Winter 2018

ArcUser

The Magazine for Esri Software Users

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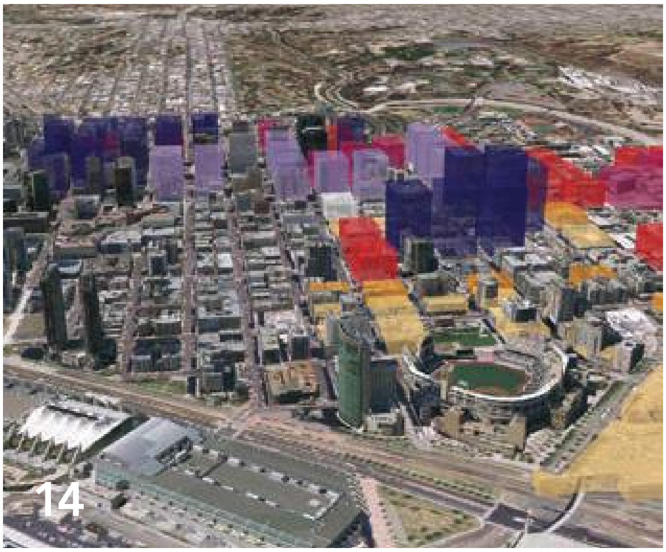

Focus

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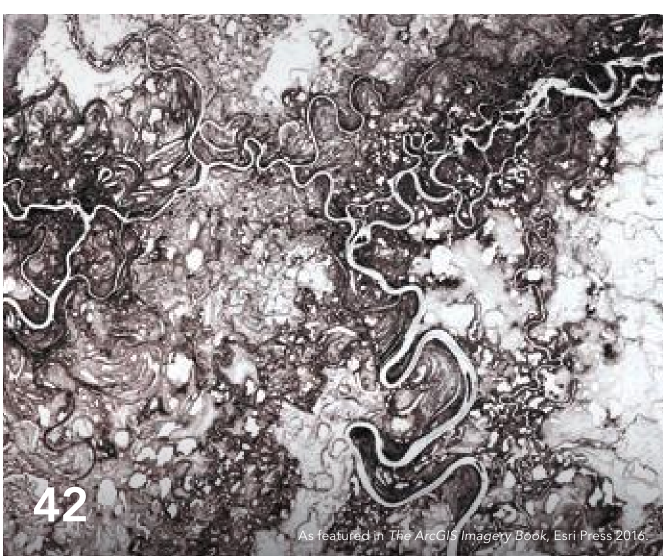


As featured in *The ArcGIS Imagery Book*, Esri Press 2016

Special Section

On the Cover

Tristan da Cunha is the world's most remote inhabited island. WorldView 3 (False Color-481). As featured in *The ArcGIS Imagery Book*, Esri Press 2016.

A Better Place to Live

When Esri was founded in 1969, the world was a far less crowded and a decidedly less urbanized place. Of an estimated 3.6 billion people, only about 36 percent of them lived in cities. Currently, it's estimated that 54 percent of the world's 7.9 billion inhabitants are crowded into cities.

Clearly, how we design cities matters more to more people. That is one of the reasons that the recent partnership between Esri and Autodesk, facilitating the integration of spatial intelligence with 3D design model information, is an important step in the process of designing more liveable and sustainable cities.

The ArcGIS platform is continually incorporating previously separate technologies—imagery, 3D modeling, and real-time analysis of big data—and developing tools that substantially help us gain an understanding of the interdependency of the Earth and its residents.

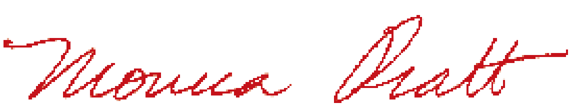
These capabilities to ingest, process, analyze, and visualize data can inform decisions and enlighten the design and management of cities in ways that were not previously possible.

An article in this issue illustrates just this point. Mobileye has developed advanced driver assistance systems (ADAS) technology that uses GIS and analyzes sensor data in real time that can help prevent the motor vehicle accidents that injure millions and kill thousands each year in the United States.

The greatly enhanced imagery capabilities in the ArcGIS platform let us take advantage of the tidal wave of imagery that continually decreases in cost and increases in availability. By unlocking the secrets of imagery, we can better respond to disasters, inventory resources, and monitor change over time.

3D visualization, available across the ArcGIS platform, provides the ability to "try before you buy" by letting designers and planners model buildings to measure their effects before ever placing a shovel in the ground.

GIS lets us see more deeply and with a greater understanding of the consequences of our actions so we can build cities where we not only survive but thrive.



Monica Pratt
ArcUser Editor

ArcUser

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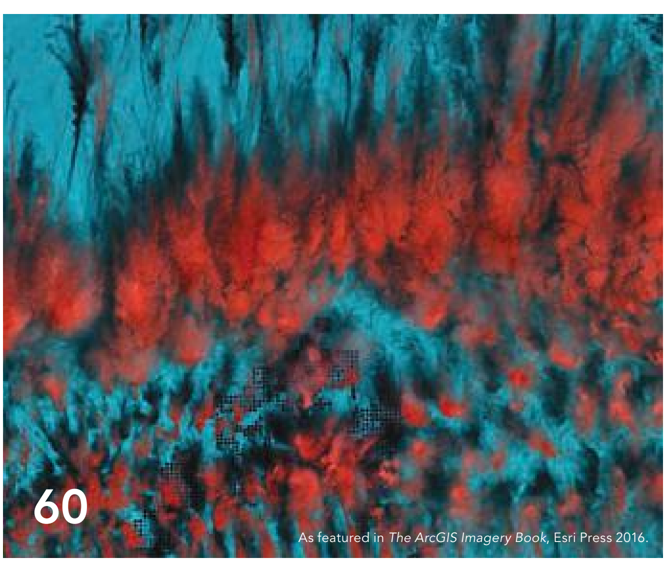
Departments



As featured in *The ArcGIS Imagery Book*, Esri Press 2016.

Briefly Noted

→ ArcGIS Software Donated to GISCorps

Esri recently announced that it will donate personal use licenses of its ArcGIS software for each GISCorps volunteer who takes a GIS Service Pledge to volunteer for a worthy cause.

GISCorps is a program of the Urban and Regional Information Systems Association (URISA). GISCorps volunteers have been involved in the response to disasters since 2003, providing a range of mapping and disaster response services.

Each personal use license being donated has a commercial value of approximately $6,000 per year and will enable volunteers to address crucial location-based issues. GISCorps volunteers can leverage this software donation to support any cause or organization, whether local or abroad, which they are passionate about and that meets the criteria described on the GISCorps website.

Anyone interested in joining the GIS Service Pledge program should visit the GISCorps home page at www.giscorps.org.

↑ GISCorps volunteers have been involved in the response to disasters since 2003, providing a range of mapping and disaster response services.

→ United Nations' New Global Data Hub Based on the ArcGIS Platform

Esri and the United Nations Statistics Division (UNSD) are working with a number of UN member states to utilize a data hub that will allow countries to measure, monitor, and report on Sustainable Development Goals (SDGs) in a geographic context.

The SDGs are a set of global goals that include such objectives as poverty eradication, access to safe water, clean oceans, eliminating hunger, gender equality, climate action, peace and justice, education, and other important areas on the UN agenda.

Called the Federated System for the SDGs, this data hub is based on Esri's ArcGIS platform. It will use location intelligence to make it easier for countries to collect, analyze, and share the data required to monitor progress toward the SDGs.

The Federated System explores new ways for facilitating dataflows and action through data hubs and supports and informs data-driven decision-making through access to data that is usable, interoperable, and visual.

"The key challenge to collaboration between nations is a common digital context," said Esri founder and president Jack Dangermond. "Data hubs provide this context with location intelligence and use organizations' core data to engage stakeholders, communicate policy, inform the public, and measure progress." Participants of the UN forum in Mexico City issued a declaration on the importance of geospatial technology's role in implementing the SDGs.

Using Esri's capabilities to enable access, collaboration, analytics, and powerful maps provides visualization and awareness that supply the critical information needed to ensure each country meets its commitment to these goals. Most importantly, the Federated System allows collaboration across countries and makes it possible to measure the success of global SDG initiatives for the first time.

Based on early success, UNSD and Esri are working to advance the initial research exercise to support broader adoption by other member states and organizations in 2018.

→ Meeting Environmental Challenges with GIS, Deep Learning, and Artificial Intelligence

Current methods for collecting the detailed geographic data needed for land-cover mapping are highly labor-intensive. Advanced technologies, such as artificial intelligence (AI), could help with the collection of this critical data but are not widely available for conservation applications. To remedy this situation, Esri and Microsoft are collaborating to provide greater access to these technologies through a newly aligned grant process.

This grant process will allow eligible organizations and individuals to receive ArcGIS, access Microsoft's Data Science Virtual Machine and Cognitive Services offering, and obtain Microsoft Azure credits. Microsoft AI will integrate with Esri's ArcGIS Living Atlas of the World and ArcGIS Image Server to help users perform high-resolution image classification and generate insight into land-cover changes that go far beyond current capabilities.

These new capabilities have been demonstrated by the Chesapeake Conservancy. This organization has done a great deal of work protecting and restoring the local watershed, but it needed more precision data to focus its work on the areas that could most benefit. To generate current and accurate data, it used ArcGIS and AI in the Microsoft Azure cloud to produce dynamic land-cover products in minutes rather than days.

"We believe that human ingenuity and AI can pair together to tackle some of our biggest societal challenges—including managing climate, water, agriculture, and biodiversity resources. We're excited to work with Esri to deliver AI technology to researchers and organizations that will help them address these challenges," said Lucas Joppa, chief environmental scientist at Microsoft.

→ Lands Critical for Biodiversity Preserved through Donation by Esri Founders

A private donation of $165 million by Esri founders Jack and Laura Dangermond has enabled The Nature Conservancy to purchase and permanently protect rare, coastal habitat in Santa Barbara County, California. The area, inhabited by at least 39 threatened or special status species and adjacent to a marine protected area, connects coastal lands to mountains and contains crucial wildlife corridors.

"This is an incredibly rare, ecologically important place with eight miles of coast and centuries-old coastal oak woodlands," said Jack Dangermond. "This deserves to be preserved and managed by an organization like The Nature Conservancy."

The site, encompassing more than 24,000 acres at Point Conception, will be named The Jack and Laura Dangermond Preserve and will be owned and managed by The Nature Conservancy. The Dangermonds' gift, the single largest philanthropic gift in The Nature Conservancy's history, has inspired other generous donations to the organization.

"We want to inspire more people to give major contributions toward conservation; that's the only reason we've chosen to share our involvement. We want to set an example. Conservation isn't just being nice to animals or plants; it's investing in the continued life support systems of humans and all other species on the planet. We need more people to step up to protect our last great places," said Dangermond.

ArcGIS Online Update Gives More Control to Administrators and Users

The December 2017 update to ArcGIS Online includes many user experience and administration enhancements in addition to the release of the ArcGIS Online version of Insights for ArcGIS (see the accompanying article "New Version of Insights for ArcGIS Available for ArcGIS Online") and updates to many apps.

As an ArcGIS Online user, you have more options for discovering and managing content. If you are an administrator, you have more granular control over members and content and can perform administrative tasks more quickly.

New features help you get to what you need quickly. You can specify the start page—the page you first see when you sign in to your account. Go to your Profile page and choose from the drop-down under Start page and click Save. The page you pick will now appear when you log in.

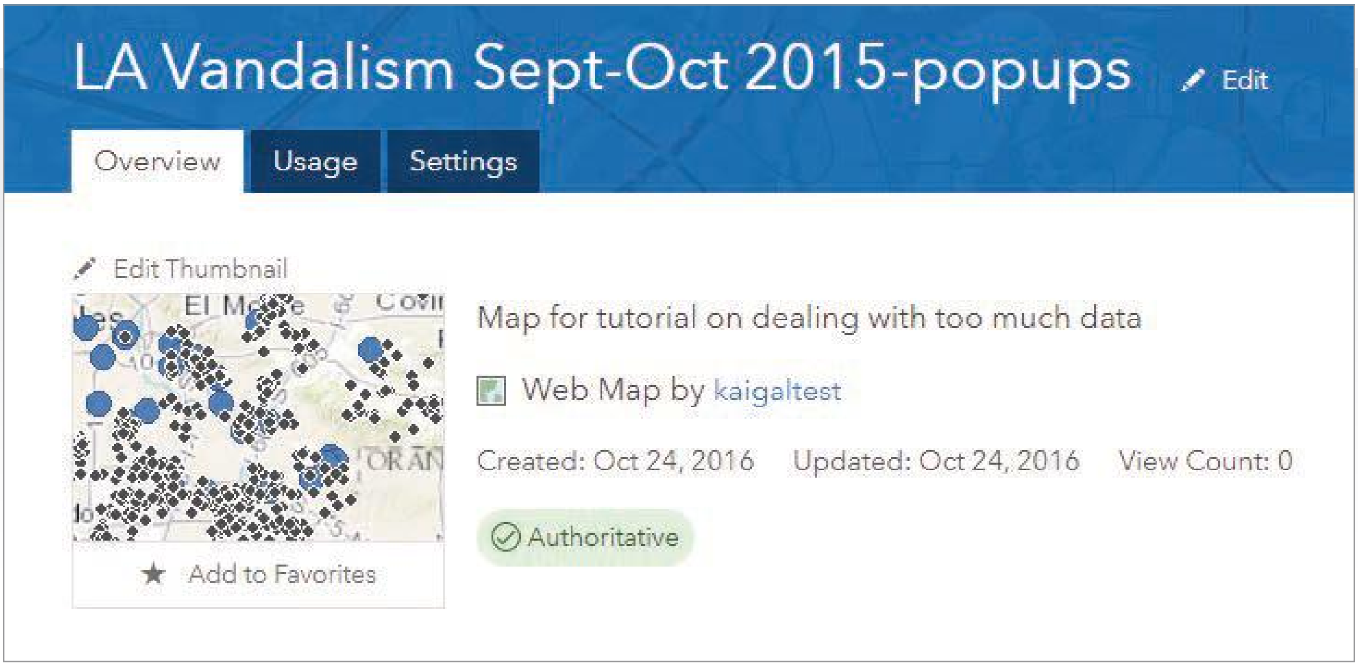
Manage Content

Administrators and content curators can mark items as authoritative or deprecated. This helps members of your organization manage content more intelligently by indentifying authoritative items and-discouraging the use of items that are becoming out of date. Item status is indicated by a badge on the item page.

The Status filter can be used, in addition to the other filters, when searching or browsing for content. Searches can be restricted to authoritative layers when authoring maps using the Map Viewer. The authoritative status of items is currently only visible within your organization, while the deprecated status of an item is visible inside and outside your organization.

The new Item information status bar and interactive checklist on an item's Overview page helps item owners and administrators

↓ Administrators and content curators can mark items as authoritative or deprecated, and content searches can be restricted to items marked as authoritative.



improve item information by suggesting improvements so the item will be easier to find, understand, and use by others. It moves through the elements of the item page (summary, thumbnail, description, title, tags, and terms of use). As you complete item details, the status bar updates and offers suggestions for improvement.

You can also update the URL of layers in your map from HTTP to HTTPS or from staging versions of your ArcGIS service layers to production versions using the Settings tab for the map item. ArcGIS Online inspects each layer in the map. If any layers use HTTP, ArcGIS Online attempts to make a request to the same layer using HTTPS and then updates the map and any associated layer items you own or administer. If a layer does not support HTTPS, you are notified, and the layer URL is not updated.

Mapping and Visualization

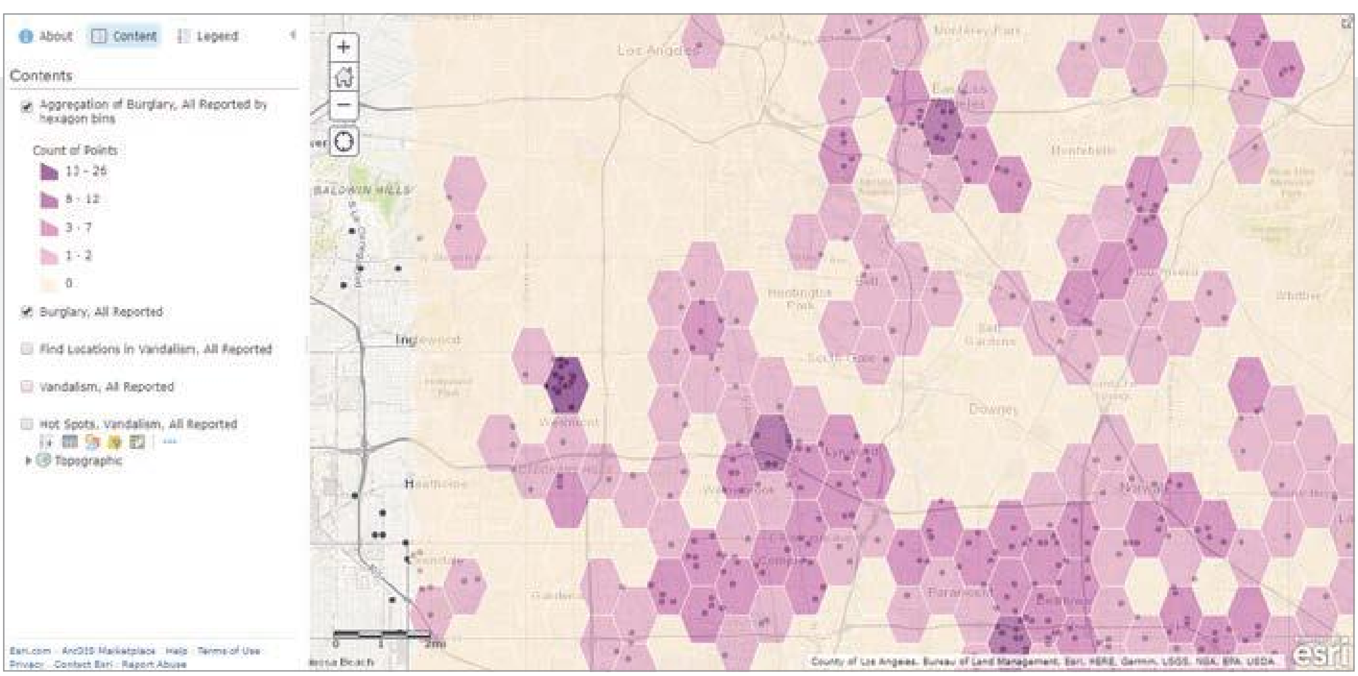
The Map Viewer, the built-in app for viewing, authoring, and editing maps and performing analysis, has an additional analysis tool—Find Centroids—and new capabilities for the Aggregate Points and Summarize Within tools. Use Find Centroids to find the geometric center of multipoint, line, or area features. You can use the Aggregate Points and a custom square or hexagon bins instead of summarizing data within an input area layer.

You can use geometric operations in Arcade expressions defined for smart mapping styles, labeling, and pop-ups. Use advanced functions to normalize by area, test spatial relationships, compute distances between defined areas, and more.

Add GeoJSON files to your map. GeoJSON is a widely used open standard format for encoding a variety of geographic data structures in JavaScript Object Notation (JSON) format.

Scene Viewer has new capabilities and improved performance. You can measure distances in 3D between two points in Scene Viewer. Choose different measuring units and leverage interactive laser lines to calculate the direct and vertical distances in scenes. Buildings and integrated mesh scene layers load faster using the correct priority order. When zooming to scene layers, data is temporarily cached so layers redraw much faster. Use 3D symbols from ArcGIS Pro in scenes by using style files published from ArcGIS Pro. Administrators can also configure custom web styles for Scene Viewer.

↓ The Aggregate Points tool can now aggregate points to a custom square or hexagon bins.



Administration

Administrators can now make web apps available to organization members by adding apps to the app launcher. The app launcher appears in the upper right next to Search on all pages except Map and Scene once you are signed in. Members can personalize their view of the app launcher by dragging and dropping apps to change their display order. Administrators can prevent all ArcGIS Pro licenses in the organization from being taken offline.

The ability to link to enterprise groups can be granted by administrators to custom roles. To add this to existing custom roles, edit the role, add this new privilege, and save the role. Organizations can now create groups whose membership is controlled by Security Assertion Markup Language (SAML)-based enterprise groups.

Members with Level 1 accounts can now join external groups if assigned to a custom role granting this privilege. Members who can update member account information, as well as administrators, can also reset passwords for other members.

Inviting members to ArcGIS Online is easier. Administrators can enable Esri access when inviting and adding members, so a member whose account has Esri access enabled can use My Esri and the GeoNet community and forums, access e-Learning on the Training website, and manage email communications from Esri.

Data Management for Hosted Feature Layers

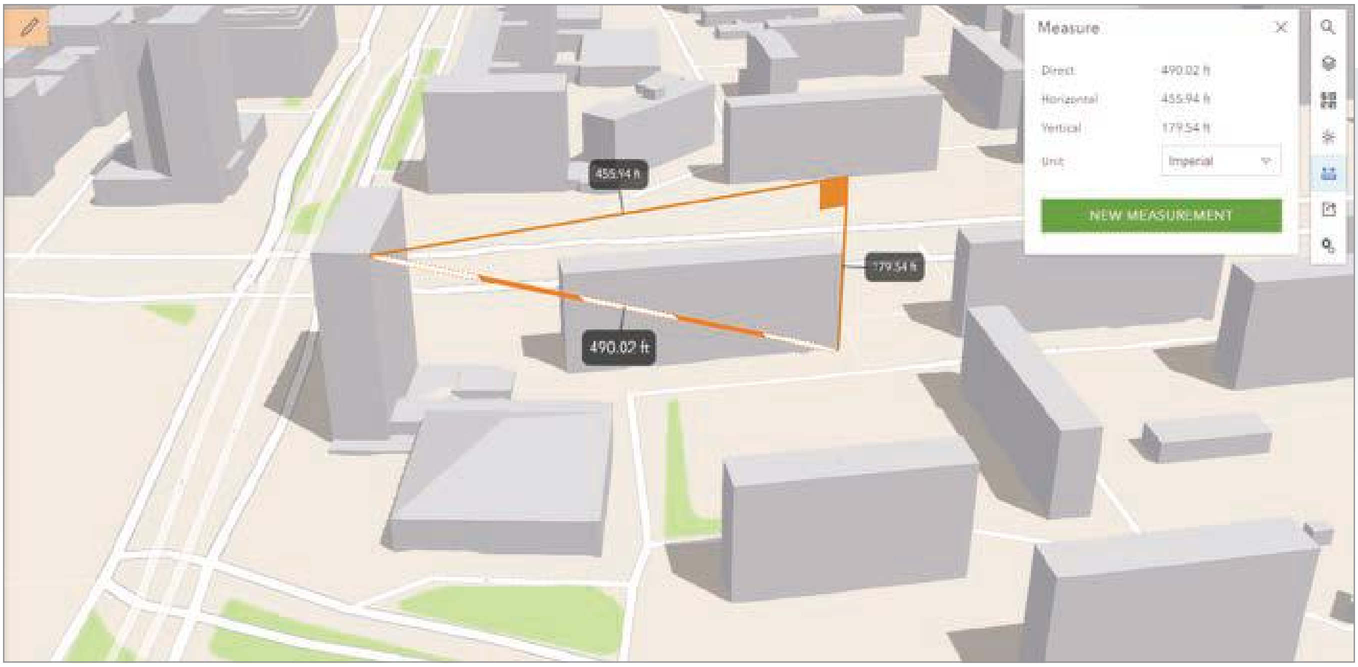
Publish hosted feature layers using CSV and Microsoft Excel files stored in Microsoft OneDrive and Dropbox. If you update the data in the file on the cloud drive, you can overwrite the data in the hosted feature layer using the updated cloud data. Google Drive, including Google Sheets, will be supported soon.

Administrators and owners can now append data to layers in existing hosted feature layers without needing to overwrite the entire hosted feature layer. You can now define an area of interest for hosted feature layer views to limit access to features within a particular area.

New editing options for hosted feature layers and hosted feature layer views provide more fine-grained control over what operations editors can perform.

For additional information, see the "What's New" topic in ArcGIS Online Help.

↓ Measure distances in 3D between two points in Scene Viewer and calculate the direct and vertical distances in scenes.



New Version of Insights for ArcGIS Available for ArcGIS Online

Insights for ArcGIS, the web-based data analytics workbench, is now available for ArcGIS Online in addition to ArcGIS Enterprise.

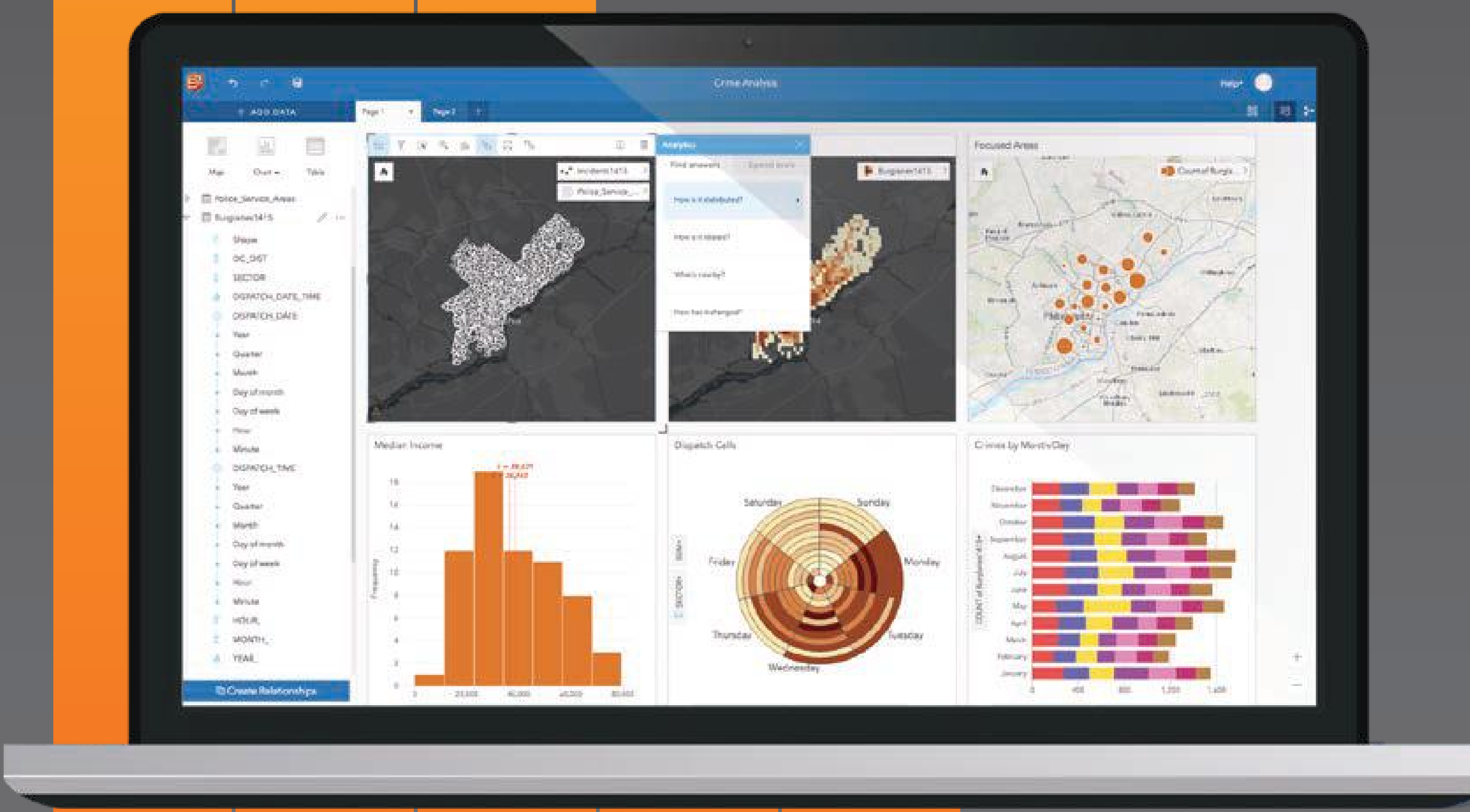
Using interactive linked cards, you can analyze data and make new discoveries about your spatial and nonspatial data. Linked cards allow you to click a map or chart and see related data highlighted on another card.

Insights for ArcGIS allows you to save time by performing iterative and exploratory data analysis without having to manually track your analyses. Insights automatically records your analysis workflow so you can clearly communicate how you arrived at your conclusions.

The analysis view in Insights for ArcGIS breaks down the workflow—data, filters, and analyses—so you and others can run it again to solve other problems. Easily publish analysis results within your organization.

Insights for ArcGIS leverages the power of the ArcGIS platform to offer you flexible deployment, the means to level up your analysis, and share your results more broadly.

For more information, visit esri.com/insights.



