ArcNews

Esri | Summer 2023 | Vol. 45, No. 3

Briefly Noted

Get GIS Guidance from Esri Experts
Esri Services is offering free, 30- to 45-minute consultations with focused experts on a range of topics at the upcoming Esri User Conference (Esri UC). Participants can obtain guidance on defining or refreshing their geospatial strategies, maximizing a GIS initiative's adoption, brainstorming and implementing a solution, assessing GIS data, and developing an organization's workforce. Visit go.esri.com/UCAppointments to sign up.

GIS Helps Local Governments Tackle Equity Issues
Esri has joined the Chief Equity Officer Network—a partnership between the Harvard School of Public Policy, the National League of Cities, the National Association of Counties (NACo), and Bloomberg Philanthropies—to help local governments use GIS to make equity efforts strategic and actionable. "We are thrilled to collaborate with Esri and are thankful for them bringing their expertise on how GIS is applied to equity across our nation's communities," said Teryn Zmuda, NACo chief research officer and chief economist. The network will bring together equity officers and leaders from various states to cultivate and nurture ideas to address equity and how it applies to their communities' needs.

Esri Founders Receive Conservation Visionary Award
The International Land Conservation Network (ILCN) awarded Esri founders Jack and Laura Dangermond with the Conservation Visionary Award at the 2023 Geodesign Summit. The award recognizes the Dangermonds' ongoing work toward understanding the connection between humans and the planet to help build a more sustainable world.

ArcGIS Reality Creates a Digital World with Geospatial Context

In industries that range from architecture, engineering, and construction (AEC) to transportation and government, digital twins are transforming how people make decisions based on data from the physical world. ArcGIS Reality, a suite of photogrammetry software products, enables users to create accurate digital renderings of objects and scenes at multiple scales and extents—from a single project site to whole cities and even countries.

With ArcGIS Reality, users can turn all types of aerial imagery from drones, crewed aircraft, and satellites into highly accurate maps and 3D models. The technology allows them to interact with a digital world that shows places and situations as they truly are, layered with geospatial data that enriches reality with greater context.

ArcGIS Reality includes the following four products:

- **ArcGIS Reality Studio:** This new, focused app for reality mapping helps users take aerial images and apply them to mapping entire cities and countries. Its interactive, mapcentric interface is built for large-scale production workflows and allows users to efficiently deliver survey-grade representations of reality.
- **ArcGIS Reality for ArcGIS Pro:** This new extension for ArcGIS Pro allows users to input images from drones or crewed aircraft into desktop GIS software to generate highly accurate 3D outputs for reality mapping.
- **Site Scan for ArcGIS:** Esri's cloud-based, end-to-end reality mapping software for drone imagery simplifies drone program management and imagery data collection, processing, and analysis.

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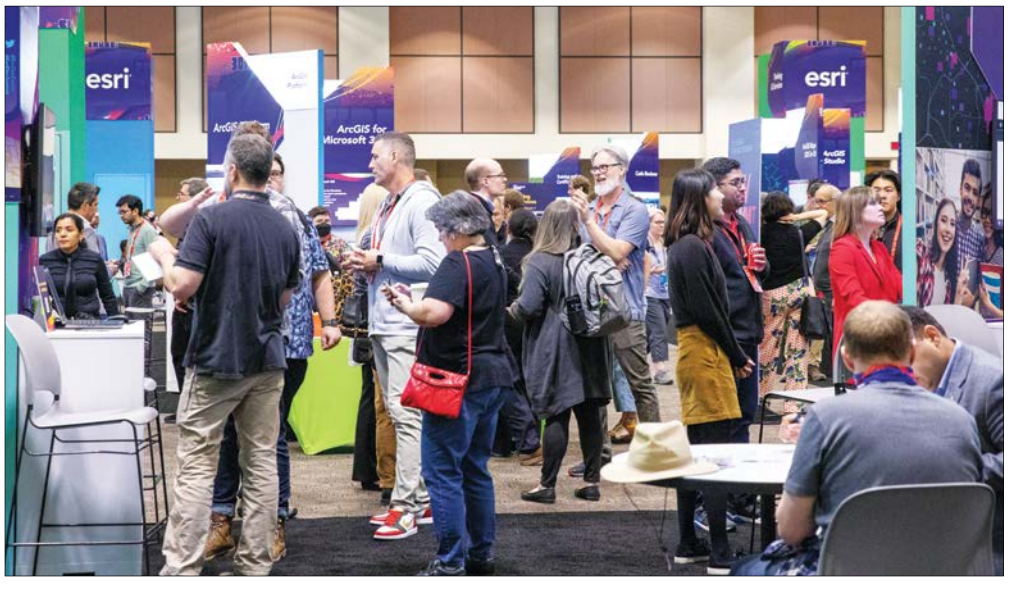
↑ With ArcGIS Reality, users can create accurate digital renderings of whole cities, such as Frankfurt, Germany. (Imagery data courtesy of Bluesky International.)

Developers Push GIS Beyond Its Current Limits

At the 18th annual Esri Developer Summit (DevSummit), held March 7–10 in Palm Springs, California, the message was clear: With the latest advanced capabilities that have been added to ArcGIS, developers can save time, keystrokes, and mouse clicks while creating location-based solutions for myriad uses.

Developers continually engage with Esri, providing product teams with critical feedback that helps make these technological advances possible.



← There were 1,850 in-person attendees at the 2023 Esri Developer Summit (DevSummit).

"You provide us *[with]* feedback on our products," Esri product manager for developer technology David Cardella told the 3,130 people who attended DevSummit in person and virtually. "You push our technology to the limit, and you challenge us to do better."

This symbiotic relationship between the developer community and Esri has helped galvanize ArcGIS product teams to make strides in game engine development, solving issues of scalability and resilience, turning ArcGIS into a comprehensive spatial analytics system, and much more.

While the takeaways from the 2023 DevSummit were manifold, four of them stand out for how comprehensively they improve the developer experience. Continue reading to learn about the expanded capabilities of ArcGIS Maps SDK for JavaScript and ArcGIS Maps SDKs for Native Apps; new developments in ArcGIS Enterprise; and the fully automated, cloud-native geospatial infrastructure that's now available with ArcGIS Enterprise on Kubernetes.

→ Powerful GIS Capabilities Available on the Web

Using ArcGIS Maps SDK for JavaScript, developers can bring the power of traditional, desktop- and

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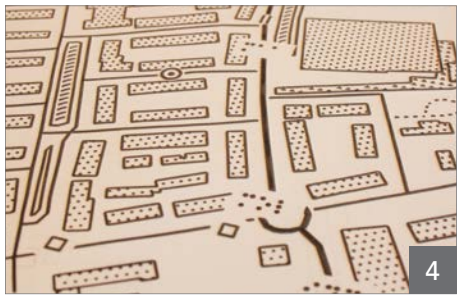
The Palace of Versailles and its surrounding estate comprise nearly 2,000 acres. GIS-powered web apps, maps, and services now help visitors understand the history and heritage of Versailles, as well as aid staff in managing the expansive grounds.



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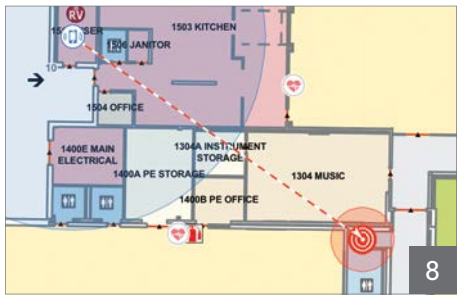

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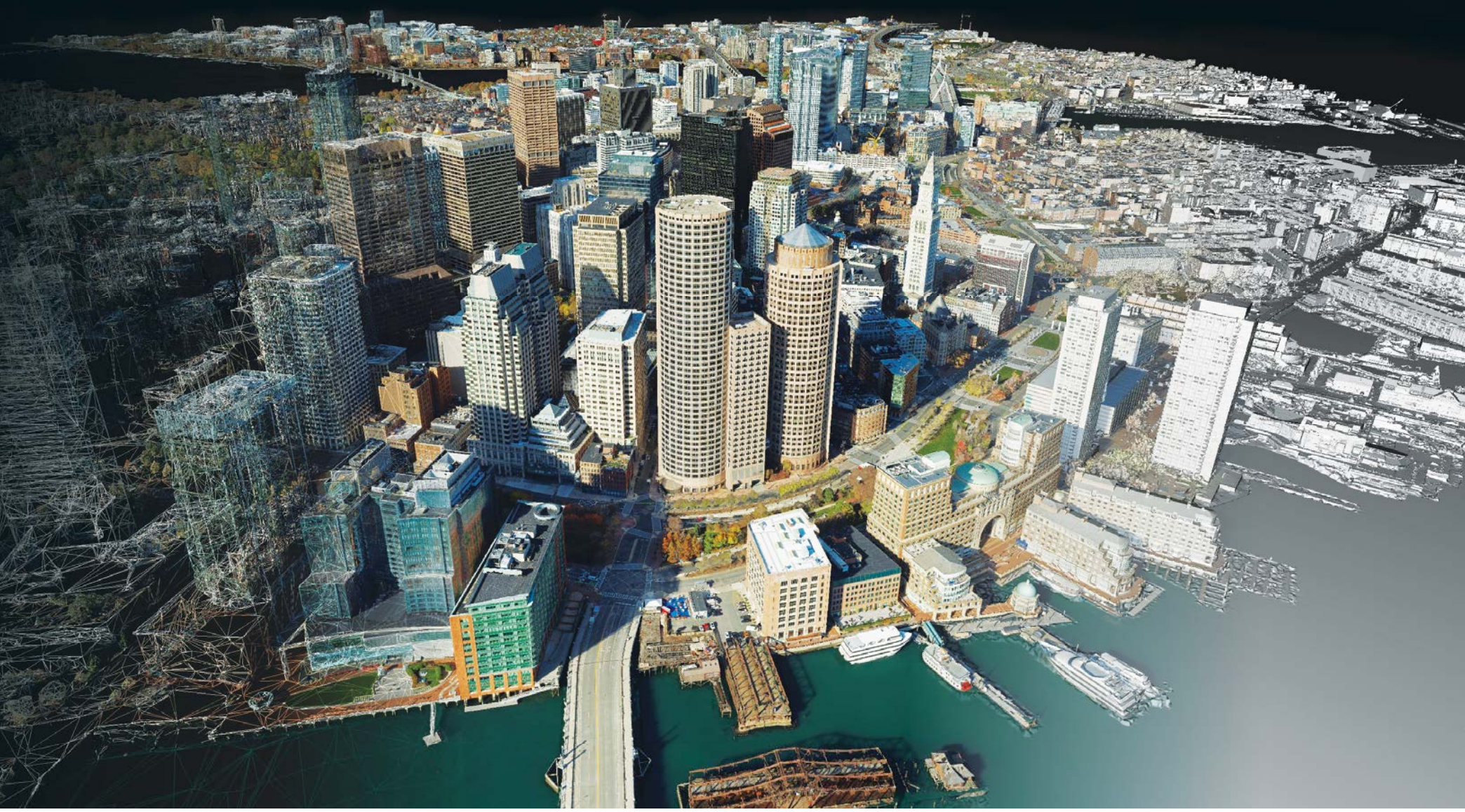
ArcGIS Reality Creates a Digital World with Geospatial Context



↑ ArcGIS Reality enables users to interact with a digital world that's layered with geospatial data. (Imagery data courtesy of Bluesky International.)

