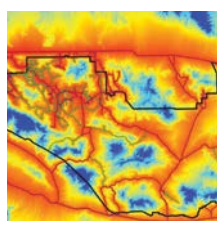

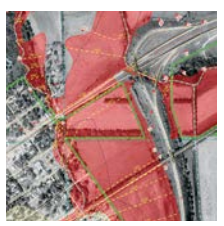

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Field Apps Help Utility Streamline Work

With Collector for ArcGIS, Survey123 for ArcGIS, and Navigator for ArcGIS, Missouri's Central Electric Power Cooperative Is Now More Efficient

Over the 70 years that Central Electric Power Cooperative (CEPC) has provided electric transmission services across central Missouri, it has amassed volumes of paper maps and asset data forms to document its electrical system. Today, CEPC's service area consists of 22,000 square miles with 1,555 miles of line. Eight separate power distribution cooperatives collectively own CEPC.

For the system to run smoothly, all its poles, rights-of-way, and equipment must be maintained, serviced, and annually inspected. But due to outdated and sometimes inaccurate system maps, the office staff and linemen in the field were often working with different information. While some of CEPC's asset data was recorded electronically, all its maps were on paper.

To service assets, linemen had to rely on paper records or access information from an office computer before heading into the field. Since paper records did not always get returned to the office, office records were not always accurate. The paper maps tended to become outdated quickly. And as workers retired, it was difficult to capture their electrical system knowledge and retain it for use by new staff.

To streamline processes and make information more accessible, timely, and accurate, CEPC chose to implement ArcGIS field mobility apps. The CEPC team tested Collector for ArcGIS, Survey123 for ArcGIS, and Navigator for ArcGIS—and quickly realized that ArcGIS apps could serve as a unified system, allowing everyone to work from the same data, whether they were in the field or in the office. CEPC decision-makers were also attracted to ArcGIS apps because of how well they work together in connected and disconnected environments, since the utility's electrical system covers mostly rural areas where Internet connectivity is not widely available. In addition, they liked how the apps function on multiple popular operating platforms.

The utility's goal was to achieve accurate and thorough asset data collection for service, maintenance, and inspections. CEPC also wanted to be able to navigate to and from the many assets that span its entire service area. Together, ArcGIS field apps are supporting much greater efficiency—providing precise asset record keeping while helping linemen easily get to and from their assignments.

An Accurate Basemap

To build a complete solution, the CEPC team first needed to make an accurate basemap of its entire service area. This proved challenging, however, because of the massive size of the high-resolution satellite imagery data that had to be fed into a map tile package from ArcGIS Online.

Using ArcGIS Pro, CEPC ultimately built a map tile package that could be side loaded onto a mobile device for use offline, anywhere across the utility's service area. Working with Esri partner Ptarmigan Software, Stacey Dudenhoeffer, an IT specialist II at CEPC, used Collector to record the existing paper and electronic data for all assets and make it available as a feature layer to display on the map. Then, using Survey123, Dudenhoeffer built a smart form to record asset inspections. Finally, with Navigator, field employees would be able to navigate from asset to asset across CEPC's road network.

With the promise that these apps would work together seamlessly, CEPC was ready to begin testing.

"Our goal was to have apps in place for the linemen for the annual winter inspections project," said Dudenhoeffer.

Training and Implementation

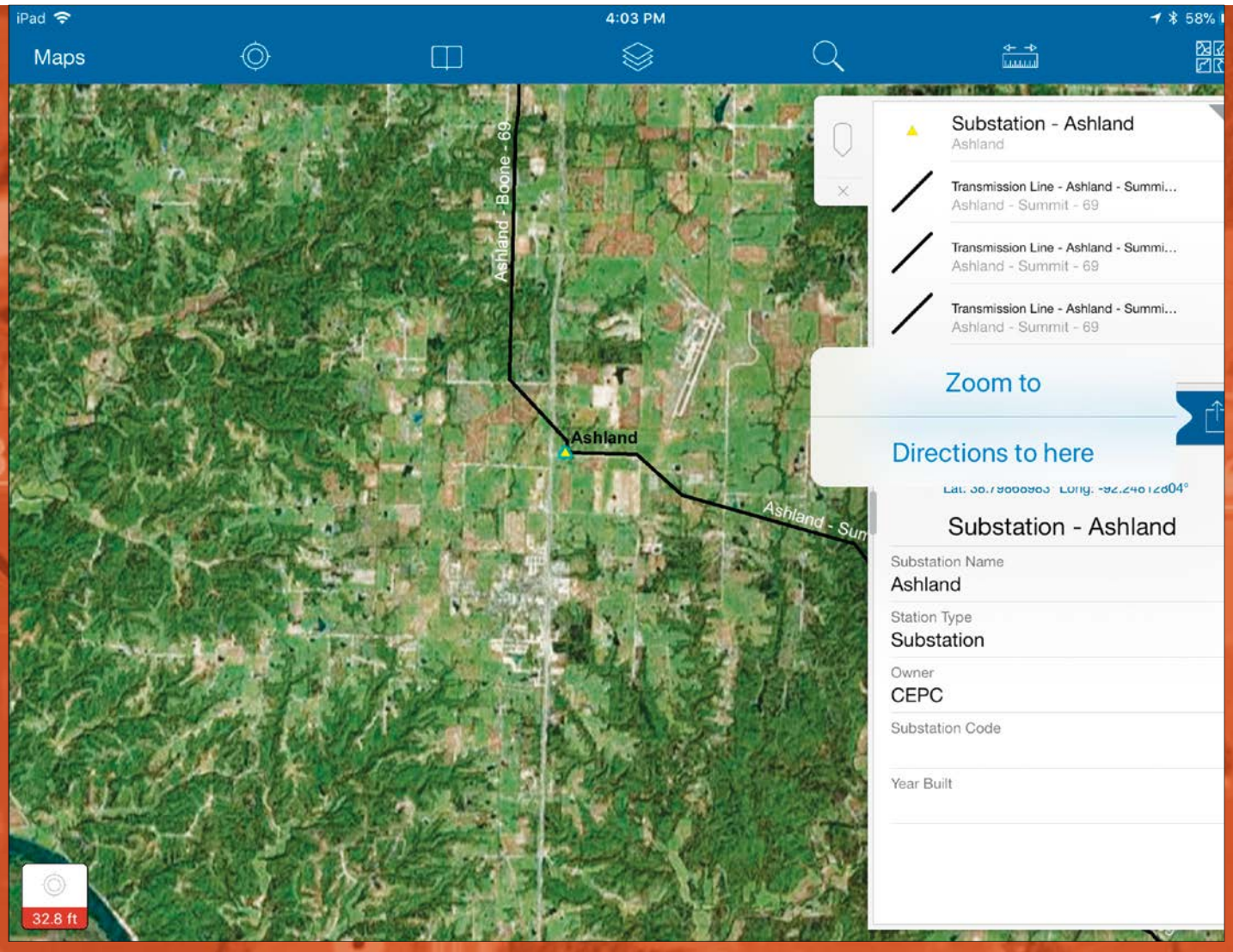
Following a three-month testing period, CEPC was convinced that moving forward with the ArcGIS apps was the right solution. Many employees in the information technology department were familiar with Apple products, and CEPC was pleased with how they performed in the field, so it chose to use iPads for field data collection.

Prior to this, many of the linemen had very little computer experience—some limited to completing time sheets only. A number of linemen had cell phones, but for others, this was their first introduction to a smart device.

Given the varying degrees of comfort staff had with mobile technology, CEPC created a detailed, paper-based manual that documented how to use the apps with step-by-step notes and pictures. The IT and line design departments also conducted a training session for the entire field workforce, demonstrating various scenarios while linemen followed along on their iPads.

The linemen reported positive feedback, saying how using the ArcGIS field apps on their CEPC-issued iPads helped them get their jobs done. Because the mobile devices had side-loaded satellite imagery basemaps for the entire service area, field crews could retrieve the information on-demand—whether they had Internet access or not—and see the details for any asset of interest, including its service records.

↑ Field crews found that using Collector for ArcGIS and Survey123 for ArcGIS on company-issued iPads helps them streamline their workflows.



↑ Having the location of each asset on the Collector map makes it easy for linemen and right-of-way coordinators to obtain driving directions to assets across the network.

→ Collector contains all the existing paper-based and electronic data for CEPC's assets.

For the first time, staff had all the information for each asset at their fingertips. In addition, they could easily jump between Collector and Navigator to navigate to any asset in the system. Linemen in the field now had everything they needed to complete their daily work assignments without calling back to the office or referring to paper maps.

The Apps in Action

Using both Collector and Survey123 has made CEPC's data more complete, consistent, and conformant with regulatory requirements.

For last year's annual winter inspection of poles and lines in the transmission system, crews used Survey123 to create fully documented inspections of each structure. A glance at the interactive map clearly reveals red dots that indicate hot spots where problems exist, making it easy to see where to focus repairs.

"By streamlining the inspection process, more people can do queries to see where attention is most critically needed and the full scope of what's needed in an area," said Andy Adrian, a right-of-way coordinator at CEPC. "This helps to focus on and prioritize the serious problems."

Additionally, CEPC reports that using Navigator has dramatically improved how its field crews get around its expansive electric system. Having the location of each asset on the Collector map makes it easy for linemen and right-of-way coordinators to obtain driving directions to assets across the network from their current locations. This is especially beneficial to those who visit some areas of the system relatively infrequently. And having different "car" or "truck" modes within Navigator allows employees and contractors who drive various vehicles to jobsites to receive specialized driving directions for their vehicle types.

"Navigator for ArcGIS has been a great tool for the newer employees," added Adrian. "They are able to efficiently get to our assets without having years of experience navigating through our service area. The Navigator app guides them efficiently and safely to where they need to go."

Departmental Collaboration

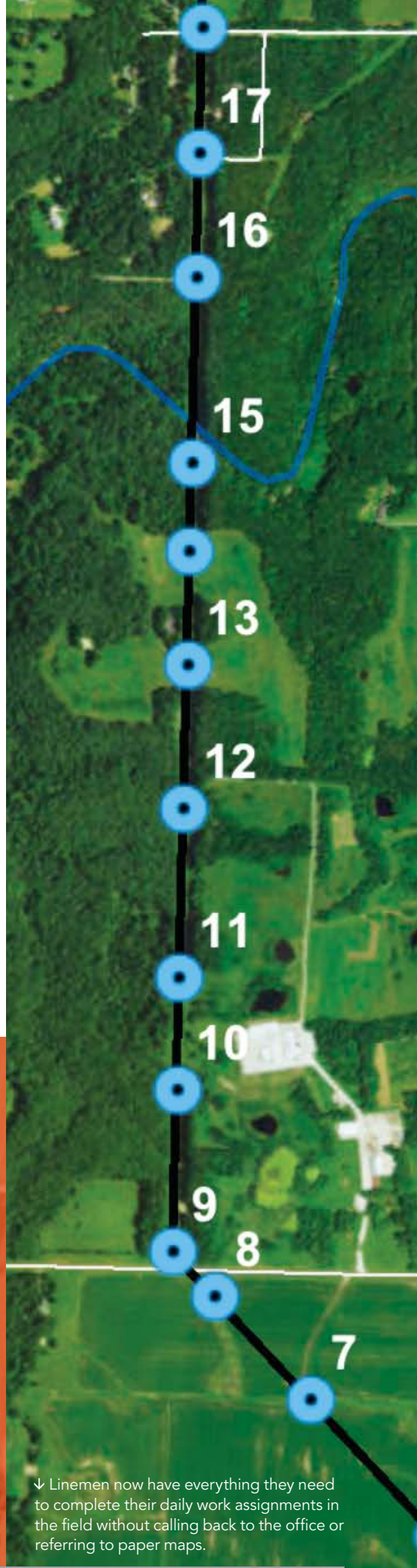
For CEPC, using ArcGIS field apps has opened up communication among departments and generated a lot of new ideas.