Integrating Geography and Design Tools

ArcGIS Maps for Adobe Creative Cloud Gives Direct Access to Esri Content in Adobe Products

Extract the maximum value from your organization's GIS by making maps and the results of geographic analyses available to larger audiences and enhancing collaboration and productivity across departments with Maps for Adobe Creative Cloud.

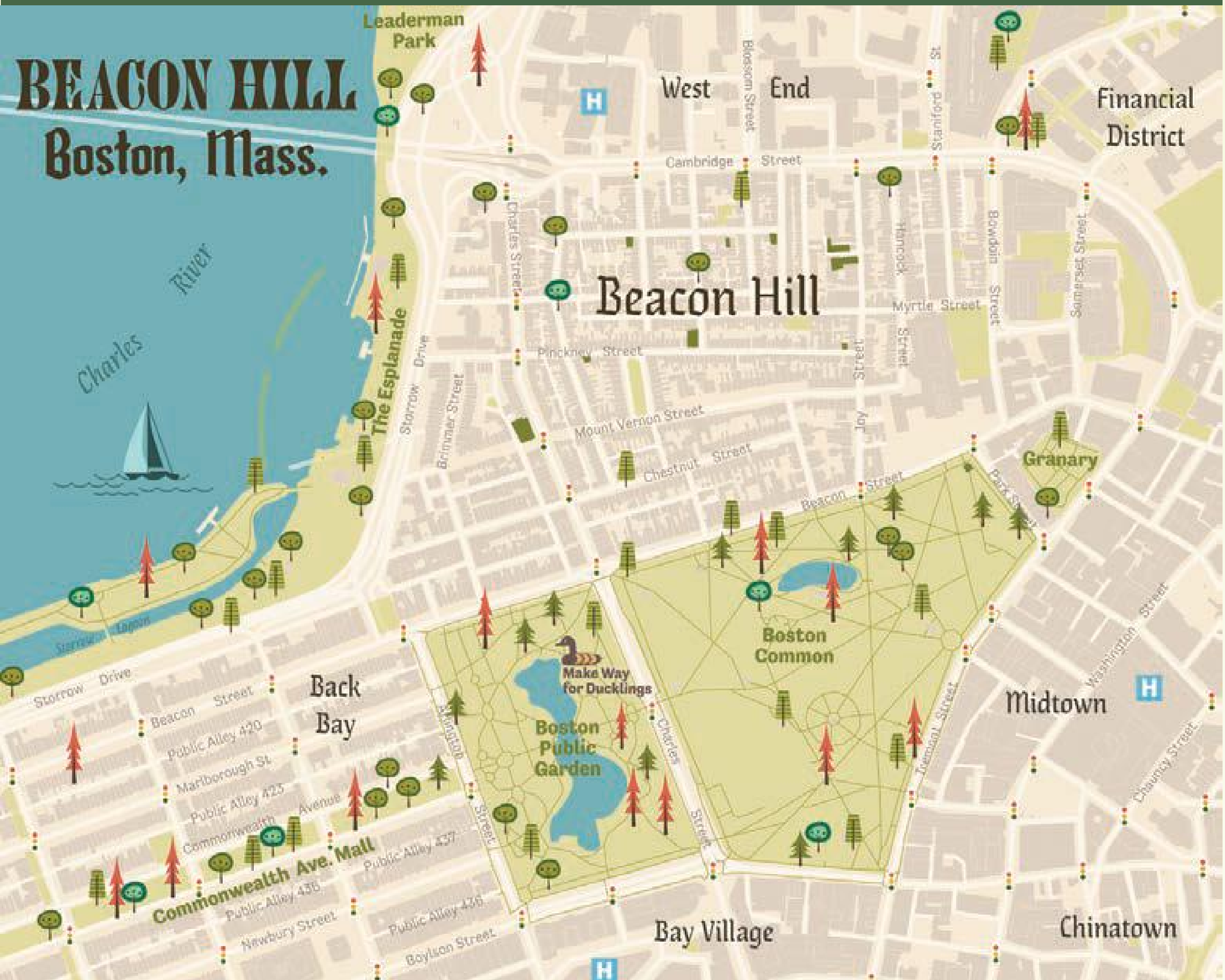
The role of maps for storytelling, infographics, data visualization, analytics, sales, and marketing is constantly expanding, but until now, taking GIS maps into Adobe design products to enhance and reuse them was a labor- and time-intensive process that could limit the currency of the final product. This new app connecting ArcGIS and Adobe takes the process from hours or days to minutes with a commensurate increase in data currency.

This new Esri app makes the most current data-driven maps and geographic content available seamlessly in the Adobe Photoshop and Illustrator Creative Cloud apps for use in design, marketing, and publishing projects.

When Maps for Adobe Creative Cloud users sign on to ArcGIS Online as anonymous users and as users of evaluation copies of the software, they can access all the public content hosted on ArcGIS Online. This means access to thousands of maps, as both vector and image layers; satellite images; and other geographically relevant data from around the world. ArcGIS content is compiled from commercial vendors, open data sources, and Esri user organizations and includes authoritative data from the ArcGIS Living Atlas of the World. If users are named users in ArcGIS Online, they can also access all an organization's content.

Cartographers benefit from working in Adobe and ArcGIS simultaneously. They can take work done in GIS and make more beautiful maps. The integration between ArcGIS and Adobe is seamless. For the first time, cartographers have the tools to keep content in ArcGIS but allow it to be shared with Adobe's design apps. They can run spatial analyses in ArcGIS and access the results inside Adobe apps to create captivating maps. Map extents can be defined geographically or by using Adobe Photoshop and Illustrator preferences.

GIS users can share their map assets with the design department in formats familiar to designers and work with them easily. Designers can use maps and the results of GIS analyses to produce maps that reflect the style and branding of an organization while working with familiar Adobe tools. Cross-departmental



collaboration saves time and effort and improves the quality of the final product.

This integration of ArcGIS and Adobe tools demonstrates the value of Esri's continued commitment to interoperability by enhancing collaboration and productivity, saving both time and money. By making spatial information more directly and widely usable by the design and communications professionals, it helps increase the value of GIS information products.

Download and install ArcGIS Maps for Adobe Creative Cloud by visiting esri.com/m4cc and clicking "Get It Today."

DESIGNING THE URBAN LANDSCAPE INSIDE AND OUT

On November 15, 2017 Esri and Autodesk announced a new relationship that will integrate spatial intelligence with 3D design model information.

By building a bridge between building information modeling (BIM) and GIS mapping technologies, Esri and Autodesk will enable people in a broad range of industries to plan, design, build, and operate infrastructure assets more efficiently and save precious time and money by understanding them in context.

"Our goals are to provide industry and city planners with the ability to design in the context of the real world," said Autodesk CEO Andrew Anagnost. "This will allow communities to build more connected, resilient cities and infrastructure with a focused eye on sustainability."

Combining these technologies can connect information across the project life cycle. Enabling BIM and GIS mapping software to work more seamlessly will improve the end-to-end flow of materials and scheduling during construction, which has

↑ The move to improve the integration of GIS with BIM is one of the ways Esri is helping design smart communities.

the potential for dramatically reducing the time required for and the cost of projects. The industries that will most immediately benefit from this partnership are urban planning, infrastructure construction, facilities management, and transportation.

"It is important to consider the needs of future generations during the design and building of projects today," said Esri president Jack Dangermond. "The benefits of partnering with Autodesk will include securing sustainable resources for the growing population, a responsible human footprint on our natural environment, better use of our planet's resources, and more resilient cities."

The world's population is expected to grow by more than two billion people in the next three decades. At the same time, more of that population will be living in cities, increasing the pressure to maintain existing infrastructure and requiring the building of additional infrastructure. To meet these challenges will require a better understanding of how people and place relate. The urban and natural landscapes form a tapestry that is affected, in increasingly profound ways, by the actions of people.

The move to improve the integration of GIS with BIM is one of the ways Esri is helping design smart communities that use technology to better understand problems and develop better solutions for planning, transportation, and building design and construction. More intelligently designing urban landscapes will enhance public safety, improve the livability of cities and the health of their inhabitants, and help make cities more economically viable.

Bringing GIS and BIM together to meet the demands of the future is but one example of Esri's larger vision of applying geographic science—The Science of Where—through GIS technology to the challenge of building a better future. Geography provides the framework and the science for understanding both the natural and urban landscapes and the interactions of both with human activities.

GIS technology provides the tools for managing, analyzing, and visualizing data about those landscapes and interactions to produce information that is the basis for decisions that take into account not only immediate impacts on places and people but also future impacts.

The visualization capabilities of GIS have rapidly increased in the past decade. 3D visualization is available across the ArcGIS platform as point clouds, 3D models, and 3D meshes and at scales that range from individual structures to cityscapes to the Earth. 3D can allow structures not normally visible, such as subterranean utility infrastructure, to readily be modeled and maintained. The impact of proposed structures, whether as shadows cast, egress impaired,

↓ Esri president Jack Dangermond and Autodesk CEO Andrew Anagnost announced the companies' partnership at Autodesk University in Las Vegas, Nevada.

or view diminished, can be evaluated and reevaluated as design changes are considered. The use of Esri CityEngine can realistically render urban landscapes and share them through a web browser.

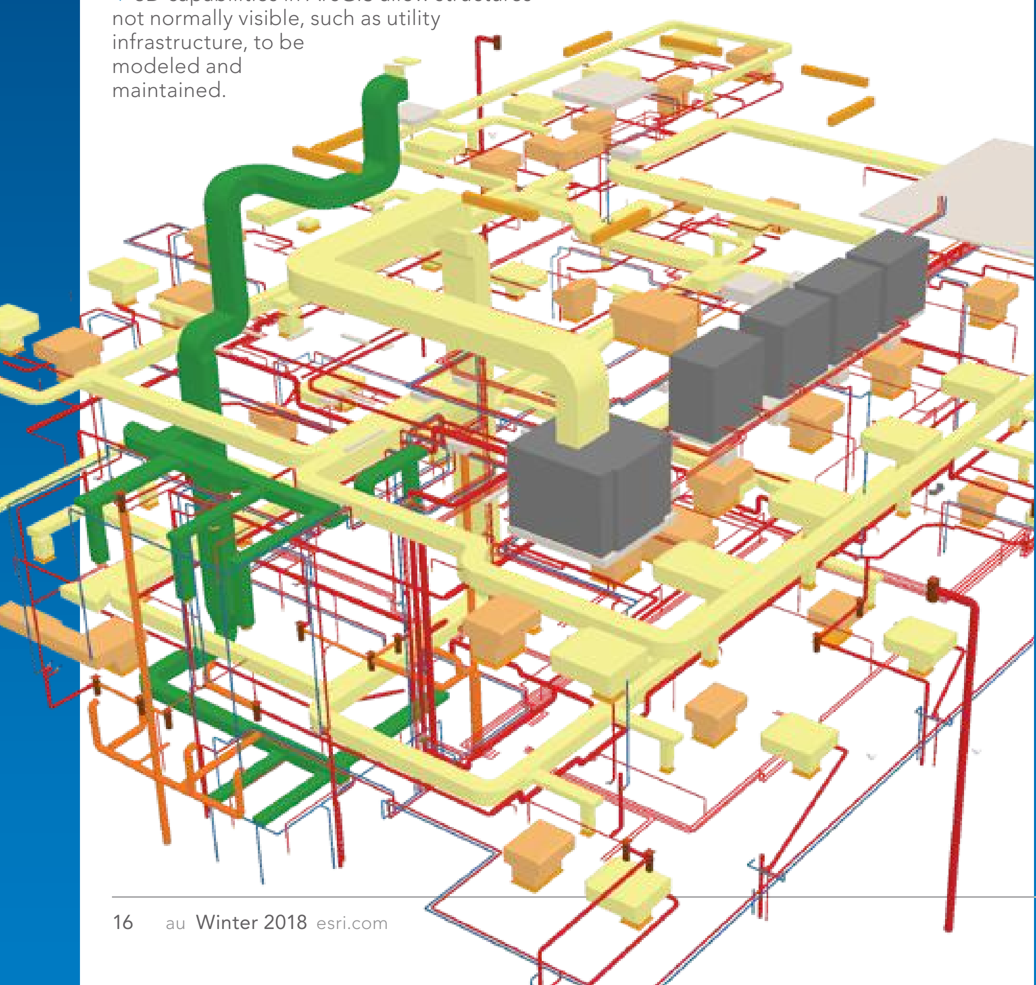
An abundance of remotely-sensed data is available for use in the ArcGIS platform. Petabytes of constantly updated imagery are hosted by Esri and made available through the ArcGIS Living Atlas of the World and ArcGIS Online. The use of imagery by GIS has evolved a great deal from the early years when imagery was a backdrop for vector data. The ArcGIS platform can manage and serve huge amounts of imagery effectively. Imagery is now a rich data source for analysis that informs numerous GIS applications. GIS is the key to unlocking the secrets of imagery so they can be applied to understanding the world on many scales from neighborhood to nation.

> The visualization capabilities of GIS have rapidly increased in the past decade.

To further the design of smart communities, these ArcGIS capabilities are available from mobile devices that can go into the field. Immersive technologies, such as augmented reality and virtual reality, have been incorporated into mobile GIS apps.

These capabilities dovetail with developments in 3D visualizations and advancements in real-time data use and big data computing on the ArcGIS platform that make real-time updating possible. With the ability to handle inputs from thousands of sensors, analyzing and

↓ 3D capabilities in ArcGIS allow structures not normally visible, such as utility infrastructure, to be modeled and maintained.



New ArcGIS for AutoCAD Release Adds Access to Web Services

Even before the partnership between Esri and Autodesk was announced in November, Esri had been working on tools that enable the design of smart communities. A free plug-in for AutoCAD, ArcGIS for AutoCAD makes maps, imagery, and geographic features in ArcGIS available in CAD drawings.

This plug-in improves the design of infrastructure and facilities management by letting engineers and managers create and edit GIS data in standard DWG files. With ArcGIS for AutoCAD, multiple georeferenced ArcGIS maps can be viewed and queried in AutoCAD without data conversion so interior and exterior spaces can be visualized and analyzed within a real-world context.

The latest release of ArcGIS for AutoCAD provides AutoCAD users with access to ArcGIS web services and the ability to share ArcGIS data in AutoCAD DWG files.

ArcGIS for AutoCAD 370 is an incremental update that includes certification for 64-bit versions of AutoCAD 2015–2018. Although this release marks the deprecation of 32-bit versions of ArcGIS for AutoCAD, 32-bit versions and support for them will still be available.

The previous version of ArcGIS for AutoCAD functioned with AutoCAD 2018 versions (including AutoCAD Map 3D and Civil 3D), but it required installation of the ArcGIS for AutoCAD 365 version on an older version of AutoCAD and loading the software using NETLOAD. This release includes the installation and desktop launcher for the 64-bit versions of AutoCAD 2018, as well as several fixes.

Future releases of ArcGIS for AutoCAD will continue improving the integration with ArcGIS Online and portal. Additional integrations of ArcGIS and AutoCAD are being considered that will enhance CAD/BIM/AEC applications.

↑ Petabytes of imagery, hosted by Esri (such as this recently added AirBus Defence and Space WorldDEM4Ortho elevation data), is constantly updated and available from the ArcGIS Living Atlas of the World and ArcGIS Online.

visualizing them to produce information that is actionable not only as maps but also through charts and dashboards, GIS is helping realize the promise of the Internet of Things to gain a more comprehensive understanding of the interactions of phenomena across urban and natural landscapes.

Understanding landscapes is all about understanding context. Through its data integration, analysis, and visualization capabilities, GIS has always provided context. Initially that context informed planning decisions, but its value has been recognized in an ever-increasing number of industries and applications. The other strengths of GIS—fostering collaboration and enhancing communication—are also crucial to the creation of smart communities.

The expansion of the technologies that GIS encompasses has led to the development of a discipline for connecting and empowering design and planning communities called geodesign. It is a discipline that uses ArcGIS to join the design of the natural landscape with the design of the built landscape in a holistic and iterative process that models proposals and measures the impacts of decisions. It incorporates specific workflows in the design and building of smart communities while preserving the green infrastructure around them.

Esri CityEngine and GeoPlanner for ArcGIS specifically support the growth of geodesign because they embed the tools and practical workflows that connect GIS to planning and design activities. GeoPlanner evaluates alternative designs and provides statistics on the impacts of those designs in charts and graphics. Esri CityEngine automatically generates 3D urban visualizations.

While geodesign is not an entirely new approach to design and planning work, its transdisciplinary approach to problem solving uses tools that can be applied to projects of various types and at a variety of scales. GIS helps us understand how the Earth works. Geodesign helps us understand how the Earth should look—what will work, what will be sustainable. It is planning and design wrapped up with resiliency requirements that can be explored, modeled, and tested.

Geodesign continues the evolution of GIS from descriptive to prescriptive. As GIS becomes an ever more inclusive System of Record, capturing the characteristics of the natural and built world and its inhabitants, it is also a System of Engagement that fosters communication and collaboration that can enable more livable cities and a more sustainable world. More recently, its big data, real time, and more robust analysis capabilities have made it a System of Insight. These three systems—record, engagement, and analysis—have enabled the creation of a fourth system, the System of Geodesign.

BIM will be an important piece in this larger vision that GIS is helping realize: a sustainable urban landscape. Esri technology continues building the technology that can change the way the future is built through improving understanding of how it works and the interactions of people and place.

Real-Time Analytics and Computer Vision Mitigate Traffic Accidents

By Jim Baumann, Esri Writer

Motor vehicle accidents resulted in more than 4.6 million injuries and 40,000 deaths in the United States in 2016, according to the National Safety Council (NSC), a US-based nonprofit organization.

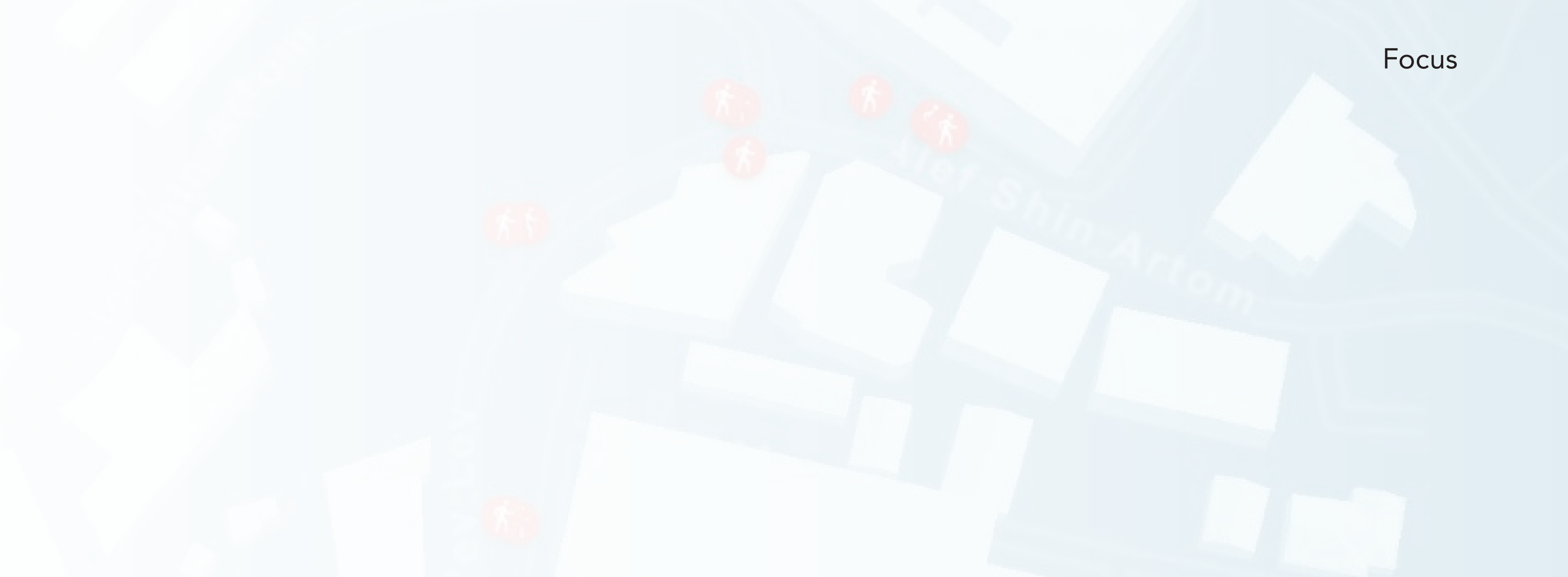
↑ Advances in sensor technology implemented as real-time alert systems may make drivers aware of potential accidents in enough time to react.

While accidents can be traced to a variety of factors including distraction, fatigue, aggression, and impairment, the fact remains—far too many vehicular accidents occur on the roadways.

With recent advances in sensor technology implemented both in roadsides and vehicles, there is a belief that real-time alert systems will give drivers a greater awareness of accident potential and sufficient time to react.

One of the leaders in advanced driver assistance system (ADAS) technology is Mobileye, which develops camera-based products that have been embedded in millions of vehicles across the globe. The technology is not only providing critical road safety capabilities, but that same data is also being applied by municipalities to enhance their smart community initiatives.

Mobileye's technology uses visual sensors that repeatedly scan and identify common highway features, obstacles, and conditions including lane markings, speed limits, road conditions, weather, pedestrians, accidents, obstructions, and other roadway-related information. Distances to these traffic constraints are continuously recalculated in real time



↑ Synthesizing data from a sensor network, analyzing it, and visualizing it can give cities a new kind of situational awareness.

and potential dangers are conveyed to the driver with visual and audio alerts. The system employs computer vision, an application of artificial intelligence that extracts cognitive information from digital images and videos that emulate how humans process and respond to visual information.

The technology deployed includes several traffic monitoring capabilities. The resultant safety features include autonomous emergency braking, blind spot monitoring, lane centering, forward collision warning, intelligent speed adaptation, night vision, pedestrian detection, road sign recognition, and other functions. The extensive amount of data collected to support these features is processed on the fly using onboard technology capable of performing trillions of mathematical calculations per second.

The spatial analysis capabilities in Esri's software is used on the data collected by Mobileye's ADAS to expand its functionality and provide cutting-edge location intelligence, refined visualization, and enhanced mapping capabilities. By synthesizing the data from this network of sensors into a common unified map, cities can now have a type of situational awareness that was previously unavailable.

"Vehicles equipped with this technology can function together as a fleet of powerful sensors that are actively moving around the city continually collecting imagery and data," said Jim Young, the head of business development at Esri. "The data collected provides the opportunity for the real-time monitoring needed for a number of community initiatives including

Cities can now have a type of situational awareness that was previously unavailable.

public safety and emergency response. We can provide it in a dashboard, overlaid with other data layers, to city officials to support better civic engagement."

When combined with other geospatial data maintained by the city, this information can stimulate cross-disciplinary collaboration among local traffic planners and engineers, police officers, and policy makers in support of smart community initiatives. Vision Zero is one such initiative that is gaining support in cities throughout the world. It was first implemented in Sweden in the 1990s in an effort to eliminate traffic fatalities and severe injuries while increasing safe, healthy, equitable mobility for all.

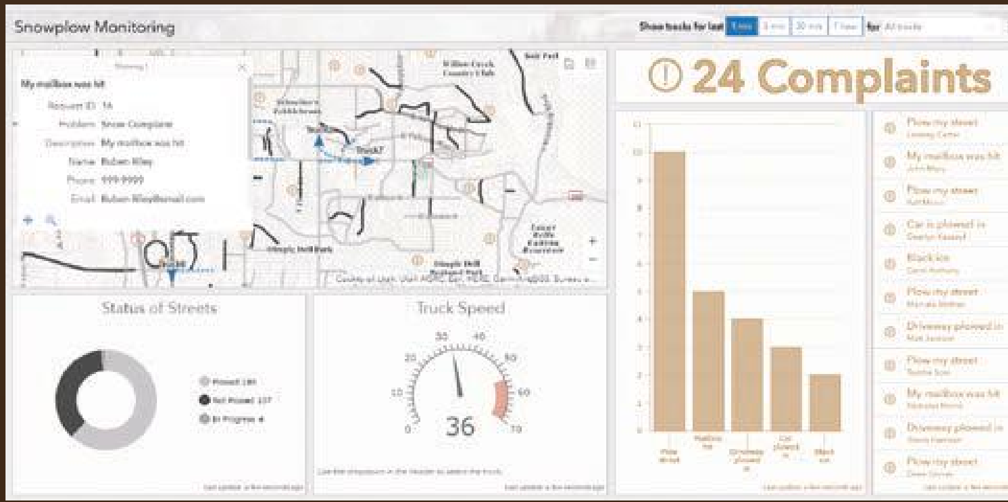
"Currently, we are developing connected ADAS systems," said Nisso Moyal, director of Business Development & Big Data at Mobileye. "What this means is that we will be able to alert drivers not only to a potential collision that has been detected by the onboard camera itself but also to dangerous conditions that are on the roadway ahead, such as a sharp curve or an accident 500 meters up the road that has been identified by another vehicle equipped with our technology."

Mobileye is planning to make greater use of artificial intelligence in the autonomous car system it is developing so that the cars using the system can respond more quickly and intelligently in emergency situations as well as heavy traffic conditions. By analyzing and learning from the data it collects and the decisions it makes based on that data, the technology will go beyond rule-based decision-making and develop more human-like response skills.

↑ Including the temporal dimension in visualizations of potential collisions with pedestrians can improve safety efforts.

Dashboards Make Data into Actionable Information

With the release of the next generation Operations Dashboard for ArcGIS, you can now have a comprehensive and engaging real-time view of your data that can be completely authored in a web browser.



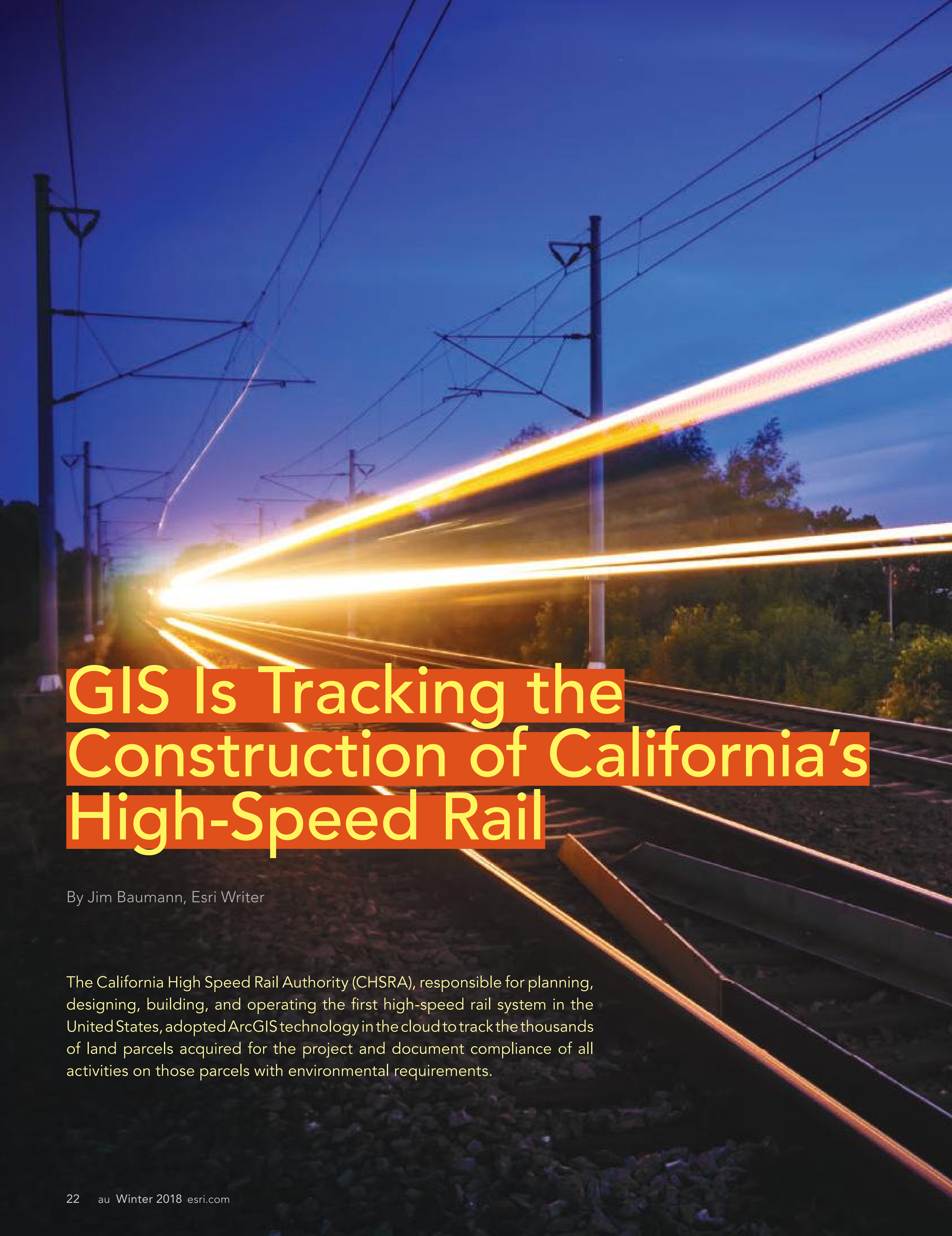
↑↑ This Water Quality Status dashboard instantly provides current information on the status of 182 stations.