- **ArcGIS Drone2Map:** This is an intuitive desktop app that makes it easy for users to generate maps from drone imagery, thanks to its offline processing and in-the-field rapid mapping capabilities.

Read on to find out more about each product as well as how they work together within ArcGIS Reality.

ArcGIS Reality Studio

The need to build realistic representations of an area is not limited to individual sites and small regions of interest. It took years of research to design and build Reality Studio—software that's optimized to use aerial imagery to map very large areas with precision, speed, and simplicity.

Reality Studio lets users apply reality mapping to regions of any size so that they can create the foundation for a 3D digital twin. The software provides automated processing workflows to help users quickly align large collections of images and efficiently create photo-realistic, survey-grade data products. Users can then bring this data into their GIS and mapping systems to perform advanced analysis and visualization.

The key capabilities and benefits of Reality Studio include the following:

- **Data processing is fast**. Users can process large or multiday data captures in a single project, rather than splitting them up across multiple projects.
- **Content production is automated at scale**. Users can employ automated workflows to create true orthos and 3D meshes—even for entire cities and countries.
- **Results are accurate and photo-realistic**. The workflows in Reality Studio automatically determine the optimal parameters—such as pixel size and quality—at each data processing stage, so the products that are generated are true to life.
- **Customers see immediate value**. Outputs created with Reality Studio can be used within the ArcGIS system or other, third-party mapping systems, enabling users to begin making informed decisions immediately.

ArcGIS Reality for ArcGIS Pro

GIS is rapidly expanding its uses far beyond traditional mapping, and the ability to integrate photo-realistic 3D representations directly in the mapping environment puts ArcGIS ahead of the curve.

Reality for ArcGIS Pro provides reality mapping tools that allow GIS professionals to create the foundation for digital twins and provide data for spatial analysis in ArcGIS. The extension allows users to use ArcGIS Pro to generate photo-realistic true orthos, point clouds, and 3D meshes from drone and aerial imagery. Processing and outputs are seamlessly integrated with ArcGIS, so they are quickly ready to use for analysis and visualization.

With Reality for ArcGIS Pro, users can do the following:

- **Generate 3D outputs in-house**. Reality for ArcGIS Pro delivers reality mapping capabilities in ArcGIS Pro, expanding what GIS users can produce to include true orthos and high-quality textured 3D meshes.
- **Process drone and aerial imagery**. Reality for ArcGIS Pro is camera agnostic and supports a wide range of drone and aerial sensors. This makes it flexible and able to grow with users as their hardware evolves.
- **Integrate reality mapping content into analysis**. Content that users create with Reality for ArcGIS Pro is immediately accessible in their ArcGIS spatial analysis workflows, so users can swiftly determine relationships, detect and quantify patterns, assess trends, and make predictions and decisions.

Site Scan for ArcGIS

As the use of drones for decision-making continues to expand, organizations need a solution that allows them to leverage drone-collected data whether their IT infrastructure is built on-premises or in the cloud. Site Scan for ArcGIS is Esri's cloud-based reality mapping app for drones that enables geographically dispersed users to collect, process, and store large datasets regardless of local storage or compute capacity.

Now part of the ArcGIS Reality family, Site Scan helps users maintain their drone inventory and flight history, stay up-to-date with and securely process accurate imagery, and perform advanced analysis. The app leverages the same processing technology as the rest of the products in ArcGIS Reality, giving users a consistent way to create photo-realistic true orthos, point clouds, and 3D meshes.

ArcGIS Drone2Map

For organizations that use high-resolution drone imagery to make decisions quickly, especially in the field, this desktop reality mapping app enables users to process and analyze drone imagery without being connected to the internet. The accurate 2D and 3D representations of the real world that Drone2Map generates can be easily shared as well. Just like Site Scan, Drone2Map is now part of the ArcGIS Reality family and employs the same processing technology to allow users to consistently create photo-realistic true orthos, point clouds, and 3D meshes.

To learn more about ArcGIS Reality, visit **go.esri.com/arcgis-reality-arcnews**.

Tactile Maps Built with GIS Help People Who Are Blind Gain Spatial Awareness

For people who are blind or have low vision, the voice commands on common navigation apps—often coupled with other aids, such as a walking stick or guide dog—work wonderfully to help them get from point A to point B. But users of these apps typically miss a lot of context along the way.

"Navigation apps tell you that you have to go straight, or right, or left at the next corner. But is it a 60-, 90-, or 120-degree corner? What kind of street will it be—a narrow one for pedestrians or a wide one with a lot of cars?" mused Arend Jan van Dongen, a resident of Vught, the Netherlands, who is legally blind. "You don't get that information from the navigation app. You need a map to get an overview of that."

A spirited and swift-moving collaboration is underway in the Netherlands to give people who are blind or have limited vision regular access to tactile maps that can help them gain situational awareness of the places they go—whether they're walking around their neighborhoods, traveling to the next town over, or taking a trip to a far-away city. The Netherlands' Cadastre, Land Registry and Mapping Agency—known as Kadaster—is working with Esri Nederland (Esri's distributor in the Netherlands), several local accessibility organizations, and a handful of universities and academics to use ArcGIS technology to produce maps on swell paper that people with vision impairments can touch to get overviews of neighborhoods, regions, whole countries, and the world.

← People who are blind or have limited vision have been testing the maps.

The group wants to ensure that the maps are functional for a wide range of user needs and preferences—and that people with low or no vision can order the maps on demand, without the aid of a sighted person. The collaborators have also set their sights on reaching people beyond the Netherlands.

"Through ArcGIS Living Atlas of the World, we have data for the whole world available at several scales," said Vincent van Altena, a research and innovation consultant at Kadaster. "The project group would like to make these maps available on demand for people everywhere, especially those who live in places with limited access to resources like this."

"All visual media needs to be adapted for visually impaired people or people with reading disabilities for the simple reason that, first and foremost, they are people," added Julian Nauta, the product manager for tactile graphics at the Dedicon Foundation, a nonprofit that reproduces texts and images in alternative formats and is contributing to the project. "For them to be able to fully participate in our very visual and image-heavy society, they need a way to understand images, read text, and experience maps."

A Digital Solution Emerges

Although tactile maps are available for people who are blind or have low vision, they are often difficult and time-consuming to produce.

"Dedicon has been making tactile maps for a long time, but it has always been a manual process," said Nauta. "When somebody calls and asks for a map of a certain country or area of their city, one of our illustrators starts drawing the area street by street, which, of course, is very labor-intensive. This means that we can't make very many maps per day, per year."

Six years ago, van Altena was representing Kadaster at a conference and encountered Anna Vetter, an Esri Switzerland intern at the time, who had used ArcGIS technology to make a tactile atlas of Switzerland. Van Altena was interested in her work and asked her to send him the data and project files so he could try creating something similar with Dutch data. He didn't have time to pursue the project immediately, but a few years later, when van Altena was working with Daan Rijnberk, who was then an intern at Kadaster, the idea resurfaced.

The two of them got in touch with Bartiméus, an institute for the visually impaired; the Accessibility Foundation, an organization that focuses on digital, physical, and social accessibility; the Dedicon Foundation; and the Swiss Library for the Blind and Visually Impaired. These organizations helped them conduct focus groups with people who are blind to discover how tactile maps could aid them in their everyday lives.

Nauta recalled one user at an early focus group saying that he once took the local railway line to go to a hardware store in a neighboring village. A few days later, the person took the rail line again to visit a home electronics shop. He realized that the two stores were near each other and said that, if he had known this earlier, he would have visited both shops during his initial journey.

"We sighted people, when we navigate to a place, can immediately see everything that's around that destination," Nauta said. "Up until now, visually impaired people couldn't really do that, except with the handmade maps that Dedicon produces but can't produce in large enough quantities."