Having the ability to see every asset and its related information empowers crew members to plan what they need to bring into the field each day to get their jobs done. This helps them avoid unnecessary trips back to the office to retrieve additional equipment. The apps have also made it easier to train new hires, since all the information about the system is available digitally, negating the need to have them memorize aspects of the electrical system from the get-go. Linemen also report that communication with landowners for right-of-way issues is greatly enhanced by having an accurate map to lead the discussion and show proposed changes.

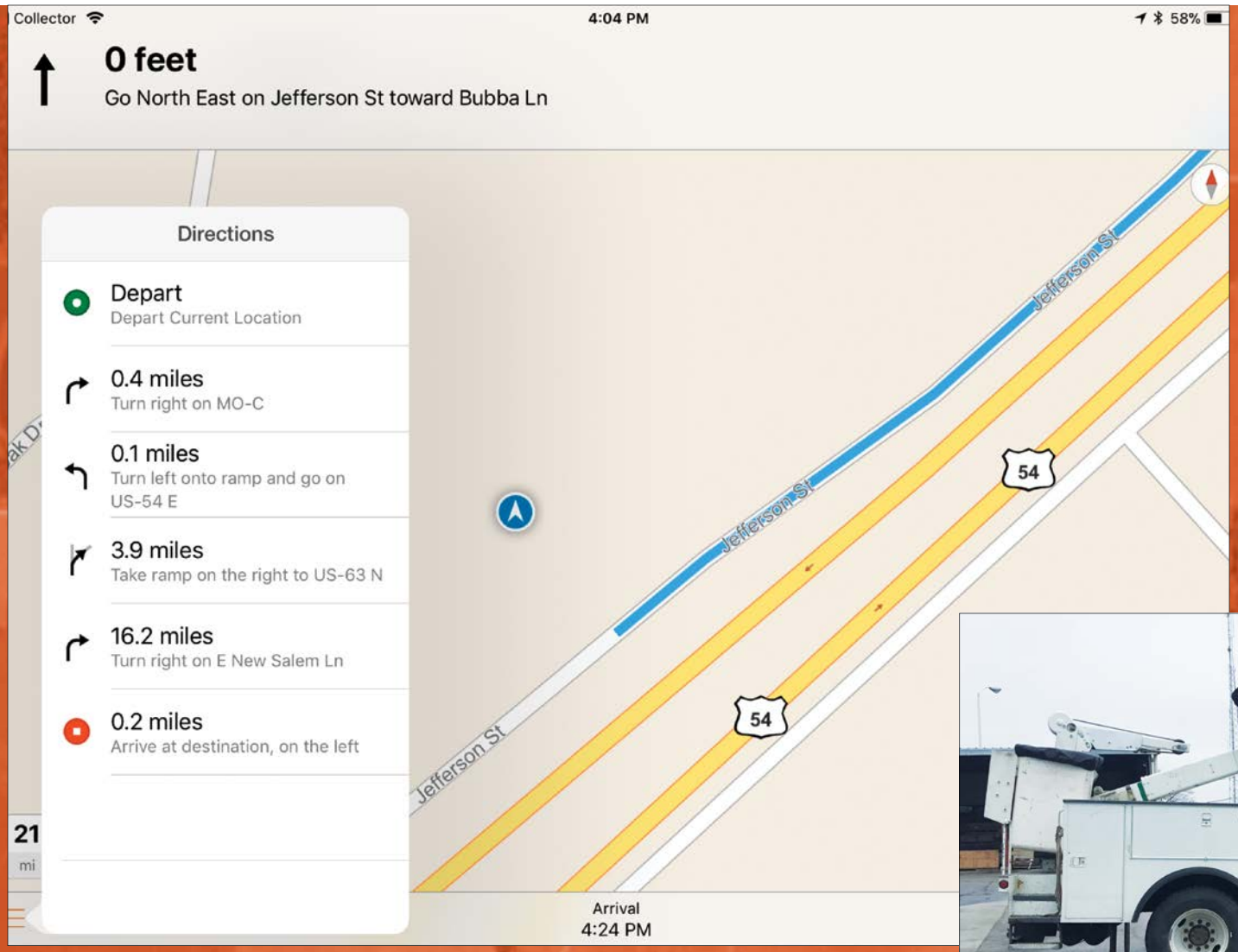
From the office or the field, CEPC staff members now have a common view of the utility's network. And that has made all the difference for streamlining operations and increasing the efficiency of field activities.

"The initial reluctance of the crew to move to a digital solution was quickly overcome, as they found the apps were easy to use and made work more efficient," said Adrian. "Now, crews rely on their iPads as a single source of truth for an accurate picture of the electric system while they're in the field."

For more information on how CEPC is continuing to employ ArcGIS apps for the field, contact Dudenhoeffer or engineering technician Lori Bartlett at 573-634-2454.



↓ Linemen now have everything they need to complete their daily work assignments in the field without calling back to the office or referring to paper maps.



↑ With Navigator for ArcGIS, field employees at Central Electric Power Cooperative (CEPC) can easily navigate from asset to asset.

URISA's PAC Has Your Back

By Glenn O'Grady, Urban and Regional Information Systems Association's Policy Advisory Committee

Many GIS professionals may not be aware of this, but for more than 10 years, the Urban and Regional Information Systems Association's (URISA) Policy Advisory Committee (PAC) has been looking out for their best interests.

While the URISA board of directors is responsible for formulating the association's official positions on government and professional issues, it depends on the PAC—which is composed of seasoned geospatial professionals—for research and advice regarding those positions. The committee's original charter, which holds true today, is to examine geospatial matters that pertain directly to URISA's mission and recommend formal policy positions without engaging in partisan political lobbying.

Matters that impact the GIS profession come from multiple sources: state and federal legislation, standards, legal and regulatory proceedings, new technology and procedures, and more. Some critical issues have the potential to affect how GIS professionals do their jobs, such as when states propose legislation that would require people to obtain special licenses to perform general GIS tasks.

URISA members, its board, URISA chapters, PAC members, and even nonmember GIS professionals can request that the PAC put an issue under consideration. Once the PAC is aware of something, it deliberates to determine whether the issue requires URISA to take a formal position on it.

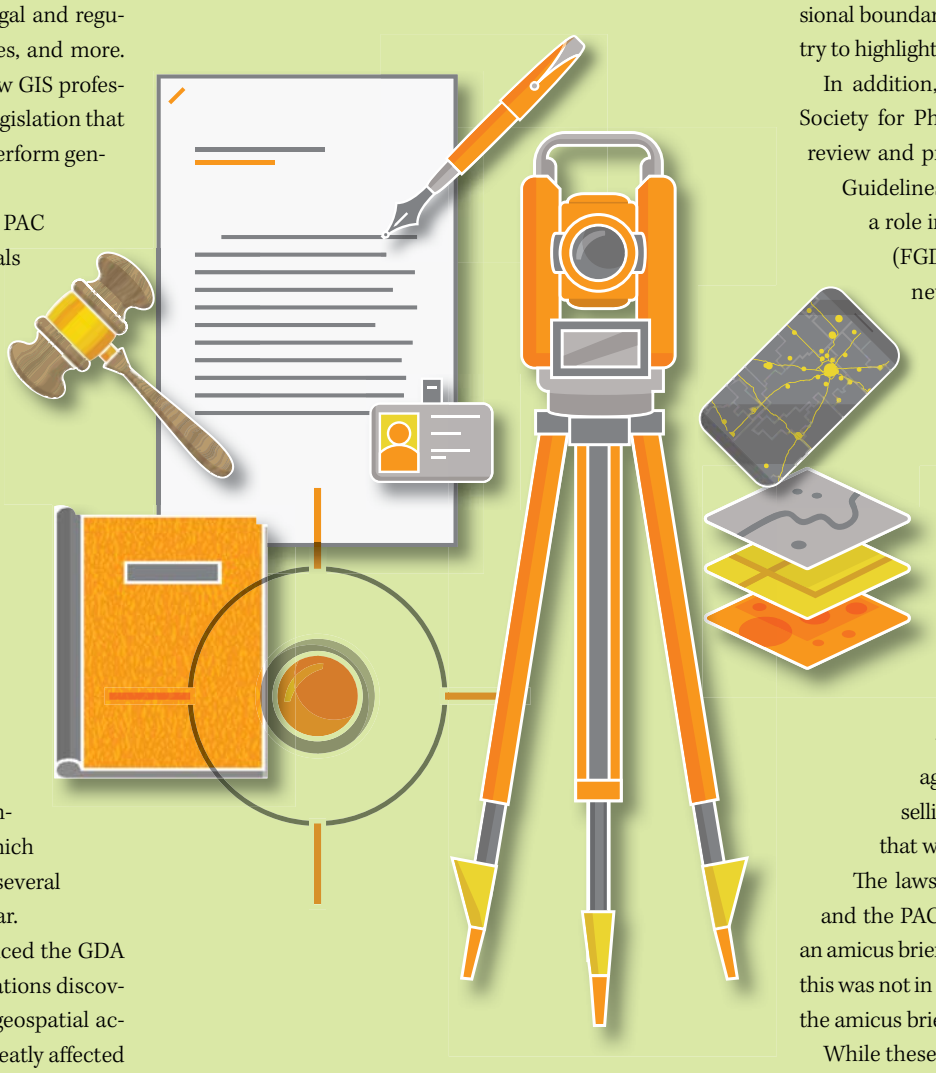
When the PAC recommends that URISA take a position, the committee drafts a position statement and submits it to the URISA board for acceptance and action. Sometimes, however, the PAC will simply provide guidance to affected members.

Recently, the PAC has played a pivotal role—along with the American Association of Geographers (AAG)—in honing the language of the bipartisan federal Geospatial Data Act (GDA) that is currently pending in Congress. When the GDA was first introduced in 2015, the PAC recommended that URISA support the act as written, which the board did. But the legislation was opposed by several geospatial organizations, so it failed to pass that year.

When Senator Orrin Hatch from Utah reintroduced the GDA in early 2017, the PAC and other geospatial organizations discovered that it contained new language that defined geospatial activity specifically as surveying, which would have greatly affected GIS professionals' ability to participate in federal geospatial activities without having a surveyor's license. In that second round, the PAC recommended that URISA's board join other geospatial associations in opposing this new version of the GDA. This opposition was instrumental in getting Hatch to introduce a revised GDA bill on November 15, 2017—Senate bill S.2128—with the objectionable language removed. Representative Bruce Westerman of Arkansas put forth a companion bill, House bill H.R.4395, in the House of Representatives.