↑ With the Snowplow Monitoring dashboard, streets that have been plowed, are being plowed, and have not yet been plowed can be identified immediately as well as the location and substance of all complaints.

Operations Dashboard for ArcGIS brings maps, lists, charts, gauges, indicators, and other elements together in a single web browser window, providing insights for at-a-glance decision-making. Most of these elements are data-driven and can use filtering capabilities to represent the information that fulfills the dashboard's purpose. The different data visualizations in a dashboard can communicate with each other and update in real time so you can monitor events, people, services, and assets. It turns your data into actionable information.

Dashboards can be operational. They can help your organization monitor what is happening now and respond to changes, incidents, or events. Dashboards can be strategic. These dashboards track key performance indicators and metrics. Dashboards can also be analytical. They can identify data trends or other interesting data characteristics.

Because Operations Dashboard for ArcGIS is fully integrated with ArcGIS Online and/or ArcGIS Enterprise, it can integrate your organization's data layers and maps. Since dashboards are items within an organization, they can be shared across the organization or with the public so everyone shares a common view. Create a new dashboard from the Map Viewer, Content page, a web map's item page, or launch Operations Dashboard for ArcGIS from the App Launcher in the header of your ArcGIS site. Add one or more elements, then drag, group, stack, and resize elements. Configure each one to present your data in the most useful way. Use the action framework to control the behavior of elements and build interactions that let users derive key performance indicators using selectors. If you currently use Operation Views created from the legacy Windows-based Operation Dashboard app, they will continue to work and be supported, but consider migrating to the new web-browser based Operations Dashboard app. Operations Dashboard for ArcGIS is included with your ArcGIS Online subscription and with ArcGIS Enterprise 10.6.



GIS Is Tracking the Construction of California's High-Speed Rail

By Jim Baumann, Esri Writer

The California High Speed Rail Authority (CHSRA), responsible for planning, designing, building, and operating the first high-speed rail system in the United States, adopted ArcGIS technology in the cloud to track the thousands of land parcels acquired for the project and document compliance of all activities on those parcels with environmental requirements.

High-speed rail (HSR) began in the post-World War II era as countries in Asia and Europe began rebuilding transportation infrastructure that had been destroyed during the war. These governments sought efficient methods for quickly moving people and connecting cities.

In the United States, Congress passed the High Speed Ground Transportation Act of 1965 as part of US President Lyndon Johnson's infrastructure-building initiatives. This was the first attempt to foster HSR in the United States. It precipitated a number of regional feasibility studies and the introduction in 2000 of the Acela Express, an Amtrak service that runs along America's Northeast Corridor and attains speeds of 150 mph along some sections of its routes.

High-Speed Rail in California

A long-time advocate of a high-speed rail system in California, Governor Jerry Brown signed legislation for a study concerning the economic, social, and environmental impacts of implementing HSR in the state during his first term in office in the late 1970s. CHSRA, formed in 1996, accelerated the project's plans. In 2008, California voters approved a bond issue to begin funding the project, and the state was awarded federal stimulus funds as part of the American Recovery and Reinvestment Act of 2009. Construction of the CHSRA project began in 2015.

The project will extend high-speed rail from Sacramento to San Diego, making the total high-speed rail system about 800 miles (1,300 kilometers) in length. The multifaceted project requires the study and acquisition of more than 10,000 parcels of land and the construction of extensive infrastructure including viaducts, tunnels, electricity generating stations, railway track beds, and other critical components. Because some proposed routes require running track through environmentally sensitive areas, stringent monitoring by CHSRA is necessary to adhere to environmental regulations.

The Challenge of Maintaining Compliance

A fundamental component of the design, construction, and maintenance workflows of the project is CHSRA's Environmental Mitigation & Management Application (EMMA). This database serves as a repository for the thousands of documents required by local, state, and federal authorities certifying that each required activity—review, survey, or environmental commitment—is in compliance with the environmental requirements specified in existing laws and the guidelines of various regulatory agencies. EMMA 1.0, based on Microsoft SharePoint and created in-house by CHSRA consultants, was launched in early 2014.

"The original version of EMMA was form driven and had no geographical component," said Ethan Casaday, senior environmental compliance planner for Cordoba Corporation, a subcontractor to WSP, an engineering professional services consulting firm that is the prime contractor on the CHSRA project. "This was because most construction projects being implemented around the country are within a relatively small footprint where environmental compliance or commitments can easily be managed traditionally with flat spreadsheets or checklists by a small group of staff."

An environmental commitment is anything CHSRA is obligated to do in relation to the project. They can be incorporated into documents such as project plans and permits. Because a commitment is recognized as part of the contract, it can be included in any stage of the process, such as the design, preconstruction, construction, and postconstruction, as well as operations and maintenance. Permits to do specified work are issued by government authorities, and commitments are part of the permit issuing process. Some permits have hundreds of commitments attached to them.

"The commitments can be pretty wide-ranging," said Chris Bente, planning and design delivery technologies manager for WSP." For example, one might require that a construction site be kept free of garbage. This is because garbage is not only a nuisance, but it can also attract predatory animals that could kill or injure an endangered species that inhabits the local area. Another common commitment is that there should be no permanent ground disturbance within a specified distance from a wetland to preserve the natural habitat.

"Once we moved beyond the design phase and into construction, the limits of EMMA 1.0 became apparent. The Phase 1 construction site is more than 500 miles long, and it is critical to know the location of all of the parcels of land that are part of the overall project and their related environmental commitments to see how they might impact one another," said Bente.

Using GIS to Monitor Compliance

In 2016, CHSRA began creating an enhanced version of EMMA with Amazon Cloud Services and ArcGIS for Server Advanced Enterprise as core components. Developers used ASP.NET MVC and a combination of C# and JavaScript, with JavaScript on the client side and C# for the server side of EMMA 2.0.

"With ArcGIS at the core of EMMA 2.0, we can now easily track the location and maintain detailed information about parcels of land we have acquired and will continue to acquire for the project and commitments related to those parcels that must be monitored and tracked," said Bente.

GIS, an integral component in the environmental compliance management process in EMMA, provides a mechanism for end users to effectively plan for future construction activities on parcels that require specific environmental commitments to be fulfilled prior to construction. Once an activity is completed, it becomes an EMMA record that provides evidentiary documentation that the commitment was fulfilled.

There can be 20 to 50 commitments on a single parcel that must be completed and tracked on a regular basis. Tracking commitments for environmental compliance on 10,000 or more parcels across the 800-mile route is a task of formidable size and scope. Building a tool like EMMA, with its robust GIS capabilities, was critical to accomplishing HSR objectives.

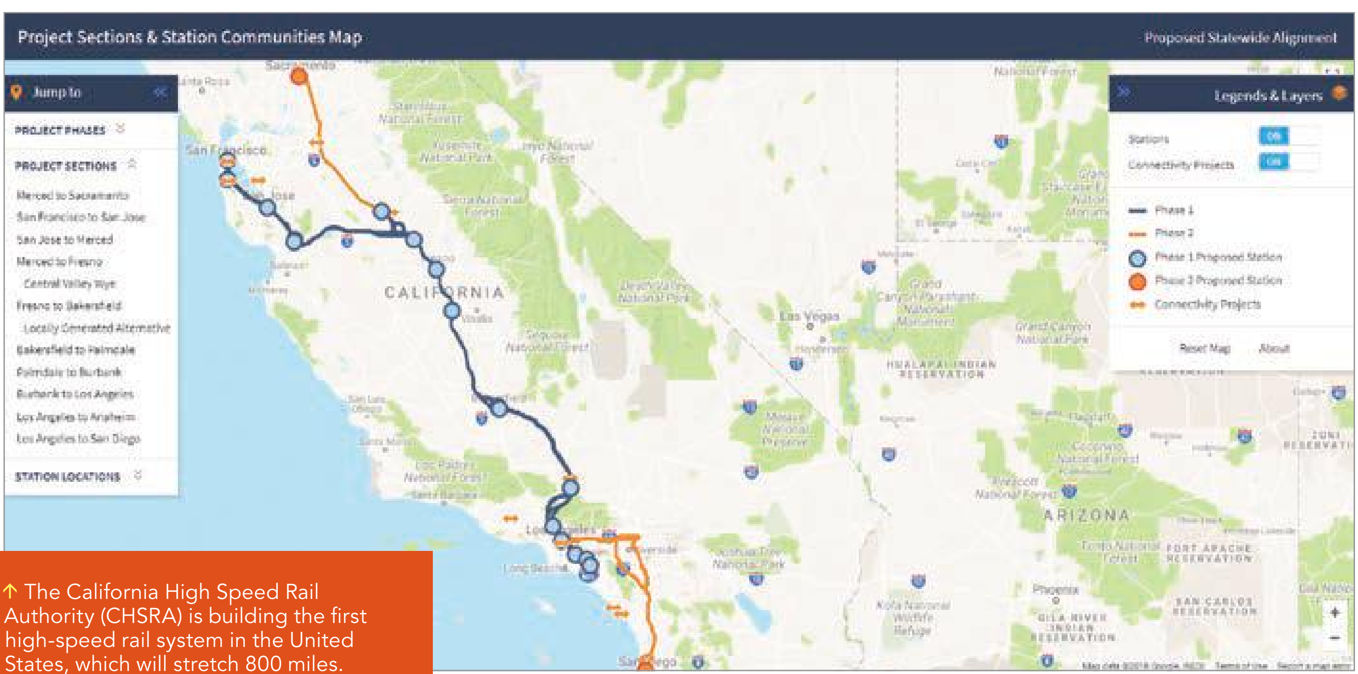
"EMMA 2.0 provides a powerful mapping interface that allows design build contractors to quickly identify the location of their work in the field," said Casaday. "It comes with intuitive search tools so that users can easily find environmental compliance commitments related to that location. Some of the commitments have to be addressed before beginning construction, and others have to be fulfilled on a regularly scheduled basis, depending on their nature."

Bringing that workflow to the field was a key requirement for EMMA 2.0. During the construction phase, much of the environmental compliance work is completed in the field. Inspections are conducted by specialists in disciplines, including biology, anthropology, hydrology, air quality, and cultural resources, that ensure all construction activities remain in compliance with established environmental policies and the specified commitments related to those disciplines.

"The new mapping interface allows contractors to more easily specify the location of their work and its progress for the many different contractors and agencies involved in the project," said Casaday. This streamlines reporting, review, and approval processes. In addition, the system manages complex environmental mitigation and tracks the available compensatory mitigation credits at sites across California that are required to offset project impacts.

A contractor working in the field can now digitally link a commitment with its matching Evidence of Compliance over the Internet. The records are connected to their corresponding location using the GIS interface. The combined information is referred to as an EMMA record. Maps, filters, and text searches can be used to query the database to create environmental compliance reports.

GIS data used by EMMA is maintained in the GeoPlatform, CHSRA's enterprise geospatial asset management system. This system maintains geospatial data such as project footprints, parcel datasets, and



↑ The California High Speed Rail Authority (CHSRA) is building the first high-speed rail system in the United States, which will stretch 800 miles.

↓ The San Joaquin River Viaduct will span the San Joaquin River in north Fresno and the Union Pacific tracks parallel to State Route 99 and feature a pergola structure to allow high-speed trains to cross over the top of the Union Pacific tracks.

↑ GeoPlatform, CHSRA's enterprise geospatial asset management system, maintains the GIS data used by the system that tracks environmental compliance for the project.

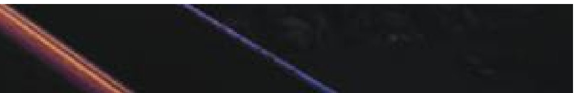
the construction package extents that are used by the contractors for construction purposes. EMMA is tightly integrated with the GeoPlatform.

EMMA's Future Capabilities

"ArcGIS for Server manages all our web services," said Bente. "We are currently using Geocortex Essentials *[from Esri partner Latitude Geographics]* for consuming those services and developing web mapping applications. We're planning to move to a front end *[that is]* more based on the ArcGIS API for JavaScript in the future."

Additional enhancements to EMMA will include expanding the map interface to act as a spatial selection tool. For example, if HSRA wants to know what kind of work or the volume of work that is being done in a specific location, the system will produce a report on all work at that site, and it will be available in a variety of common formats, such as PDFs and Microsoft Excel spreadsheets.

In addition, a Consultation Tracker module will be implemented because some parts of the CHSRA project are so large that they must be completed by more than one contractor. This requires a separate set of permits for each contractor. The application will allow different contractors to stay informed of the status of the parts of the project they are working on. Another planned module will track replanting of trees and other vegetation after construction to provide metrics on the restoration of the natural landscape, another aspect of the project's environmental compliance.



Protecting New York City's Water Supply

By Joshua VanBrakle

A nonprofit organization dedicated to preserving water quality and a viable rural economy in upstate New York used imagery and GIS to better safeguard the New York City Watershed.

The New York City Watershed is the largest unfiltered surface water supply system in the United States. Every day this region in upstate New York's Catskill Mountains provides more than a billion gallons of clean drinking water to the more than 9 million people residing in New York City and upstate counties. The system includes 19 reservoirs, three controlled lakes, and a watershed that spans more than a million acres. In some cases, water travels more than a hundred miles to reach New York City.

Other large US cities typically own the land that drains into their reservoirs. New York City is unique. Private citizens control about 75 percent of the water supply region. Consequently, New York's water quality depends in large part on the actions of the 30,000 landowners who live, work, and recreate on watershed lands.

The Watershed Agricultural Council (WAC) is a nonprofit organization based in the New York City Watershed. WAC seeks to balance water quality protection with a viable rural economy. To accomplish this, the organization uses technical assistance and cost-sharing to help watershed farmers and loggers use water quality protection measures (known as best management practices, or BMPs) in their farm operations and timber harvests. Since WAC's founding in 1993, the organization has helped 90 percent

↑ Forests act as natural water filters, removing many pollutants before the water reaches streams, lakes, and reservoirs. The New York City Watershed has extensive forests, but most are owned by private citizens. The choices these landowners make about the management of their forests can help or harm the drinking water for 9 million New York residents.

of the watershed's farms improve the effect of their operations on water quality.

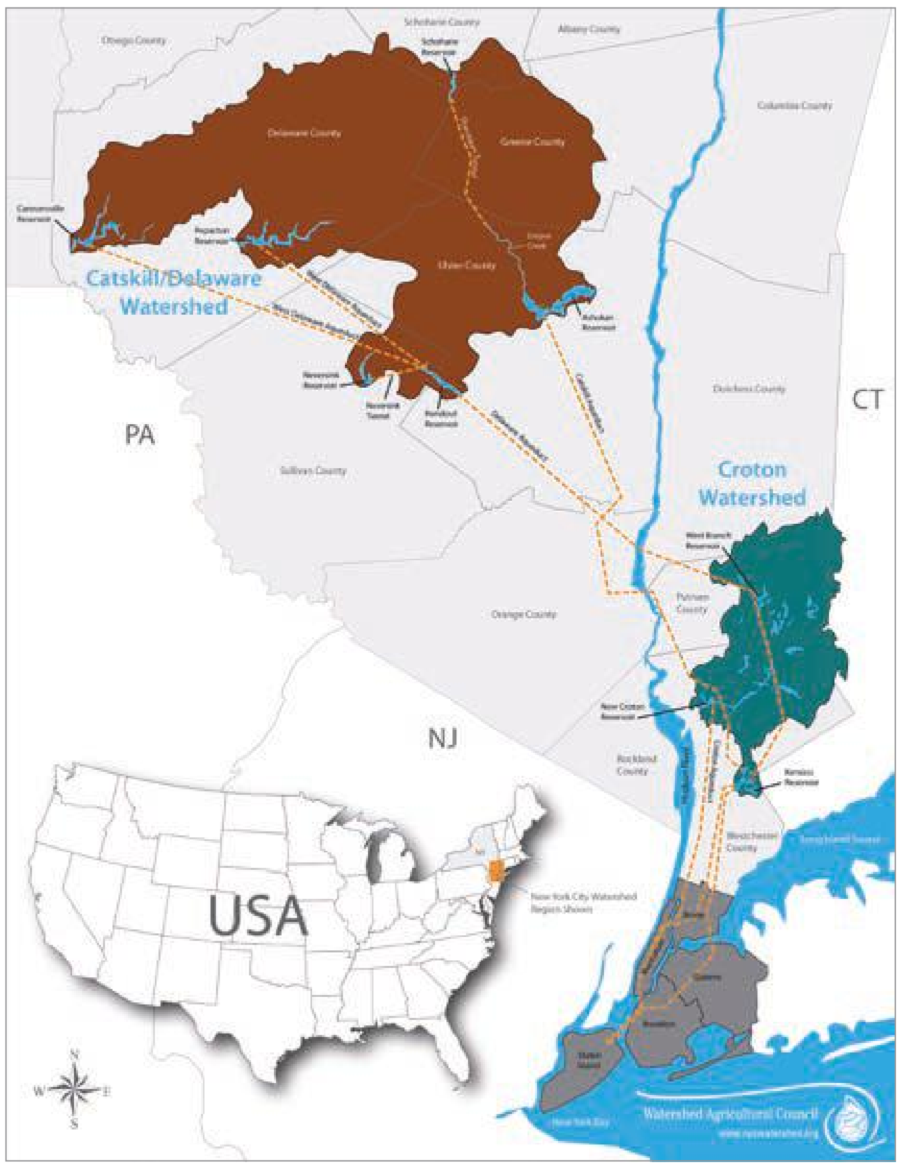
Until recently, WAC had no way to gauge its effectiveness in improving the effect of logging operations on water quality. Farms are static, but logging operations move across the landscape. Unlike some other US states, New York has no system of timber harvest notification requiring landowners or loggers to alert the state before logging. This meant WAC had no way of knowing how much logging was taking place in the New York City Watershed, the extent that logging activities threatened water quality, or how effective WAC's programs were in reducing water pollution from logging.

That changed in 2016. WAC learned about Feature Analyst, an extension for ArcGIS developed by Esri partner Textron Systems. Feature Analyst can interpret aerial photographs and translate the features in them to create ArcGIS layers suitable for geoprocessing. WAC set out to use ArcGIS and Feature Analyst to identify all logging in the New York City Watershed.

In the first step in this process, a GIS analyst added aerial photos of the watershed to ArcGIS. WAC used National Agriculture Imagery Program (NAIP) photos taken in 2013 and 2015 because they were the most recent "leaf-on" (i.e., taken during the growing season) images available. Leaf-on imagery was essential to spot canopy gaps that would signify where logging had occurred. The GIS analyst used original TIFF photos rather than compressed county mosaics because creating mosaics alters the value of individual pixels. Most of the NAIP images for the New York City Watershed were taken in July 2013 and July 2015, so those months became the start and end dates for logging site identification.

The next step was manually indicating examples of what WAC wanted Feature Analyst

↓ The New York City Watershed covers more than a million acres in upstate New York, with most of the land in the rural Catskill Mountains.



A

B

C

to find in the images—to create training sets for the software. WAC records where BMP cost-share programs work with loggers, so those were the initial locations for training sets. Those training sets marked canopy gaps, usually spots of brown, bare ground surrounded by green tree canopy. Feature Analyst uses the reflectance values and textures of the features inside and bordering the training set to identify similar features elsewhere in an aerial photo. The initial output is often poor and contains many irrelevant features such as roads, fields, and buildings.

To improve these initial results, Feature Analyst allows the user to indicate sample areas that the software got right or wrong. Feature Analyst then uses this information to learn what the user is looking for. After several rounds of this learning process, the software became better at identifying canopy gaps. Once Feature Analyst could reliably identify canopy gaps, the software's batch processing function allowed analysis of multiple aerial photos automatically. WAC identified properties where logging occurred by overlaying Feature Analyst's results with county tax parcel layers. The organization only works on private lands, so they excluded tax parcels owned by government agencies.

Feature Analyst isn't perfect. Even after multiple rounds of training, it would pick up features that looked like logging sites but were blowdowns and trees killed by insect infestations. To correct these issues, the GIS analyst manually double-checked the results and removed tax parcels where Feature Analyst had erroneously selected features. The GIS analyst intentionally trained the software to be aggressive in identifying canopy gaps, because it was easy to remove incorrect parcels, while there

A
Training set features shown in pink were used to teach Feature Analyst to identify canopy gaps in a known harvest location.

B
The first run based on the training set misidentified roads, fields, and buildings as canopy gaps.

C
After three rounds of training, many more features were correctly identified as canopy gaps.

was no practical way to find logging sites Feature Analyst missed.

When Feature Analyst located a logging site, the analyst confirmed whether it happened during the project window by comparing the 2015 photo against the 2013 one. If it did, the analyst recorded the harvest boundary based on the canopy gaps Feature Analyst identified. The analyst also classified the logging in one of four categories—Light, Heavy, Clearcut, or Land Clearing—based on how much canopy was removed.

Light areas had less than 50 percent of the canopy removed, while areas classified as Heavy had more than 50 percent of the canopy removed. Clearcut areas had 100 percent of the canopy removed. Land Clearing areas were places where the land use changed to nonforest use.

Harvests classified as Land Clearing were recorded but excluded from the final tally because they represented land-use change. WAC wanted to know where logging occurred on land that would either remain as is or return to forest cover after the harvest.

In practice, separating Land Clearing areas from Clearcut areas was straightforward owing to factors such as the size of the cut, its location relative to roads, the size of the parcel, the addition of any structures, and whether other logging occurred in the same parcel.

Finally, the analyst identified all the areas where logging occurred within 100 feet of a stream by intersecting the final logging layer with a 100-foot buffer of New York City Watershed streams. The National Hydrography Dataset (NHD) provided the stream layer to produce this buffer. The NHD was chosen for its accuracy and inclusion of smaller streams compared with similar layers.

The entire project took one GIS analyst about three months to complete. WAC plans future replications of the project as new NAIP imagery becomes available. This project revealed—for the first time ever—the scope of logging in the New York City Watershed. WAC learned that the watershed has 183 timber harvests on private lands annually, covering an area of 7,092 acres. This area represents 1.25 percent of the watershed's private forest cover, a level of harvesting that should allow for a sustained yield of timber over time. WAC's logging BMP cost-share program works on 45 of these harvests annually, but these are primarily the larger harvests, so 40 percent of the harvested acres occurred on logging jobs where WAC funded BMPs.

The project also revealed areas of the watershed where WAC has little presence, which will help the organization market its programs. WAC will be able to selectively reach out to loggers and landowners in these regions to encourage them to work with the organization when they log their properties.

WAC also learned that the cutting of trees is not specifically a threat to New York's water supply. Nearly all acres logged were Light harvests (93 percent), meaning loggers removed less than 50 percent of the canopy. Almost no logging (5 percent of harvested acres) occurred within 100 feet of a stream, and 96 percent of that logging was Light.

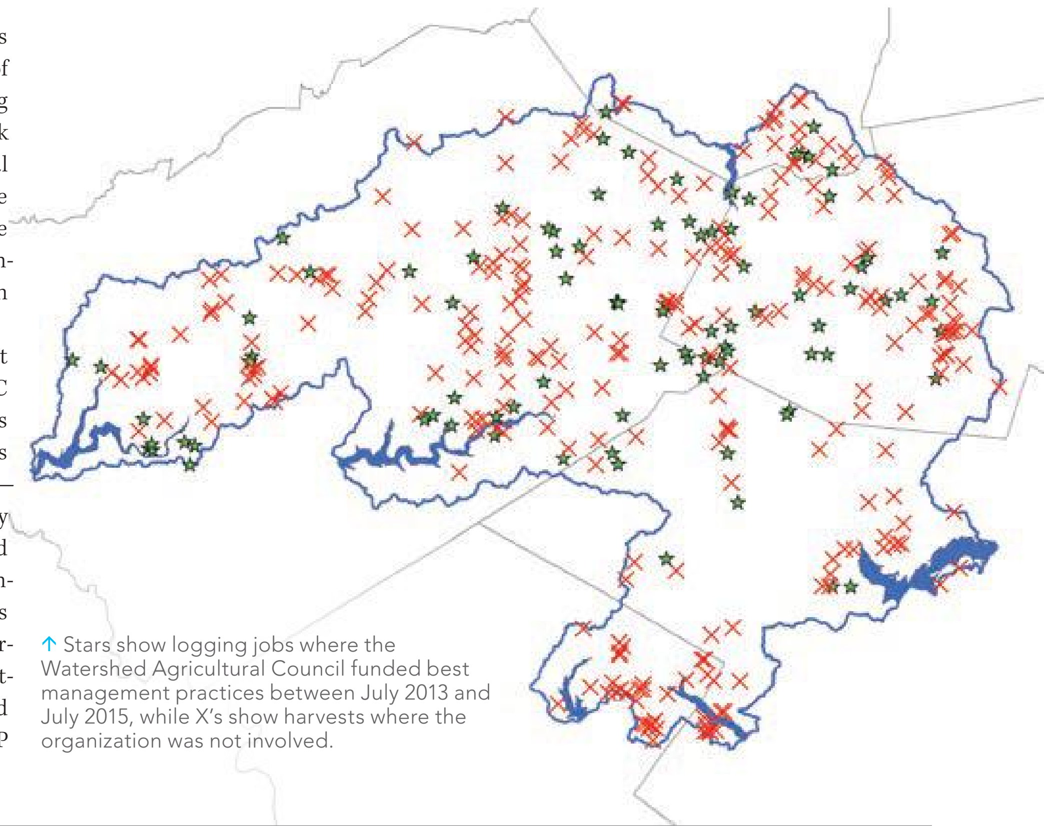
This is good news for water quality, because previous research in the watershed had found that when canopy removal is less than 50 percent, increases in common water pollutants like nitrates are minimal and short term. Only when intensity increases beyond 50 percent do those increases become significant and long lasting. That said, the systems of roads and trails loggers use to remove timber from the woods can still cause water quality problems even for Light harvest areas, so WAC plans to expand its efforts to help loggers adopt more BMPs on those trails.

Thanks to ArcGIS and Feature Analyst, WAC learned the extent of logging and its water quality impacts in the New York City Watershed. The organization also gained insight into the reach of its cost-share programs and identified places to target its outreach. With this technique, WAC finally has a way to track its progress and ensure the logging industry does its part to protect the water 9 million New Yorkers depend on.

For more information, contact Josh VanBrakle, GIS specialist at the Pennsylvania Land Trust Association, at joshvanbrakle@gmail.com.

About the Author

Josh VanBrakle is a GIS specialist at the Pennsylvania Land Trust Association but was the research and evaluation forester at the Watershed Agricultural Council (WAC) when this project was carried out. He is also the author of *Backyard Woodland: How to Maintain and Sustain Your Trees, Water, and Wildlife*. VanBrakle holds a bachelor's degree in environmental economics and policy from Lebanon Valley College and a master's degree in natural resource management from the State University of New York (SUNY).



↑ Stars show logging jobs where the Watershed Agricultural Council funded best management practices between July 2013 and July 2015, while X's show harvests where the organization was not involved.

Can a Map Speak for Those Who Cannot Speak for Themselves?

By Christopher Thomas, Esri Director of Government Markets

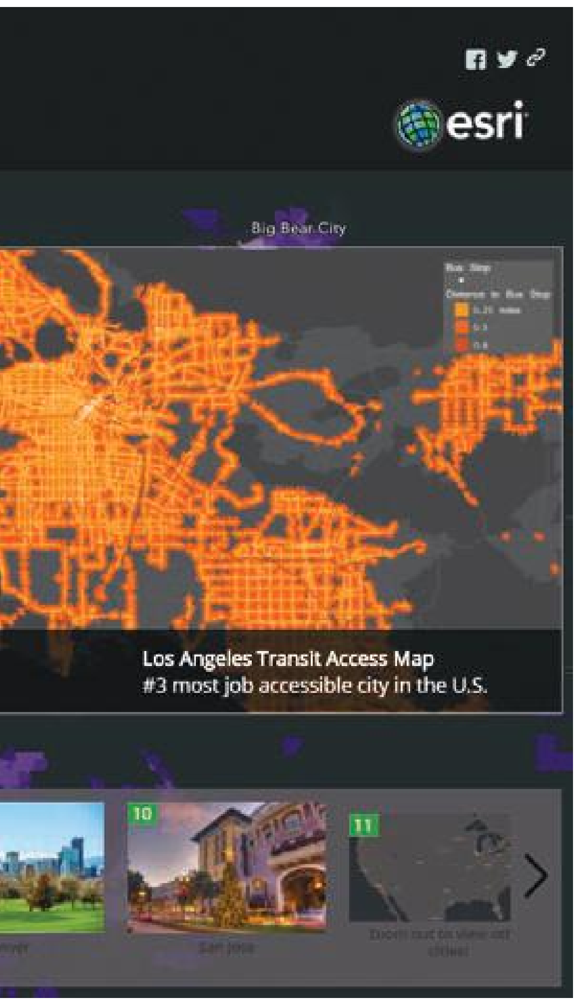
I am not certain that what I am about to share with you qualifies as a trend yet. It may simply be the realization that GIS can be applied to things other than trees, concrete, and taxes.