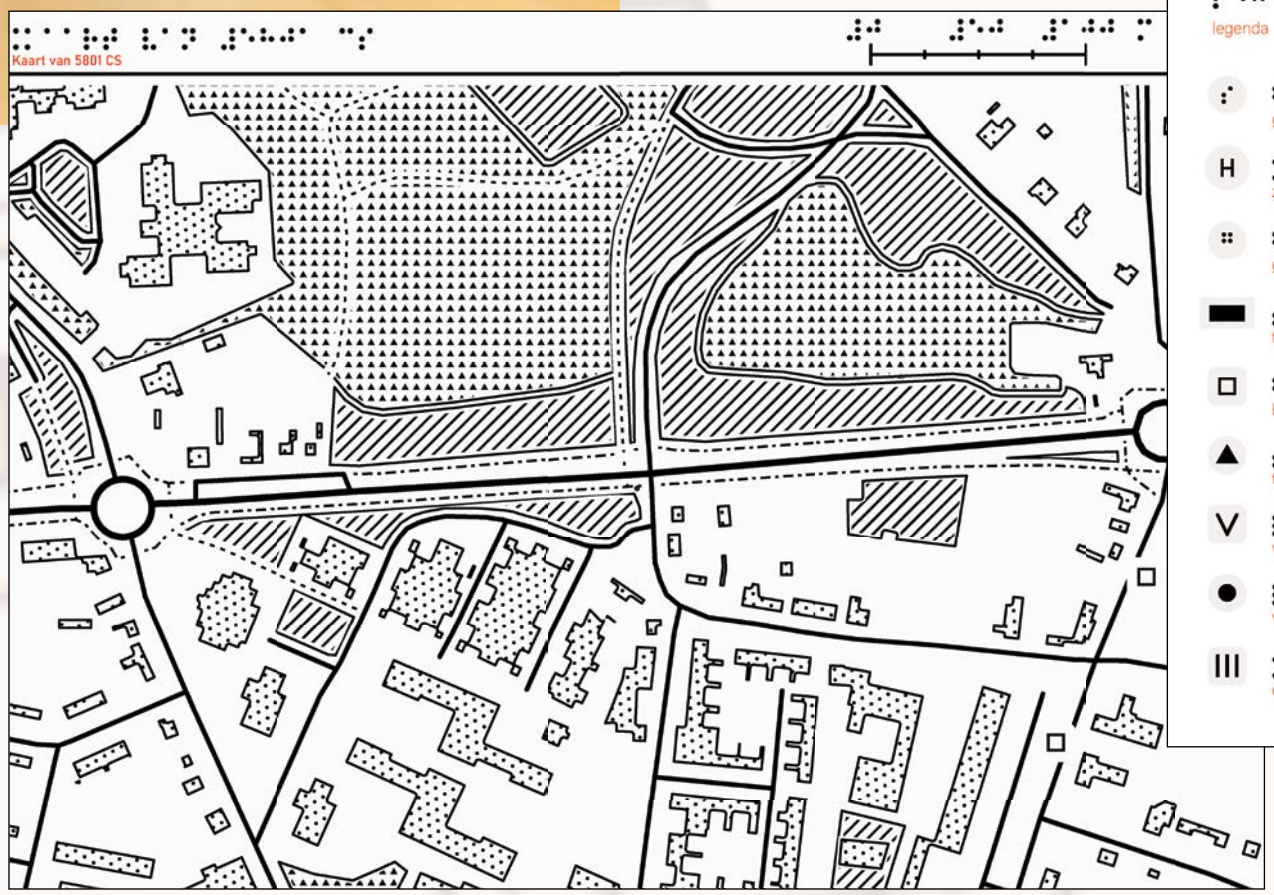
A New Way to Gain Context

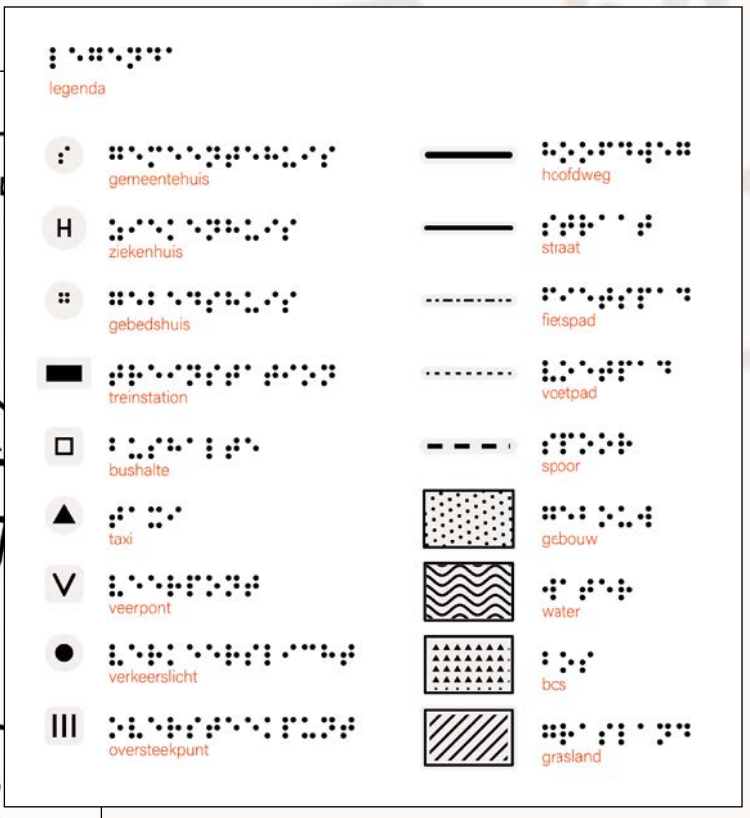
Working with Esri Nederland, van Altena and Rijnberk used ArcGIS Pro, along with data from Kadaster and ArcGIS Living Atlas, to make some maps. Rather than taking days, it took them about 20 minutes to put together each prototype.

"We produced tactile printable maps of neighborhoods, as well as maps of the Netherlands that provided context, such as provincial capitals and the way railroads run through the country," said van Altena.

The team then carried out usability testing with people who are blind or have limited vision. Ellen Zieleman, one of the testers, said she was astonished the first time she felt one of Kadaster's tactile maps of the world.

"With one finger, I could cover the Netherlands, and I needed both hands to get an idea of Russia's size," Zieleman said in

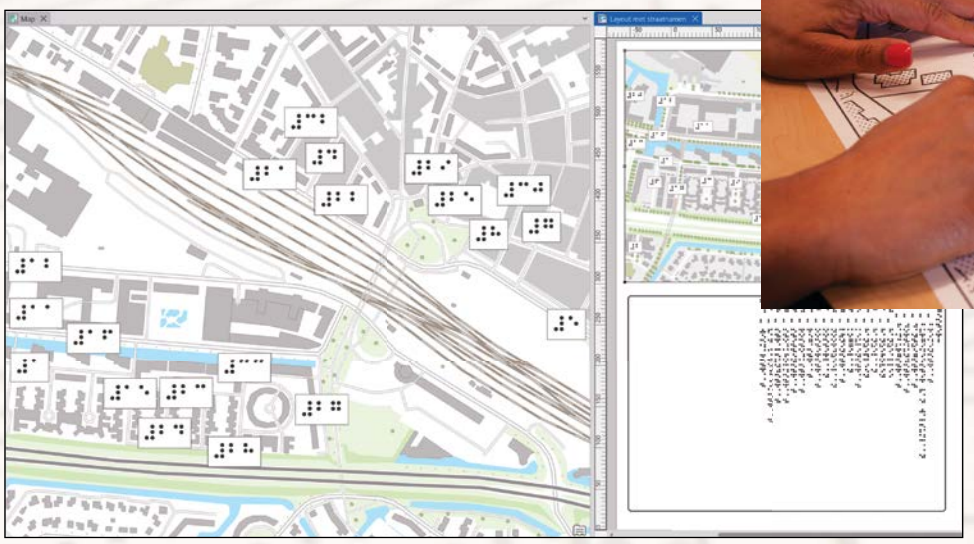




↑ The map legends explain the symbology in Braille.

← People who are blind or have low vision can use their fingers to tell where pedestrian footpaths, roads, rail lines, buildings, grass, and water are.

→ Braille labels must be in 24-point with a horizontal orientation, so not many can fit on a map.



↑ The group is working to figure out what symbology should be used on the maps and how many different symbols someone can distinguish with their fingertips.

a video produced by Kadaster that highlights her experience as a map tester. "My worldview has been enriched because I now have the same access to knowledge that other people have."

When van Dongen tested the tactile maps, he did so in Zwolle, near Kadaster's office.

"I was able to recognize the area, but I also saw things on the map that I didn't know," he said. "With a map made in the correct way, you can get a good overview of a situation and use it to orientate yourself in daily life. … For instance, when I'm on holiday, I like to know the surroundings of the hotel or apartment complex where I'm going to stay. Or if I have to go to a hospital, I can get an overview of the corridors and how the different parts of the hospital are situated so I can more easily find my way when I'm there."

Through testing, the team learned that people largely want to use the maps to figure out how cities and neighborhoods are laid out, where stores are located, and what routes are available for getting around. One woman, who lost her sight several years ago, wanted to know what the new mall in her community looks like.

"She knows what her neighborhood used to look like, but she doesn't know what the mall looks like—and she goes shopping there frequently," said Niels van der Vaart, head of product management and innovation at Esri Nederland. "She asked us to create a map of the mall so she could get a sense of how it's laid out."

Van Altena believes that the spatial awareness provided by these maps can go beyond people's immediate, day-to-day needs as well.

"The maps can also hopefully give users a better understanding of society and specific situations—within their own cities, but also on a more European and even a global level," he said.

The Challenge of Data Filtration

Just as sighted people can adjust digital maps to their liking—by zooming in to a particular area or filtering the layers so they only show buildings or vegetation—people who do not see with their eyes need to be able to create their own maps.

"The most important thing is that you can decide what you want on a map," said van Dongen. "For me, when I enter a *[train]* station, I want to know if I'm entering the front or back of the hall. Other people may not care about that."

Data filtration is particularly challenging when producing tactile maps because of how little information can be put on each map.

"Because people who are blind use their fingertips to explore maps, they need space between the structures, patterns, and lines to be able to distinguish them," said van Altena.

"To be able to feel a line, the minimal thickness of it needs to be about three-quarters of a millimeter," Nauta explained. "To distinguish a line from a slightly thicker line, that second line has to be almost twice as thick. And to be able to determine where one object ends and the next begins, there needs to be three or four millimeters of space between them."

In aiming to make these maps as accessible as possible, the team is using letter-sized swell paper that works in laser printers. The maps get printed in black ink, and then the paper is placed in a small oven (which looks like a laminator) that activates the paper's chemical coating. Within seconds, the ink expands upward to a uniform height. The result is a map that people can feel with their fingertips.

Because the surface area of the maps is so limited, the team is experimenting with how to present information on the tactile maps.

"We're trying to figure out how many different symbols someone can distinguish with their fingers, what symbology we should use, and how many layers of information we should present," said van der Vaart. "Do we first present a map with just roads and then present a second map with roads and buildings, or do we start with a map with a lot of information on it and then give people a map with less information?"

How Tactile Map Symbology Works

The team is still grappling with those questions. But right now, the first map that the team makes for users is a base layer that only shows the waterways, railways, and roads in an area.

Footpaths are delineated by a dotted line with short dots. Bicycle paths are lines in which every other dot is three times as long as the others—so, a one-millimeter dot, then a three-millimeter dot, and so on. There's different symbology for roads that are largely for cars, as well as for highways. If a road allows cars and bicycles, the map just shows the symbology for a car-based road because it would be too crowded to display the symbology for both.

From there, users can build their own accompanying maps. Say someone wants a map that shows restaurants and public transit stations. A second page in a set of maps might contain roads and restaurants, and a third page might show roads and transit stations. Or perhaps all three could fit on a single map if there's enough space between symbols.

"The maps also have an anchor point on them so users can orient themselves and figure out where particular locations are, based on that spot," said van Altena.

Although there aren't any worldwide standards for tactile map symbology, the group is working with researchers who study tactile symbols while continuing to employ the best practices that organizations like the Dedicon Foundation and the Accessibility Foundation have developed.

An Entirely Autonomous Process

The next step in the project is to create a system that allows people who are blind to request—and even build—the maps themselves, without help from others.

"We're working on a process to let people order the maps online," said Aafke van Welbergen, an expert on inclusive and user-centered design at the Accessibility Foundation. "It's very important to not only have the maps exist but to also allow people to order and use them autonomously."

"We are looking at building a web-based dissemination system, and we want to see how this could tie into the ways that people who are blind already get information—through Dedicon, for example," said van der Vaart. "For the web development part of this, we are thinking of using ArcGIS Maps SDK for JavaScript to create not only the map-ordering mechanism but also the dynamic legends that we want to use in the maps."

Once the team gets the whole process of making, ordering, printing, and using tactile maps to be autonomous, project participants hope that they can extend their work to other organizations—and to people in other countries.

"We want to take our proof-of-concept designs that show how these maps can be made using national datasets and ArcGIS Living Atlas and share our knowledge with other organizations and national mapping agencies," said van Altena. "We are looking to collaborate with more people so we can continue to build on these ideas."

↑ Tactile maps need to have ample space between the structures, patterns, and lines.