The PAC continues to follow the GDA as it works its way through Congress while keeping tabs on other federal geospatial legislation as well, such as the Digital Coast Act and the National Landslide Preparedness Act.

The PAC has also been involved in a number of legislative issues at the state level. Primarily, it has responded to proposed legislation that restricts GIS professionals from mapping physical and administrative features in the course of performing their normal duties. The proposed state legislation often includes language that puts most mapping functions under the guise of licensed surveyors, even if the work is not meant to be authoritative as defined in the National Council of Examiners for Engineering and Surveying's (NCEES) Model Laws for surveying. Although technology has improved the accuracy and ease of capturing real-world coordinates, that doesn't mean that GIS



is land surveying or vice versa. Surveying involves much more than simply capturing coordinates.

Upon being informed of proposed legislation like this, the PAC works with local URISA members to try to revise the wording so it doesn't affect GIS professionals and their jobs. Recently, the PAC has responded to these kinds of legislative issues in the states of Georgia, Virginia, Pennsylvania, and North Carolina.

While the PAC has been successful in working with local URISA organizations to amend or kill this type of proposed legislation, in the case of North Carolina it became involved too late in the process, and legislation was passed that requires a licensed surveyor to either do or supervise most GIS work. Although many GIS practitioners were grandfathered in as surveyors when the law passed, at least one GIS company in North Carolina has gone out of business because of it.

As a result of the slip in North Carolina, the PAC is currently investigating whether URISA should subscribe to a legislative service that will notify the organization of any pertinent state or federal legislation in a timely manner rather than rely on word of mouth, as it has been doing. The PAC is also developing guidelines and resources to assist local URISA members in addressing future legislative issues themselves. The intent is to provide and maintain one location where URISA members can identify and track these issues. The guidelines will also provide perspective on the professional boundaries among GIS, land surveying, and photogrammetry to highlight the areas in which GIS can confidently operate.

In addition, the PAC has been working with the American Society for Photogrammetry and Remote Sensing (ASPRS) to review and provide comments on its Geospatial Procurement Guidelines. And, while not directly involved, the PAC played a role in getting the Federal Geographic Data Committee (FGDC) to adopt an address standard and establish a new Address Theme.

The PAC has also been monitoring Ligado Networks' application to the Federal Communications Commission (FCC) to repurpose for broadband the spectrum adjacent to the one used by GPS/GNSS, which could interfere with the latter's accuracy, especially in urban areas. Although a similar application was rejected several years ago, this resubmitted application has only proposed minimal technical adjustments that will not successfully remove all the potential harmful effects to the GPS/GNSS spectrum.

All that said, the URISA board does not agree to every PAC recommendation. A number of years ago, there was a California lawsuit to prohibit the selling of public data—specifically one parcel database that would have set the precedent for the rest of the state. The lawsuit had reached the Supreme Court of California, and the PAC recommended that URISA become a cosigner to an amicus brief supporting the lawsuit. But the board resolved that this was not in the best interest of its members and declined to join the amicus brief. In the end, the lawsuit was successful.

While these are only some of the issues that the PAC has been involved in, they demonstrate that URISA has a strong commitment to its members and the GIS community as a whole. Working together not only with other GIS professionals but also with professionals from other fields, such as land surveying and photogrammetry, the PAC aims to improve all geospatial disciplines and aspires to foster mutual understanding and respect.

For more than 50 years, URISA has been instrumental in developing and guiding GIS. The PAC is just one of the many benefits of having the URISA community. Expanding that community by adding your voice to it will only make it stronger. Learn more about becoming a URISA member at urisa.org.

About the Author

Glenn O'Grady was the founding chair of URISA's PAC and is currently serving as chairman again, in addition to being on the URISA board. He has been a member of URISA since 1979 and is a former URISA president. O'Grady retired from local government in 2006 after spending the majority of his 30-year career in some GIS capacity. He has been a planning commissioner for the City of Encinitas, California, for the past eight years and is currently its chair.

Crossing Borders

A column by Doug Richardson
Executive Director, American Association of Geographers

Federal Geographic Data as a Strategic Resource

Quietly but surely, Ivan DeLoatch, executive director of the Federal Geographic Data Committee (FGDC), and his team have been transforming thousands of disparate federal geographic databases into a dynamic, coherent, and strategic resource for better governance, economic development, and public access. The once-staid FGDC has taken the lead in recent years in powering new platforms and methods for accessing, integrating, and using the United States' plethora of valuable geographic data assets.

One of the FGDC's many core endeavors is to help people better understand and address important issues using compatible geospatial data—for example, when agencies deployed public safety datasets from the Homeland Infrastructure Foundation-Level Data (HIFLD) Open Data site (p.ctx.ly/r/7q8x) in support of hurricane response efforts in 2017. In addition, FGDC, through its member agencies, has worked with Esri to make key layers available in ArcGIS Online via ArcGIS Living Atlas of the World. Through this collaboration, Esri has turned these layers into high-performance, ready-to-use services that can be mashed up and shared openly.

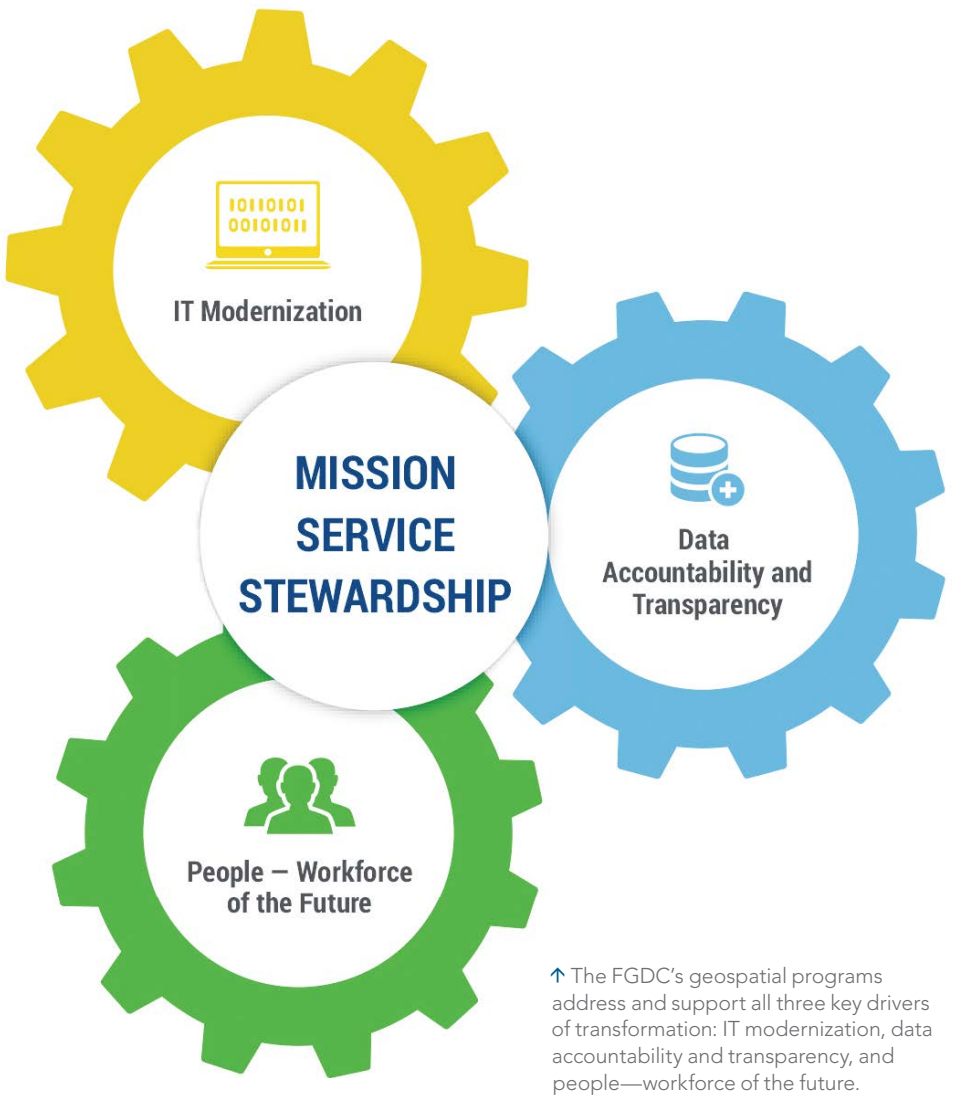
Thanks to its small but highly talented and dedicated staff, the FGDC also manages a number of large programs. These include the massive National Spatial Data Infrastructure, metadata and standards programs, the GeoPathways Initiative for workforce development, and extensive international planning and coordination programs for geospatial and remote-sensing data. For more information on the FGDC's leadership and indispensable contributions to our many GIS communities, visit fgdc.gov.

The new President's Management Agenda (PMA), released by the Office of Management and Budget in March, singled out the FGDC's management accomplishments as a model for enterprise governance. The PMA's enterprise governance agenda identifies three key drivers of transformation: modernizing IT systems, promoting data accountability and transparency, and realigning the federal workforce for the twenty-first century. The FGDC's multiple geospatial programs address and support all three of these efforts.

The PMA report (available at p.ctx.ly/r/7fig) also sets out priorities for generating and managing government data as a strategic resource by, for example, establishing data policies; specifying roles and responsibilities for data privacy, security, and confidentiality protection; and monitoring compliance with standards throughout the information life cycle. It specifically states that the federal government's new enterprise governance strategy will build on "the Federal Geography Data Committee's notable successes implementing portfolio management processes for federal geospatial data assets and investments *[that]* helped agencies to more efficiently support their mission and priorities."

Coordinating and working together across all federal governmental agencies on geospatial issues—as well as with state, local, and tribal governments and the private sector—are not easy tasks. Fortunately, the newly appointed chair of the FGDC, Dr. Tim Petty, has the right combination of political experience, scientific expertise, and determination to do just that. Petty holds a PhD in the geosciences and has served as senior staff on key Senate committees for many years. He is now assistant secretary for water and science at the US Department of the Interior, in addition to being chair of the FGDC.

DeLoatch, Petty, and the FGDC staff have worked hard—and creatively—on behalf of our robust and growing GIS and geospatial communities. By continuing to collaborate across the full range of the geospatial ecosystem, I am confident that we will continue to create a more central role for geographic data and knowledge in our governments, businesses, and throughout society.



↑ The FGDC's geospatial programs address and support all three key drivers of transformation: IT modernization, data accountability and transparency, and people—workforce of the future.

Contact Doug Richardson at **drichardson@aag.org**.

Performing Data Checks Keeps Water Running

Colorado Water and Sanitation District Implemented Data Reviewer—and Will Save a Year of Time

The two-person GIS team at South Adams County Water and Sanitation District (SACWSD), based in Commerce City, Colorado, handles huge datasets for drinking water, irrigation, and sewage systems. Serving nearly 50,000 customers over about 65 square miles, SACWSD is the largest combined water and sanitation district in Colorado. It gets its water from wells, a reservoir, and the Denver Water utility. For a separate irrigation system, SACWSD draws water from nonpotable well supplies. In an effort to conserve drinking water, it is also building one of the largest nonpotable irrigation systems in the United States.