Governments started to use GIS for land assessment, infrastructure planning, and urban design, but now we see a shift toward using GIS technology to improve disparities and social inequalities. The problems we hear on the news—homelessness, income inequality, unemployment, opioid abuse, blight, community policing, access to public transit, food deserts—all point to the social issues we should be applying data and analysis to solve.

Does your organization feel the pressure to address these social inequities? Is this an opportunity for GIS professionals to become superheroes in social justice?

Governments have been producing

Will you accept the challenge to apply technology to overcome social inequities in your community today?



demographic maps that show basic population information for decades. However, Stephen Goldsmith, director of the Innovations in American Government Program at Harvard's Kennedy School of Government, has observed that we need to shift from demographic maps to policy maps that showcase the opportunity to intervene and overcome social inequalities today.

We now see that governments are moving from creating simple maps of bus routes to looking at analysis of transit routes in relation to income, availability of cars, and job opportunities. This application of analysis lets maps speak for those who can't speak for themselves. I cannot think of many technologies that can reveal insights and the interdependencies between people, government services, and social inclusion in the way that GIS does.

Clearly, using data—big *and* small—to better understand inequities and resolve issues in real time is a trend. Open data and crowdsourcing show us new ways to understand our world.

For example, policy maps showcase employment data and overlay it with analytics that shows whether household income is above or below the living wage or whether new jobs can support a higher standard of living.

Musician and philanthropist will.i.am uses data to validate his argument about the need to prioritize education spending over prison spending. Where's the Love? Where's the Education?, an Esri Story Map app he created for his foundation's website, shows that we are spending more on prisons than education. It shows that we may not be allowing people to turn their lives around.

Insight without immediate action is not enough. Iterative policy making—addressing issues in real time—is the next shift we need to make. Dekalb County, Georgia, was the first county in the nation to geocode its

↓ Communities are mapping where citizens can drop off unused prescriptions or find treatment programs.

Open data and crowdsourcing show us new ways to understand our world.

homeless populations in real time to locate unsheltered people who were eligible for housing assistance. This helped the county identify those in need down to the street level and better allocate resources.

In New Orleans, Louisiana, the city released a mobile crowdsourcing application to gather invaluable data on blighted properties. Using this publicly available app, citizens and government employees collected accurate profiles of the condition of more than 16,000 properties within weeks. With this information, government officials could develop policies and tactics that addressed the issue of blight almost immediately. These stories are examples of government agencies making use of GIS in new ways to tackle social issues as well as more traditional uses of the technology.

Time will tell how much the application of GIS to social inequities will benefit our communities. Early adopters are already finding success by collecting and analyzing disparate datasets to reveal new insight, taking advantage of readily available applications and dashboards to improve situational awareness and operational tactics, and shifting to iterative policy making to address issues in real time.

Will you accept the challenge to apply technology to overcome social inequities in your community today?

About the Author

Chris Thomas is a founding team member of the industry marketing department at Esri and the director of government marketing for Esri. Prior to joining Esri in 1997, he was the first GIS coordinator for the City of Ontario, California. Thomas is a frequent columnist on the use of GIS by government. Follow him on Twitter @GIS_Advocate.

↓ Dekalb County, Georgia, was the first county in the nation to geocode its homeless populations in real time to locate unsheltered people who were eligible for housing assistance, and to better allocate resources.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Six Essentials for Your Next GIS Implementation

By Jeff Robinson, CIO of Professional Services, Esri Australia

When it comes to rolling out a new GIS, there are pitfalls that can derail even the best-laid plans. During any given month, my team has more than 20 different GIS implementation projects in process. After six years of seeing firsthand what works and what doesn't, I thought I'd share a few hard learned lessons. This article shares my six top tips for successfully implementing a GIS.

1 Don't overcomplicate things.

Sometimes you'll find that the simplest application can deliver significant results. Consider establishing an initial operating capability (IOC) that you can build on as you become more familiar with the outputs of your new system. Be careful not to be wowed by add-ons that you might not need initially. Start from a solid foundation, optimize your workflows, and analyze the results. Do this and you'll be in a far better position later when your team is ready to deliver more advanced GIS capabilities.

2 Forget the past.

When it comes to GIS swap outs or major system upgrades, one of the costliest errors is configuring the new system to mimic the functionality of a legacy system. When this happens, the limitations of the old system are invariably replicated in the new system.

When it comes to scoping the new configuration, it's best to start by thinking about what functionality you want rather than the functionality you are most familiar with. This way, you'll avoid seeding your new system with the very functionality that brought you to the decision to upgrade. It's also a fail-safe way of ensuring that you are addressing future needs.

3 Prioritize training.

You wouldn't put a high-performance vehicle in the hands of a student driver. The same principle applies to your new GIS. Don't accept a basic knowledge handover at the end of a project. Insist on receiving ongoing learning and skill development from your solution provider. Ideally, look for professionally delivered one-on-one training or facilitated group courses. Once your new system is established, it would also be worth tapping into low-cost training alternatives like webinars, user groups, and technical blogs.

4 Establish a data-sharing plan.

One of the biggest oversights in GIS rollouts is the absence of a holistic data-sharing plan. Considerations such as secure environments usually (and understandably) take precedence in planning, but often at the expense of other, more practical requirements such as ensuring that data custodians' and consumers' needs are aligned or fluctuating demands have quickly scalable solutions. To keep from deploying a GIS with limited information transfer capabilities, ensure that your plan covers the *who, when, how,* and *where* of data sharing.

5 Keep IT in the loop.

There is nothing more disappointing than going through the ordeal of getting approval for a system upgrade only to have your project obstructed by your IT department. As a CIO, I can assure you that IT people have feelings too. My best advice is to get your IT team involved early and ensure they're aware of your organization's GIS objectives. Do that and you may just find a willing GIS champion within their ranks. If your IT team has concerns about the capabilities of staff or systems, your technology provider should be able to present a solution that boosts both expertise and capacity.

6 Don't rush to replace.

When it comes to big GIS implementations, one of the things I'm seeing less and less is a rush to kill off outdated systems. Before you undertake a wholesale swap out of your existing GIS, I'd recommend that you take a quick look at how complex organizations like utilities are deploying the latest GIS technologies to bolster their legacy systems. It's inventive spatial thinking at its best.

Those are my top tips for managing a GIS implementation. Best of luck with your next project.

About the Author

Jeff Robinson leverages more than 20 years of industry experience to provide organizations with the highest value from their GIS technology. As the executive manager across Esri Australia's professional services offering, he is responsible for all consulting, project delivery, and support to Esri Australia's partners. He manages a nationwide team of 100 GIS professionals that partner with some of the region's leading blue-chip companies and government agencies to deliver tangible benefits to their businesses.

Web Developer Spotlight

Five Useful Tidbits for the ArcGIS API 4.x for JavaScript

By Julie Powell, Rene Rubalcava, and Yann Cabon
Esri Software Product Development

Wish you could sit down with an experienced developer and pick up some productivity tips or learn some of the less well-known capabilities of the ArcGIS API for JavaScript? Well, now you can. This article shares some of the handiest features in the API that you can use right away.

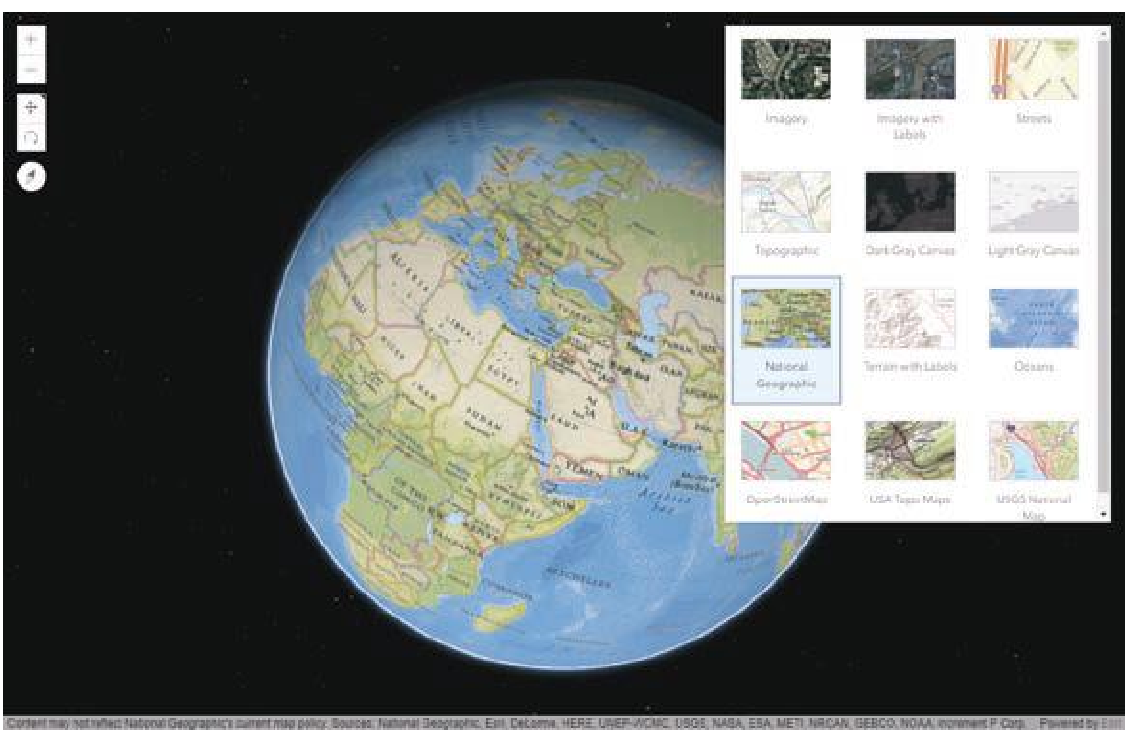
1 Save time with queries

Many apps need to perform queries as part of key workflows. If you've built an app with the ArcGIS API for JavaScript, you might be familiar with QueryTask, which allows you to do spatial and attribute queries against services to find features that match your criteria.

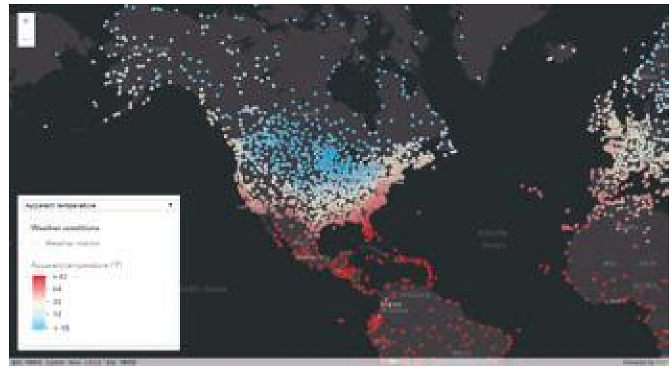
There is a less well-known way to do queries that could save you time. Instead of using the traditional approach to create a new query object, create a query right from a feature layer or scene layer by calling the featureLayer.createQuery() or sceneLayer.createQuery().

If you create the query directly on the layer, your queries will be prepopulated with existing definition expressions or other query parameters already set on the layer. You can then modify the query parameters as needed. For example, you can specify a geometry for a spatial query or adjust the where statement.

After you have executed your query, easily zoom to the envelope of the returned features by passing the query results to the goTo method. This works for both 2D (in a MapView) and 3D (in a SceneView).



← Use the BasemapGallery widget to display a collection of images representing basemaps from ArcGIS Online, ArcGIS Enterprise, or a custom set of map or image services.



→ This map uses an Arcade expression to calculate values for visualizing the apparent temperature measured at weather stations worldwide.

2 What you need to know about picking basemaps

You pick one of Esri's default basemaps simply by referencing it by name inside your map definition (e.g., basemap: "streets" or basemap: "topo-vector"). Several default basemaps are available in either vector or raster format, and each version has a unique name. For example, the raster version is "topo," and the vector version is "topo-vector."

You can also use a basemap that is not an Esri default basemap in your application.

Find any of the basemaps provided by the ArcGIS platform by searching ArcGIS Online. Once you find the desired basemap, reference it by its item ID to load it in your application. The item ID is found in the item URL after "id=". Use this form:

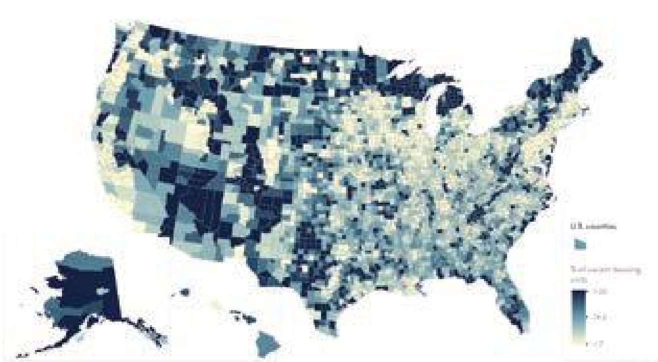
```
new Map({baseMap: {portalItem: {id:"WebMap-id-with-basemap"}}})
```

You can even update the basemap used by a web map after it is loaded by providing a new portalItem as shown in Listing 1.

```
webmap.load().then(() => {
        webmap.basemap = {
          portalItem: {
            id: "b74e3eeef31942869c1f611f341ce8ed"
          }
        };
```

↑ Listing 1: Updating the basemap

↓ This map of the United States includes three map views in three different spatial references. It uses the dynamic projection of features in a feature layer inside each map view.



If you'd like to try this using a fun basemap, search "creative vector tile layers" on www.arcgis.com and browse some of the interesting vector tile basemaps Esri has published.

You can also let the end user pick the basemap. The ArcGIS API for JavaScript gives you a few widgets you can use to allow your end user to dynamically switch between basemaps in your app.

The BasemapGallery widget displays a collection of images representing basemaps from ArcGIS Online, ArcGIS Enterprise, or a custom set of map or image services. If the user is signed in to an ArcGIS Enterprise or ArcGIS Online account, the group of basemaps configured for the organization will automatically populate the BasemapGallery widget. You can also let the user switch between two basemaps using the simple BasemapToggle widget. This widget, like all widgets in ArcGIS API for JavaScript, is responsive and will adapt appropriately to any screen size.

3 Use an expression to dynamically create an attribute for visualization

The ArcGIS API for JavaScript provides powerful ways for you to turn data into information using data-driven visualization. Attributes in a layer can be used to drive the color, opacity, size, or rotation of features. Traditionally, this is done by directly using the attribute values in the layer.

What if those attributes aren't in the layer? You can now use an Arcade expression to dynamically calculate another field at run time to drive the desired visualization. This dynamic field can be calculated using any information source—including a combination of other attributes in the layer.

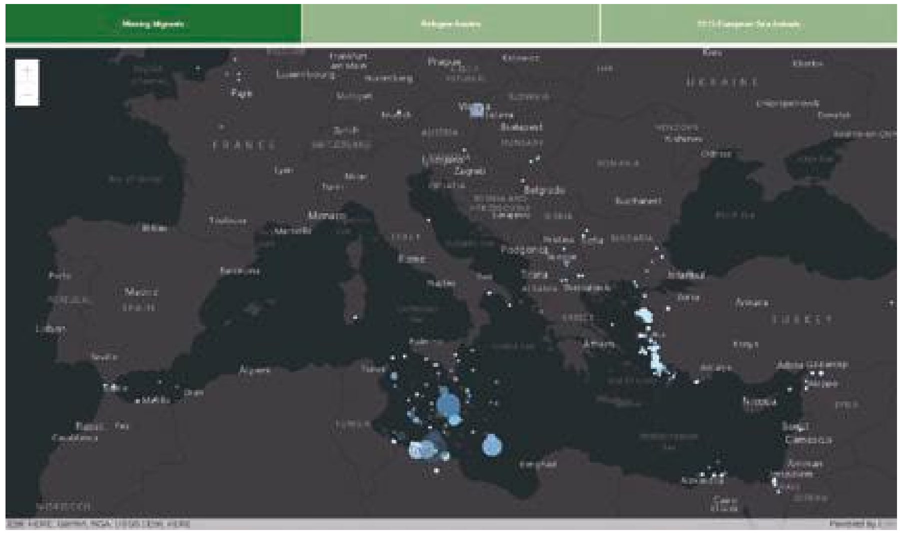
Using Arcade eliminates the need to add new fields to a service layer but yields the same results. For example, to visualize the temperature that people actually perceived rather than the temperature that was measured at weather stations worldwide, wind chill and heat index attributes available in a weather service were used by an Arcade expression to generate the fields used for this visualization of apparent temperature. The expression determined which variable (wind chill or heat index) to use as the apparent temperature.

4 Display the same map with different projections

With version 4.x of the ArcGIS API for JavaScript, you can display multiple views of the same map using different spatial references. Perhaps you have a primary map of a region that is best displayed with a particular spatial reference, and an inset map showing another region that is best displayed with another spatial reference. Each view uses the same map instance containing a feature layer.

Feature layers are dynamic and include support for projecting features to different spatial references. Note that this ability to reproject on the fly separates the feature layer from other static layers, such as a vector tile layer, that only display data with the spatial reference applied to the data when the vector tile was created.

By default, the view will use the spatial reference of the basemap. If the basemap isn't specified, then the spatial reference of the first operational layer is used. Explicitly setting the view's spatial reference to a different coordinate system overrides the spatial reference of the operational layers. You can play with a sample demonstrating this functionality by going to js.arcgis.com, clicking the Sample Code tab, and searching the samples for "composite views."



→ To maintain the center, scale, and rotation between web maps, assign each web map to a single instance of the map view and use the web map properties to create a new map view object for each web map.

5 Switch between web maps in your app and maintain focus

blogs.esri.com/
esri/arcgis

To tell a story, you might want your app to allow the user to switch between web maps in the app to show different datasets or alternative visualizations. You can either maintain the center, scale, and rotation of the map view when the user switches between the web maps or allow all web maps to be initialized independently using the properties originally saved in each web map.

If you want a smooth experience when showing different datasets or visualizations of the same location without changing the map's focus, maintain the center, scale, and rotation between web maps. If the web maps have data appropriate for different extents or scales, you'll probably want to use the properties saved with the web map. With either approach, the first step is to create a WebMap object for each web map you want to display by referencing the web map ID.

To maintain the center, scale, and rotation between web maps, assign the web map you want to be displayed to a single instance of the map view.

To use the properties saved with the web map, create a new map view object for each web map and display the currently selected view.

To play with this functionality, go to js.arcgis.com, click the Sample Code tab, and search for "swap web maps."

Read the *ArcGIS Blog* (blogs.esri.com/esri/arcgis) regularly for current and helpful information. Just search for "javascript" to locate posts on the ArcGIS API 4.x for JavaScript. Also check out the ArcGIS API for JavaScript developer site at js.arcgis.com, which contains a wealth of samples, an API reference, and guide topics to help you.

Happy coding!

About the Authors

Julie Powell is the product manager for the ArcGIS API for JavaScript. Rene Rubalcava, is a product engineer on the ArcGIS API for JavaScript team. Yann Cabon is the lead developer on the ArcGIS API for JavaScript team.

It's All about You at the DevSummit

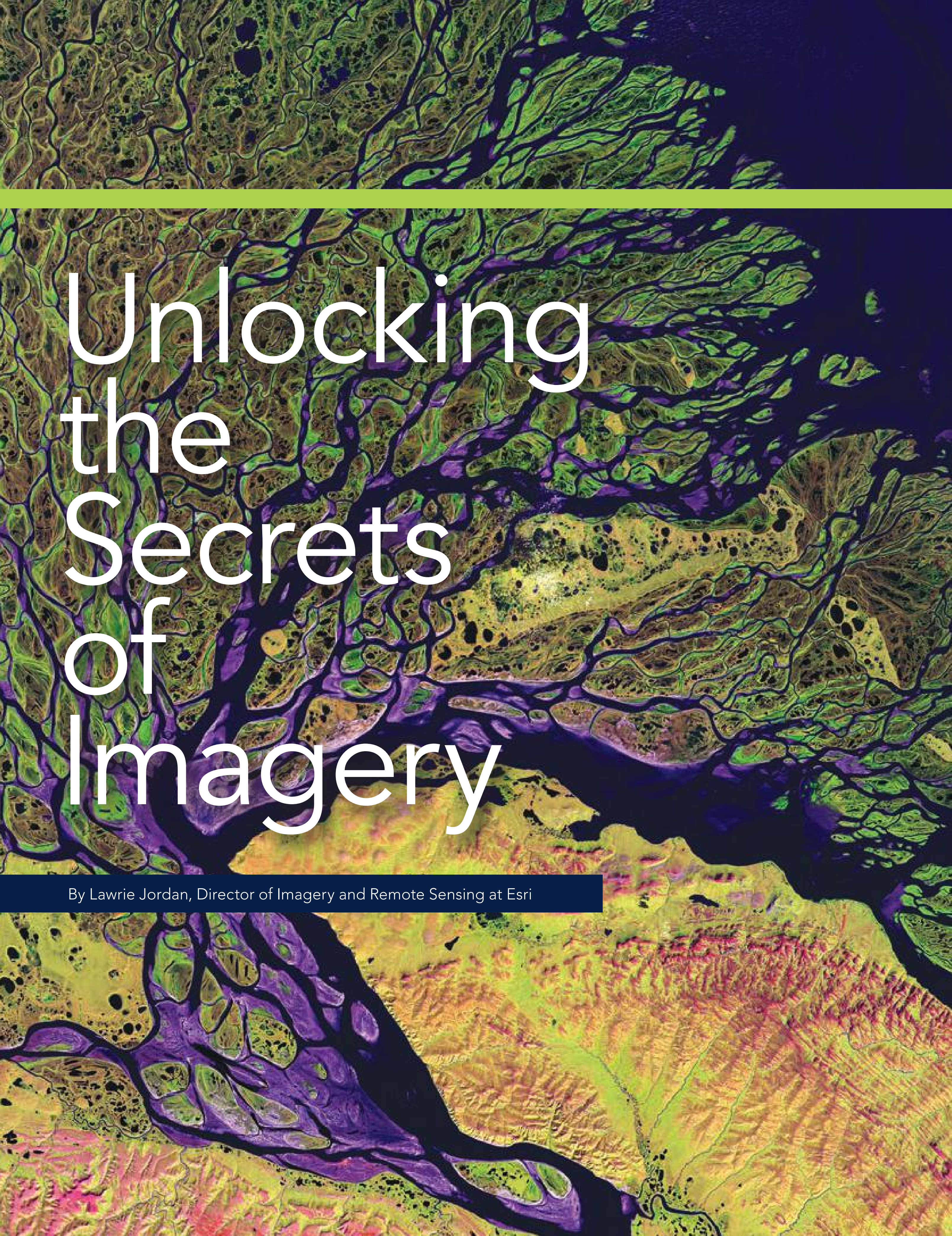
The 2018 Esri Developer Summit (DevSummit), March 6–9 in Palm Springs, California, is an opportunity for developers who use Esri technology to meet face-to-face with the developers who make Esri technology.

During three days of demonstrations, discussions, and dodgeball, you can learn about the latest software development tools and where the technology is going in the coming year while having fun and networking with peers. Learn tips, share your experiences, and socialize at this event designed exclusively for developers who use GIS technology. Take home best practices for web application security, performance, scalability, map services, caching, feature services, and editing.

Because DevSummit is by developers, for developers, user presentations are chosen by you and your fellow devs. Lightning Talks are an opportunity to share experiences with a tough problem or a masterful solution in just five minutes. Exchange ideas and maybe meet your next collaborator during SpeedGeeking.

DevSummit is not only a chance to work hard but also a chance to play hard. Play in the epic annual dodgeball tournament. During Tuesday and Wednesday evenings, join fellow devs exploring Palm Springs using the free shuttle bus to get around town. Hang with old friends and meet new ones at the social events.

Registration includes all scheduled developer sessions, continental breakfasts, beverage breaks, daily lunches, access to the Esri Showcase, the Monday GIS Solutions Expo Social, and the Thursday Developer Summit Party. Register today at esri.com/devsummit.



Unlocking the Secrets of Imagery

By Lawrie Jordan, Director of Imagery and Remote Sensing at Esri

← Imagery can provide exquisite views of the world as shown in this image of the Lena River Delta Reserve in Russia. (As featured in *The ArcGIS Imagery Book*, Esri Press 2016.)

A special relationship exists between remote sensing and GIS.

It's a relationship that goes back to the very beginnings of modern GIS in the late 1950s and early 1960s. During those days, computer systems for GIS were big mainframes that were very expensive and very slow. The databases that GIS operated on were built primarily from imagery: either digitized maps that were abstracted from imagery or features that were digitized directly from aerial photographs.

Right from the beginning, imagery played a key foundational role in the creation of modern GIS. The two technologies co-evolved. The terrain and elevation data typically came from stereo image pairs. Roads, building, land cover, land use, and cultural features—even subsurface features like geology and soils—were either directly or indirectly inferred from remote sensing. GIS and remote sensing are like two sides of the same coin.

In 1972, a revolution happened with the launch of the first satellite of the Landsat system. This was the first publicly available earth observation imaging satellite. It continuously imaged the earth, capturing a new image of the same spot every 16 days. Because it was so high up, Landsat gave us an entirely different picture of the earth. It continuously refreshed that picture and gave us things we couldn't see with our naked eye, such as thermal and infrared imagery, which gave us new information. The Landsat system was a real breakthrough because it not only gave us a new view but also a new vision of the possibility of what GIS could be.

That system continues to be a workhorse today, led by the Landsat 8 satellite, as the overall Landsat program is now entering its forty-sixth year of continuous operation. Landsat started a revolution in commercial earth observation that continues today. The volume of remotely sensed imagery is now exploding with hundreds—and soon thousands—of small satellites, microsatellites, and video cameras in space.

There is a wealth of information—a whole host of secrets that are locked away inside remotely sensed imagery. We want to unlock those secrets and get information products—not just the data, not just the pretty picture—out of this imagery.

We want to answer difficult questions. Where are the healthy forests? Where are the sick crops? How much damage was caused by that earthquake or that tsunami? How do we get to that information quickly without being an expert?

Today imagery is fully integrated into a modern GIS, and the emphasis is on simplicity and speed. This whole trend toward simplicity is a very important one in GIS. Modern GIS is becoming much simpler and easier to use, and this is a very good thing.

A relevant example that illustrates how complex technology can be made simple and easy to use is the car navigation system. I like to call this the illusion of simplicity. Think about the car navigation system. It knows where you are. You give it an address and it just takes you there—gracefully. If you get lost or you don't follow directions, it will growl at you for a minute, then recalculate and take you a new way. The benefit of this is you are never lost. You just hit the Home button and it takes you home. Society is no longer lost.

What we don't see (fortunately) is all the technology in the background that makes this happen, which includes four of the most complicated technologies ever invented. The car navigation system requires a constellation of satellites orbiting a few thousand miles up that are triangulating with each other more than a thousand times a second and communicating with your car through the atmosphere. At the same time, the earth is moving, the satellites are moving, and your car is moving at a variable rate of speed. Your car's precise location is dynamically plotted using advanced routing algorithms as it travels along a topologically structured vector network that is attached to a geodatabase that contains attributes that can be used to tell the location of the nearest gas station.

Luckily for us, this all works behind the scenes, and we don't have to fight with it or become an expert. We get the benefits without having to struggle with the technology. This is what I mean by simple and quick. The future belongs to the simple and the quick.

Where is GIS technology going? GIS is now harnessing an amazing array of globally distributed sensors that is growing exponentially. Sensors are in everything. It's like the "sensorification" of society. There are imaging sensors, full-motion video, microsatellites, drones, and big satellites. There are sensors in cars, thermostats, and ships.

→ Imagery gives us new perspectives. This image shows channels that are remnants of an ancient drainage network in Kenya. (As featured in *The ArcGIS Imagery Book*, Esri Press 2016.)

The map of the future is an intelligent image.

All this information is being harnessed together into what is popularly referred to as the Internet of Things.

This Internet of Things is an amazing collection of dynamic, live information streams that are feeding into GIS. You can think of these streams as arteries that feed the heart of a modern Web GIS. The heart of this new GIS is a geoinformation model that is taking the place of the previous generation's central geodatabase, and it is based on the concept of distributed services. Although this concept is technically advanced, we can understand it in practice because we understand pictures. We understand something when we can see it. As Einstein famously once said, "If I can't see it, I can't understand it."

Today, all previous constraints on dynamically processing massive collections of imagery and producing meaningful information products are rapidly falling away through the adoption of a services architecture that brings processing to the data, along with the development of the ArcGIS Enterprise platform and a family of advanced servers, including ArcGIS GeoEvent Server, ArcGIS Image Server, and ArcGIS GeoAnalytics Server.