A Comprehensive Imagery System

An insurance agent needs to identify affected policy members after a hurricane. A United Nations operations commander needs to ensure the safety of a convoy that's delivering aid to a small, remote village. A park director who's trying to stem illegal poaching activities needs to maintain awareness of what's happening in and around the nature reserve.

In each of these situations, imagery can help people understand changes in landforms and infrastructure over time. When new imagery of the area of concern becomes available, it needs to be processed, shared, and analyzed quickly to provide the insurance agent, operations commander, and park director with the information they need to get their jobs done.

Various organizations in many sectors—such as government; agriculture; and architecture, engineering, and construction (AEC)—turn to imagery to make critical decisions that affect their success and the communities they serve. For these organizations, it's vital that they're able to share datasets with stakeholders and ensure that the right information is available on time.

ArcGIS provides a comprehensive imagery system with flexible data management and storage solutions, extensive sensor support, comprehensive imagery processing and analysis capabilities, and data sharing options that are quick and secure. Read on to get answers to some common questions about making imagery a seamless part of GIS workflows.

↑ When a natural hazard strikes, imagery needs to be collected, processed, shared, and analyzed quickly to provide first responders with the information they need to do their jobs.

How do I ensure that my stakeholders can access the imagery they need, when they need it?

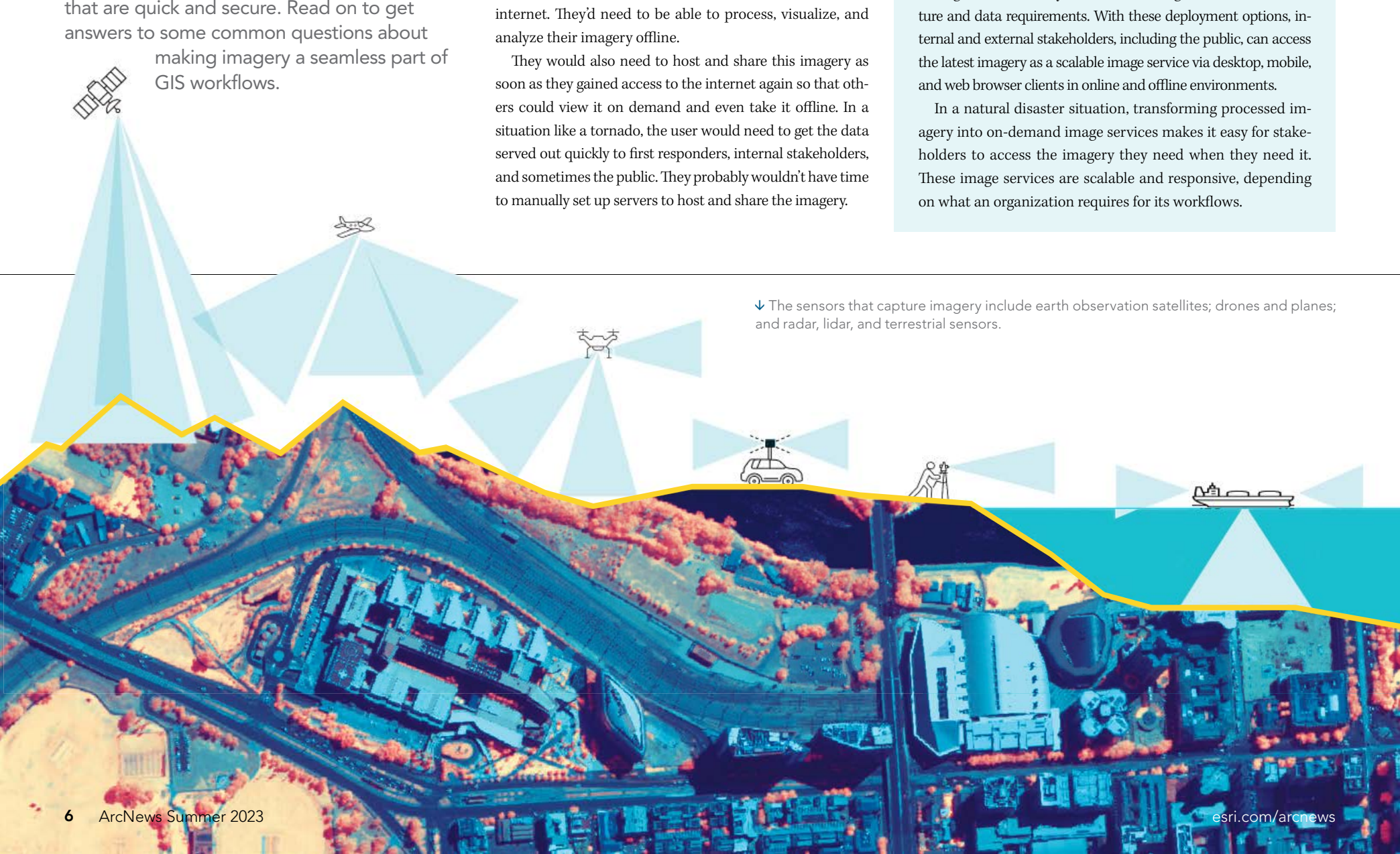
During a rush job or an event like a natural disaster, the way users process and store imagery needs to be flexible. Say a user collected drone imagery of damage from a tornado, but they are in a remote area with no way to connect to the internet. They'd need to be able to process, visualize, and analyze their imagery offline.

They would also need to host and share this imagery as soon as they gained access to the internet again so that others could view it on demand and even take it offline. In a situation like a tornado, the user would need to get the data served out quickly to first responders, internal stakeholders, and sometimes the public. They probably wouldn't have time to manually set up servers to host and share the imagery.

Flexible Imagery Deployment Options

The ArcGIS Image suite extends ArcGIS Pro, ArcGIS Enterprise, ArcGIS Online, and imagery that's already stored in cloud environments to provide flexible deployment options that support image management and analysis based on an organization's infrastructure and data requirements. With these deployment options, internal and external stakeholders, including the public, can access the latest imagery as a scalable image service via desktop, mobile, and web browser clients in online and offline environments.

In a natural disaster situation, transforming processed imagery into on-demand image services makes it easy for stakeholders to access the imagery they need when they need it. These image services are scalable and responsive, depending on what an organization requires for its workflows.



↓ The sensors that capture imagery include earth observation satellites; drones and planes; and radar, lidar, and terrestrial sensors.

Will all the imagery I collect be supported and performant?

The sheer number of sensors now available to capture imagery is staggering. More earth observation satellites are deployed each year—not to mention drones and planes, along with radar, lidar, and terrestrial sensors.

In situations like disaster response, it is critical that the imagery from various sensors—in its varied formats and with its associated metadata—be supported and optimized so that stakeholders can access and exploit the data to streamline response efforts. In times of crisis especially, users need to have the option to restructure data into cloud-optimized formats and process it quickly to make it accessible to those who need it.

Vast Support for Imagery Sources and Formats

ArcGIS provides a single system that integrates various data sources and supports nearly all available sensors and imagery formats. ArcGIS supports more than 150 image formats, as well as compressions such as Limited Error Raster Compression (LERC). Esri has also created cloud-optimized formats and structures, such as the Cloud Raster Format (CRF), which is used for reading and writing large datasets like multidimensional raster data. For sensors that are not directly supported by ArcGIS, users can add these sensors to their workflows by customizing raster types in Python to reformat their metadata.

In terms of performance, ArcGIS allows users to stream image services that have been saved as tiled imagery layers and dynamic imagery layers. This provides stakeholders with the speed they need when performing analysis and feature extraction without compromising the metadata and bands associated with the imagery. Users can also share imagery as hosted tile layers to optimize performance for visualization purposes.

↓ A 3D mesh shows a flood risk simulation for buildings in Utrecht, the Netherlands.

Where and how should I manage and store my imagery?

As organizations employ more imagery, the costs associated with storing that imagery need to be taken into consideration.

Traditionally, images were primarily stored locally on computers or in network-attached storage devices. If the images needed to be shared, the data generally had to be stored on disks, which then had to be physically shipped to stakeholders.

Now, many organizations have embraced cloud storage, where imagery can be quickly uploaded and made available for analysis and visualization. This is a scalable solution that makes it easier to share imagery data with stakeholders, increase storage as imagery volumes grow, and provide openly accessible data to anyone who needs it.

Organizations that are accustomed to using local storage may want to use cloud storage as their imagery data stores get larger—especially if the data is maintained by one team or individual. They may even want to perform their analysis in the same cloud region as their imagery data.

Adaptable Imagery Management Practices

With ArcGIS products, users can adapt their management practices as the amount of imagery their organizations use increases and usage patterns change. Imagery curators can have full control over how data is managed, processed, and shared across the entire organization. Individual users or managers can also upload imagery to the cloud and host it there. This makes it easier to share the imagery and control who can access it by setting permissions.

Products in the ArcGIS Image suite allow users to access and store imagery in the cloud, on-premises, and even in an organization's own cloud environment (which ensures efficient computation and reduces egress costs when data needs to be moved to the processing location). Additionally, ArcGIS can catalog stored imagery and metadata, making it easier for users and stakeholders to search and discover imagery collections.

How can I gain actionable insight from imagery?

Typically, imagery analysts, GIS analysts, and remote sensing scientists process and analyze imagery to gain actionable insight. These experts often need to make simple enhancements to the images to see things like vegetation health or the parameters of an active fire under a bed of smoke. They can also perform more complex operations, such as orthorectification and automated feature extraction.

The tools used for image processing and analysis must be adaptable to support all dataset sizes; handle many images simultaneously; run a wide range of analysis tasks with local, regional, and global functions; work with raster and vector data; and be scalable.

Extensive Image Analysis Tools

With the ArcGIS Image suite, users have access to extensive image analysis tools that can help them understand change, see trends in multidimensional data, develop and test analyses on small areas captured in imagery, and scale up analysis—to the entire world, if needed. Users can employ machine learning, deep learning, geoprocessing tools, and raster functions to perform analyses.

For more information on the imagery and remote sending capabilities in ArcGIS, visit **go.esri.com/imagery-system**.

Detailed Indoor Maps Help First Responders During School Emergencies

When there is an emergency at a school—an earthquake, a child in need of medical assistance, or (unfortunately) an active shooter—it is imperative that first responders have a detailed map of the campus's indoor and outdoor spaces. This helps streamline response efforts and reduces the time it takes to get to key locations.

However, not many schools provide these maps to local public safety organizations—if the schools have them at all. This is what motivated Gregory Ballentine, the executive director of the Denco Area 9-1-1 District in Denton County, Texas, to map all the schools in the region. It is plausible that a major event could occur on a school campus, according to Ballentine, so first responders need accurate location information for these facilities, especially since they tend to comprise very complex indoor and outdoor environments.

Denco 9-1-1, which serves roughly 800,000 people, recently collaborated with Esri partner GeoComm to put together detailed maps of 86 K–12 schools in the area. The emergency response organization is now looking to expand this effort to private schools and local businesses.