To keep all the water running, SACWSD has to have good, accurate data. But in fall 2016, as the district was using GPS to collect data on its infrastructure systems, GIS supervisor Cliff Sullivan and GIS technician Mark Dickman noticed that the data quality was varying widely. They were tasked with cleaning it up, and it initially appeared as though this assignment was going to be a long and tedious one.

Sullivan and Dickman started by manually reviewing each piece of data for spatial accuracy and attribute correctness. But this type of quality control (QC) was limited, since it was exploratory rather than comprehensive.

After the bulk of the data had been collected, Sullivan was browsing the agenda for the Esri Water Conference and noticed that Esri offered data health checks. He then learned about ArcGIS Data Reviewer, an extension he could use with ArcGIS Desktop and ArcGIS Enterprise to make his and Dickman's QC job go much faster.

Learning Data Reviewer

In addition to getting the ArcGIS extension, SACWSD purchased on-site consulting services from Esri's Professional Services. Over two days, Sullivan and Dickman worked with Michelle Johnson, a senior GIS Quality Assurance (QA) lead and ArcGIS Data Reviewer advocate, to implement Data Reviewer and gain authoritative knowledge of the extension.

Data Reviewer allows users to perform hundreds of checks on their data, which is what Sullivan and Dickman liked about the extension—though it also meant that they didn't really know where to start. At first, they used Data Reviewer to get an overall snapshot of the collected data. Then, with Johnson's help, they learned which data checks to prioritize and decided where to begin the editing process.

"Michelle was patient and very thorough in showing *[us]* how to use the product," said Sullivan. "We covered a lot in the two days that she was on-site. Our experience with Esri Professional Services was stellar."

Working directly with Johnson on configuring the required checks for their datasets allowed Sullivan and Dickman to make rapid progress. While some checks are self-explanatory, other more advanced ones require experience to understand the logic behind them and to get them to run correctly. For SACWSD, intergovernmental standards and best practices are now captured in templates and made available for use by anyone at the district who uses compatible software.

"I highly recommend this approach for small shops *[that]* are not able to dedicate 100 percent of their time to doing QC," said Dickman.

Doing the Data Checks

With Johnson's guidance, Sullivan and Dickman decided to focus first on finding disconnected features. This ensured that all the features in a water system were correctly connected so that SACWSD's water modeling software could run successfully and provide accurate results.

Next, Sullivan and Dickman used the Unique ID Check to make sure each asset ID was populated and didn't have duplicate values. This would help employees and contractors create work orders and service requests correctly within SACWSD's asset management software.

Johnson was also instrumental in building the GIS team's databases and giving Sullivan and Dickman advice on data modeling. For example, it is currently best for them to use domains instead of subtypes. She also helped them build a data schema that is now self-explanatory to users at SACWSD.

"By the time she left, we had our dataset on the path where we wanted to go," said Sullivan.

And that was evident. Within three months, Sullivan and Dickman had completely cleaned up one of the three datasets they were tasked with fixing. They are now completing the spatial edits needed on the remaining two larger datasets. Using Data Reviewer also helped the GIS team standardize a new QC process, which now consists of prioritizing and finding errors and tracking corrections.

Ahead of Schedule

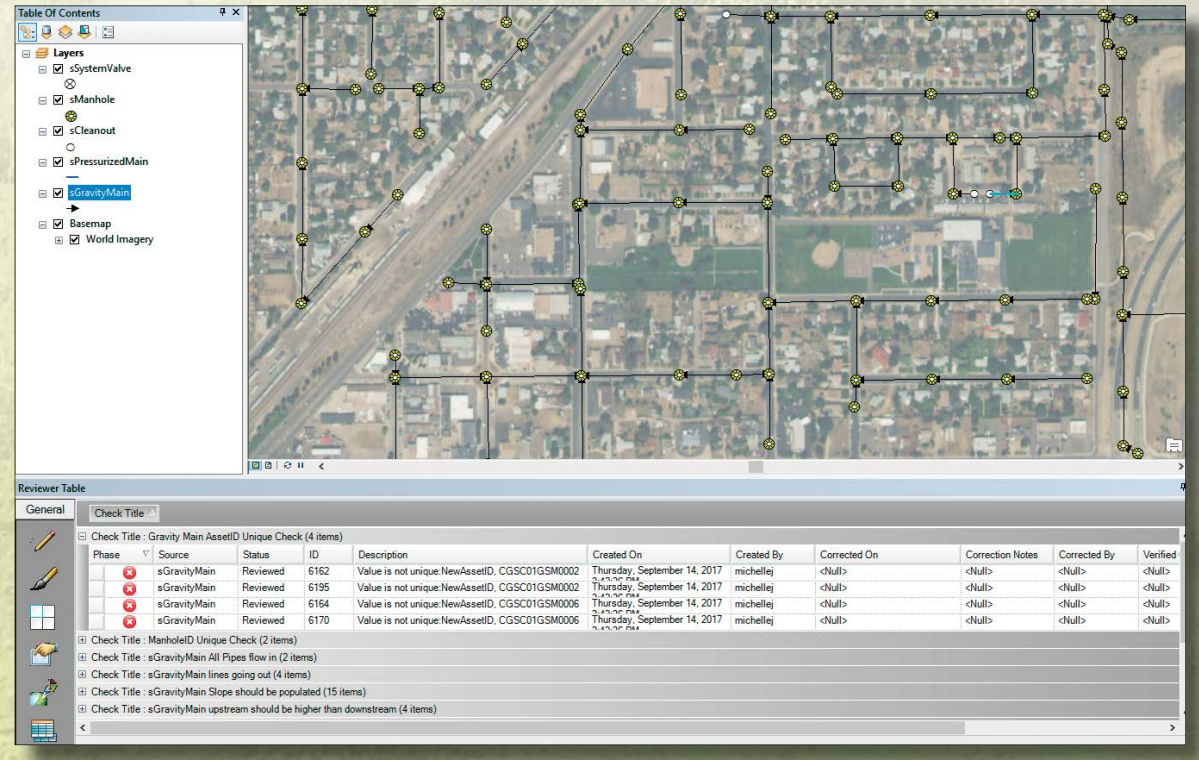
Before they acquired Data Reviewer and contracted Johnson's help, Sullivan and Dickman were looking at a years-long process of manually checking features as they built their database. Both of them, plus an intern, were doing the work.

Now, Dickman is the primary staffer working on the effort, and he is already six months ahead of schedule. By the time all three datasets are complete, the GIS team expects to have saved more than a year of time.

"Enabling customers to use their GIS effectively and efficiently is what Esri does," Johnson reflected. "It was my pleasure to work with a great set of folks like Cliff and Mark, and I am happy to be part of their success."

As SACWSD continues moving forward with new infrastructure development, the GIS team plans to keep using Data Reviewer to perform QC on all new geospatial data, as well as to maintain existing data.

"Investing in Data Reviewer will reward the investor by *[saving]* time and effort," said Sullivan. "It just gives users quality assurance that they won't have otherwise. It's well worth it."



↑ Using ArcGIS Data Reviewer, the two-person GIS team performs hundreds of checks on the district's data.

→ The GIS team noticed that data quality varied widely when the South Adams County Water and Sanitation District (SACWSD) was collecting data on its infrastructure systems using GPS.

Startup Takes On Stormwater Management—and Salinas Gains Efficiency

"I have spoken of the rich years when the rainfall was plentiful. But there were dry years too, and they put a terror on the valley."

John Steinbeck, *East of Eden*

That is the Salinas Valley's relationship with water, described by Salinas native John Steinbeck in his 1952 novel *East of Eden*. While California's relationship with rainfall has always been prickly, water management has changed in the valley since Steinbeck's time—arguably becoming even more critical to sustaining life in the arid American West.

Located 60 miles south of Silicon Valley, the City of Salinas, California, is surrounded by agricultural fields yet is one of the state's 50 most densely populated cities. For its water supply, Salinas relies exclusively on local groundwater. But because of decades of overpumping, that water source is now threatened by saltwater intrusion. Additionally, due to the high density of impervious groundcover in Salinas, the volume of stormwater runoff that leaves the city each year is excessive, amounting to a missed opportunity for the city to use this valuable resource to recharge its groundwater and supplement local water supplies. This urban runoff also carries pollutants and litter into local waterways—and every acre of land in Salinas drains into a stream that the Environmental Protection Agency (EPA) has designated as impaired.

To radically change how Salinas manages its stormwater, the city's public works department has teamed up with Esri startup partner 2NDNATURE to better leverage ArcGIS to collect smarter data and streamline the workflows that undergird its regulatory reporting requirements.

Applying a Watershed Context

Typically, Salinas's stormwater manager spends five months each year gathering data from 12 different city departments to comply with reporting requirements. For the 2016–2017 fiscal year, the city's report to the Regional Water Quality Control Board exceeded 2,800 pages of narratives, lists, tables, and static maps.

City staff were frustrated by the inefficiency of this process and wanted to create actionable information to guide and justify their stormwater management decisions. In January 2017, the City of Salinas started using 2NFORM (2nform.com), a suite of software from 2NDNATURE that works in step with ArcGIS Online to help public works departments conduct inspections and process data in compliance with their National Pollutant Discharge Elimination System (NPDES) permits—regulations that stem from the federal Clean Water Act of 1972 and require cities to protect local waterways.

Salinas implemented 2NFORM to make data collection and management more efficient and to effectively communicate the benefits of its stormwater compliance program within and across city agencies. The fit-for-purpose software integrates topography with city storm drain networks, linking urban landscapes to the waterways into which they drain. This hydrographic foundation empowers Salinas's stormwater managers to apply a watershed context to all their stormwater decisions and regulatory reporting.

Conducting Better Evaluations

One key feature of 2NFORM is that it enables city staff to monitor and evaluate best management practices (BMPs), which are various activities municipalities undertake to control the effects the urban landscape has on water resources. In Salinas, the city and private landowners implement various BMPs—such as street sweeping, litter reduction programs, pollution prevention initiatives, and green infrastructure development—to either control runoff and pollutants at the source or to intercept, capture, and remove pollutants from stormwater runoff.

With 2NFORM, Salinas is building a stormwater asset database. City staff catalog BMPs by location and type so that public works can see exactly where they are. While permit regulations require cities to periodically inspect public and private BMPs to demonstrate that they are working, there is typically no uniformity to these inspections, and they are not grounded in geospatial-based record-keeping systems. So cities don't always know what improvements need to be made, or where.

Now, city staff employ 2NFORM's custom-built rapid assessment methods, or RAMs, to generate objective, standardized, and repeatable evaluations of how BMPs are functioning. The 2NFORM RAMs can be conducted using both Collector for ArcGIS and Survey123 for ArcGIS to record uniform data about each BMP via standardized inspections.