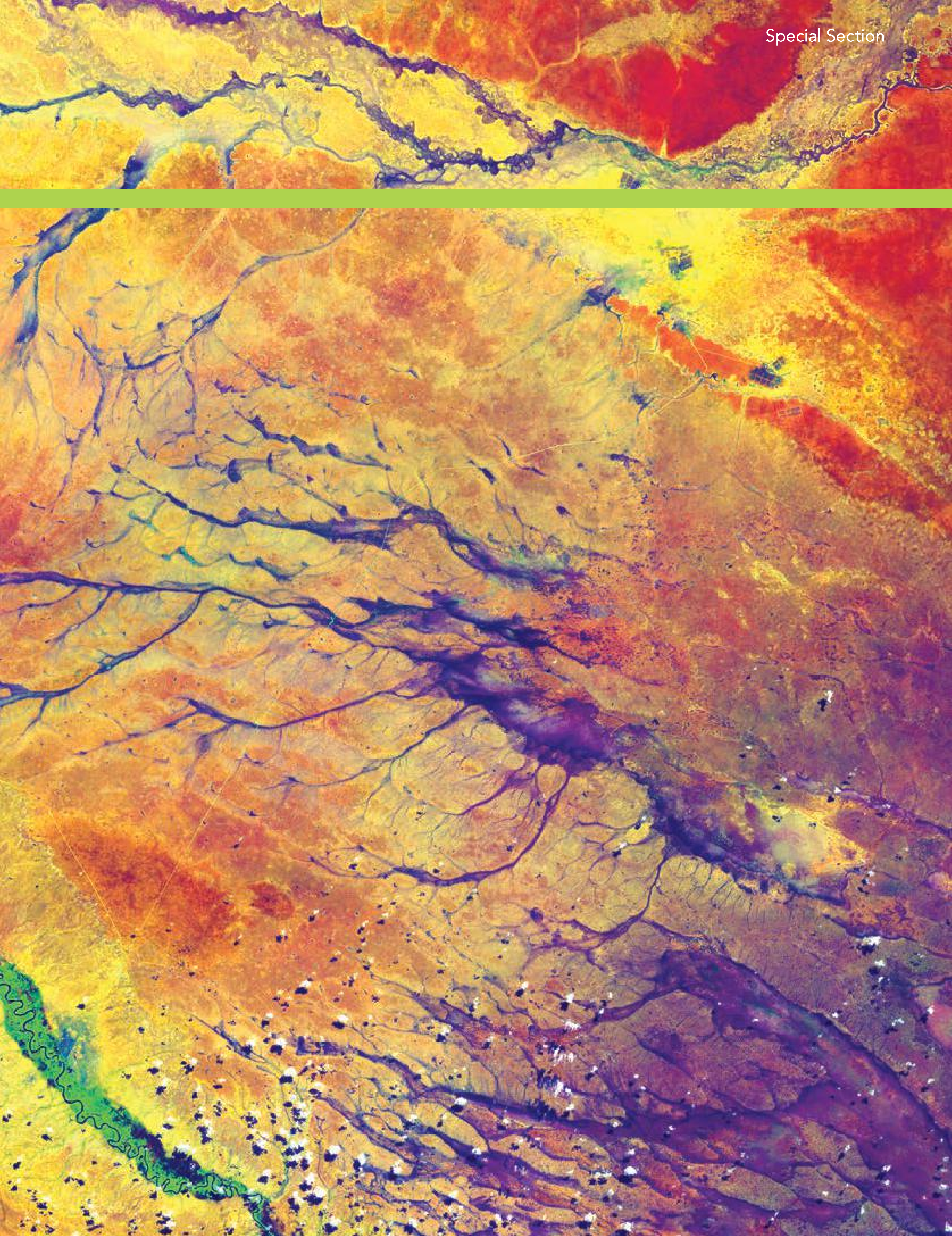
With ArcGIS Pro and the ArcGIS Image Analyst extension, image analysts have an imagery analysis workstation (IAW) with the tools for interpreting and exploiting imagery and creating information products. The IAW has stereo and mensuration capabilities. It supports image coordinate space so the map is brought to the image instead of deforming the image by bringing the image to the map. ArcGIS Pro with the Image Analyst extension supports plotting points, lines, and polygons correctly on an oblique image. Access to raster analytics means jobs that are too big to ever be done on the desktop can now be handled in the cloud—true scalability.

Access to all these capabilities is bringing GIS to life. The static two-dimensional world of the past is transforming into a living, dynamic, active, understandable, motion-driven, 3D GIS of the future. We are seeing the opening of an entirely new chapter in the history of GIS, and geography itself is being reinvented. The ArcGIS Living Atlas of the World drives the creation of a living planet and the reinvention of the map as we know it.

The map of the future is an intelligent image.

About the Author

Lawrie Jordan is the director of imagery and remote sensing at Esri, as well as special assistant to Esri founder and president Jack Dangermond. He has more than 35 years of experience as a leader in the field of image processing and remote sensing. Jordan was cofounder and president of ERDAS, Inc., for more than 20 years and played a key role in evolving a long-standing, strategic partnership with Esri. He is a member of the European Academy of Sciences and Arts, a trustee of the ISPRS Foundation, and the 2015 recipient of the Geospatial World Leadership Lifetime Achievement Award for his decades of contribution in the field of image processing and earth observation. He is also a grateful recipient of the US government's medal for Outstanding Support and Patriotism. He received degrees in landscape architecture from the University of Georgia and Harvard University.



Georeferencing Drone-Captured Imagery

By Mike Price, Entrada/San Juan, Inc.

What you will need

- ArcGIS Pro 2.1 license
- ArcGIS Online for Organizations account
- Sample dataset downloaded from the *ArcUser* website
- An unzipping utility

This tutorial introduces georeferencing techniques available in ArcGIS Pro using imagery collected by drones during a multiday training exercise testing response and recovery capabilities of US and Canadian emergency agencies. The training exercise was held across the westernmost portion of the US-Canada border.

During the week of November 13, 2017, public safety agencies in the United States and Canada, supported by other governmental and industry participants, conducted the fifth Canada-United States Enhanced Resiliency Experiment (CAUSE V) exercise. The scenario for this exercise, which was also the basis for a tutorial in the summer 2017 issue of *ArcUser*, "Modeling Volcanic Mudflow Travel Time with ArcGIS Pro and ArcGIS Network Analyst," included a hypothetical crater collapse on Mount Baker, a dormant composite volcano with accompanying seismic activity that would result in volcanic mud and debris flows (lahars), riverine flooding, landslides, and other natural phenomena. To learn more about CAUSE V and Mount Baker, read "Testing Cross-Border Disaster Response Coordination" and "Mount Baker (Briefly)" in the fall 2017 issue of *ArcUser*.

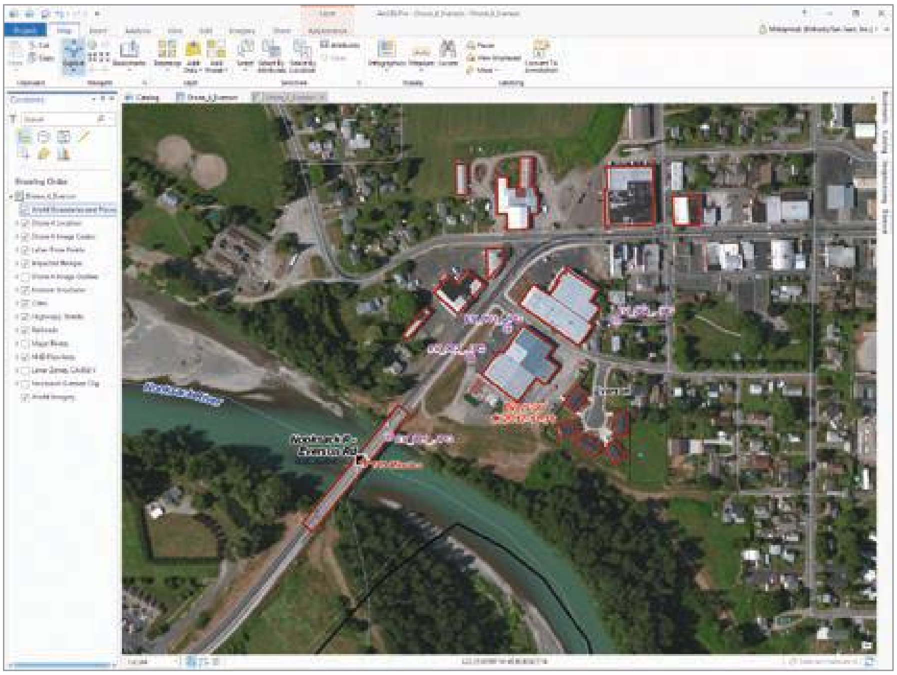
An Overview of Georeferencing

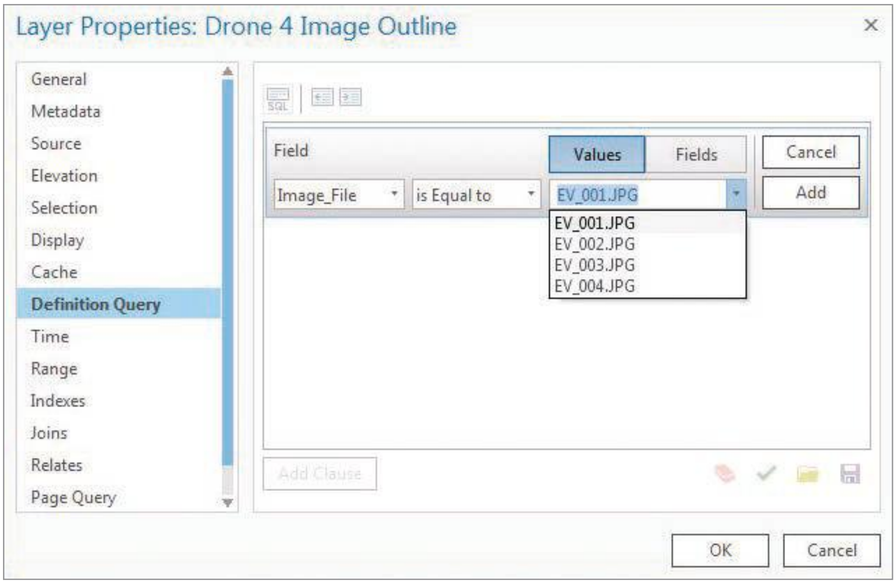
Raster data can be obtained from many sources including satellite sensors, aerial cameras, scanned maps, and drawings. Many current capture technologies can extract coordinate information, embedding it in or providing it with imagery. Older scanned aerial photos and maps must be georeferenced. Although they might display in local or regional coordinate systems, they must be repositioned to fit a flat object into a spherical coordinate system.

Sometimes, it is necessary to locally fine-tune georeferencing. By georeferencing a raster, it can be viewed, digitized, and analyzed with other data in the coordinate system that was applied. To georeference a raster requires that you

1. Add the target raster to a projected map that includes appropriate reference data.
2. Create control points and connect them with the corresponding reference point locations on the raster.
3. Review control points and edit them or add additional points as necessary.

↓ This high-resolution basemap shows the southwest corner of Everson, the Nooksack River, and the Highway 544 bridge, and the imported layers show the centers of the drone images and outlines for structures and the bridge.





↑ Apply a definition query to the Drone 4 Image Outline layer so only the outline for EV_001.JPG will be visible.

4. Assign an appropriate transformation that is based on the number and distribution of control points.
5. Save the georeferencing information with the raster or export the georeferenced raster as a new raster.

About the Imagery Used

To support data collection and analysis during the CAUSE V exercise, drones and robots were deployed at multiple locations to collect data via remote sensors. Field data was transmitted back to the Whatcom County Emergency Operations Center (EOC) in Bellingham, Washington, in real time, using land-based broadband and satellite technologies.

Imagery was captured by a DJI Phantom 4 drone provided by TacSat Networks Corporation of Santa Clara, California. TacSat Networks specializes in the integration, delivery, and sale of deployable secure wireless communications for public disaster emergency response agencies and the private sector in the United States and overseas.

The drone sent streaming video and still images back to the EOC over its ViaSat Pro 2 Ka-band satellite network. Three separate locations in Washington were supported: Newhalem on November 15 and Deming and Everson on November 16. The drone and deployable satellite communications were quickly remobilized between sites, and communications were established throughout both days.

Four high-resolution still nadir (down-looking) images taken from the Everson location were delivered as JPEG files without orthorectification. These images included a return flight path over the Washington Highway 544 bridge and the southwestern portion of the town of Everson, just north of the Nooksack River.

In "Modeling Volcanic Mudflow Travel Time with ArcGIS Pro and ArcGIS Network Analyst," it was estimated that the path of the lahar (volcanic mudflow from Mount Baker) down the Middle Fork Nooksack would reach the Everson bridge in approximately 120 minutes, hitting the bridge and possibly flowing into Everson.

Drone imagery enabled incident managers at the EOC to view areas that would experience lahar and riverine flooding for several miles up and down the Nooksack River. This tutorial uses two of several raster images captured by drones and places them on a map using the universal transverse Mercator (UTM NAD 1983) Zone 10N projection.

Getting Started

Begin by downloading the sample dataset for this exercise from the *ArcUser* website (esri.com/esri-news/arcuser) to a local drive. Cause_V_Drone_4.zip contains several file geodatabases, four training JPEG images, and an MXD file that will be imported into ArcGIS Pro. Unzip the sample dataset archive to a local drive.

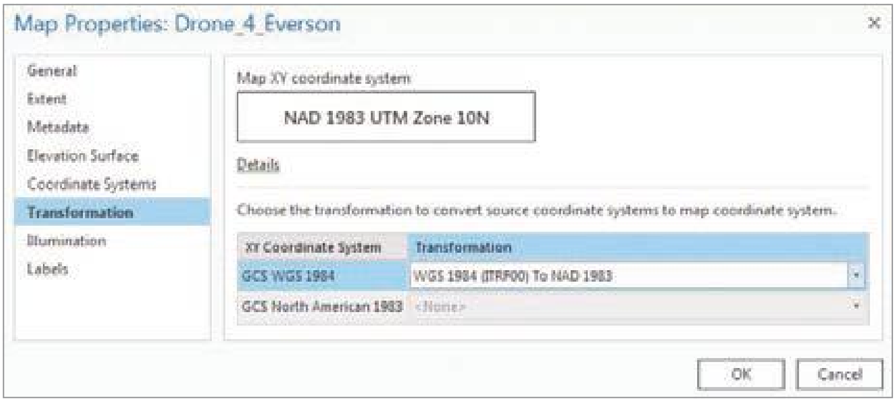
Start ArcGIS Pro and choose new Blank project. When prompted, create a new project, name it Drone_4_Everson, and store it in Cause_V_Drone_4. *Make sure you store your project in the Cause_V_Drone_4 folder.* Once the ArcGIS Pro map opens, select the Insert tab and click Import Map. Navigate to Cause_V_Drone_4, select Drone_4_Everson.mxd, and click OK.

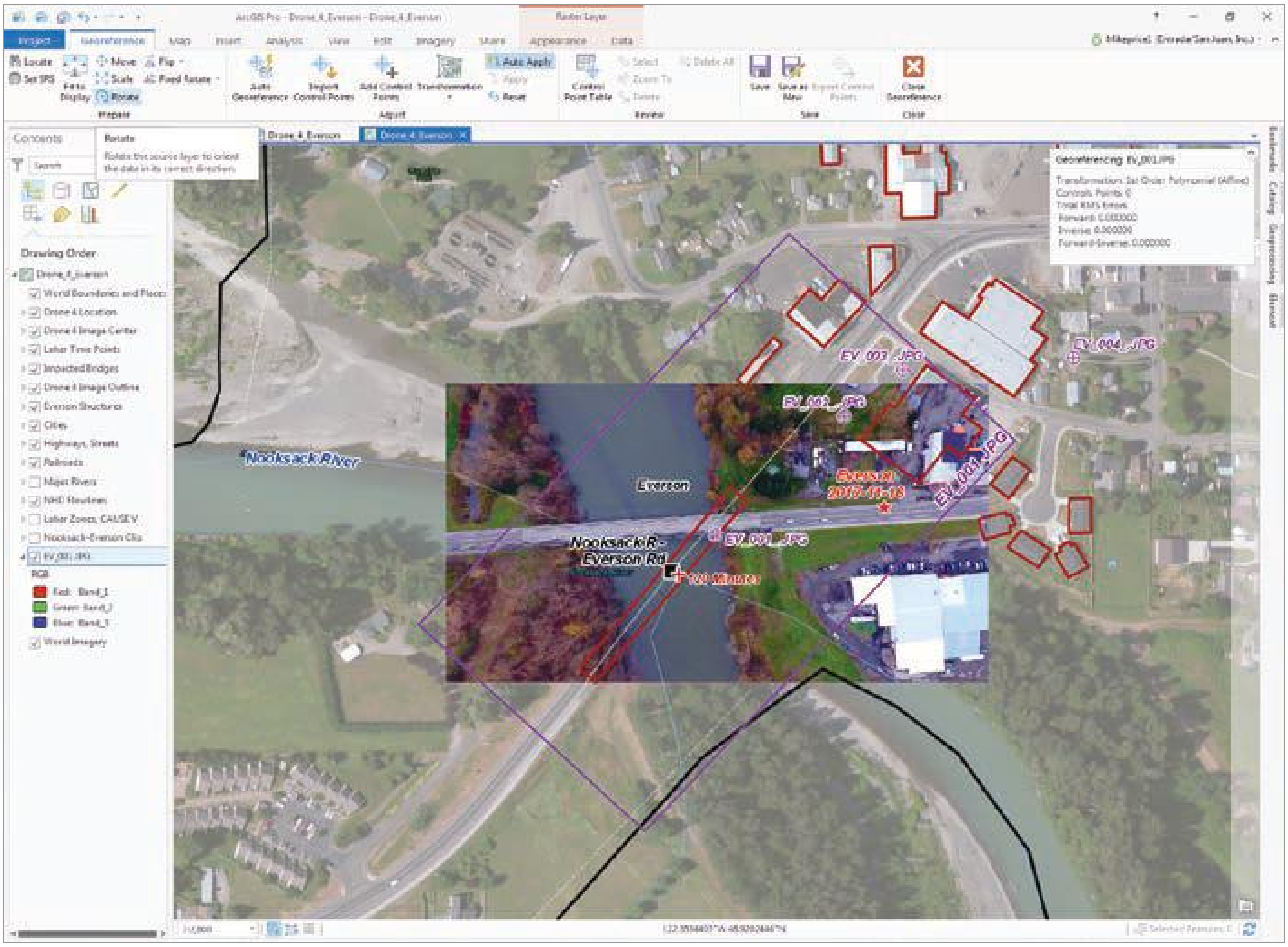
Inspect the map just imported. The map's current extent shows the Nooksack River flowing west in the southwest corner of Everson and contains a local transportation layer. The layout's map scale is 1:2,500.

Open the Catalog pane, expand Maps, right-click Drone_4_Everson, and choose Open. The imported map opens on a new tab as an ArcGIS Pro map with the same name. The imported map is linked to the ArcGIS Pro map. The map should be in map view, which will be used to georeference images.

Click the basemap drop-down and select Image with Labels. The high-resolution basemap shows the southwest corner

↓ Set the transformation from GCS WGS 1984 to WGS 1984 (ITRF00) TO NAD 1983 for EV_001.JPG.





↑ After applying the transformation to EV_001.jpg, click Fit to Display. Deemphasize the underlying raster by setting its transparency to 40 percent.

of Everson, the Nooksack River, and the Highway 544 bridge. Turn on the Drone 4 Location, Drone 4 Image Center, Lahar Time Points, Impacted Bridges, and Everson Structures layers. Turn off Major Rivers. Leave the layers that were already on alone. Inspect the map. Save the project.

Using Reference Image Footprints to Create Control Points

The Drone 4 Image Outline layer contains outlines for all four image files. Using a definition query will let you limit the number of image outlines displayed to just one.

In the Contents pane, turn on and right-click the Drone 4 Image Outline layer. Open Properties, select Definition Query, and click Add Clause. In the query builder, create the expression Image_File is Equal to EV_001.jpg. Click OK to apply. Right-click the Drone 4 Image Outline layer and choose Zoom to layer.

Click the Imagery tab and locate the Georeferencing tool. Click the small Alignment button on the lower-right corner. The Georeferencing Options window allows you to customize the tools. Accept all defaults and close the window. Save the project again.

Add and Transform EV_001.JPG

Click the Map tab and click Add Data > Data to add data to the map. Navigate to \CAUSE_V_Drone_4\Imagery\Everson Images and select EV_001.JPG. Verify that the image loaded in the Contents pane immediately above the World Imagery basemap. Inspect several Structure Footprints, including the bridge deck and several buildings, which are outlined in red. The Nooksack R-Everson Road bridge is on the list of essential and critical facilities. The drone was used to carefully inspect the bridge and photograph the floating material trapped on its northern abutment.

In the Contents pane, select EV_001.JPG, click the Imagery tab, and click Georeference. Notice the Georeferencing window in the upper-right corner. On the far left of the Georeference ribbon, click the Set SRS (for spatial reference system) button. Confirm that the Map XY coordinate system is NAD 1983 UTM Zone 10N.

Click Transformation and set the transformation from GCS WGS 1984 to WGS 1984 (ITRF00) TO NAD 1983. Click OK to apply and save again.

Get Ready to Georeference

In the map, right-click the Drone 4 Image Outline layer and choose Zoom to layer. Write down the scale visible in the lower-left corner.

Calculate two-thirds of that scale value (for example, if the scale at Zoom to layer is 3,000, then change the scale to 2,000).

On the Georeference ribbon, click Fit to Display.

To deemphasize the underlying raster, select World Imagery in the Contents pane, click the Appearance tab, and set Layer Transparency in the Effects group to 40 percent.

ArcGIS Pro includes a powerful image rotation tool in the Georeference toolset. In the Contents pane, select EV_001 and, with the Georeference ribbon active, select Rotate (*not* Fixed Rotate). Move your cursor over the center of EV_001 and study the live rotation graphic. Hold the left mouse button down on the green circle and rotate the raster until it closely fits its image outline.

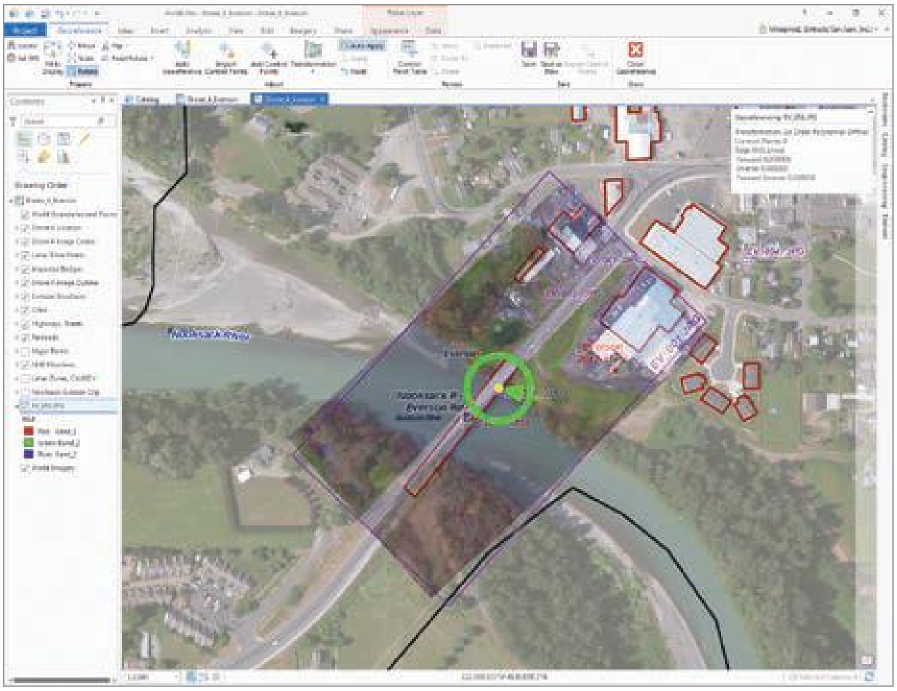
This image requires a counterclockwise rotation of approximately 30 degrees. Don't worry about being too precise because four control points will be set—one on each footprint corner. Save the project to preserve these changes. If your raster image behaves badly, simply reload it and start over.

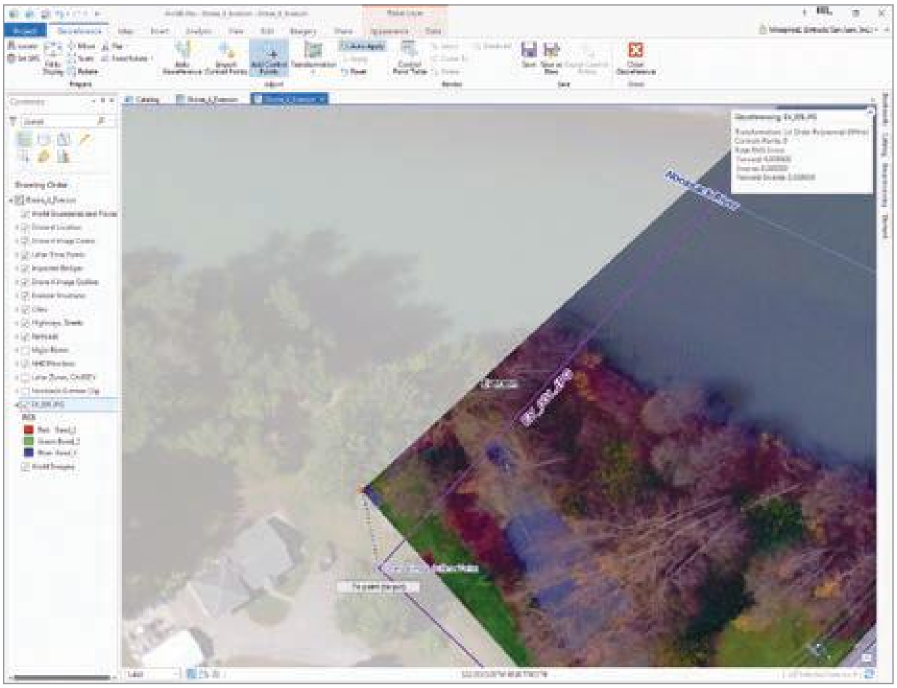
Zoom to the southwestern corner of the rotated image and its outline and inspect the relationship between the outline and image.

Before creating a control point to connect the raster corner to the same corner in the reference Image Outline, click the Edit tab, open the Snapping tool on the Editing ribbon, and confirm that **only Vertex Snapping is available**.

↓ Use the powerful image rotation tool in ArcGIS Pro to rotate the raster until it closely fits its image outline.

↓↓ Locate and left-click the southwest corner of the image, confirm that From point (source) is active, then move your cursor to the southwest reference polygon corner and allow it to snap. Click again and create a To point (target).





Creating Easy Control Points for EV_001.JPG

Return to the Georeference ribbon, verify that EV_001.JPG is selected, and click the Add Control Points tool located in the Adjust group. Locate and left-click the southwest corner of the image and confirm that From point (source) is active. Move your cursor to the southwest reference polygon corner, allow it to snap, and click again to create a To point (target).

Move diagonally to the raster's northeast corner and create a second control point. Move to the northwest corner and create a third control point, then create the fourth and final control point at the southeast corner.