"The indoor maps are…a response tool during a crisis," Ballentine said. "While the maps won't prevent a tragic event, access to this enhanced data should assist in emergency response, thereby increasing the potential of saving lives."

A New System for Safety

GeoComm specializes in developing public safety solutions for a range of clients. Its new GeoComm School Safety solution runs in customers' own ArcGIS Online organizational accounts and incorporates a host of other Esri technologies.

The solution helps customers employ GeoComm services and software solutions to build GIS-based school maps that cover both the indoor and outdoor areas of a campus. The indoor maps conform to the ArcGIS Indoors Information Model and are created from a variety of inputs, including floor plan blueprints, 2D and 3D digital models generated with photogrammetry and lidar data, on-site surveys and measurements, and other maps.

Once the school maps are ready, they are published as hosted feature layers in customers' ArcGIS Online organizational accounts. Customers include school districts; local public safety and emergency management agencies; and state-level departments of education, public safety, and homeland security.

The team at GeoComm can then configure a variety of Esri apps to support various use cases. A hub site, built with ArcGIS Hub, serves as an entry point for stakeholders into the system of engagement and collaboration.

A handful of public-facing pages within the hub site describe the objectives and benefits of having this system of engagement and detail current initiatives—such as collecting floor plans from all schools in the area or conducting school censuses—and their statuses. These pages also provide instructions for how other local schools and public safety agencies can join the community.

In addition, the hub site serves as a gateway for authorized users to access sensitive information, maps, and apps. A dashboard, developed using ArcGIS Dashboards, shows the status of the mapping initiative; census data for all the schools being mapped; and relevant events, metrics, and measurements. There are several end-user apps on the hub site as well that can be used to plan for and respond to emergencies in and around school campuses. A web app, configured using ArcGIS Experience Builder, serves as a tactical mapping app that school resource officers can use. And field personnel can employ ArcGIS Field Maps and ArcGIS Survey123 to collect data in near real time using their mobile devices. This data collection can happen during emergency planning—to determine reunification sites, for example—or during a live incident to enhance collaboration. The mapping apps employ web maps and web scenes to display indoor and outdoor maps in both 2D and 3D.

During an emergency, it is imperative for stakeholders to be able to share information quickly and securely. The maps and apps powered by ArcGIS Online support this kind of seamless collaboration. For example, GIS administrators at the local police department can enable location tracking within their ArcGIS Online organization to ensure that all officers who are dispatched to an emergency are sending location tracks back to the organization while using Survey123 or Field Maps.

The entire ArcGIS technology-based solution also enables schools to seamlessly share their campus maps with local public safety agencies and 9-1-1 call centers. GeoComm makes the school maps available to other existing 9-1-1 and emergency responder apps so that 9-1-1 operators, dispatchers, and other emergency personnel can use the maps when coordinating responses. GeoComm's APIs also enable public safety agencies to share information—such as the near real-time locations of 9-1-1 callers and emergency responders—via the solution. This way, everyone involved in an emergency has a common operating picture, enabling faster, more efficient responses when every second counts.

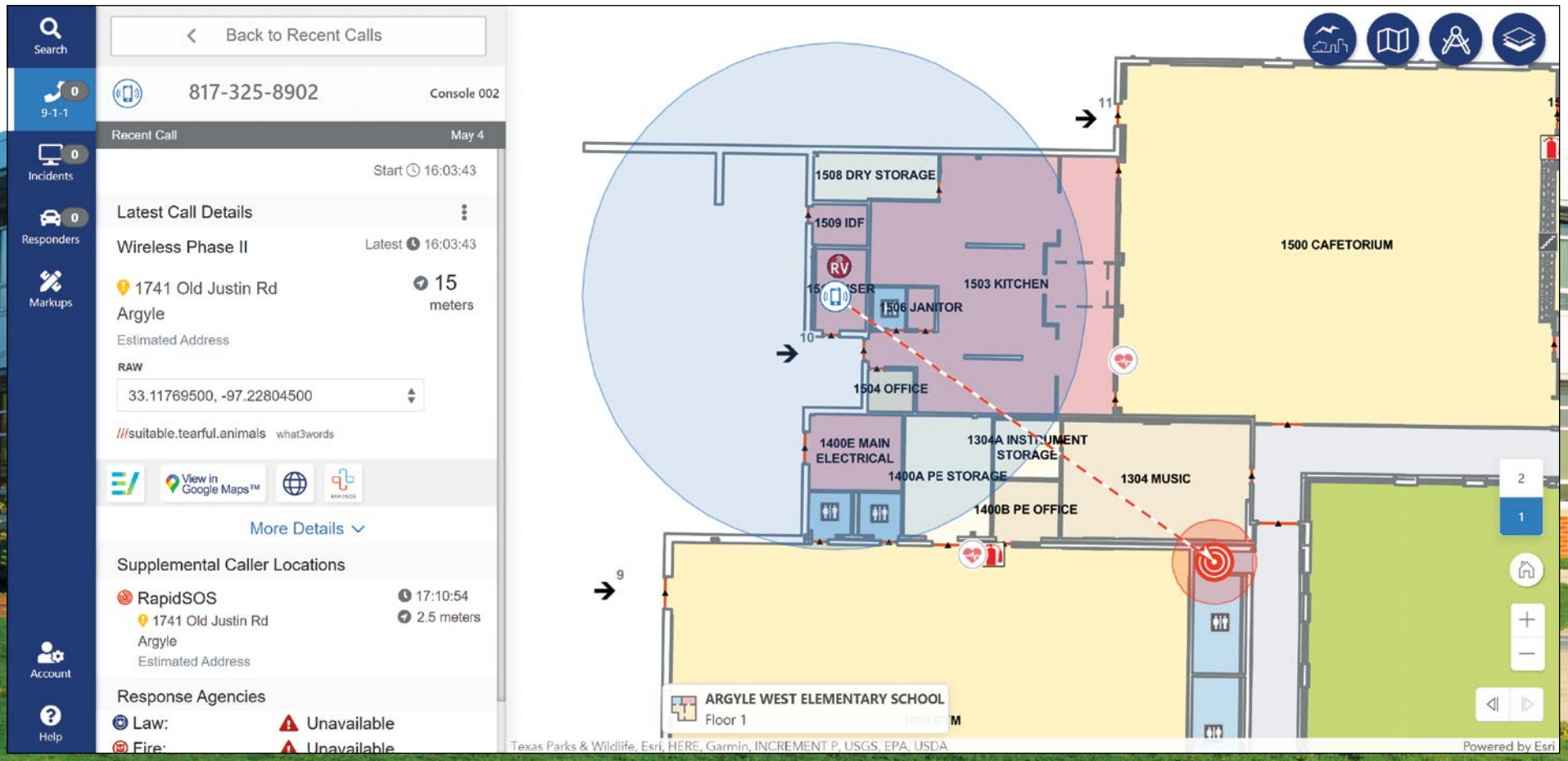
Better Visualization of Complex Spaces

To make the school safety solution operable in Denco 9-1-1's jurisdiction, Ballentine and his colleagues requested floor plans and other relevant information from each school. With help from the team at GeoComm, they then used these resources to create the digital maps. This was challenging, according to Ballentine and Denco 9-1-1 GIS manager Vanessa Green-Montgomery, because while some schools sent their floor plans right away, others took a long time to respond and had to be prodded. Another issue was that the quality of some of the floor plans was too poor to use to generate accurate maps of the facilities.

"With that particular challenge, we had to come up with a process," said Green-Montgomery.

Denco 9-1-1 ended up purchasing equipment from Esri partner GeoSLAM to get 3D scans of the schools that had submitted low-quality floor plans. Nearly four years after the start of the project—with some major delays due to the COVID-19 pandemic—data collection was completed for all public schools in the Denco 9-1-1 response area by early 2023.

The maps, which consist of more than 220 school buildings, are now in use at emergency communication centers throughout the Denco 9-1-1 response area—including at the Flower Mound Police



↑ Emergency operators, dispatchers, and other personnel can use the maps in their existing 9-1-1 and emergency responder apps to help coordinate responses.

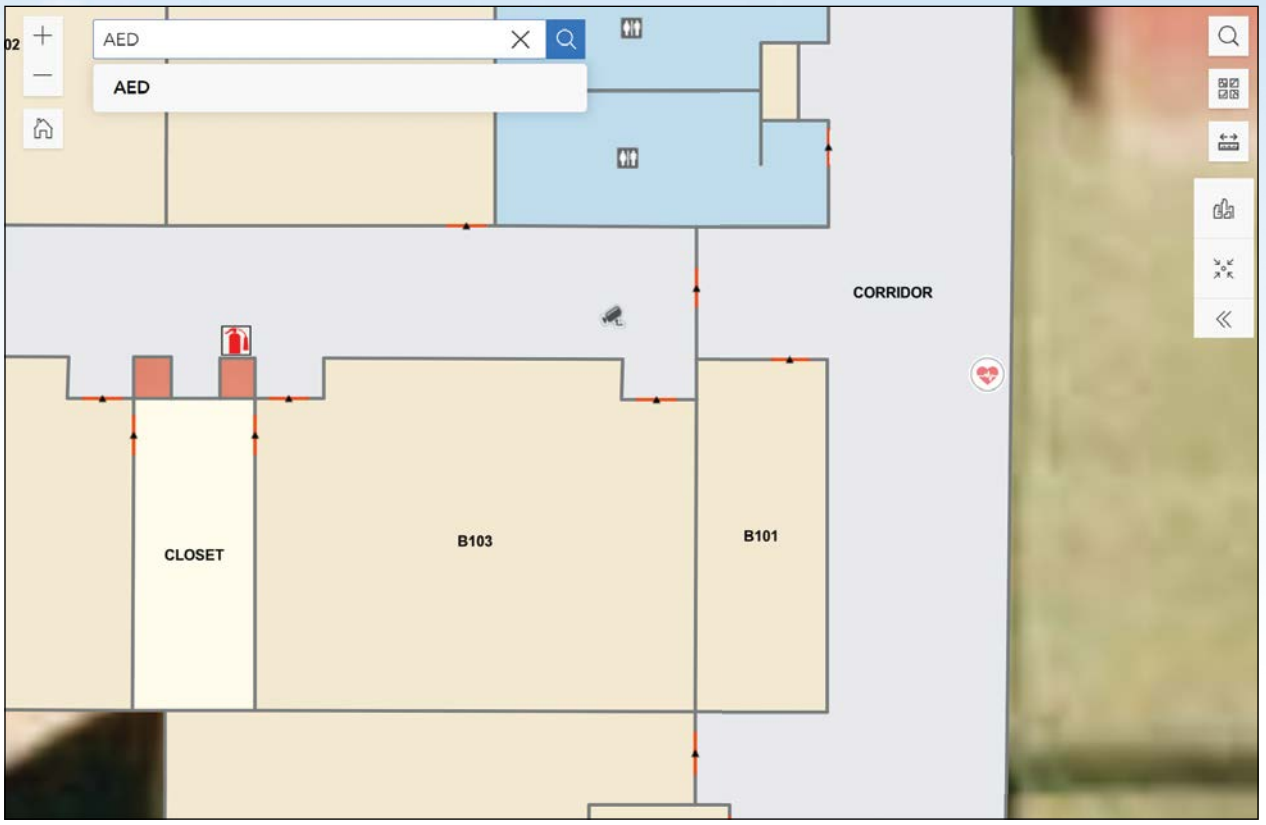
Department, where captain Jason Hawley works. He said that the detailed layers benefit first responders, whether they're called in for an active shooter situation or another type of emergency.