To evaluate the effectiveness of litter controls, such as street sweeping, education and outreach, and adopt-a-street programs, two employees now drive inspection routes with continuous collection (or the "breadcrumb trail" feature) enabled in Collector. This allows them to trace their path while recording how much litter is on the route, which reduces the time it takes to both do inspections and input data manually. Evaluating a bioretention system—like a rain garden that traps rain runoff in a vegetated area to absorb some of the water and release cleaner runoff into the stormwater system—is now completed by public works employees using RAM field inspection forms in Survey123 that make assessments simple, repeatable, and rapid. What's more, anyone in Salinas can conduct litter surveys using the Survey123 trash inspection form that is compatible with 2NFORM. After downloading the form, they can quickly and easily document how much litter there is, where, and when they see it.

All this inspection information feeds directly into 2NFORM, which enables the public works department to conduct additional geospatial analytics and evaluate where it needs to focus maintenance efforts or make improvements.

Quantifying Reductions in Runoff and Pollution

Beyond stormwater asset management, 2NFORM models stormwater runoff and pollutant loading as well using the Tool to Estimate Load Reductions, or TELR. Employing publicly available datasets—such as the Natural Resources Conservation Service's (NRCS) soils survey, the United States Geological Survey's (USGS) impervious land-cover data, and local precipitation data—TELR provides Salinas with estimates of the average amount of stormwater runoff and pollutants that get delivered to every local waterway each year.

Once these baseline estimates are calculated, TELR employs the city's BMP inspection results to evaluate whether the private and public BMPs implemented throughout the city are reducing runoff and pollutant loading. This gives Salinas the ability to track how well its stormwater initiatives and methods are working. It also helps the city actively manage locations and solutions that are not functioning appropriately so it can better protect and improve local waterways.

TELR can be used on a wider scale, too. To demonstrate the benefits of harvesting stormwater, 2NDNATURE created an Esri Story Maps app called *CA Stormwater Opportunity* that shows the TELR-generated average annual stormwater runoff for communities all over California. The results can be seen at arcg.is/4z4yX.

Sharing Progress and Priorities

Now that Salinas's public works department can visualize the spatial patterns of stormwater runoff and pollutants via ArcGIS Online in 2NFORM, the city can easily communicate program priorities and progress among departments and even to the public. Mapped results make it simple for anyone to see where the city has achieved its runoff and pollutant control objectives, as well as where more improvements are needed.

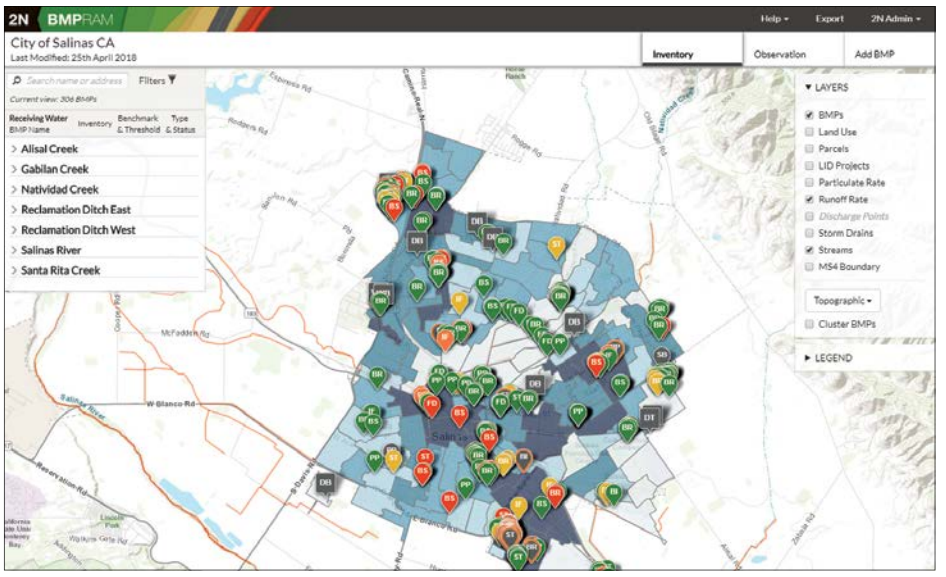
All the map-based tools available from 2NDNATURE also give Salinas a standardized way to complete its annual compliance reporting and ensure that it is actually implementing effective actions that reduce excess stormwater runoff, litter, and other pollutants from ending up in its waterways. Furthermore, public works staff are saving hundreds of hours collecting and managing the data they need to comply with regulations.

More Stormwater Information for More People

Since 2NDNATURE launched 2NFORM in early 2017, 30 California municipalities have adopted it. And state regulators now review submitted municipal records directly within 2NFORM via read-only access.

By leveraging the powerful web-based infrastructure of ArcGIS Online, science-based stormwater information is now more accessible to many more people. This empowers cities to make smart decisions about stormwater that can reduce the impact of urban development and restore hydrologic function to urban watersheds.

To learn more about 2NDNATURE, a proud new addition to the Esri Startup Program, visit 2nsoftware.com/tools.



↑ With 2NFORM, public works staff can see exactly where best management practices (BMPs) are and perform rapid assessments to evaluate how well they are functioning.

The Esri Startup Program gives emerging businesses an edge by helping them integrate spatial functionality into their products and services. Program participants receive ArcGIS platform technology, training, support, and marketing opportunities to help them succeed. Find out more about the Esri Startup Program at **developers.arcgis.com/startups**.

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Each year, Esri acknowledges outstanding partners that deliver innovative solutions and services to extend the ArcGIS platform and foster positive change at organizations around the world. At the 2018 Esri Partner Conference, held in March in Palm Springs, California, Esri recognized 13 partners in 12 award categories that reveal just how skillfully these companies are amplifying The Science of Where.

This year's award winners are tackling some of the world's toughest challenges, developing remarkable GIS solutions that help with community engagement and push GIS into new markets, all while demonstrating best practices in business.

Get to know these Esri partners and their solutions a bit better.

Bringing Insights
Value Lab | valuelab.it/en

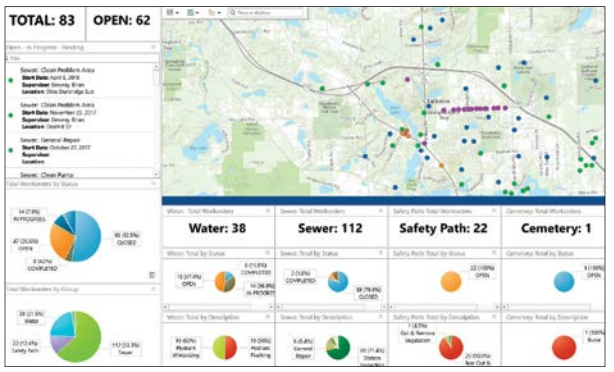
A management consulting and IT company focused on retail and commercial markets, Value Lab uses ArcGIS to help production, distribution, and services organizations gain a better understanding of how their businesses function. Value Lab's users can prioritize their sales territories by intersecting market potential indicators with brand coverage assessments to reduce risks, make smarter operational decisions, and increase revenue.

Creating Realistic Context
vrbn AG | vrbn.io

The team at vrbn, which provides consulting services to urban planning and design firms, applies its 3D visualization expertise to help users get a realistic view of historical, current, and future models of various cities. Specifically, the 3D landscapes generated by vrbn's MasterPlanner tool—an add-on to Esri CityEngine—give city planners a deeper understanding of the potential effects of their proposed developments on the surrounding environment.

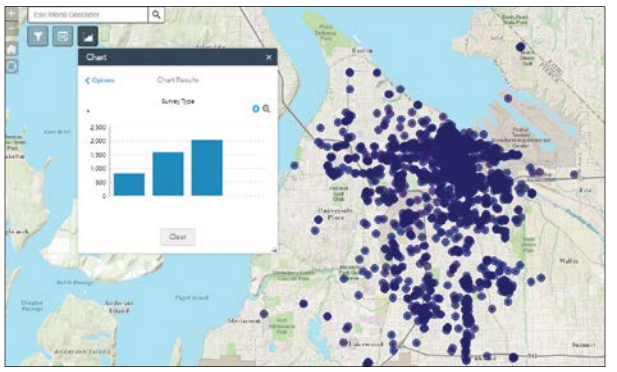
Innovating Solutions with New Capabilities
GISinc | gisinc.com

GISinc helps its users in the government and commercial spheres solve complex problems by employing groundbreaking location technology. Its GeoIoT platform combines GISinc's services and ArcGIS software with partner-developed Internet of Things (IoT) solutions to better leverage analytics, positioning, and mapping. Recently, GISinc used ArcGIS Enterprise to help Independence Township, Michigan, implement a new dashboard, visible on any device, that monitors all its location-based systems—from the ArcGIS platform and GISinc's own solutions to software from other vendors like Esri partner Cityworks. Now, the township can access more information, monitor activity, and make smarter decisions, all from a single system.



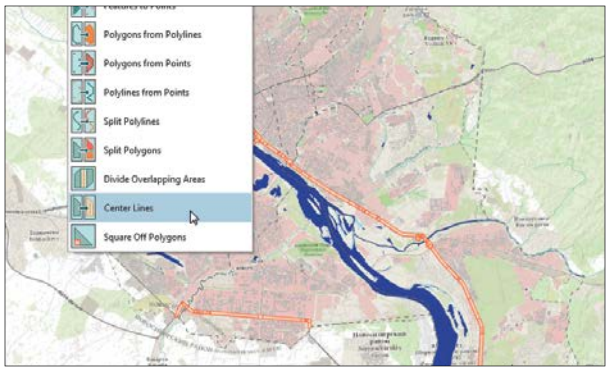
Taking GIS to the Field
Frontier Precision, Inc. | frontierprecision.com

With its exceptional team of natural resources professionals, Frontier Precision addresses a wide range business needs—from surveying and mapping to administering water resources and performing mosquito and vector control. To help users achieve their objectives, the company develops a comprehensive work plan that defines each user's needs before recommending the appropriate geospatial solutions—including ArcGIS apps for the field. For instance, Frontier Precision assisted the nonprofit Comprehensive Life Resources (CLR) in putting together a survey with Survey123 for ArcGIS to collect data on homeless activity in Tacoma, Washington. (Read more about this in *ArcNews* at p.ctx.ly/r/7bz1.)



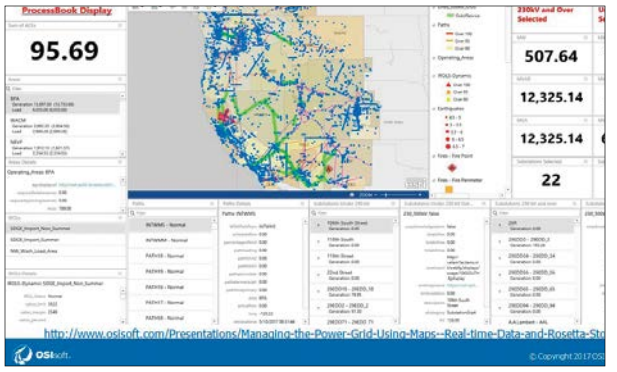
Turning Pro
Data East, LLC | dataeast.com/en

Data East's popular XTools Pro solution has more than 80 features that extend the capabilities of ArcGIS Desktop. But more and more of the company's 10,000 software customers and 20 partners around the world began requesting that XTools Pro be migrated from ArcMap to ArcGIS Pro. The company did just that, creating the new XTools AGP ArcGIS Pro add-in. More than 2,500 XTools Pro users have already started using XTools AGP. (Read the *ArcNews* article that details how Data East migrated its tool from ArcMap to ArcGIS Pro at p.ctx.ly/r/7bz2.)