Open the Control Point Table, located in the Georeference Review group. In the

↓ Table 1: Transformation types

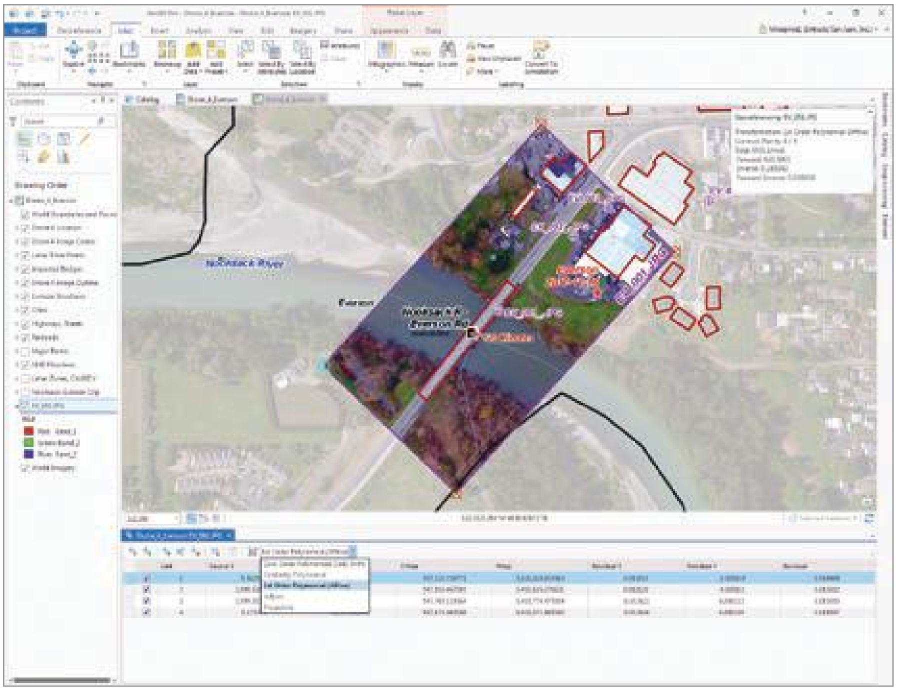
Transformation Type	Minimum Points Required
Zero-order polynomial	1
First-order polynomial	3
Adjust	3
Projective transformation	4
Second-order polynomial	6
Third-order polynomial	10
Spline transformation	10

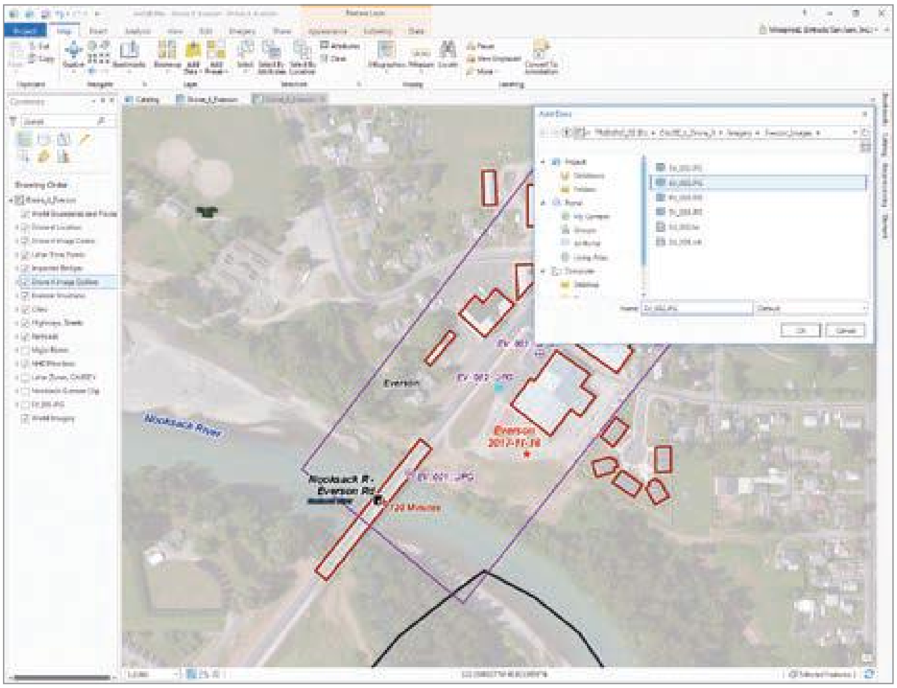
Control Point Table, inspect the transformations available from the Transforms drop-down and review Table 1, which shows the number of points required for different transformation types. In the Control Point Table, select individual records. Because only four control points were created, the number of transformations available is limited.

Now, it's time to decide how to preserve the updated image. There are two options: update the georeferencing for the current image or save the image as a new transformed image. To ensure the registration can be fine-tuned later, temporarily save the control information by locating the Georeference Save group and clicking Save. Click the Close Georeferencing tool located on the right end of the Georeference ribbon.

↓ Once all four control points have been added, open the Control Point Table and inspect the results of the transformation.

↓↓ In the second half of the exercise, turn off EV_001.jpg, change the definition query for the Drone 4 Image Outline layer to show EV_002.jpg, and add EV_002.jpg.





More carefully inspect the georeferenced image by selecting EV_001, opening the Appearance ribbon, and choosing the Swipe tool. Use the Swipe tool to reveal the underlying World Imagery and compare structures in EV_001 with the same structures on the basemap image. Also compare structures shown in EV_001 with the outlines in the Everson Structures layer. EV_001 is fairly closely aligned with the basemap and the Everson Structures layer, but its positioning can be improved. Save the project and take a quick break.

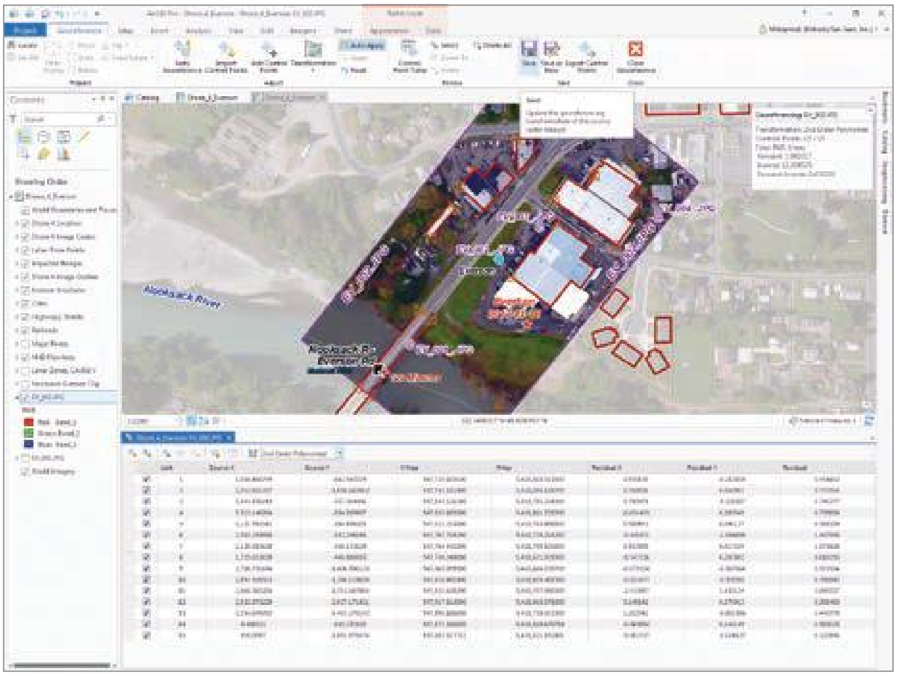
Importing a Control Point Set to Georeference EV_002

If someone has georeferenced a specific raster but has not provided updated georeferencing, you can import control point sets to georeference that image on your computer. Once the control point set is imported, you can test the various transformations possible based on the number of control points.

Control points let you relate accurate, high-resolution locations on a raster with spatial data that can include road intersections, streams, and building footprints. In Everson, accurate building footprints and other man-made points were used to connect high-resolution drone imagery with locations on the ground. Fortunately, 15 accurate control points had already been defined for image EV_002.

Begin this portion of the exercise by turning off EV_001. Change the definition query for the Drone 4 Image Outline layer to show the outline for EV_002. Right-click the Drone 4 Image Outline layer, open Properties, and select Definition Query. Click Add Clause and, in the query builder, create the expression Image_File is Equal to EV_002.jpg. Click OK to apply.

Navigate to \CAUSE_V_Drone_4\Imagery\Everson_Images and add EV_002. Inspect EV_002 for the clarity and resolution of the buildings and other features. Look for exposed ground-level building corners and the end of the concrete bridge deck. Not all



↑ Once you have loaded the control points for EV_002.jpg, open the Control Points Table and inspect the results.

building ground corners are visible. Since this image was captured at a low elevation (approximately 200 feet above the ground), elevated structures may appear to lean away from the center of the image.

Right-click the Drone 4 Image Outline layer and choose Zoom to layer. Select EV_002 and open the Georeference ribbon. In the Adjust group, select Import Control Points. Navigate to \CAUSE_V_Drone_4\Imagery\and load EV_002.txt.

Inspect the repositioned image and review how closely it fits with its outline in the Drone 4 Image Outline layer. Open its Control Point Table, located in the Georeference Review group, and inspect records for the 15 points.

Notice that the current transformation is First Order Polynomial (affine). *[Transformations are required to convert data between different geographic coordinate systems or between different vertical coordinate systems so that data will line up and be useful in analysis and mapping. To better understand the georeferencing process and transformations, read the ArcGIS Pro Help topic "Overview of georeferencing."]* Since there are more than 10 control points, all available transformations can be tested by selecting them from the drop-down in the Control Point Table.

Testing all available transformations reveals that the Second Order Polynomial is the best transformation for the entire image. Apply this transformation, save the updated information, and save the project. Use the Swipe tool (Appearance ribbon) to confirm the image's accurate position.

Exporting Images to a PDF Map

Turn on EV_001 and EV_002. In the Catalog pane, expand Layout and right-click to open the Drone_4_Everson layout. Open the Catalog pane and right-click the Drone 4 Everson layout.

In a file manager (such as Windows Explorer), create a Graphics folder in the \CAUSE_4_Everson folder. Right-click on the layout and choose Export to file. Export the file as a PDF named Drone_4_EV_110_EV_002.pdf and choose 300 dpi and best quality.

Once the PDF has been exported, use the file manager to navigate to the Graphics folder to open the new PDF. Expand its Layers options and experiment with layer visibility and observe that transparencies are supported. All objects—including rasters—can be turned on and off. There is no longer an Image layer at the bottom of the PDF stack.

Zoom in to the drone launch point and note the vehicles parked near the picnic table that was used as an office for the exercise. The image quality, resolution, and spatial position of this imagery are amazing!

Summary

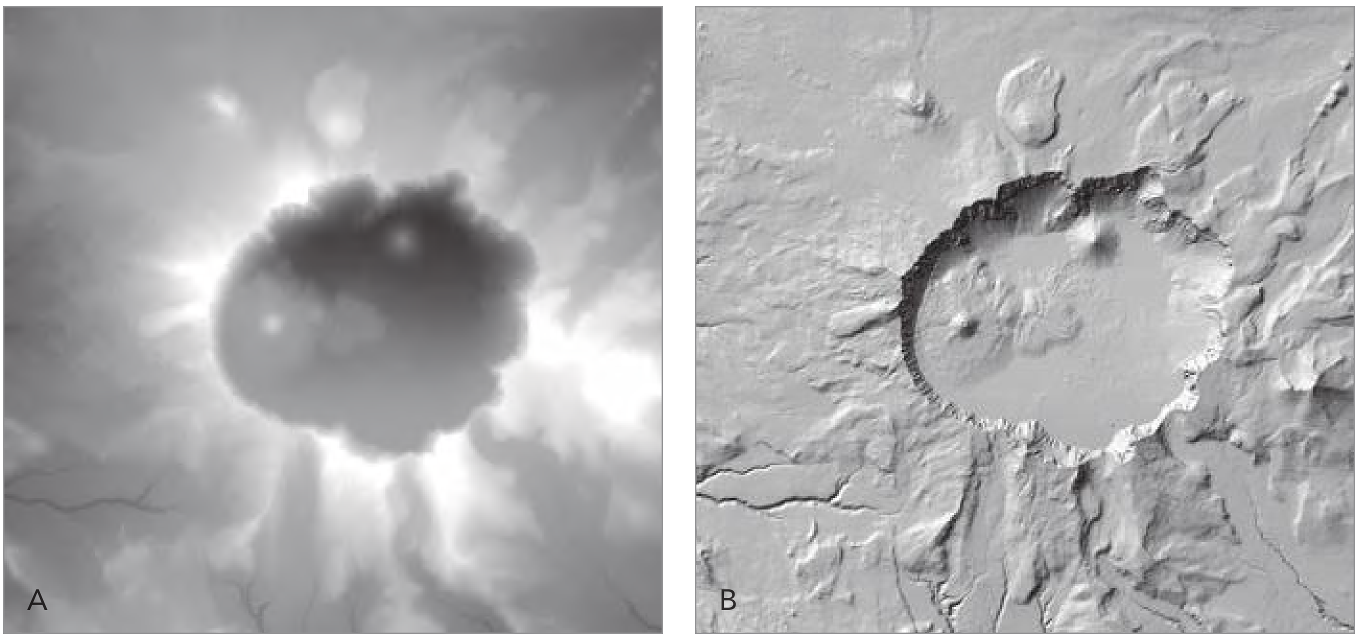
The CAUSE V text of drone imagery collection and remote satellite communications was a resounding success. In this exercise, you georeferenced two of four drone images from the CAUSE V exercise using two methods: simple control points that were created and a prepared control point file that was imported.

Acknowledgments

I appreciate that the CAUSE V participants gave me the opportunity to observe, advise, and map this exercise. Special thanks go to personnel from Whatcom County Emergency Management and Sheriff's Office for incident design, coordination, and oversight; to TacSat Networks Corporation for remote satellite communications and drone service; and the staff of Seattle City Light's Newhalem operation for remote operations logistics and support. It was truly my pleasure to participate in and assist with this exercise.

Create Amazing Hillshade Effects Quickly and Easily in ArcGIS Pro

By Aileen Buckley, Esri Research Cartographer



Give your maps depth and dimension by using a hillshade effect in them. Hillshades enhance the three-dimensional appearance of the terrain by using patterns of light and shadow to create a 3D representation of the surface that makes it easier to identify landscape features.

To create this effect, you can use digital elevation model (DEM) data—a type of raster data that contains an elevation value for each cell. With ArcGIS Pro, you simply apply the hillshade effect to DEM data rather than create a new layer. This can save storage space, especially if either the map extent or DEM dataset is large.

With ArcGIS Pro, you can use the stunning multidirectional hillshade option, which simulates diffuse illumination by combining light from sources in multiple directions. *[The multidirectional hillshade option, inspired by the legendary Swiss artist Eduard Imhof, uses an algorithm that computes hillshade from six different directions.]* This is more dramatic than a traditional hillshade that shows light from a single light source in the northwest.

Applying a hillshade effect in ArcGIS Pro is quick, easy, and efficient because ArcGIS Pro uses a raster function instead of a geoprocessing tool. Raster functions are operations applied on the fly and directly to the pixels of an image or raster dataset that are displayed. Only pixels visible on the screen are processed.

A raster function can be applied to all types of rasters, and the output will be a virtual raster layer. This shortens processing time and saves you the trouble of creating and storing additional data.

In ArcGIS Pro, raster functions are accessed from the Analysis tab. To use a raster function to apply a hillshade effect, follow these simple steps:

1. Open the Raster Functions pane.
2. Expand the Surface functions and select the Hillshade option (or search for Hillshade in the Raster Functions pane).
3. Set Raster to your DEM dataset.
4. Set Hillshade Type to Traditional or Multidirectional, as desired.
5. Set Scaling to None if you are making a map at a single map scale (such as a printed map), or select Adjusted if you are making a multiscale map (such as a web map). You'll also want to select Adjusted scaling if you are making a hillshade of a large map extent, since no scaling would result in little terrain variation at small map scales.
6. Set Z Factor to a higher number to exaggerate the height variation in the terrain, or use it to convert the elevation units to the x,y linear units if they happen to be different (see "Applying a z-factor" in the ArcGIS Pro Help to learn more about this second reason).

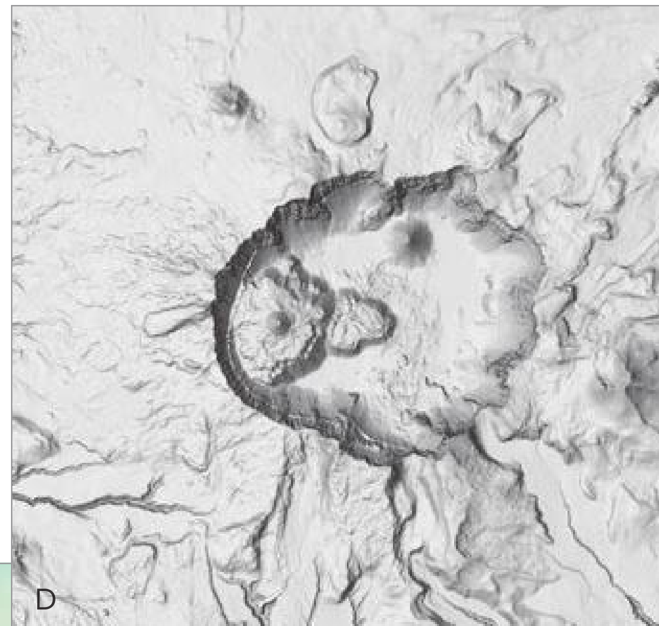
A
This 30-meter DEM data for the Crater Lake area in Oregon shows higher elevations in lighter tones and lower elevations in darker tones.

B
A traditional, one-light-source hillshade.

C
The multidirectional hillshade shows the beautiful texture of this DEM.

D
The multidirectional hillshade reveals more terrain variation when higher-resolution (1-meter) data is used. When displaying other data with the DEM, such as land use, or when symbolizing elevation values using hypsometric tint, it results in 3D terrain with a lighter overall tone.

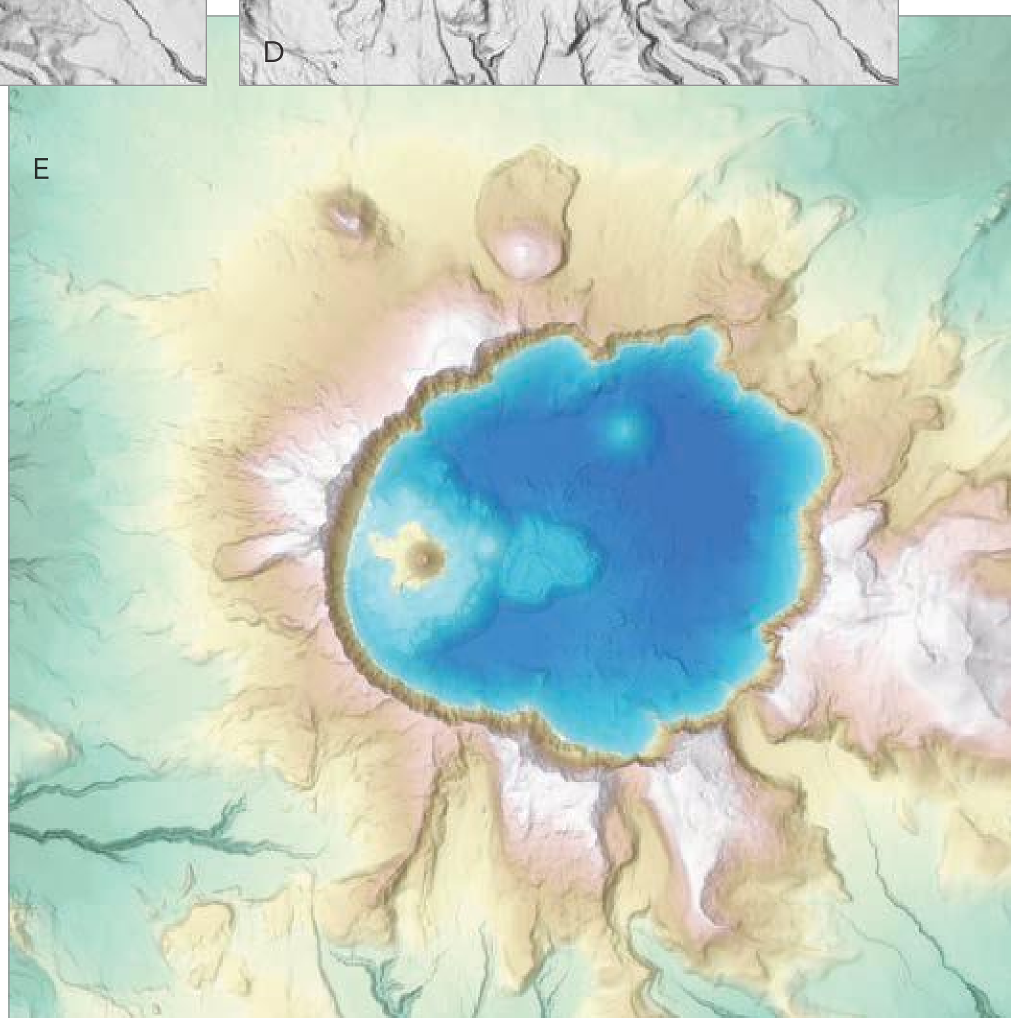
E
Elevation and bathymetry are colorized and displayed transparently over the multidirectional hillshade.



7. Click the Create new layer button at the bottom of the Raster Functions pane to create a new layer in the current map. Note that this is only a new display of the processed data—it is not a new raster dataset.

The hillshade effect is quick and easy to create in ArcGIS Pro, and it produces visually stunning results. Try it out yourself and be sure to experiment with the multidirectional hillshade option.

To learn more about the hillshade and other raster functions, read ArcGIS Pro Help topics on the Hillshade function and raster functions.



→ The source for the Crater Lake data used in the illustrations is "High-Resolution Digital Elevation Dataset for Crater Lake National Park and Vicinity, Oregon, Based on LiDAR Survey of August–September 2010 and Bathymetric Survey of July 2000": US Geological Survey Data Series 716 by Joel E. Robinson, 2012, and available at pubs.usgs.gov/ds/716/.

Find Just What You Were Looking for with Locator Views

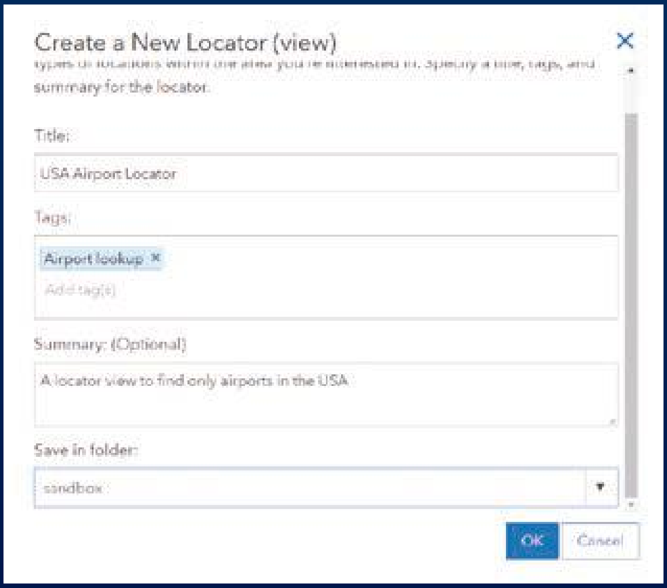
You can now customize geosearch (location search) and geocoding (obtaining x,y coordinates for addresses, postal codes, or populated places) to return only the results you want. Locator views help you perform searches more efficiently and eliminate the need to sort through results.

With a locator view, you configure a view of the Esri World Geocoding service that limits geosearch to specific types of locations or coordinates or limits geocoding results to the postal code level or a specified subcategory of addresses or populated places. For geosearch, searches can be limited to an area determined by an extent or a country. For geocoding, search can be limited by country.

You can share a locator view with your organization so it can be used by any apps that support geosearch, such as Map Viewer, configurable apps, and ArcGIS Explorer. It can also be used for batch geocoding.

Locator views were released as part of the ArcGIS Online update in September 2017 to improve the precision of results from address and coordinate searches and the reliability of results from point of interest (POI) searches.

↓ Make sure you indicate the constraints of the locator view in the item description.



The following example creates a locator view that constrains search by a specific POI (airports) and geographic extent (United States). The locator view generated will limit searches to airports—and only airports—in the United States.

Step 1

Create a Locator View

In ArcGIS Online, click Content, click the Content Tab, and click the Create drop-down. Choose Locator (view). Give the new locator view a title, tags, summary description, and folder location. Click OK.

Step 2

Define the Locator View

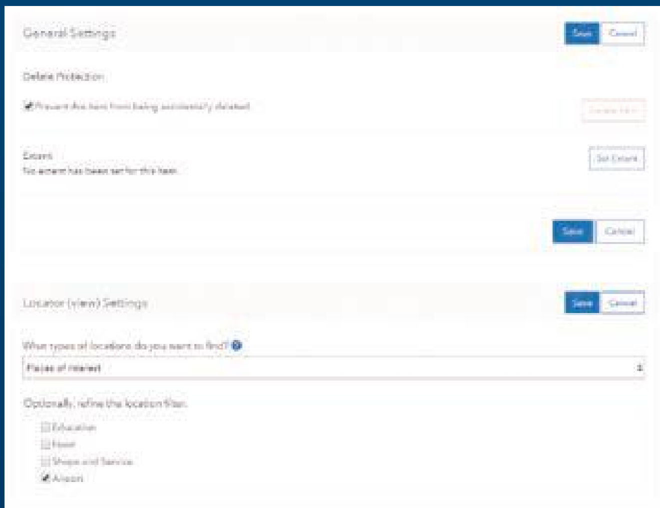
Use the settings page for the locator view item you just created to configure the locator view to search for only specific types of locations or geocode for address or coordinates and/or constrain the search within a specified area. Check Delete Protection to prevent accidental deletion.

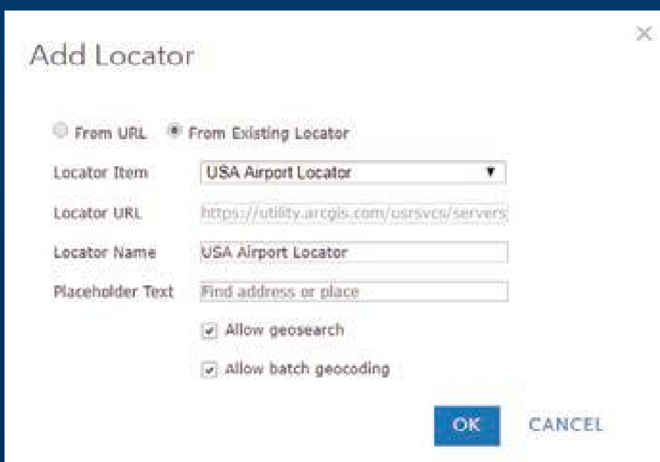
To set the search extent interactively or by using coordinates, click Set Extent and either draw boundaries or type them in. For this scenario, skip this section.

Under What types of location do you want to find?, the drop-down lets you choose addresses, postal codes, or populated places; coordinates such as longitude, latitude; latitude, longitude; Military Grid Reference System (MGRS); United States National Grid (USNG); or places of interest (POI) with specific filters for education, food, shops and services, and airports. For this scenario, select Places of Interest and check only Airport. A complete listing of supported subcategories for addresses, postal codes, or populated places is listed in the ArcGIS Online Help.

Scroll down to Where do you want to search for locations? and choose In selected countries. Scroll through the country list to select the United States.

Make sure you click the Save button to update the locator view item with these settings.





↑↑ Use the settings to determine the type of search and the area to be searched.

↑ You need to add the locator view to the Utility Services in ArcGIS Online.

Step 3

Share the Item with Your Organization

Click the Overview tab on the locator view item page. Click the Share button to share the locator view item you just created. Share it with your organization so coworkers can search more efficiently. If your organization shares apps with the public, only users who have access to your organization's internal locators will be able to find places with apps that use location views.

Step 4

Configure the Item for Use

Once the locator view is shared, you (if you are an administrator for ArcGIS Online) or your administrator should to go to the Organization tab and select Edit Settings. Under the Utility Services menu, add the locator view that you created.

In this step, an administrator can also limit this locator for use in geosearches or configure it to allow both geosearch and batch geocoding. Geosearch does not consume any service credits. Because the batch geocoding operation consumes service credits, you or your administrator may want to limit the use of the locator view for batch geocoding. The same service credit rates apply to batch geocoding whether using locator views or the online World Geocoding service.

You can reorder locators in this section so that ArcGIS Online will use one or more locator views first. That way your search request will initially limit the search.

Step 5

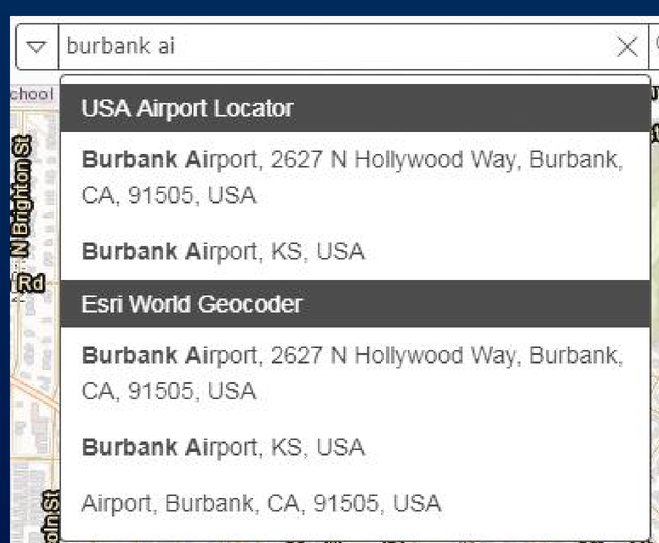
Use the Locator View

With the locator view set up, open Map Viewer in ArcGIS Online and select the drop-down button in the search pane to bring up the available locators you can search against. Select the newly created locator view, USA Airport Locator, to limit the search to airports in the United States.