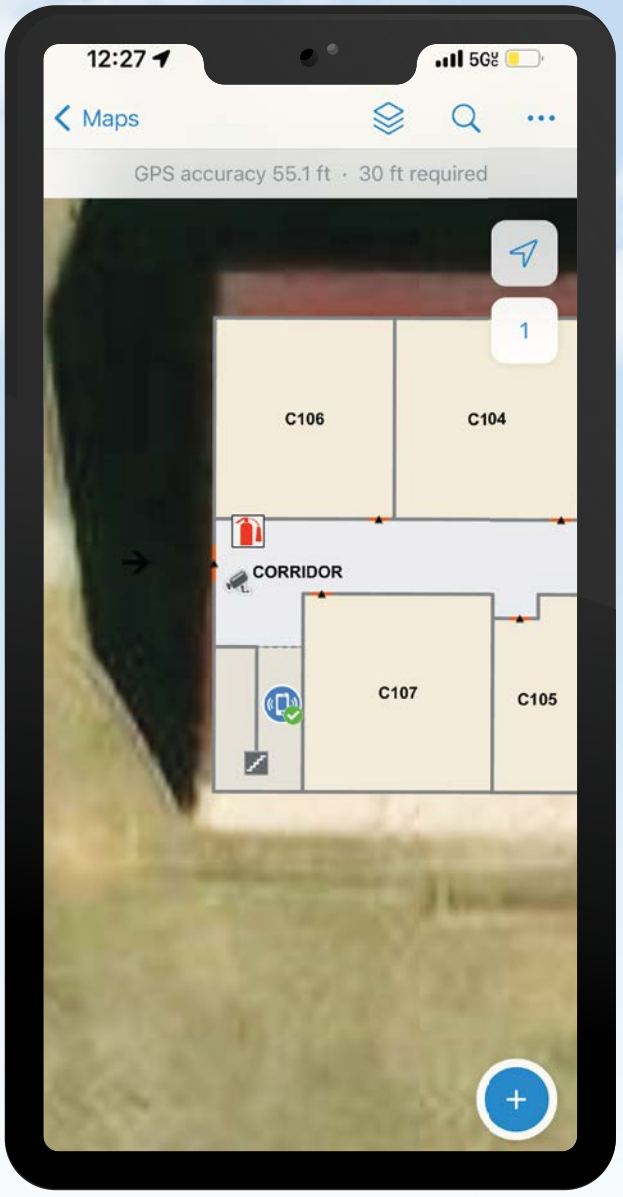
The maps contain information such as the locations of fire extinguishers; security cameras; and automated external defibrillators (AEDs), which are used to quickly treat someone experiencing cardiac arrest. In addition to showing first responders where this equipment is, these landmarks can help callers identify the exact location of an emergency. This is a far cry from the PDF-based school maps that the Flower Mound Police Department worked with before. Those were often outdated and made it difficult to find specific locations.

"This technology is better," said Hawley. "We can now visualize these maps in a cleaner manner that actually is suited to how it fits in our GIS."

Now that 86 school maps are in Denco 9-1-1's system, if an emergency call comes in from one of those schools, operators can use the floor plan and other details in the school's indoor and outdoor maps to plot a precise location for where the call is coming from. The more information the caller gives, the more likely that the operator can plot the call down to the room.

"You would actually be able to see where the call is coming from," said Green-Montgomery. "GIS plays an integral part in that."





↑ On-site responders, such as school resource officers, can see indoor maps—including the location where a 9-1-1 call is being made—in a map on their mobile devices.

← The maps show the locations of fire extinguishers, security cameras, and automated external defibrillators (AEDs).

ArcGIS AllSource Helps Mitigate Cybersecurity Threats

The annual cost of cybercrime is expected to exceed $8 trillion by the end of this year, according to research company Cyber Ventures. To mitigate the consequences of cybersecurity attacks, cybersecurity teams continually evaluate and develop creative methods for response and preparedness. Advances in surveillance, detection, and analysis can serve as a force multiplier for the many outnumbered, task-saturated crews that are charged with protecting software and technology.

ArcGIS AllSource, Esri's new intelligence software, facilitates investigative, geospatial, and link analysis. AllSource can be used in all phases of the cyber threat intelligence cycle, from developing an understanding of the threat and collecting, processing, and analyzing data to disseminating the results and gathering feedback. AllSource enables users to leverage the advanced analytics of ArcGIS Enterprise along with ArcGIS Knowledge to identify threat vectors and deploy mitigation strategies that protect an organization's cyberinfrastructure.

Take a tour of the six steps that cybersecurity teams typically use to find and study adversaries' tactics, techniques, and procedures. Using a right-to-left override attack—which tricks people into clicking malicious text files—as an example, find out how AllSource helps put defense strategies in place and evolves with the complexity of each threat.

1. Determine Appropriate Actions to Take

All stakeholders within an organization must be able to gain a clear and specific understanding of the potential impacts of a cybersecurity compromise, as well as their role in preventing one. AllSource can serve as the starting point from which a cybersecurity program grows by allowing analysts to, first, record the attack methods, known attackers, and organizational infrastructure that should all be prioritized.

It is essential to identify what an organization needs to protect, such as networks, physical assets, customer data, and trade secrets. From there, the organization's cybersecurity team can develop and implement a threat intelligence strategy. This ensures that all team members understand the organization's key priorities and allows them to mount a highly responsive defense in reacting to or preventing an attack.

2. Collect Data on Threats

When cybersecurity analysts detect activity based around a certain threat vector—the way an adversary can breach or infiltrate a network or system—they can use AllSource to investigate the threat and set in motion a series of steps to preemptively mitigate an attack.

During a right-to-left override attack, analysts can import data into AllSource and make connections to sources such as the MITRE ATT&CK framework, an openly accessible knowledge base of cyberattack tactics and techniques. They can then layer in threat information and operational data and use the link analysis tools, graphs, and timelines in AllSource to see patterns in the attack and gain insight into the situation.

3. Process the Threat Data

Once data sources are mapped and information flows into AllSource, it is typically necessary to normalize the data for use within the enterprise.

The MITRE ATT&CK dataset, for instance, offers many ways to access the data, including as a JavaScript Object Notation (JSON) file, a Python library, or a Microsoft Excel workbook. The tools available in AllSource help analysts prepare and clean the data so that it's easier for others to use.

Say the MITRE ATT&CK dataset is downloaded as an Excel workbook. An analyst would import each sheet into a mobile geodatabase within AllSource to ensure that all the field types are correct and allow for a more robust analytical experience. Using the Convert Time Field tool, for instance, the analyst could change many field types to a date field (or a text or numeric field). This would give the organization clean, usable MITRE ATT&CK data in a mobile geodatabase that can be shared or set as a local copy.

4. Analyze and Present the Data

With the data prepared for use, analysts can leverage the advanced analysis functionality provided by the back-end ArcGIS Knowledge Server site deployed within ArcGIS Enterprise to get a deeper understanding of the threat vector—in this case, the right-to-left override.

An analyst would drill down further into the data to discern the number, cadence, and location of similar attacks that have been reported—both within the organization and from other organizations—over a specified period. Expanding the resultant knowledge graph from the MITRE ATT&CK dataset within AllSource, the analyst could detect a handful of organizations that are prone to this kind of attack. The analyst could then pinpoint particular threat vectors and see that Entity 1 tends to use these threat vectors. If the analyst selects Entity 1 within the knowledge graph, they could see that it is a terror organization.

Through the relationships that are established in the knowledge graph, it would appear that Entity 1 is known to employ additional threat vectors in its attacks. Using AllSource, the analyst could identify such attacks and determine the best steps to take to mitigate them. Seeing that Entity 1 matched well with the description of activities found in open-source intelligence collections, the analyst could also make recommendations with a marked level of confidence for how to allay the effects of such an attack and bolster their organization's security posture.

5. Disseminate Analysis Results

Once all the relevant data has been analyzed, analysts can generate reports directly within AllSource with recommended mitigation actions that show the way forward. This gives stakeholders and decision-makers the full scope of the operational landscape in which the cybersecurity team is operating.

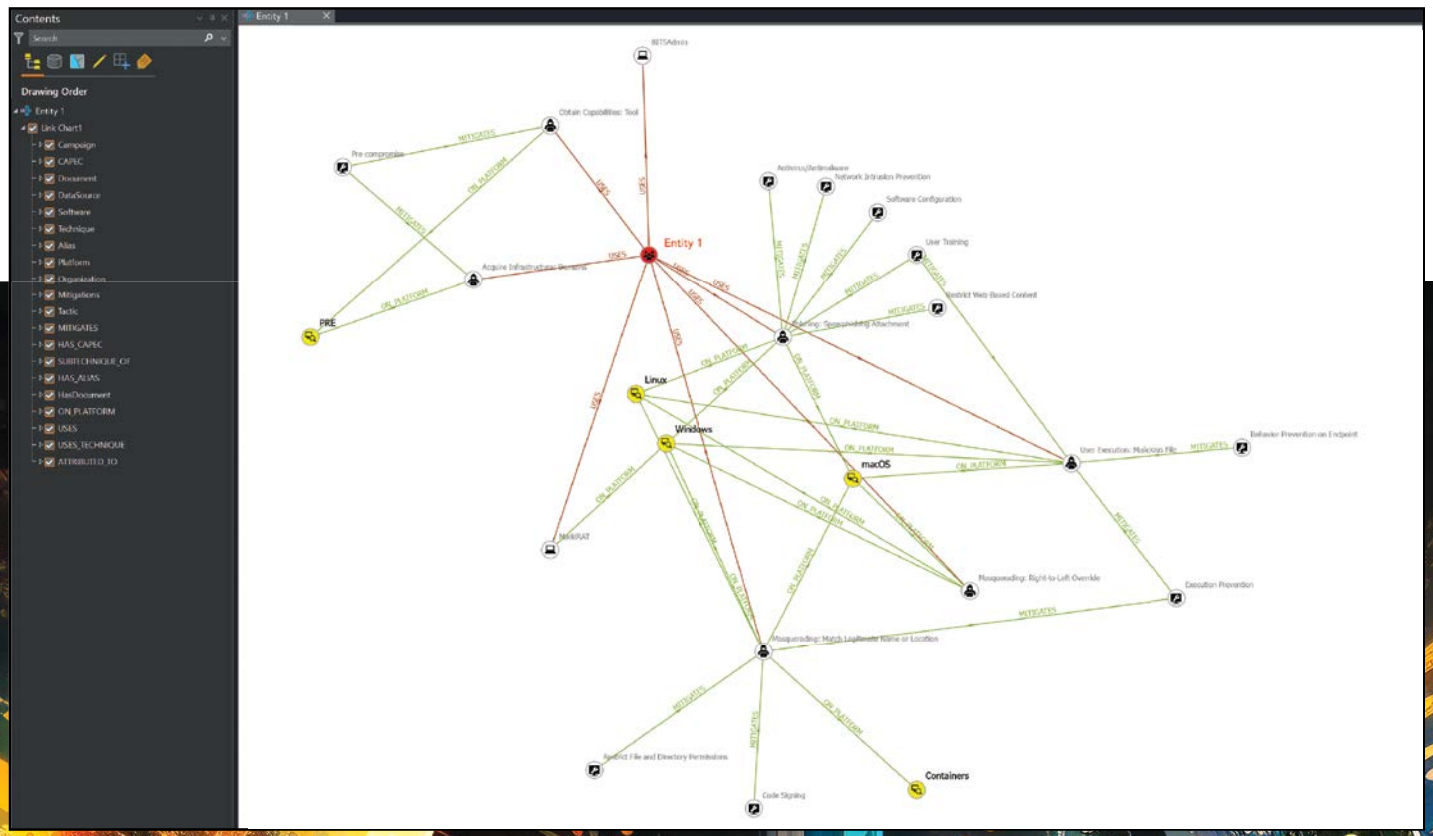
Analysts can also easily share critical information with other analysts as feature services, web maps, layouts, reports, and layer and project packages. This gives them access to the source data, allowing anyone working on a team or across shifts to conduct their own research and continue threat mitigation or response efforts. It enables cybersecurity teams to set mitigation actions and take additional measures to prevent or insulate their organization's architecture from follow-on attacks.