Delivering in Real Time
OSIsoft, LLC | osisoft.com

OSIsoft provides operational intelligence to users who manage energy production and infrastructure—so, for them, having real-time situational awareness is vital. With PI System for ArcGIS, OSIsoft users can apply spatial analytics to their real-time data to optimize organization, reduce downtime, lower costs, and increase reliability. (Read the *ArcNews* article about how Peak Reliability uses PI System to manage electricity output throughout the Western Interconnection of the North American Grid at p.ctx.ly/r/7bsa.)



Driving Enterprise Platform Adoption

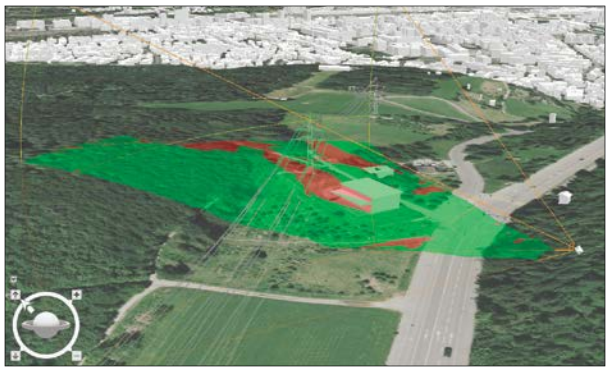
GEOMAP-IMAGIS | geomap-imagis.com

GEOMAP-IMAGIS offers comprehensive enterprise geospatial solutions and services to local governments and utilities, and it is currently ushering GIS into new markets, including real estate. To make it easier for its users to incorporate multiple solutions into their work and take advantage of the latest advances in GIS, GEOMAP-IMAGIS is working in close collaboration with Esri France to migrate its entire product suite to the ArcGIS platform.

Being Release Ready

Geocom Informatik | geocom.ch/en

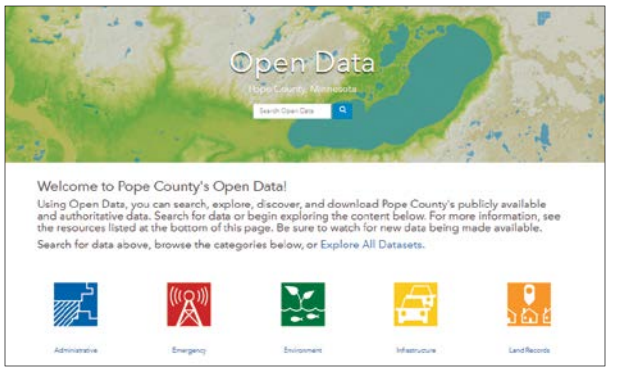
Geocom Informatik—a management consulting firm for users in the utility, transportation, logistics, energy, planning, security, and local government fields—always ensures that it is working with the most up-to-date releases of the ArcGIS platform. To deliver its robust offerings, the company continually upgrades its solutions and services, including GEONIS, which helps users incorporate GIS and spatial data into their existing organizational processes and systems.



Leading Web GIS Transformations

Pro-West & Associates, Inc. | prowestgis.com

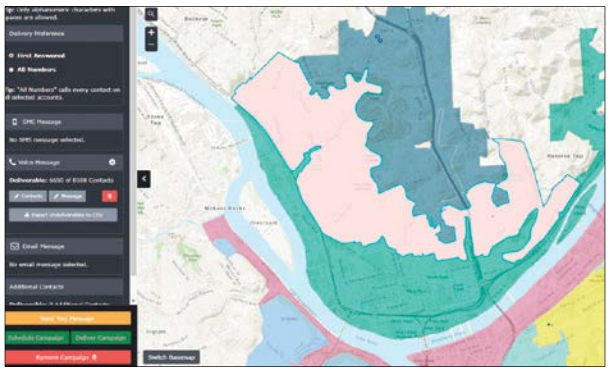
Pro-West & Associates, known for its specialized GIS consulting and data services expertise, is transforming the way governments and utility, mining, and agricultural organizations access and share information through Web GIS using ArcGIS Online. For instance, the company helped Pope County, Minnesota, build an open data hub that promotes citizen engagement and offers people access to problem-solving tools, such as datasets linked to emergency services, the environment, and land records.



Quick to Market

GeoDecisions | geodecisions.com

The spatial IT experts at GeoDecisions have made it a priority to align with Esri technology—so much so that they are able to tap into early releases and quickly configure the ArcGIS platform in ways that make their solutions valuable and affordable for their local government and commercial users. All seven apps in the GeoDecisions AppSuite run on ArcGIS as a common platform, so users can easily integrate them into their existing systems. That is what the Pittsburgh Water and Sewer Authority did when it used GeoDecisions' Notify app to pinpoint who in the city would likely be affected by a water event, such as a water main break or wastewater runoff, so it could notify them of the potential harm via text, email, or a phone call.



Partnering to Lead New Strategies

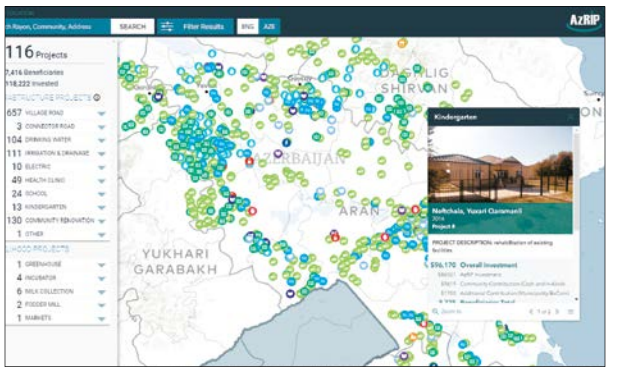
SSP Innovations | sspinnovations.com
RAMTeCH | ramtech-corp.com

Merging their expertise in the utilities sphere, SSP Innovations and RAMTeCH worked together to launch the Utility Network Advantage Program (UNAP), a comprehensive way for users in the utilities, oil and gas, and telecommunications fields to implement the ArcGIS platform and transition to the ArcGIS Utility Network Management extension. UNAP takes into consideration each user's current business framework, data, and processes and determines how to best take advantage of the new benefits provided by ArcGIS Utility Network Management.

Engaging Communities

Blue Raster, LLC | blueraster.com

Blue Raster helps build strong communities by bringing government agencies, nonprofit organizations, businesses, and citizens together in collaborative environments that revolve around interactive mapping solutions, data analysis, and implementation and development services. Using the ArcGIS platform to deliver both web and mobile solutions, Blue Raster aids nontechnical users in visualizing, understanding, and solving complex problems. For example, the company recently collaborated with the World Bank and the Azerbaijan Rural Investment Project (AzRIP) to develop maps that give citizens insight into local community projects and help stakeholders make data-driven decisions.



The Relevance of Cartography

A Cartographer's Perspective

A column by Menno-Jan Kraak
President of the International Cartographic Association

To See or Not to See

As experienced map users, we probably don't always realize that not everyone can enjoy the beauty and usefulness of maps. And there might be several reasons why.

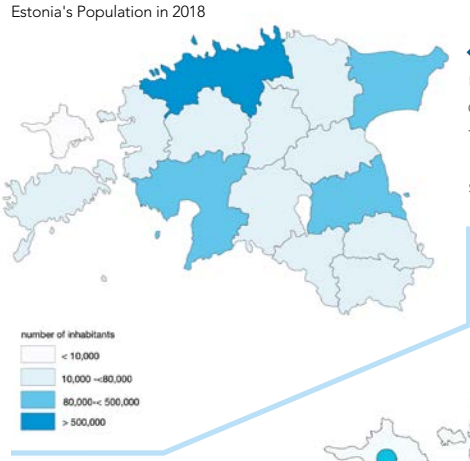
On one hand, people could be visually impaired, ranging from total blindness to color blindness. Any problems they encounter when trying to read maps stem from the human visual system. On the other hand, someone could have trouble with map literacy. This could mean that the person is missing key map-reading skills. Or it might be a reflection of the mapmaker's limitations.

The International Cartographic Association (ICA) is doing its best to address each of these difficulties in myriad ways. Here's how.

To approach the first issue, ICA has a Commission on Maps and Graphics for Blind and Partially Sighted People. Its purpose is to exchange and disseminate information on how to best design and produce mapping technologies and graphics for persons with visual impairments. The commission, chaired by Alejandra Coll Escanilla, recently published a book called *Methodological Guidance: Teaching and Learning Space Through Touch*. Written in conjunction with colleagues—several of whom are blind themselves—at the Organization of American States' Pan-American Institute of Geography and History (PAIGH) and Escanilla's Tactile Cartography Center at the Metropolitan University of Technology (UTEM) in Santiago, Chile, the book seeks to help cartographers make tactile map products that are useful to anyone with visual impairments.

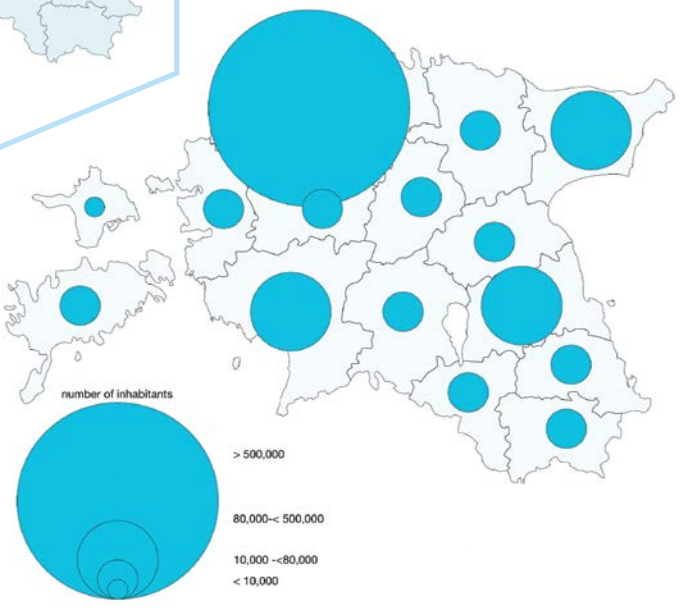
When it comes to less severe sight issues like color blindness, mapmakers can help by avoiding certain color combinations, such as red and green, when designing maps. ICA's Commission on Cognitive Issues in Geographic Information Visualization studies matters like this, researching specifically how people use maps in different contexts. The commission's objective is to produce a human-centered cartographic theory and practice based on sound empirical findings.

Estonia's Population in 2018



← Using a choropleth map to show absolute numbers is imprecise because the visual variable only lets viewers perceive order and doesn't take into consideration that a smaller unit—or Estonian county, in this case—might have significantly more inhabitants than a larger unit.

Estonia's Population in 2018



→ A proportional point symbol map, on the other hand, represents absolute numbers well because the size of the symbols immediately helps viewers understand the differences in amount all over the map.