Once a locator view is configured by you or your administrator in the utility service settings, the locator view can be used in any ArcGIS application that uses the organization's locators configured in the utility services settings. This means, for example, that someone in your organization using ArcGIS Maps for Office will be able to geocode airport codes in Microsoft Excel against the locator view you've created.

To learn more about locator views, read the "Geocoding and geosearch" topic in the ArcGIS Online Help.

↓ You can reorder locators in this section so that ArcGIS Online will use one or more locator views first.



Bring Your Points to Life with GIF Symbols

By Lisa Berry, Esri Cartographic Product Engineer

You can use animated GIFs as custom point symbols for maps in ArcGIS Online.

Of the many image formats available (JPG, PNG, BMP), the GIF, or Graphics Interchange Format, is the one we can use for animated symbols. GIF files support multiple frames. That's why they appear animated. By spacing out the timing of multiple images, a GIF comes to life.

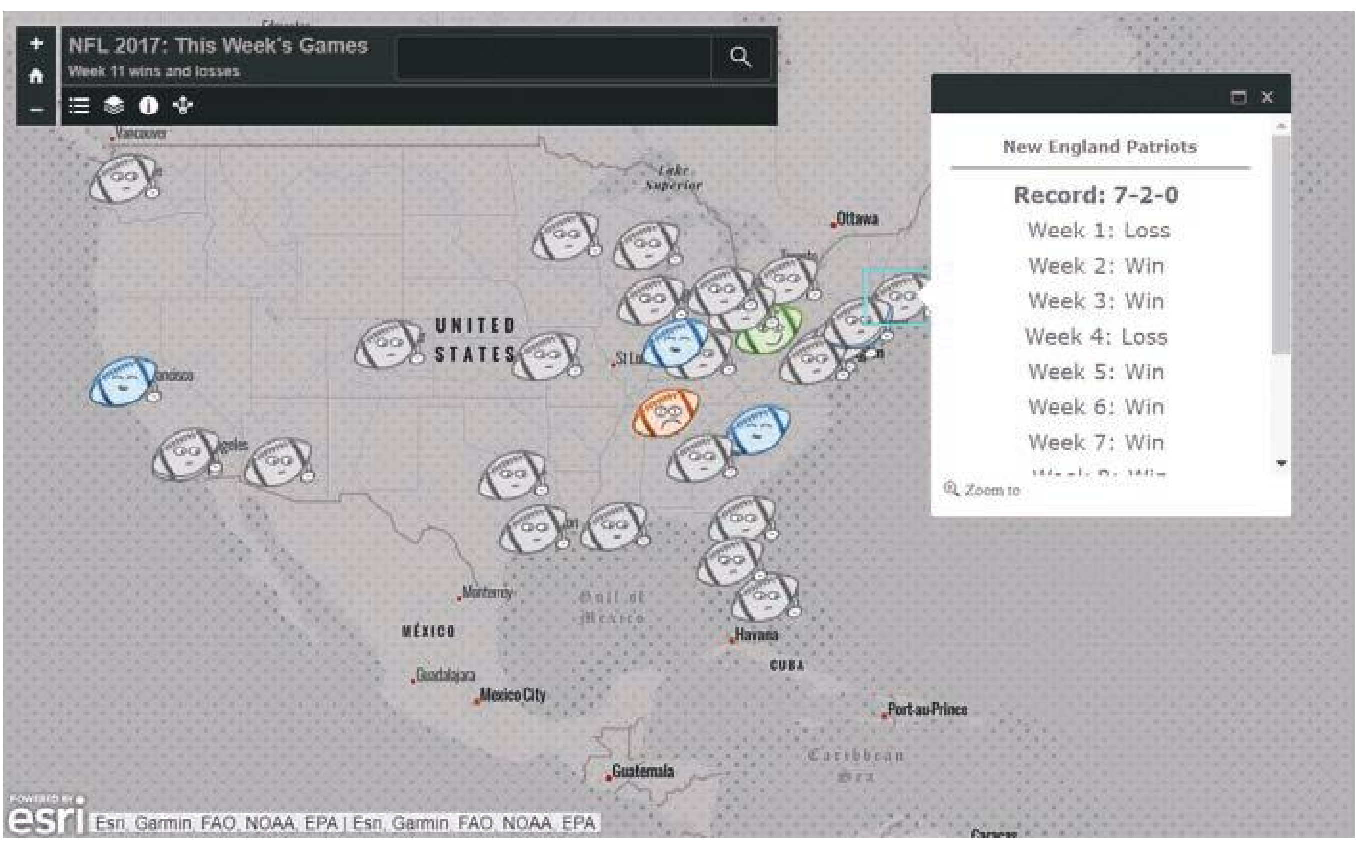
So how is this done? The process is easy:

1. Find or create the GIF you want.
2. Host the GIF.
3. Use it as your point symbol.

An example of animated GIFs in action is the map I created showing the wins and losses of NFL teams in 2017. The football symbols show week-by-week wins and losses for each NFL team. Winning teams smile with pride, losing teams cry with shame, and teams with bye weeks rest.

Since I don't have Adobe Photoshop, I created these symbols using Microsoft PowerPoint. I used basic shapes, curves, and ovals to create the little football faces. For each emotion, I

↓ This map shows the wins and losses of NFL teams in 2017, using animated GIFs.



↑ After creating the little football faces, I created versions showing facial expressions and saved each one as its own image, making sure the background of each image was transparent.

created two versions of the facial expression and saved each one as its own image. Then I used ezgif.com, a free online animated GIF maker and editor, to transform the two images into a moving animation.

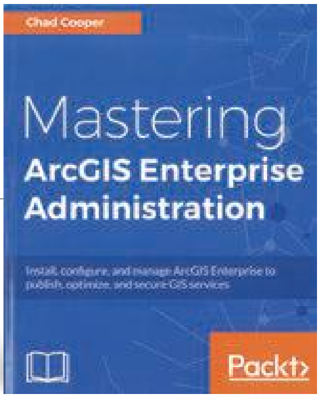
The key to creating your own animated GIFs is to make sure the background of each image is transparent. It you don't, you will get a white box around your final GIF. Avoid this by saving each image in PNG format to preserve transparency.

Once your GIF is created, just use it as a custom image for your point symbol. You will need a URL for the image. I use imgur.com to host my GIFs because it is free and easy to use, but there are many options: Flickr, Dropbox, Google Photos, TinyPic, and many others. Once your GIF is hosted, use the URL for the image as your point symbol in ArcGIS Online. Make sure the URL contains the file extension .gif.

Have fun with this technique, but not too much fun. Don't create too much movement on the map or your audience will get dizzy. Keep it simple and use animation to emphasize a specific action or event.

Happy mapping!

GIS Bookshelf



Mastering ArcGIS Enterprise Administration

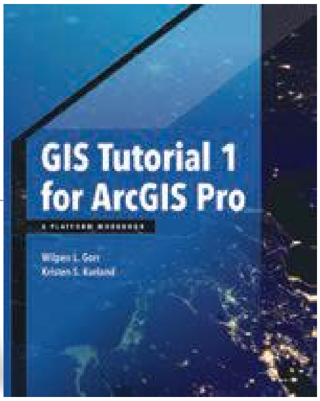
Learn how to confidently install, configure, secure, and fully utilize your ArcGIS Enterprise system.

By Chad Cooper

This comprehensive book is targeted at GIS professionals—from analysts, managers, and administrators to architects and engineers, as well as database administrators—who need to understand and utilize ArcGIS Enterprise 10.5.1, the next generation of the ArcGIS mapping and analytics platform. The information it contains will provide a thorough introduction to ArcGIS Enterprise and valuable techniques for avoiding common pitfalls and operating efficiently.

Readers learn how to install and configure an ArcGIS Enterprise geodatabase and administer ArcGIS Server, Portal for ArcGIS, and ArcGIS Data Store through user interfaces, the REST API, and Python scripts. Individual chapters cover geodatabase administration, publishing content, ArcGIS Server and Portal for ArcGIS administration, handling security on ArcGIS Enterprise, automating administrative tasks through scripting, and using the ArcGIS API for Python. The final chapters run down standards and best practices as well as troubleshooting methods for ArcGIS Enterprise.

The author, Chad Cooper, has been a technician, analyst, and developer in the private and public sectors and for academia. He has a bachelor's degree from Mississippi State University and a master's degree from the University of Arkansas, both in geology. He has authored several articles for *ArcUser,* most recently "Empowering Workers & Informing Customers" in the summer 2017 issue. Packt Publishing, 2017, 382 pp, ISBN 139781788297493.



In-Depth Instruction for Working with ArcGIS Pro

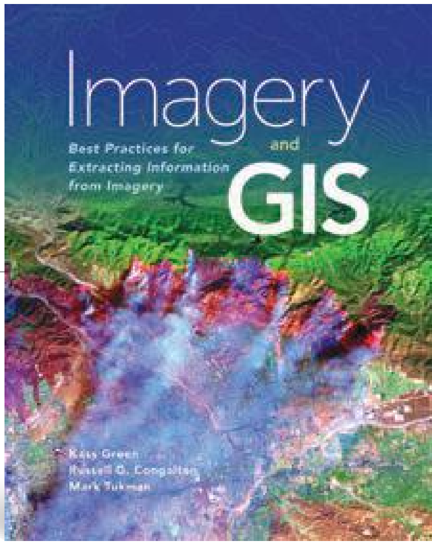
GIS Tutorial 1 for ArcGIS Pro: A Platform Workbook primarily focuses on working with ArcGIS Pro but also offers instruction on using ArcGIS Online and apps such as Collector for ArcGIS, Esri Story Maps, and Operations Dashboard for ArcGIS.

This new textbook from Esri Press teaches readers how to create and manage data, perform spatial analysis, create 3D scenes, and share projects using ArcGIS Pro. Readers will also learn how to design and share maps and work with file geodatabases and spatial data and geoprocessing tools skills such as geocoding. Through completing a real-world exercise, they will gain hands-on experience in setting up and managing a project.

Designed for use in a university classroom setting, this workbook provides teachers with access to teaching materials and includes step-by-step instructions, exercises that students can complete on their own, and in-depth assignments. Self-learners can also benefit from the book's easy to follow, step-by-step instructions.

GIS Tutorial 1 for ArcGIS Pro: A Platform Workbook was written by Wilpen L. Gorr and Kristen S. Kurland, the authors of other highly regarded tutorials including *GIS Tutorial 1: Basic Workbook, GIS Tutorial for Health*, and *GIS Tutorial for Crime Analysis*. Gorr is a professor of public policy and management information systems at the School of Public Policy and Management, H. John Heinz III College, Carnegie Mellon University, where he teaches and researches GIS applications. Kurland is a professor of architecture, information systems, and public policy at Carnegie Mellon University's H. John Heinz III College and School of Architecture. There, she teaches GIS, computer-aided design (CAD), building information modeling (BIM), 3D visualization, and infrastructure management. Esri Press, 2017, 480 pp, print edition ISBN: 9781589484665, e-book ISBN: 9781589484931.

Imagery and GIS: Best Practices for Extracting Information from Imagery



By Kass Green, Dr. Russell G. Congalton, and Mark Tukman

Imagery and GIS have a symbiotic relationship: Imagery is the foundation of most GIS datasets, and GIS can be used to more effectively manage and derive information from imagery.

Imagery and GIS: Best Practices for Extracting Information from Imagery provides GIS users with the knowledge to make informed decisions about working and processing imagery; extracting information from it; and assessing, publishing, and serving imagery datasets.

This book is especially valuable given the recent significant improvements in the availability, cost, and spectral and spatial resolution of remotely sensed data and the proliferation of remote-sensing devices. For civilian uses, the availability of remotely sensed data has exploded owing to the evolution of sensors, the development of smaller and more agile platforms such as drones, the improved positional accuracy of GPS, and decreases in the cost of storage on disk and in the cloud.

Imagery and GIS together support an increasing number of vital applications for environmental management, humanitarian aid, public safety, climate monitoring, transportation, agriculture, and many other industries. These applications will only expand in scope and importance in the future.

The book's first section introduces the fundamental concepts of imagery. It covers how remotely sensed data is collected and the characteristics of that data. With this foundation, the final chapter of the section explains how to select the most appropriate imagery for an application.

The other three sections address in very practical terms how to use imagery, extract information from it, and manage image and GIS data. The topics covered include digital elevation models, image classification, change analysis, and accuracy assessment.

Numerous screen captures, diagrams, charts, and graphs illustrate the concepts discussed, and a glossary of terms and lists of acronyms and references enhance comprehension.

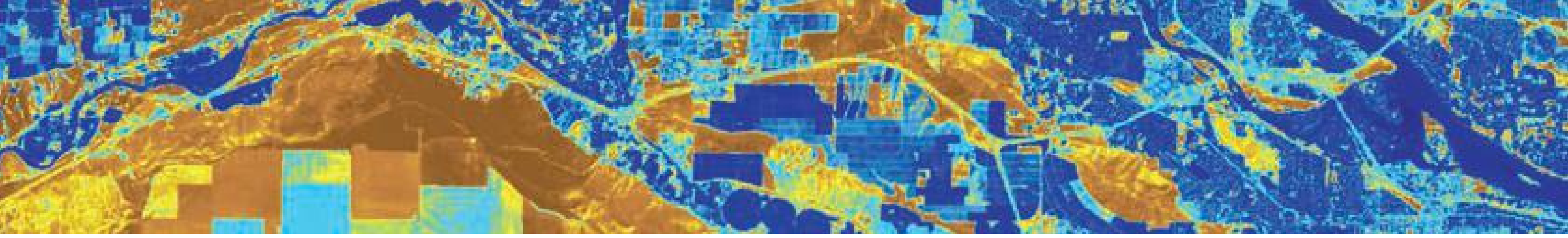
Imagery and GIS Web App, an Esri Story Map app developed to provide current information on the use of and availability of high to moderate resolution data from remote sensing satellites in service, can be accessed at esriurl.com/IGT42.

The authors have decades of experience working with imagery and GIS in research, real-world applications, and teaching.

Kass Green's career in remote sensing and GIS spans more than 30 years. She has worked for nongovernmental organizations (NGOs), public agencies, and private companies throughout the world. This work has included innovative research, multiscale and multisensor mapping projects; strategic planning; policy analysis; and decision support tools development.

Dr. Russell G. Congalton, a professor of remote sensing and GIS at the University of New Hampshire, has more than 35 years of experience teaching and researching geospatial technologies and working for private industry, federal and state agencies, and academia.

Mark Tukman, the owner of Tukman Geospatial in Santa Rosa, California, has more than 20 years' experience using imagery and other datasets to help public and private organizations map land cover, make decisions using spatial data, and support land conservation efforts. Esri Press, 2017, 435 pp., ISBN: 9781589484894.



Kass Green has spent her professional life working on the integration of GIS and imagery. The focus of her work has been helping develop solutions to real-world problems using these technologies together. *Imagery and GIS: Best Practices for Extracting Information from Imagery*, a new book from Esri Press she coauthored with Russell G. Congalton and Mark Tukman, is based on decades of the practical application of these technologies. Unlike many, if not most, books on remote sensing and GIS, this book is focused on solving users' problems rather than pushing technologies. It is designed to give GIS users the information they need to incorporate imagery into GIS projects and workflows. *[See the accompanying article, "Imagery and GIS: Best Practices for Extracting Information from Imagery."]* In this article, Green explains why GIS and imagery integration is increasingly important to GIS professionals.

Imagery and GIS Integration: Why Now?

By Kass Green, Kass Green & Associates

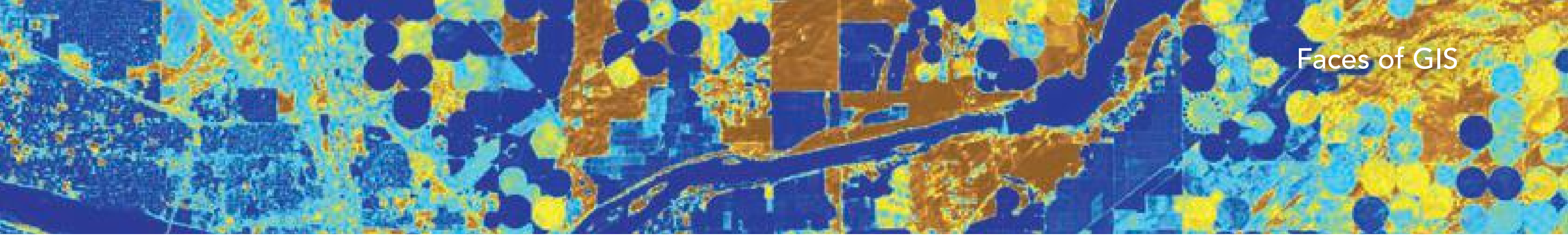
I have spent my career working with people, listening to their problems, and finding solutions for them by combining GIS and remote sensing to answer questions about place—questions such as, Why did the fire burn here and not here? What crops flourish here? Is there enough food in this area to feed these people?

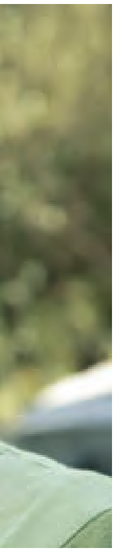
The power of imagery and GIS together allows us to perform a vast variety of tasks including weather prediction, disaster response, military reconnaissance, flood and wildfire risk assessment, preservation of sensitive ecosystems, delivery of humanitarian aid, transportation planning, agriculture crop yield estimates, fisheries management, and change monitoring.

Imagery forms the foundation of most GIS data. Whether it be a map of transportation networks, elevation contours, building footprints, facility locations, vegetation type, or land use, the information in most GIS datasets is primarily derived from imagery. Alternatively, GIS allows us to more efficiently and effectively derive information from imagery. Organizing imagery in a GIS brings the power of spatial information management and analysis to imagery.

Remote sensing has always rapidly incorporated advances in technology, but the pace of change has quickened, and recent developments drive the integration of GIS and imagery right now.

First, the sensor explosion has dramatically expanded the supply of imagery. Long a staple in military operations, imagery is now also ubiquitous in civilian applications. The evolution from film to digital arrays has made storing, accessing, and analyzing imagery easier, less expensive, and faster. The miniaturization of electronics has also allowed sensors to shrink and become lighter, and the types of imagery products have expanded beyond color and panchromatic to include lidar, radar, phodar, multispectral, and hyperspectral products. Second, platforms have become smaller, more agile, and less expensive. With the development of CubeSats and SmallSats and increasingly ubiquitous drones, the fixed costs associated with





launching and flying sensors have dramatically decreased. Combined, these technology advances have improved imagery spatial, temporal, and spectral resolutions while also lowering costs.

As a result, the structure of the imagery market is fundamentally changing. Once dominated by large, expensive systems, designed and funded by government, the market has seen the entry of multiple commercial providers that are willing to compete on price and negotiate licensing terms. More imagery is also available from government agencies, often making that data open. The moderate-resolution systems of the United States Geological Survey's Landsat and the European Union Sentinel together capture global multitemporal and multispectral measurements of the earth every three to five days, which is free and open to all users. The United States Department of Agriculture's National Agriculture Imagery Program (NAIP) imagery provides 1-meter multispectral imagery data of the United States, captured on a three-year cycle, which is also free and available to all users. Simple multiscale imagery is accessible for visualization on multiple websites. Full resolution multispectral imagery is also dynamically served by a variety of platforms, such as Esri's ArcGIS Online, for both visualization and analysis.

This is a huge benefit. When I started my career, we purchased Landsat imagery for the State of California, which cost us a quarter of a million dollars. Now I can get Landsat, Sentinel, and NAIP data free all the time. Many local, state, and federal agencies, such as Sonoma County, California, make lidar data and high-resolution airborne imagery and products available for free and without restriction as web services or online downloads. Similar to the creation of the robust value-added weather industry following the decision of the National Oceanic and Atmospheric Administration (NOAA) decision to provide free access to NOAA weather data, the opening of free access to government earth observing imagery supports economic growth and decision-making in public agencies, private companies, and nongovernment organizations (NGOs).

Finally, imagery is big data, which often is daunting to organizations trying to use it. But the advent of cloud storage combined with the plummeting cost of computer disk space and memory makes issues of cost and capacity much less of a barrier to the use of imagery. Simultaneously, advances in machine learning and artificial intelligence algorithms that support medical research and social media sites are also being applied to the extraction of information from imagery, allowing the full integration of GIS data layers into imagery classification and resulting in reduced costs and an increase in the accuracy of imagery-based maps. Spatial data has become mainstream. Location is an integral part of the IT landscape, so more software engineers are familiar with it, leading to an increase in the pace of innovation.

Taken together, these developments have resulted in greater access, decreasing costs, and declining barriers to use, which, in turn, makes imagery much more available for more applications. This is a good thing, because we keep making more people, but we're not making any more land. Our resources are increasingly scarce. Fundamentally, imagery allows us to inventory and monitor resources and link natural phenomena and the actions of citizens, governments, and corporations to impacts on our land and oceans and—ultimately—to the people who depend on them. GIS and imagery, together, are critical to our future on this earth.

About the Author

In a career that spans three decades, Kass Green has not only managed and supervised hundreds of GIS and remote-sensing professionals but has also been a leader in GIS and remote-sensing research. She also has helped shape remote-sensing policy and vigorously supported Landsat program initiatives.

Green chairs NASA's Earth Science Applications Committee and cofounded and chaired the United States Department of the Interior (DOI) Landsat Advisory Group. She is a past president of the American Society of Photogrammetry and Remote Sensing (ASPRS) and MAPPS. An ASPRS fellow, she received the society's highest honor, the Honorary Lifetime Achievement Award, in 2016. Her research has led to innovations in automated change detection, accuracy assessment, and object-oriented image classification.

Her firm, Kass Green & Associates, works on projects all over the world. Recent projects include mapping the vegetation of the national parks of Hawaii, Grand Canyon National Park, and Sonoma County; and consulting to the government of Ethiopia regarding the choice of imagery to support the country's land certification activities.

Class Project Answers Community Needs

By Ziying Jiang, Assistant Professor of Geography, Miami University

← Graduates of the City Gospel Mission job placement and career development program. Photo courtesy of City Gospel Mission.

As part of an advanced GIS class at Ohio's Miami University, students participate in a community service project that builds the students' spatial thinking and problem-solving skills.

This project lets students apply GIS knowledge and skills while contributing to the community. Students are grouped into teams and paired with real-world clients. Each team helps the client identify its needs and collects and analyzes geographic data to deliver findings that assist in client decision-making.

In spring 2016, the class worked on a 14-week project for the City Gospel Mission. Founded in 1924 by James N. Gamble of Procter & Gamble, City Gospel Mission helps the homeless break the cycle of poverty and despair. City Gospel Mission is in the process of launching JobsPlus, a job readiness and placement program. The students' work would help answer the question, Where can JobsPlus clients find meaningful, sustainable employment that doesn't require personal transportation?

Analyzing Employment Opportunities

The level of employment, the quality of jobs, and jobs access are critical components of economic development in a region. Public transit provides crucial means for people—especially those who are aged, poor, or disabled—to access economic opportunities and other resources.

It is important to understand ultimately how well transit aligns with where people work and live. How effectively transit connects people and jobs is critical for job placement programs. It is also important to the delivery of services by government departments and business.

The JobsPlus program prepares people—especially people in poverty—to find and keep jobs. To launch its classes, grow its network of area employers, and assist its graduates, JobsPlus needed to know where its attendees could find meaningful, sustainable employment that did not require personal transportation.

The students would use GIS to help JobsPlus answer this question by locating employers and employment opportunities in Butler County and evaluating the accessibility of these opportunities to public transportation. Acceptable accessibility would require no more than a 20-minute walk to a bus stop. The students' analysis would not only reveal the spatial pattern of job opportunities but also the spatial trend of regional economic development when compared with the concentration of employers in the county.

Obtaining Data

Students acquired a list of employers for the municipalities located in Butler County from the Butler County Chamber of Commerce. That list contained the company name, owner, street address, telephone number, and other information.

Job opening data for the county, provided by JobsPlus, was derived from a list of all jobs in Ohio compiled and distributed by the Ohio Means Jobs program every two weeks. Students collected the data from December 2015 to February 2016 and extracted the job openings located in Butler County.

Public transit routes and stops data was obtained from the Butler County Regional Transit Authority (BCRTA), which provides a geodatabase containing a route dataset of regional connectors and local routes, a point dataset of all bus stops in Butler County, and a network dataset of Butler County roads.

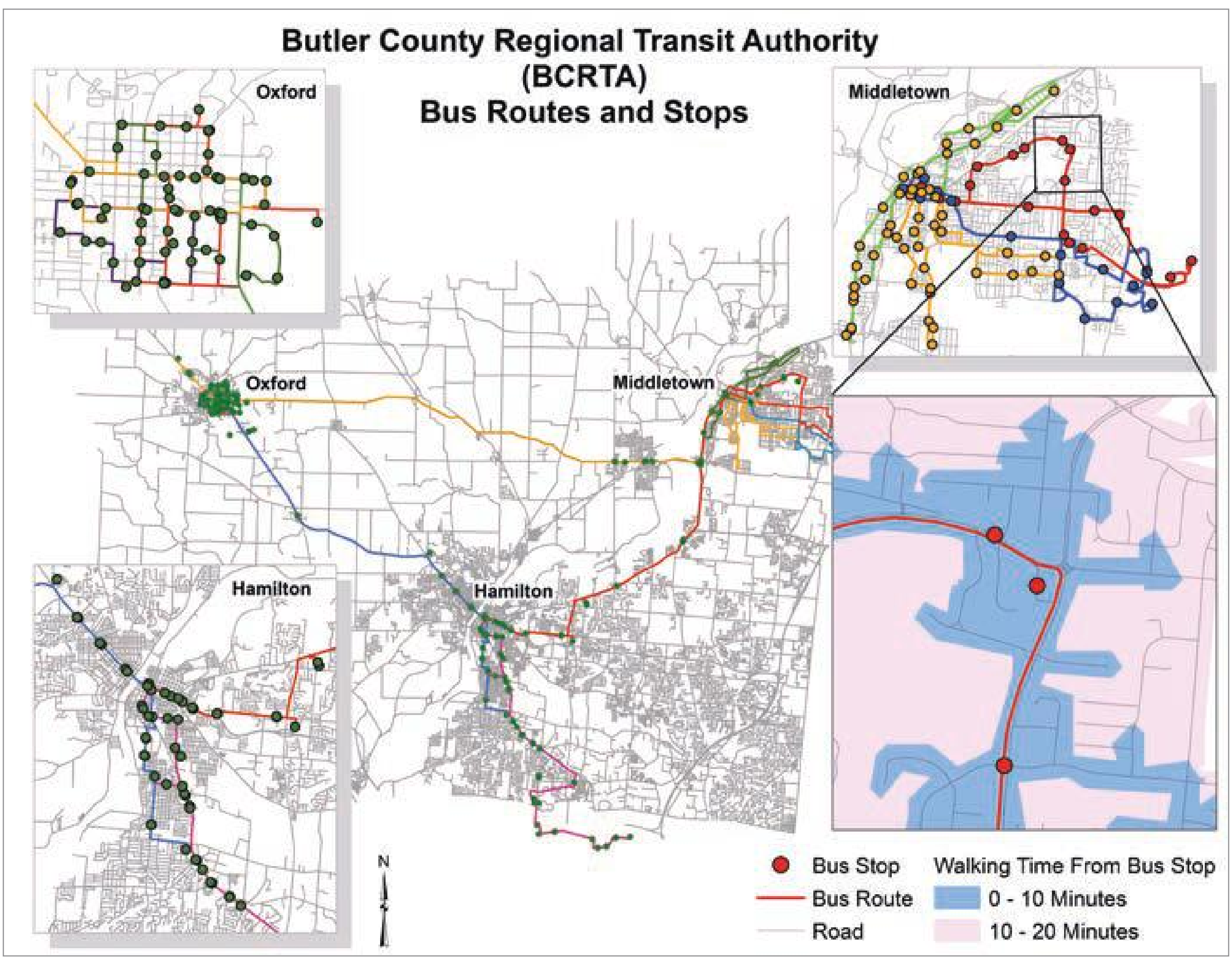
Students also examined the population density in Butler County to better understand the labor force and public transit demand in the area. US Census Bureau 2010 census block group level data was used. A census block group, generally defined to contain between 600 and 3,000 people, is the smallest geographic unit of population that can be downloaded from the Census Bureau website.