6. Get Feedback

To ensure that an organization's security posture evolves with an ongoing threat and takes new ones into consideration, cybersecurity teams continually analyze the efficacy of their responses to attacks, as well as their efforts to prevent them and lessen their severity when they do happen. In a postaction session, stakeholders can use AllSource to capture critical insight and adjust mitigation steps accordingly to make certain that any new requirements in defensive tactics are captured and cataloged.

The sheer volume of data that's available to support cyber threat intelligence operations can be overwhelming. AllSource helps cybersecurity teams make sense of that data by extracting pointed intelligence from it and bringing context to suspicious activities.

To learn more about AllSource, visit go.esri.com/allsource/summerarcnews. Current Esri users may also contact their Esri representatives.



← Analysts can use a knowledge graph to see that Entity 1 tends to exploit specific threat vectors.

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The Differences Between ArcGIS Online and ArcGIS Enterprise

Often, the Two Products Add Value When Used Together

ArcGIS Online and ArcGIS Enterprise are the backbone of all web-based GIS workflows in the ArcGIS system. Both products allow users to create; share; and use maps, apps, scenes, layers, analytics, and data. They also power Esri apps, enabling a range of geospatial workflows—from mobile workers collecting data with ArcGIS Field Maps to developers building custom geospatial web apps with ArcGIS Maps SDK for JavaScript.

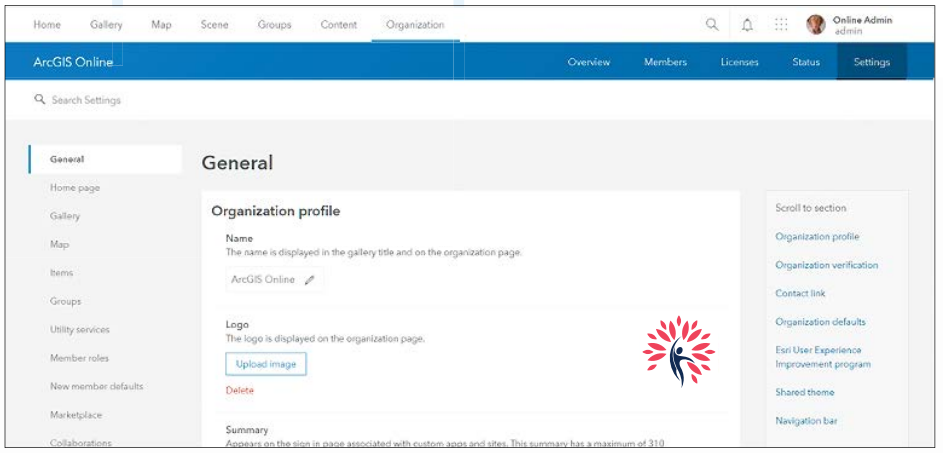
Because of the similarities between ArcGIS Online and ArcGIS Enterprise, it can be challenging to know when to choose one over the other or how to get the most out of using them together. Read on to find out the advantages of each product and then run through various implementation options.

Different Products for Different Needs

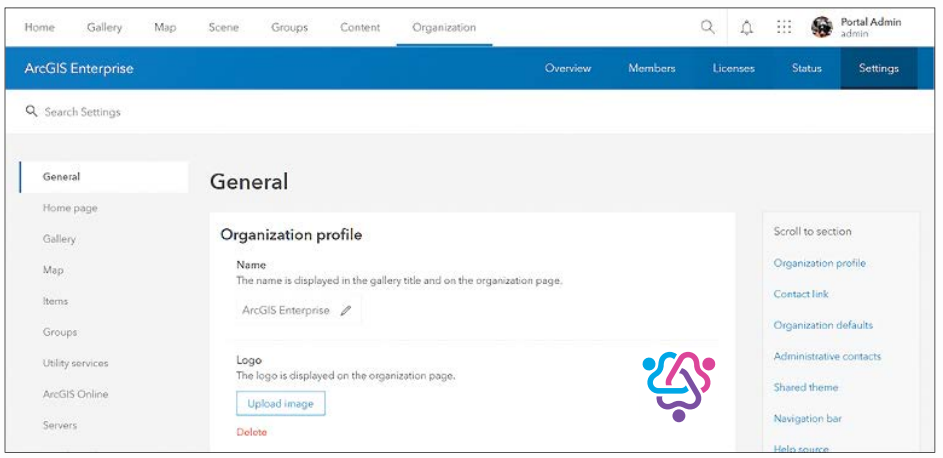
ArcGIS Online and ArcGIS Enterprise organizations have similar user experiences, so they look and feel alike. They also both integrate seamlessly with other products in the ArcGIS system.

Some individual users within an organization may not know which product they're using when creating data, web maps, or apps. One way to tell is by looking at the address bar in a web browser. If it shows arcgis.com, then it's ArcGIS Online. Otherwise, it's ArcGIS Enterprise.

Of course, there are other, more obvious distinctions between these two core Esri products. Most critically, ArcGIS Online is software as a service (SaaS), whereas ArcGIS Enterprise is software. Each type of deployment has its advantages, depending on what an organization needs.



↑↓ ArcGIS Online and ArcGIS Enterprise organizations look and feel alike because they have similar user experiences.



ArcGIS Online

Since ArcGIS Online is SaaS, Esri hosts and manages organizations' infrastructure, and users can access ArcGIS Online wherever there is an internet connection. This makes ArcGIS Online easy to set up and use, but it can't be customized and controlled the way ArcGIS Enterprise can.

Organizations that purchase ArcGIS Online don't need to architect and install a system; they simply choose whether they want a standard feature data store or a premium feature data store (for higher storage limits and more processing power) and determine how many users they need. The SaaS is up and running right away and accessible via web browsers.

Users can author maps and apps that take advantage of the performance and scaling capabilities that are built into the globally available ArcGIS Online system. ArcGIS Online also updates automatically, so organizations don't have to plan downtime for upgrades.

ArcGIS Enterprise

Because ArcGIS Enterprise is software, it is installed on infrastructure that the organization manages. This gives organizations full control over their system administration, security, customization, and integration.

ArcGIS Enterprise can be deployed on premises or in public or private cloud environments. It can also be deployed on Windows, Linux, and Kubernetes. Organizations can scale their ArcGIS Enterprise deployments according to their needs. For example, a five-member GIS team may want to deploy ArcGIS Enterprise on a single machine—whether a bare metal machine on-premises or on a virtual machine. A GIS organization with 100,000 members, however, likely needs many machines.

For organizations that require high availability, administrators can architect their ArcGIS Enterprise deployments to support stringent uptime requirements—say, making ArcGIS Enterprise available 99.9 percent of the year, with only nine hours scheduled for downtime. Also, some organizations need to have ArcGIS Enterprise installed behind a firewall or in a work environment that's disconnected from the public internet. For these organizations, it is possible to deploy ArcGIS Enterprise in environments that are fully or partially connected to the internet or completely disconnected.

The biggest considerations that organizations need to make when deciding whether to implement ArcGIS Online or ArcGIS Enterprise revolve around the kind of system administrators want to deploy and maintain, where the organization plans to store its data, and any security requirements the organization must follow. Here are specifics for each of these factors:

Features, Capabilities	ArcGIS Online	ArcGIS Enterprise
Is SaaS	✔	
Is software		✔
Gets updated automatically	✔	
Can be installed on chosen infrastructure		✔
Can be behind a firewall		✔
Has a consumption-based pricing model	✔	
Has a core-based pricing model		✔
Can share content within an organization	✔	✔
Can share content with another authorized organization	✔	✔
Can share content with the public	✔	✔
Integrates with all other Esri software and apps	✔	✔
Enables Esri-managed, hosted services	✔	✔
Enables user-managed, referenced services		✔
Has advanced server roles with special capabilities		✔
Allows for management of users, groups	✔	✔
Can visualize and analyze data	✔	✔
Can create custom web apps	✔	✔

Different Deployment and Maintenance Options

ArcGIS Online is up and running from the get-go, and Esri updates the SaaS several times a year. Receiving these updates requires no intervention or action from individual organizations. If users want to preview the changes before the updates go live, they can join the ArcGIS Online Early Adopter Program, which allows members to test interface upgrades and new features a few weeks before they take effect. Once the updates are released, all users see them immediately in ArcGIS Online.

Organizations that use **ArcGIS Enterprise**, on the other hand, need their own IT administrators to architect, deploy, and maintain the software. They must have sufficient physical or virtual infrastructure to host ArcGIS Enterprise, plus the expertise and time available to fine-tune and scale their deployments.

When it comes to maintaining ArcGIS Enterprise, administrators need to plan carefully and choose the most appropriate time to make updates. It might be beneficial to schedule downtime right after a new version of ArcGIS Enterprise gets released, or it might make sense to line up the ArcGIS Enterprise update with other significant software upgrades or wait until the organization can train staff members.