Map literacy can be defined as the ability to understand and use maps in daily life, both for work and at home. As one can imagine, there are different levels of map literacy—or illiteracy, if you like. Map illiterates vary in their map-reading abilities, and their comprehension usually depends on what type of map they are looking at and what they are trying to accomplish by reading a map.

To help someone improve his or her map literacy, it might be useful to come up with specific map-reading exercises that focus on individual skills—like, when navigating, having the map reader orient the map to link the mental exercise of reading it with what's happening in the real world. If we are aware of the person's particular map-reading problem, it might be worthwhile to adapt a map's design to the map reader's skill level.

ICA's Commission on Use, User and Usability Issues is instrumental in coming up with solutions to these types of quandaries. One of the many ways that it approaches map literacy problems is by organizing training workshops about cartographic usability for professionals who are not necessarily mapping specialists but who frequently use and make maps, such as planners and geologists.

Map readers really get into trouble when maps are badly designed. When this is the case, map-reading skills don't help very much. And I am afraid this happens quite often, especially with thematic maps.

Mapmakers who are responsible for badly designed maps are likely unaware of basic cartographic guidelines (although some maps are produced poorly on purpose to manipulate how certain issues are perceived—using the color green to illustrate a heavily polluted area to make it appear safer, for example). Most problems arise either when the characteristics of the data, such as whether it is qualitative or quantitative, are not well understood or when the wrong symbololgy is used to represent data on a map. It can be confusing, for example, when a choropleth map is used to represent absolute numbers or when different quantities are displayed using colors.

Sometimes errors like these are rooted in badly chosen software defaults. Other times they are caused by the layout or cosmetics of a map—when an abundance of colors or symbols are mixed together, for instance, causing visual confusion.

The only positive element of coming across mapmaker errors like these is that I have a lot of exam materials for my students, who should be able to judge the quality of a map. But if mapmakers would like to avoid map design blunders, they might want to consider participating in the activities put on by ICA's Commission on Map Design.

Most of the problems that render maps useless to certain segments of the population have proven solutions. And for the ones that don't, ICA has dedicated commissions to try to address those issues in an international context.

About the Author

Menno-Jan Kraak is professor of geovisual analytics and cartography at the University of Twente in the Netherlands, where he has been teaching since 1996. He has a degree in cartography from the Faculty of Geographical Sciences at Utrecht University and received his PhD in cartography from Delft University of Technology. Kraak has written extensively on cartography and GIS. His book *Cartography: Visualization of Spatial Data*, written with Ferjan Ormeling, has been translated into five languages. He also wrote *Mapping Time: Illustrated by Minard's Map of Napoleon's Russian Campaign of 1812*, published by Esri Press in 2014. Kraak is a member of the editorial boards of several cartography journals, including the *International Journal of Cartography*. He currently serves as president of the International Cartographic Association.

Another Step Forward for Lifelong Learning

New Esri Training Site Boosts Learner Engagement

As ArcGIS technology continually advances and breaks new ground, Esri is constantly exploring ways to meet its users' diverse learning needs.

"ArcGIS software capabilities are expanding quickly in areas like real-time GIS, 3D, and spatial analytics," said Patty McGray, director of customer education for Esri Training Services. "It is important that our users have easy access to authoritative learning resources when they need them."

The new version of the Esri Training site reflects Esri's ongoing commitment to the hundreds of thousands of users who take advantage of this unique learning platform each year. It has resources that support individual learning goals as well as the training needs of entire organizations.

"With this release, we've created tools to strengthen learner engagement," said McGray. "We're also providing a new tool for managers to develop team skills, support professional development paths, and monitor learning progress."

Mapping the Curriculum

The *Training* catalog contains hundreds of professionally curated resources designed by education specialists and subject matter experts. Materials are available in a variety of e-Learning and instructor-led formats.

"With so many resources available, it can be challenging for users to determine which resources best meet their unique learning needs, how resources relate to one another, and how to sequence through them," McGray pointed out. "The new site addresses this challenge in a couple of ways."

For starters, site users have a new way to explore the catalog. An interactive map displays high-level ArcGIS topics, such as analytics or data collection and management, and users can review each of them to see associated topics. Zooming in on the map reveals a progressively more targeted set of learning resources.

"The map depicts tasks that someone would use ArcGIS to perform," said Esri curriculum specialist David Davis. "For example, the Analytics capability section shows common topics, like Find Best Routes and Sites. As users zoom in and explore the map, the list of relevant learning resources filters to a very manageable level."

Learning Plan Enhancements

Once individuals have identified learning resources that meet their needs, they can start learning right away or put materials on a wish list for future reference.

To build knowledge and skills on select topics, users can also now add resources to a custom learning plan rather than rely solely on the Esri-created learning plans that were introduced two years ago. These personalized training plans work just like the Esri-generated ones: each plan contains a set of sequenced resources that individuals complete at their own pace, and progress can be tracked on personal My Learning Plan pages.

"We think this feature will be really popular," said McGray. "Learning plans work like the Pinterest model. In the *Training* catalog, when you find a resource you're interested in, instead of pinning it to a board, you add it to a learning plan. That learning plan may be an existing one that you created previously or a new plan you create on the spot. You can even make a copy of an Esri-created learning plan and then modify it by adding or removing items."

From the *Training* catalog, any item can be added to a learning plan with a single click. There is no limit to the number of learning plans a user can create. Additionally, learning plans can be shared, either with specific people or publicly with other site users.

"This is a key enhancement," added McGray. "Managers have told us they want to assign learning plans to onboard new employees and prepare their team members for upcoming projects. Also, the higher education community has asked for the ability to assign learning plans to students taking a class that incorporates ArcGIS software. We're excited that we can now support these customer requests."

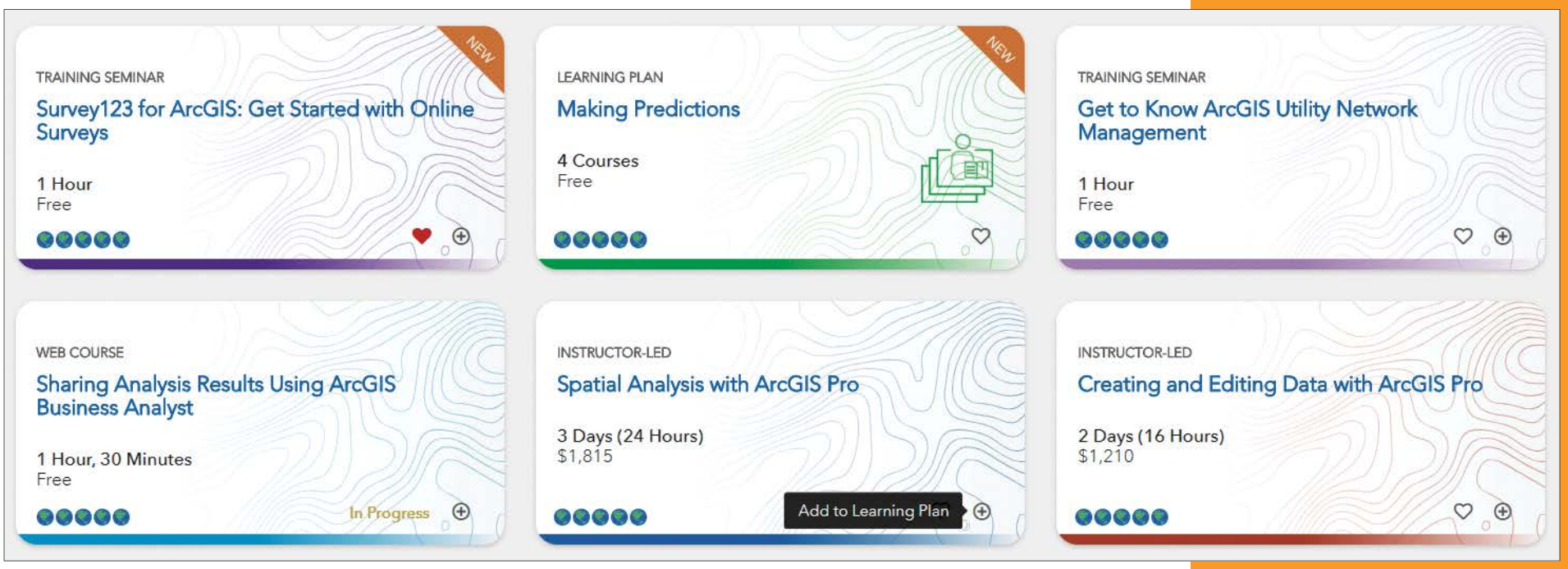
With the Training site's new email tool, managers, professors, and others can invite learners to enroll in a learning plan. The site also reports on who has accepted the invitation and shows the progress learners are making through the plan.

Lifelong Learning Anytime, Anywhere

Esri's new Training site is designed around the idea that authoritative ArcGIS learning resources should be easy to access at any time, from anywhere. Given how rapidly technology is changing, those who prioritize lifelong learning will be well positioned to take advantage of new opportunities to add value to their organizations and advance their own goals.

"We are always looking for new ways to support users who want to grow their skills and get the most value from the ArcGIS platform," said McGray. "The Training site is where you go to find up-to-date ArcGIS learning resources and take control of your own learning goals, on a timeline that works for you."

Visit esri.com/training to learn more about Esri Training options for individuals and organizations, including unlimited access to e-Learning for all customers with a current maintenance subscription.



↓ Training site users can now build custom learning plans directly from the catalog.

Esri T-shirts
Aren't All Work and No Play!

← While deployed to provide support for the 2018 Winter Olympics in Pyeongchang, South Korea, Paula Kingsbury and Parrish Henderson—both geospatial intelligence analysts for the United States government—found some time to show off their GIS gear in front of the Olympic rings near Gangneung Ice Arena.

→ Disguised as her aspiring-actress alter ego, Mapwoman takes a break from her travels around the world defending endangered places, rare species, and cultures battling injustice to soak in Stonehenge, England, with a conservation-minded geographer she found along the way. (Or it's Miranda Convis, after performing at the Edinburgh Festival Fringe in Scotland, having some geographically inspired fun at Stonehenge with her father, Charles Convis, Esri's conservation program coordinator.)

New **Training** and **Certification** Offerings

Training

New Instructor-Led Courses

Esri's instructor-led courses are developed in-house by subject matter experts who have a deep understanding of ArcGIS best practices and recommended workflows. All instructors have Esri Technical Certifications and CompTIA CTT++ certification.

Whether you work in public safety, are an app developer, or need to implement GIS across your organization, find out how to use ArcGIS to improve workflows and tackle common business issues in the following new courses:

- **Using ArcGIS for Public Safety Workflows**
  With ArcGIS Pro, public safety employees can take a geographic approach to their typical workflows. In this course, learn how to use ArcGIS Pro to map and visualize public safety data, identify patterns, create actionable information, and produce dynamic maps and 3D scenes to effectively disseminate that information.
- **Extending ArcGIS Pro with Add-Ins**
  GIS desktop app developers can attend this class to learn key ArcGIS Pro SDK programming patterns and discover how to deploy a wide range of interface customizations and custom functionality using add-ins.
- **Putting ArcGIS to Use Across Your Organization**
  This course provides a comprehensive introduction to the ArcGIS platform components and capabilities that help organizations address common business challenges. Attendees explore ArcGIS apps used for mapping and visualization, data collection and management, spatial analytics, and collaboration and sharing.