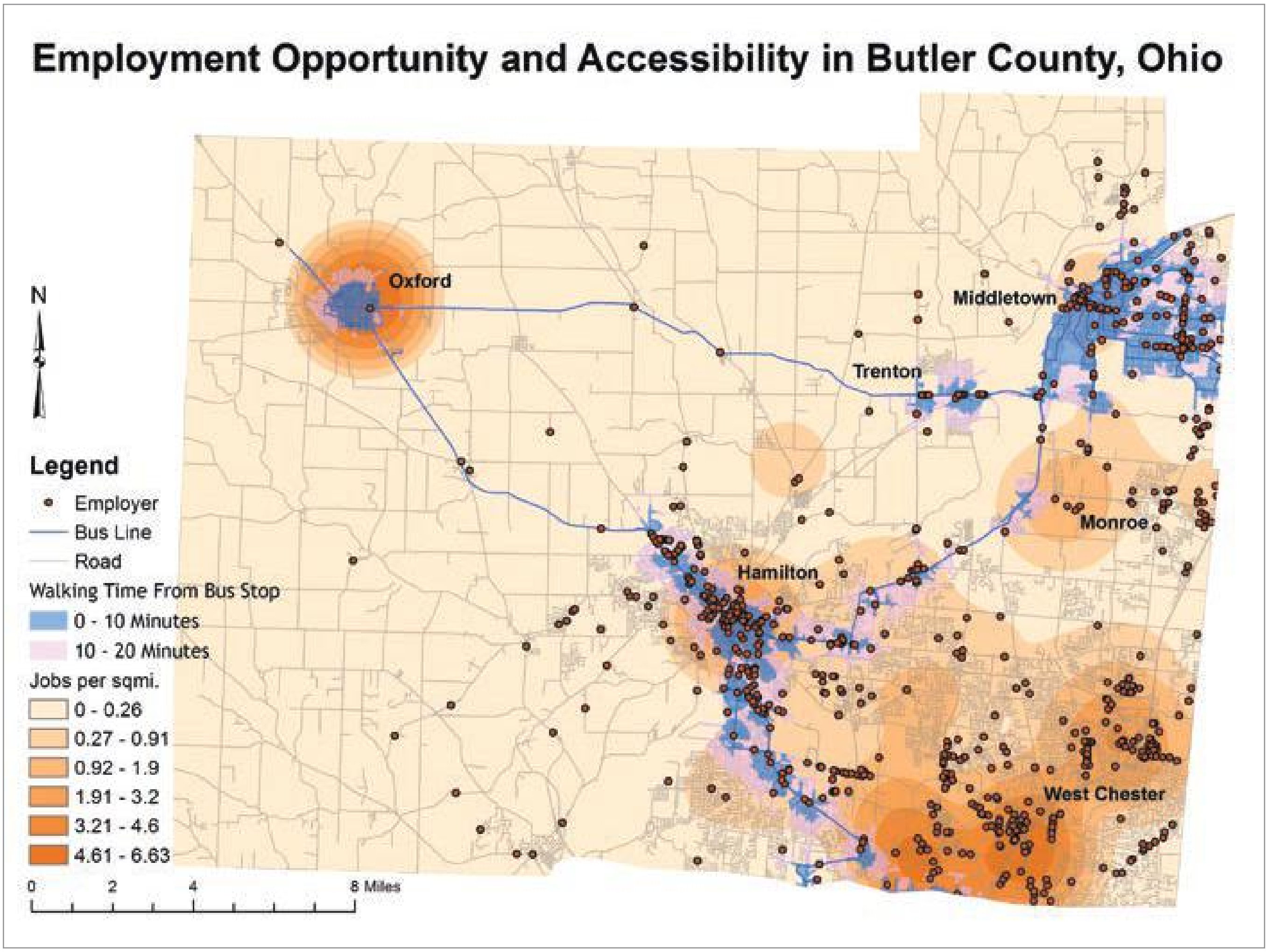
Spatial analysis and mapping were done in ArcGIS 10.3 for Desktop. Street addresses for employers and new jobs provided in tabular format were geocoded to Butler County roads and mapped as points and density surfaces. The ArcGIS Network Analyst extension was used to determine 10- and 20-minute walking distances from the bus stops along roads. Public transit accessibility of employment opportunities was evaluated based on the walking distance to employment opportunities in relation to bus stop locations.

Where the Employers Are

Of the 995 employers successfully geocoded in Butler County, 384 are in the City of Hamilton, 249 in West Chester Township, and 187 in the City of Middletown. These municipalities account for 86 percent of the employers in Butler County. When mapped with 2010 population density, employer locations showed some spatial alignment with population distribution. Two employer hot spots—Hamilton and Middletown—are the most populous areas in Butler County and have traditionally been manufacturing centers. Another area with a high employer-to-population ratio is West Chester. Unlike Hamilton and Middletown, West Chester doesn't have high population density. This suggests a separation between the business district and residential areas. Miami University in Oxford has a high population of students and was the only employer in Oxford included in this analysis.

↓ Public transit accessibility measured by walking distance from bus stops along the roads.





↑ The final map combined the location of employers, employment opportunity, and accessibility via public transportation in Butler County.

Where the Jobs Are

The ability of businesses to create new jobs and hire new employees varies depending on their type and size. From December 2015 to February 2016, 303 new positions were posted in Butler County. The number of jobs was not proportional to the number of employers across different areas. Employers in West Chester posted the largest number of new openings (67), followed by Fairfield (37). Hamilton and Middletown together posted only about one-quarter of the new jobs in Butler County.

A density map can reveal the spatial distribution of new jobs better than a dot map. The density surface map the team created revealed two pronounced hot spots in Oxford and West Chester. All new jobs in Oxford were generated by a single employer, Miami University. New jobs in West Chester came from a variety of employers and ranged from housekeeping to business intelligence development. The diverse employment opportunities in West Chester suggests that it has an expanding business sector and is experiencing economic growth.

When population was considered, West Chester exhibited greater job creation potential with 1.1 positions per 1,000 people on average, while Hamilton and Middletown offer only 0.5 and 0.39 jobs, respectively, per 1,000 people. Despite the concentration of employers and population, these historically industrial cities have been in decline since the 1970s.

Public Transportation Accessibility

Finding a reliable means of getting to work daily is crucial for people to gain and sustain employment. JobsPlus program attendees often lack the resources to own or operate a personal vehicle. Fortunately, the BCRTA public transit system serves the county through four regional connectors and two local routes. In 2015, BCRTA provided over 525,000 rides, primarily serving Middletown, Hamilton, and Oxford.

The BCRTA public transit service area was evaluated based on the walking distance to the bus stops along roads. Distances were calculated based on a walk of less than 20 minutes along a road. Based on prior published empirical research, the project team used a value of 4.5 feet per second (or three miles per hour) as the walking speed of an average person. The area within a 20-minute walking distance was defined as the accessible distance to the BCRTA bus system.

The accessibility to employment opportunities was evaluated by overlaying employer locations, bus lines, and walking distances from bus stops. The map reveals an unbalanced distribution of employment opportunities and public transit service. West Chester is substantially underserved by BCRTA bus lines. Only four of more than a hundred employers and 3 of 67 new jobs in West Chester are located within a 20-minute walking distance from a bus stop.

In contrast, most employers in Hamilton and Middletown were located within walking distance to bus stops. These two cities also had greater job accessibility compared with West Chester. Further spatial analysis also revealed that residents in Middletown face relatively longer walks to new jobs than to existing employers, which suggests recent economic activities in the city are occurring outside the established area where existing employers are clustered and served by bus lines.

Placing a New Job Readiness Class

After examining Butler County employment opportunities, the student team concluded that West Chester had the strongest economic growth and job creation potential. However, the lack of public transit accessibility could be a barrier for job seekers without private vehicles. Although Hamilton and Middletown, two postindustrial cities, have highly concentrated employment opportunities and populations, they have low employment-to-population ratios because the number of manufacturing jobs has declined. People living in these depressed manufacturing cities need job readiness programs that prepare them to get and keep a new job.

Putting Information to Work

Guided by project maps, JobsPlus located and contacted businesses on or near bus lines and identified employment opportunity hot spots in Butler County. In fall 2016, JobsPlus launched a new office in Middletown. JobsPlus will continue consulting the spatial information produced by the project to broaden the scope of employment opportunities as it expands the program.

Miami students delivered high-quality outputs. One of the maps created from the project won second place in a professional map competition with more than 20 high-quality entries at an Ohio GIS conference.

Students who participated in this service learning project found it inspiring and fun and experienced a sense of accomplishment. The project enhanced public understanding of how geography and GIS help people make better, more informed decisions and make a difference in the world.

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Learning at the Intersection of Art and Science

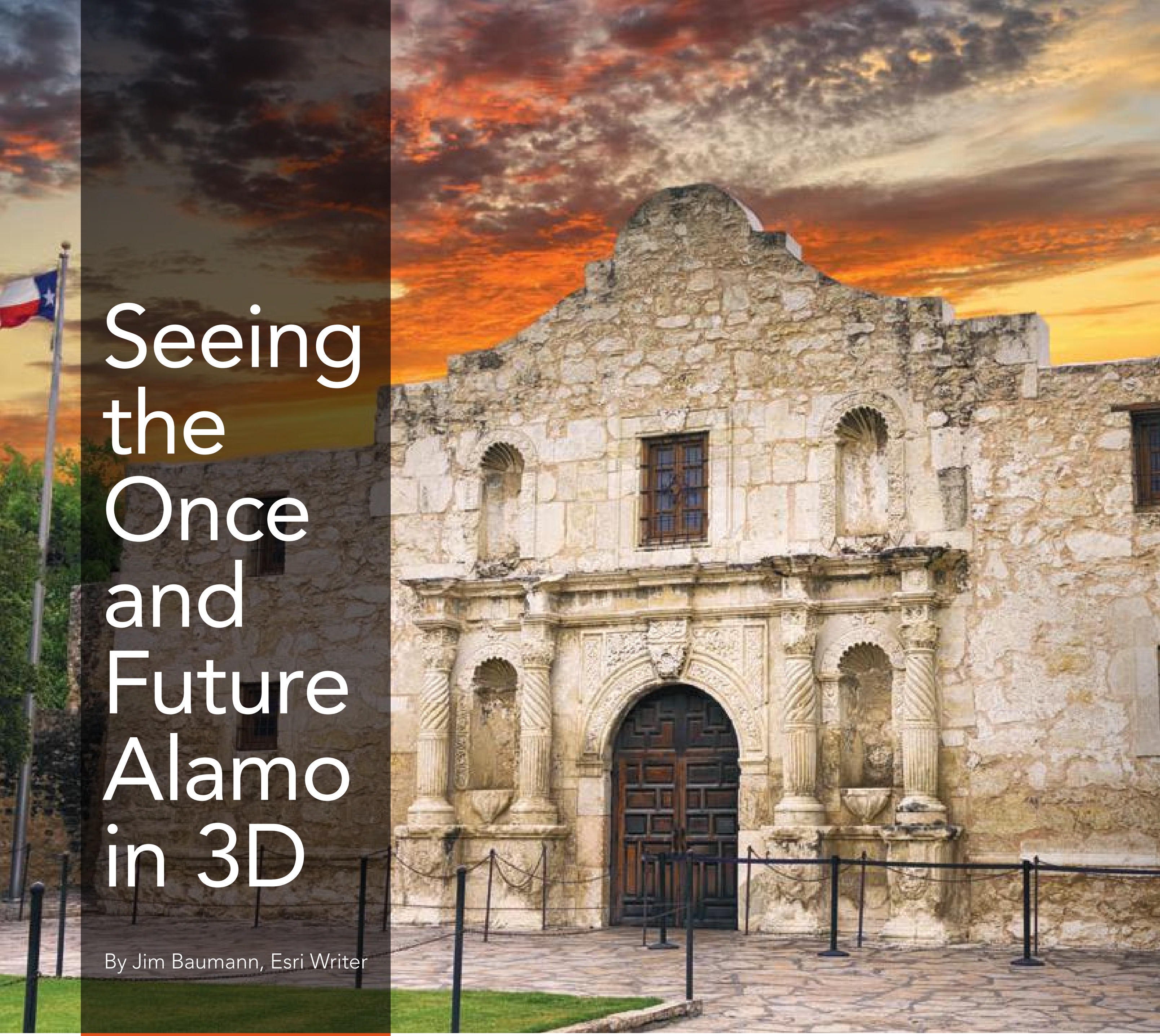
Learn to make maps that are not only beautiful to behold but effective information products by signing up for Cartography., a free six-week massive open online course (MOOC) offered by Esri.

A team of experienced cartographers, led by Ken Field, will explore the cartographic design capabilities of ArcGIS Pro while teaching students to appreciate both the art and the science. Each lesson consists of about two hours of content that includes video discussions, guided and self-guided exercises using ArcGIS Pro and ArcGIS Online, quizzes, interactions between students and instructors, and the use of supplemental resources. Coursework focuses on the creation of one exemplary map that draws together key cartographic ideas.

In addition to practical skills with ArcGIS Pro, students will learn how to think like a cartographer and gain an appreciation of the art and science of cartography. Students can explore graphics to gain an understanding of how generalization, symbology, and color affect the story a map tells. One lesson introduces typography, label styles and placement, and map composition to demonstrate how these elements help or hinder map communication. Another looks at how coordinate systems, transformations, and projects affect the map's message. The two final lessons add the third and fourth dimensions to mapmaking: representing 3D and temporal data.

The first offering of this course, the fifth since the advent of Esri MOOCs in 2014, coincides with the release of Field's new book, *Cartography*, being published by Esri Press. It joins the other Esri MOOCs—Going Places with Spatial Analysis, The Location Advantage, Do-It-Yourself Geo Apps, and Earth Imagery at Work—which have attracted more than 105,000 enrollments. The completion rate of 25 percent for Esri MOOCs is a rate much higher than that of other MOOC providers.

To sign up, visit the Cartography. page at go.esri.com/cartographymooc.



Seeing the Once and Future Alamo in 3D

By Jim Baumann, Esri Writer

"Remember the Alamo" is the well-known battle cry that inspired the Texian Army to victory over the Mexican army at the Battle of San Jacinto in 1836 and ultimately led to Texas independence.

Engineers working on a project to restore the original site of the battle of the Alamo and preserve its viewshed are using 3D GIS visualization of the site as part of the restoration plan.

The original Alamo site—the Mission San Antonio de Valero—has been venerated for more than 180 years and visited by millions each year. Over the years, neglect and the mining of collapsed structures for building materials continued obliterating the site. Because of its location in the growing downtown section of San Antonio, Alamo and Houston streets were built across a portion of the original battleground. Later, the construction of a government facility, commercial buildings, hotels, tourist attractions, and conservation efforts further encroached upon this hallowed ground.

In honor of the 300th anniversary of the mission in 2024, the City of San Antonio and

← The front entrance of the Alamo in San Antonio, Texas.

↓ The front entrance of the Alamo in 3D.

the Texas General Land Office have worked on the development of a major renovation plan for the site that accurately reflects the location of its 4.2-acre compound and historic buildings at the time of the battle of the Alamo.

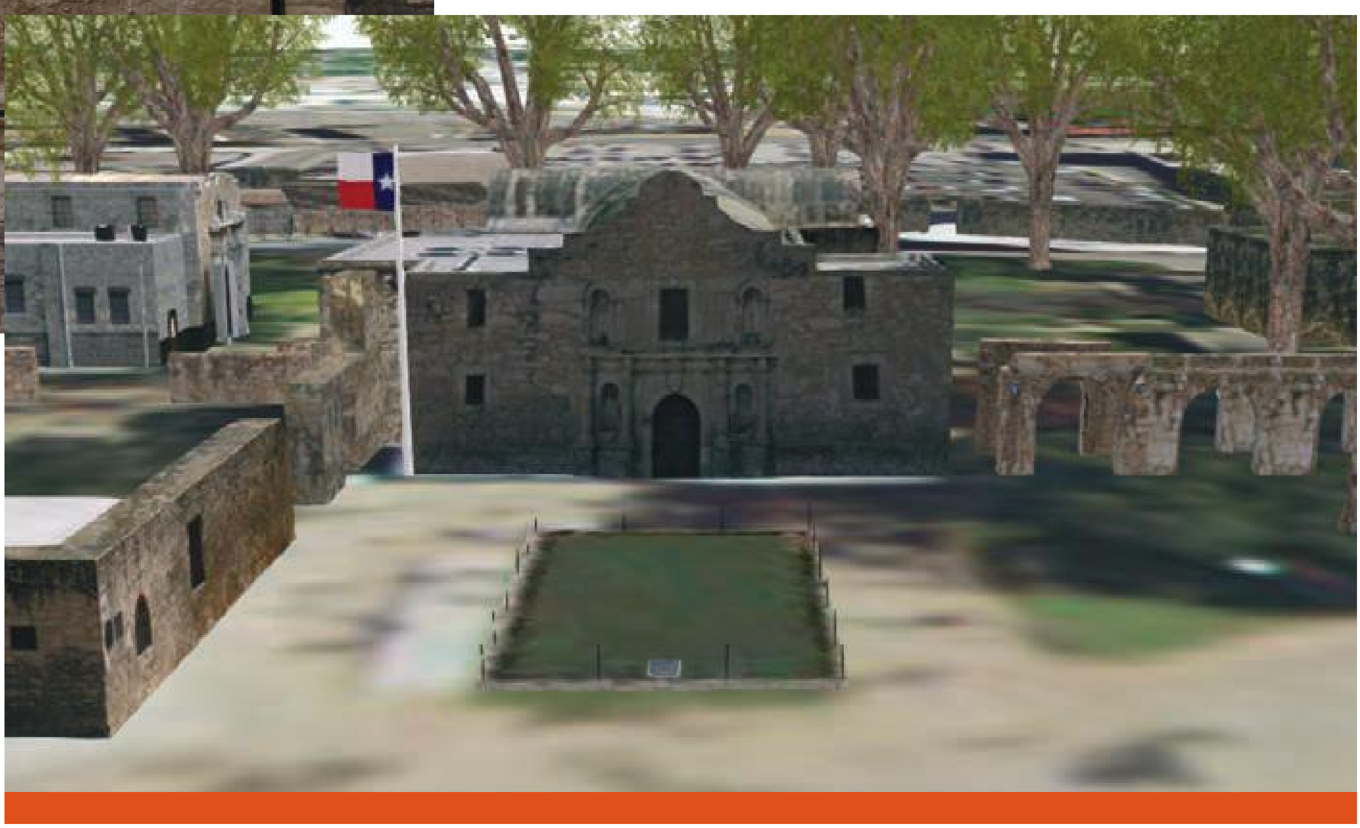
The Mission San Antonio de Valero had been hastily converted into a makeshift fort. The garrison was composed of a large walled courtyard where the famed battle took place and a small number of outbuildings that included a chapel, storage rooms, animal pens, and the Long Barrack that provided living accommodations for the soldiers. Three-foot-thick walls surrounding the site were between 9 to 12 feet in height.

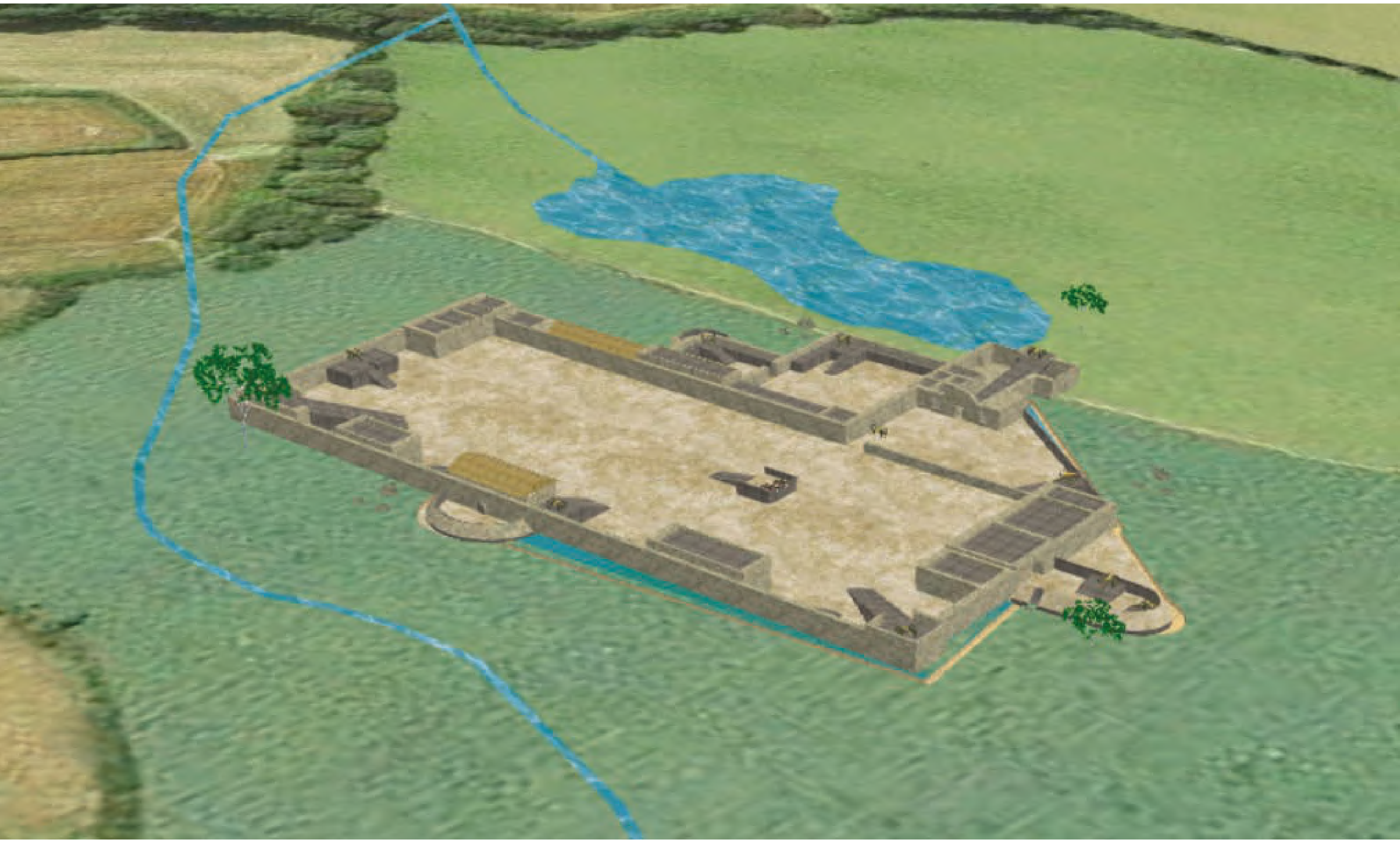
A Texas firm, Pape-Dawson Engineers, joined the group responsible for designing the reimagined Alamo site. The company led the archaeological effort to establish the exact location of the west and south walls of the compound. It also provided topographic surveying and laser scanning to document existing conditions and provide a historical basis for the concepts of redevelopment presented in the master plan for the Alamo Plaza site.

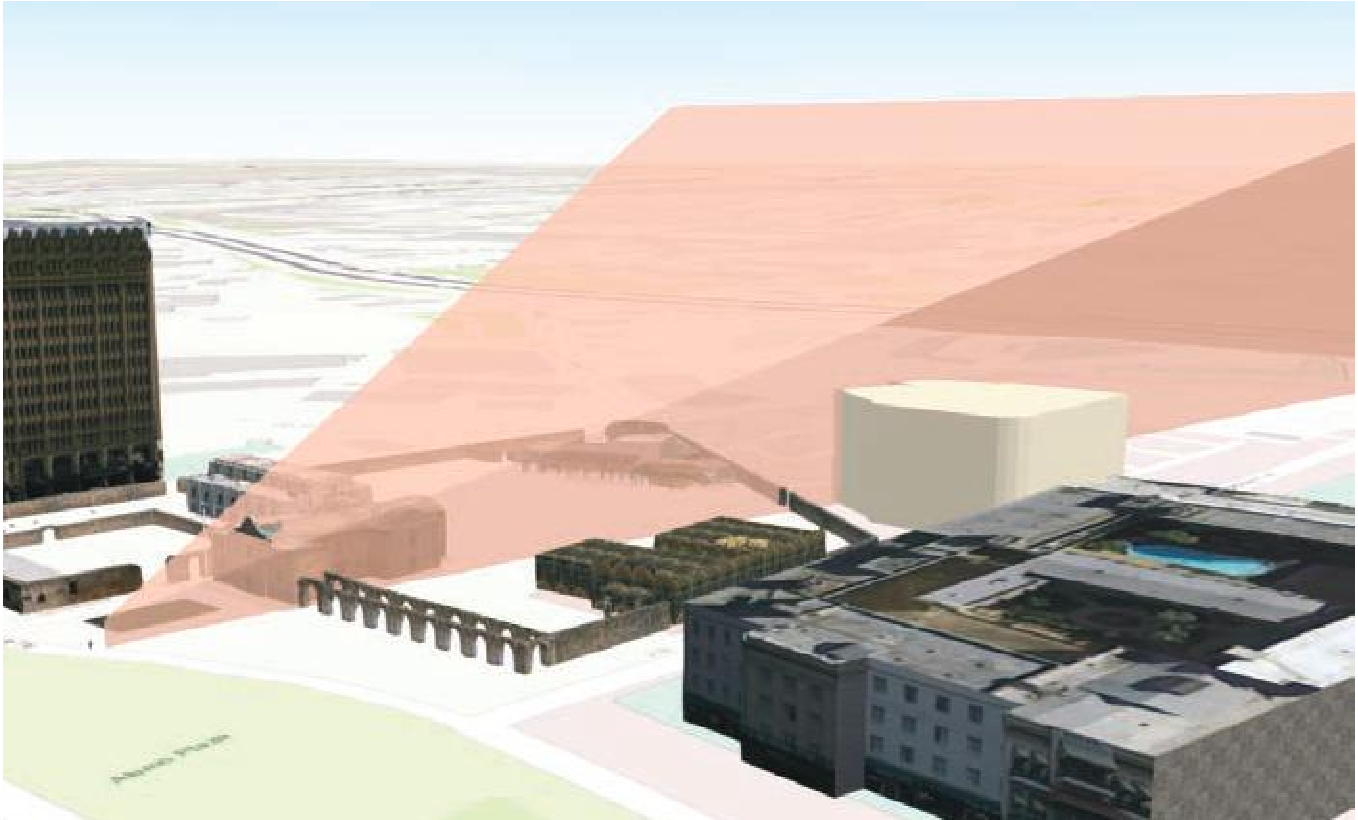
Michael Garza, GIS manager at Pape-Dawson Engineers, has been using ArcGIS for more than 15 years. As a San Antonio native, he took a personal interest in the plan to redevelop the Alamo Plaza as it appeared at the time of the 1836 battle.

"The Alamo is the most popular attraction in Texas," said Garza. "The site gives our city an enormous sense of pride."

Garza was interested in the work done by Pape-Dawson's archaeological crew members at the site, especially when they determined the location of the Alamo's long obscured walls. He convinced the company to let him contribute to the project by visualizing the site as a precise 3D model using GIS. This model would not only aid those involved in the reconstruction project but







↑ This viewshed visualization shows, as per the City of San Antonio ordinance, that there are no buildings behind the Alamo tall enough to be seen by a person standing in front of the Alamo.

could also provide an accurate historical perspective for those visiting or researching the Alamo.

"First, a basemap was created for the 3D models by clipping an image of the Alamo Plaza site from Pape-Dawson's existing aerial data, and then *[Trimble's]* SketchUp was used to create the bare earth courtyard where the battle took place," said Garza.

"A 3D historical model of the Alamo compound already existed in Trimble's 3D Warehouse, which is an open-source library of SketchUp images. We compared this model with several artist renditions of the Alamo for the 1836 time period and determined that it was historically accurate," said Garza. "We then resized and repositioned this model to match the exact location of established artifacts on the basemap, such as the west wall bricks found by our lead archaeologist Nesta Anderson."

Garza's team got the information needed to create 3D models of the missing buildings and walls from artists' renderings of the Alamo from that period, as well as from a sketch used as part of the Mexican battle plan that was made by one of General Antonio López de Santa Anna's senior officers. Footprints of the existing buildings around the perimeter of Alamo Plaza came from a GIS layer the team received from the City of San Antonio that included building footprints and heights.

Garza described the process used to produce the 3D models of the buildings and walls. First, the missing 2D footprints were created in ArcGIS Pro, extruded in 3D, converted to multipatch features, and saved in the project's geodatabase. Extrusion heights were based on the recorded building height found in the GIS database or, in the case of those buildings that had been destroyed, on historical research.

The multipatch feature was exported as a COLLADA file, a 3D interchange format that is compatible with SketchUp. In SketchUp, textures were added to building facades to make them appear realistic. Textures for the facades were created from photos of building exteriors and walls taken by the team. The team made sure the images overlapped so they could be accurately applied to the 3D models in SketchUp.

Each SketchUp-enhanced model was brought back into ArcGIS Pro as a Keyhole Markup Language (KML) file, converted back to a multipatch file, and reprojected for positioning purposes. All 3D buildings were added to the basemap using the Layer 3D To Feature Class tool in ArcGIS Pro to create a photo-accurate, geolocated 3D model of the Alamo Plaza site.

"The final interactive piece provides past, present, and future views of the Alamo Plaza. It was published as a web scene in ArcGIS Online to make it easily accessible from any web browser and compiled into a story map so that a written narrative could enhance it," said Garza.

↖ The Alamo as it appeared in 1836.

↙ Modern buildings and the street network have encroached on the original site, as shown in this 3D model.

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