E-Learning Spotlight: Training Seminars

Training seminars are one-hour technical presentations delivered by Esri experts that incorporate both conceptual material and software demonstrations. Many training seminars are delivered live on the Esri Training website, enabling presenters to participate in question and answer sessions. The live seminars are recorded and then added to the Esri *Training* catalog for prolonged access.

Here is a taste of what you could learn during your lunch hour:

- **Get to Know ArcGIS Utility Network Management**
  Find out how ArcGIS Utility Network Management—a new extension for ArcGIS Enterprise—can help organizations better manage network assets, respond more quickly to network disruptions, and deliver excellent customer service. This seminar introduces attendees to the product's key capabilities for data modeling, visualization, editing, and analysis.
- **ArcGIS Pro Editing Essentials**
  Learn essential concepts for effectively managing geospatial data using ArcGIS Pro. Presenters in this training seminar discuss the ArcGIS Pro editing environment, including the user interface and key settings that increase accuracy and efficiency while editing. They also highlight new capabilities in ArcGIS Pro that are designed to streamline editing workflows.

Visit esri.com/lts to view dozens of other training seminars on a variety of ArcGIS topics.

Certification

Going to this year's Esri User Conference? For the first time, attendees have the opportunity to take a certification exam while at the conference. The exam area will be in the Omni San Diego Hotel, right across the light-rail tracks from the San Diego Convention Center. Advanced registration is encouraged, but walk-in exam appointments are available (space permitting). For more information, email certification@esri.com.

Steven Sushka, a senior technical support analyst at Esri partner Cityworks, earned the Enterprise Geodata Management Associate certification while attending the Esri Developer Summit in March. Read Sushka's certification success story at go.esri.com/success-gallery.

To explore the latest Esri Technical Certification exams, visit esri.com/training/certification. Also join the Esri Technical Certification group on LinkedIn to connect with other professionals and discuss all things certification.

Go to esri.com/training for more information. Find courses at esri.com/training/catalog/search. Keep up with Esri training news by subscribing to the newsletter (go.esri.com/preferences), visiting the *Esri Training Matters* blog (esri.com/trainingblog), connecting with the Esri Training Community on GeoNet (go.esri.com/training-community), and following @EsriTraining on Twitter.

Esri Press

For more information on all Esri Press publications, visit esri.com/esripress.

Cartography.

By Kenneth Field

Designing an accurate and effective map is always a nonlinear journey. And nonlinear journeys are usually made easier with a guide. *Cartography.*, by Kenneth Field, is a practical and useful docent for modern mapmaking. With a wealth of illustrations, the book distills the essence of cartography into practical and useful topics that help readers find the specific ideas or methodologies they need. At the intersection of science and art, *Cartography.* is an inspiring and creative companion for novice and expert mapmakers alike. June 2018, 556 pp. Paperback ISBN: 9781589484399 and hardcover ISBN: 9781589485020.

Getting to Know Web GIS, Third Edition

By Pinde Fu

Web GIS apps are becoming indispensable in the GIS world. Learn to build them with *Getting to Know Web GIS*, Third Edition. Teaching Web GIS technologies as a holistic platform, the book explores the most current and comprehensive advances in the Web GIS field. Via step-by-step exercises, readers learn how to share resources online before moving on to building Web GIS apps—first without doing any coding and then by developing more advanced skills using a range of Web GIS technology. Each chapter contains an app project that employs both server-side and client-facing products. And this edition includes new chapters and sections on big data analysis, image services, raster analysis, virtual and augmented reality, artificial intelligence, vector tiling, portal collaboration, ArcGIS Arcade, Survey123 for ArcGIS, ArcGIS API for Python, and Operations Dashboard for ArcGIS. A practical manual for the classroom lab or on-the-job training, *Getting to Know Web GIS* includes downloadable teaching slides and exercise data. May/July 2018, 410 pp. E-book ISBN: 9781589485228 and paperback ISBN: 9781589485211.

GIS for Surface Water: Using the National Hydrography Dataset

By Jeff Simley

Combining the ready-to-use National Hydrography Dataset with the ArcGIS platform, *GIS for Surface Water: Using the National Hydrography Dataset* helps scientists, managers, and students analyze the vital surface waters of the United States. The book explains how this database of the nation's water resources was built and outlines how data about the waters—such as their chemistry and fish habitats—is linked to the database. *GIS for Surface Water* also shows how elevation data can be incorporated to produce watersheds at the micro and macro levels and reveals how this, along with climatic data, can lead to the creation of water flow and velocity estimates for every segment of the United States' 7.5-million-mile drainage network. Drawing on user stories from experienced water analysts where relevant, the book demonstrates how ArcGIS technology can be applied to the database—and to the surface water systems of any nation. May/June 2018, 600 pp. E-book ISBN: 9781589484917 and paperback ISBN: 9781589484795.

Lining Up Data in ArcGIS: A Guide to Map Projections, Third Edition

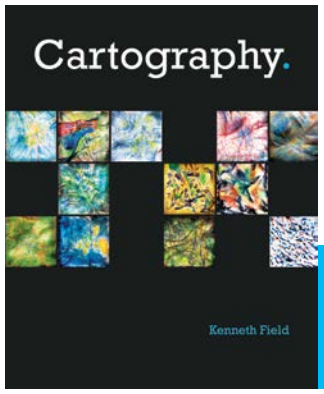
By Margaret M. Maher

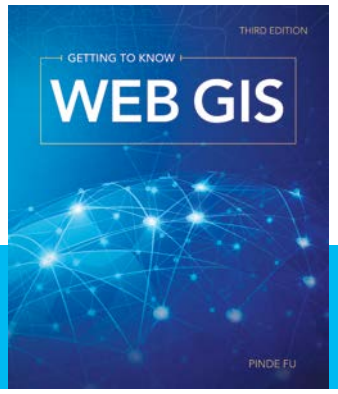
Lining Up Data in ArcGIS: A Guide to Map Projections, Third Edition, is an easy-to-navigate troubleshooting reference for any GIS user with the common problem of data misalignment. Complete with full-color maps and diagrams and updated for ArcGIS Desktop 10.6, this book offers techniques to help readers identify data projections and create custom projections to align their data. Formatted for practical use, each chapter can stand alone to address specific issues related to working with coordinate systems. And with a new chapter on vertical coordinate systems, the third edition of *Lining Up Data in ArcGIS* is useful for new and skilled GIS users alike. May/June 2018, 240 pp. E-book ISBN: 9781589485235 and paperback ISBN: 9781589485204.

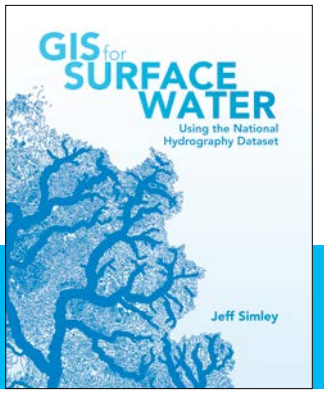
Understanding GIS: An ArcGIS Pro Project Workbook, Fourth Edition

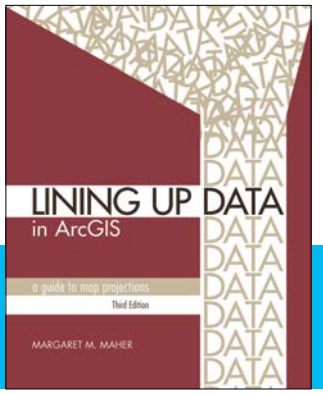
By David Smith, Nathan Strout, Christian Harder, Steven Moore, Tim Ormsby, and Thomas Balstrøm

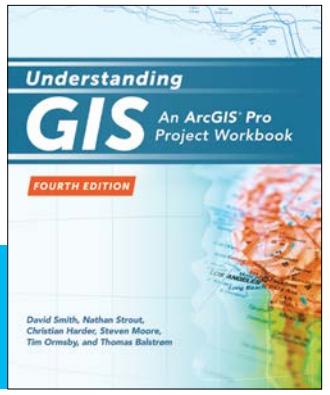
A pioneering GIS textbook, the fourth edition of *Understanding GIS: An ArcGIS Pro Project Workbook* is an excellent resource for students and educators taking or teaching an advanced, single-project-based course that incorporates GIS across a wide range of disciplines. The objective is to find the best location for a new park along the Los Angeles River in Southern California, and readers progress through nine lessons using ArcGIS Pro to do so. Each exercise offers step-by-step instructions, graphics to confirm exercise results, and explanations of key concepts. *Understanding GIS* gives readers access to ArcGIS Desktop, which includes ArcGIS Pro, as well as all the updated project data. August 2018, 380 pp. E-book ISBN: 9781589485273 and paperback ISBN: 9781589485266.











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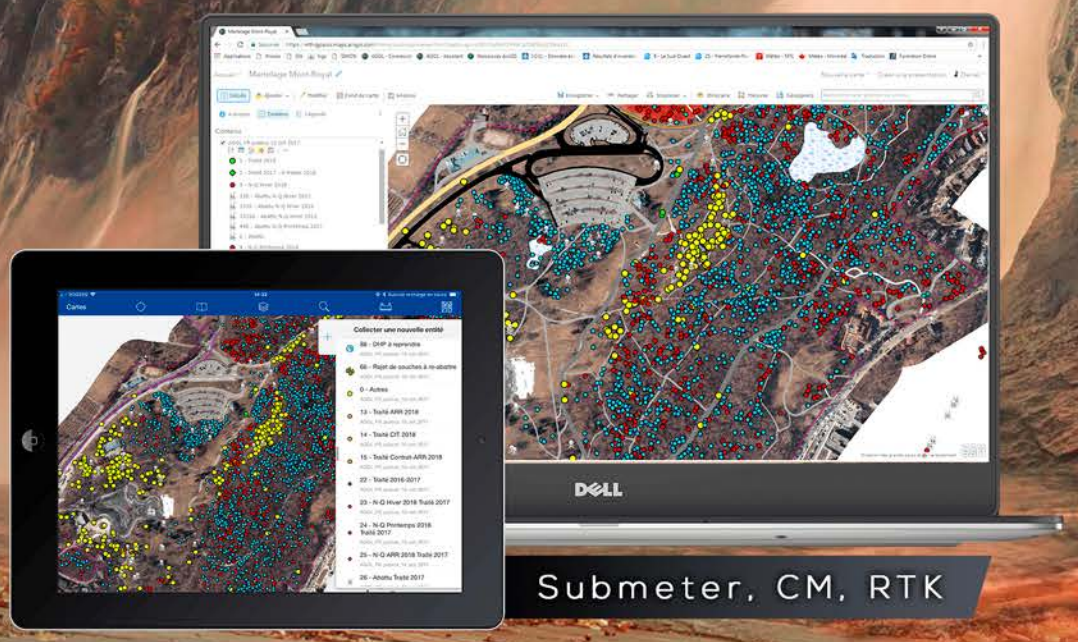

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