Distinct Data Storage Solutions

When using **ArcGIS Online**, users typically store and use data within the SaaS. ArcGIS Online comes with 500 gigabytes of feature data storage by default, with premium options of 1 terabyte or 4 terabytes of storage available as well. Users can also employ externally hosted services and layers from ArcGIS Enterprise, Keyhole Markup Language (KML) layers, Open Geospatial Consortium (OGC) web services, and other compatible web services.

ArcGIS Enterprise users get to choose where they store data. They can employ data that is hosted by the system itself within ArcGIS-managed data stores. They can also reference their own registered data stores, such as folders, enterprise geodatabases, and cloud data warehouses of any size.

Meeting Specific Security Requirements

ArcGIS Online is a secure SaaS product with a security strategy that's based on industry standards. The product features security controls at every level, for every user—including within the SaaS, across the network, and at the physical facilities that house the system. ArcGIS Online is also compliant with a set of security standards that Esri has pursued.

For organizations that need to have more direct control over security, require their system to work in disconnected environments, or host data on their own infrastructure, **ArcGIS Enterprise** meets those needs.

Choosing Between ArcGIS Online and ArcGIS Enterprise

When would it be best to use one product over the other? The following examples provide some guidance:

- The traffic on an organization's GIS data, maps, and apps varies considerably, and nobody is available to tune and scale software to accommodate this. It would be beneficial to implement ArcGIS Online because it scales to users' needs without requiring extra behind-the-scenes work.
- An organization's GIS team wants to stay at the forefront of new GIS technology and features and receive the latest updates automatically, as soon as they're available. But the GIS team is small and loaded down with work, so it's difficult to stay on top of every release and perform upgrades manually. ArcGIS Online would be the right solution because Esri upgrades the SaaS automatically, multiple times a year.
- At an organization where security is extremely important, users work in a disconnected environment. ArcGIS Enterprise is the viable solution in this case because ArcGIS Online isn't available in disconnected environments.
- An organization references and edits existing data that must remain in its present location without being moved to another system. ArcGIS Enterprise can connect to an array of external data sources, making it the best solution for this workflow.

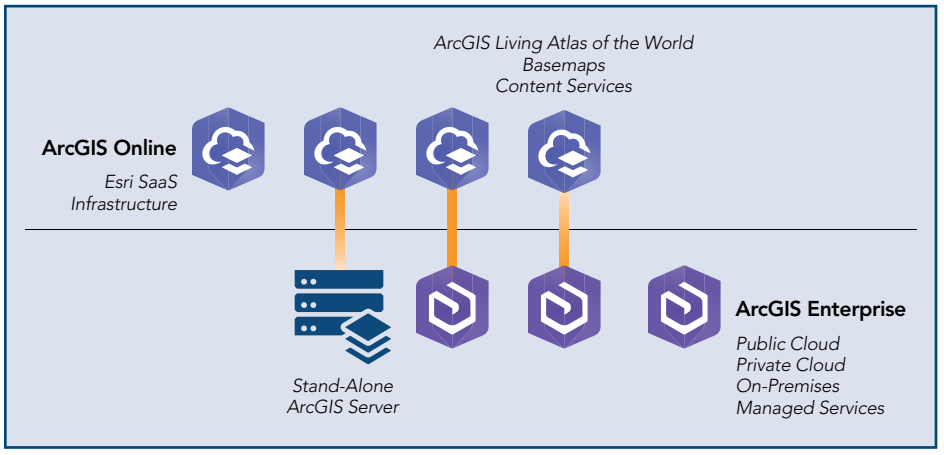
How to Use ArcGIS Online and ArcGIS Enterprise Together

ArcGIS Online and ArcGIS Enterprise can be deployed together as well to deliver more tailored data-sharing solutions. Some organizations rely more on ArcGIS Online and less on ArcGIS Enterprise or vice versa, so there is a spectrum of options for implementing both products.

For ArcGIS Online organizations that need to disseminate internally managed data to people outside the organization, they must connect to their own user-managed, referenced services. The best way for them to do this is to use ArcGIS Enterprise in conjunction with ArcGIS Online. ArcGIS Enterprise allows users to connect to their own user-managed data and then share it out as web services to ArcGIS Online.

Other organizations need to expose content from behind their firewalls—that is, within their ArcGIS Enterprise organizations—to other departments or the public. These types of organizations rely on distributed collaboration, wherein ArcGIS Enterprise and ArcGIS Online are implemented together. This hybrid setup allows organizations to extend the reach of their GIS content by seamlessly sharing maps, apps, layers, and more with others via groups.

Some organizations use ArcGIS Enterprise as their system of engagement—that is, where members of the organization interact with data and do their work—but need utility services offered by ArcGIS Online, such as printing, geoenrichment, geocoding, and directions and routing. These organizations connect their ArcGIS Enterprise deployments to ArcGIS Online to let their users leverage content such as ArcGIS Living Atlas of the World and basemaps.



↑ There are several options for deploying ArcGIS Online and ArcGIS Enterprise together.

Scenarios That Benefit from Distributed Collaboration

Distributed collaboration can take many forms. Here are three examples of how ArcGIS Online and ArcGIS Enterprise can be used together to fulfill different data sharing requirements:

- A company that helps local governments determine where to put electric vehicle charging stations uses ArcGIS Enterprise to manage its authoritative data. The company's mobile workers use ArcGIS Field Maps in ArcGIS Online to identify locations where electric vehicle charging stations could be installed. Managers want to share the latest site suitability data with mobile workers via ArcGIS Online and, in turn, have the data that mobile workers collect in the field uploaded to ArcGIS Enterprise. In this scenario, ArcGIS Online and ArcGIS Enterprise would be set up to allow two-way editing, wherein data gets copied between the two separate, but related, ArcGIS organizations.
- Employees at a city's public works department use ArcGIS Enterprise to record residents' reports of utility concerns, such as water leaks, and other incidents like graffiti. Staff in the city's department of public safety use ArcGIS Online to record crime reports. The two departments want to combine their incident reports to see if they can detect overlapping patterns. To do this, staff members from the department of public safety would share their data from ArcGIS Online as referenced data. Employees in the public works department could then use the data in ArcGIS Enterprise to do further analysis.
- The county's GIS analyst curates authoritative content in ArcGIS Enterprise that multiple cities in the region want to display in their own web apps. Some cities use ArcGIS Enterprise while others employ ArcGIS Online. The county GIS analyst would set up a distributed collaboration pattern with each city's ArcGIS Enterprise organization and the county's own ArcGIS Online organization so that the analyst could send the county's data as copies to cities' ArcGIS Enterprise organizations. The GIS analyst would also set up a partnered collaboration with the ArcGIS Online users' organizations to make it easy to periodically sync the county's data with those cities' web apps.

Two Powerful GIS Solutions

ArcGIS Online and ArcGIS Enterprise are foundational GIS technologies that enable users to manage data, make maps, create other visualizations, and perform analysis. They also power Esri's suite of apps. Each product offers unique value for different situations and, at times, they are more dynamic when used together.

Automate Workflow Management in ArcGIS Online

ArcGIS Workflow Manager Is Now Available in a Software as a Service Environment

ArcGIS Workflow Manager is a scalable enterprise workflow management system that allows organizations to orchestrate processes across web, mobile, and desktop services. Three years ago, it was introduced for ArcGIS Enterprise. Now, Esri has released a new deployment option: ArcGIS Workflow Manager in ArcGIS Online.

The Benefits of Using ArcGIS Workflow Manager

Workflow Manager has historically supported organizations that need to do the following:

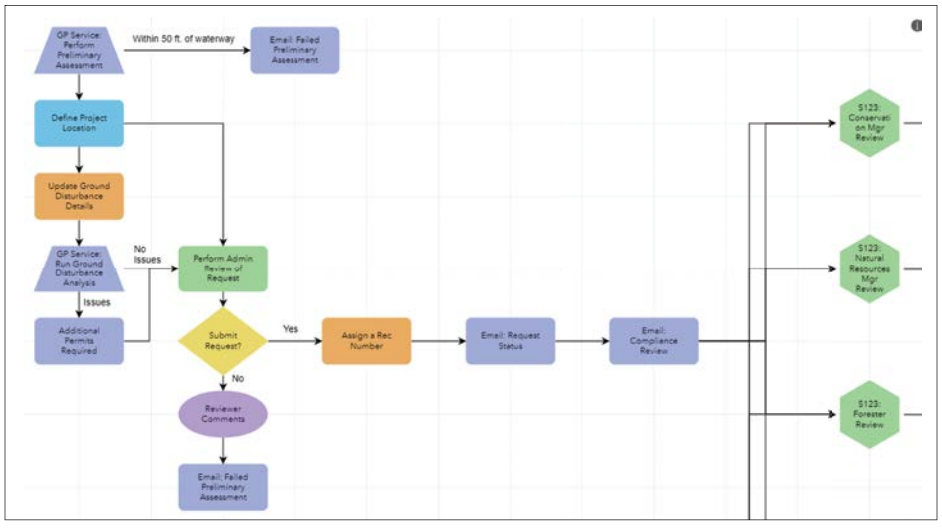
- Capture, standardize, and automate repeatable workflows involving several users across multiple departments and even multiple levels of government.
- Streamline and orchestrate complex processes across the enterprise that require integration with other business systems.
- Reduce the number of solutions and/or systems that an organization maintains.
- Replace highly customized, homegrown systems that are not capable of scaling and can't handle high-volume work.

Such organizations typically have ArcGIS Enterprise deployments. However, there are many organizations that use ArcGIS Online only and face the same challenges.

So now, the benefits and capabilities that ArcGIS Workflow Manager brings to an enterprise deployment are available in a software as a service (SaaS) environment. This means that ArcGIS Online organizations can standardize repeatable processes, automate tasks, collaborate across teams, and capture institutional knowledge to become more resilient in the face of staffing challenges.

Highlights of what ArcGIS Online organizations can now do with Workflow Manager include the following:

- Automate and streamline business processes. Out-of-the-box tools in ArcGIS Workflow Manager in ArcGIS Online allow users to automate jobs, schedule work to be completed during off-hours, and optimize other online workflows.
- Monitor and report on work statuses in real time. Users can make informed decisions by monitoring the process of work in real time. They can also create their own charts or integrate ArcGIS Workflow Manager in ArcGIS Online with ArcGIS Dashboards to generate job reports.
- Configure low-code and no-code capabilities. Users can design workflows using a drag-and-drop interface, thanks to configurable step templates and integration with ArcGIS Arcade.



↑ ArcGIS Workflow Manager helps users design optimized request submission and approval workflows that incorporate automation and integrate with other ArcGIS products.

One of Many Ways to Employ Workflow Manager

Many organizations across a range of industries want to automate the process of submitting a request and getting approval. These could be requests to update assets or documents, change an address, get a permit, perform an environmental review, or get technical support.

Such processes are traditionally performed manually. Someone makes the initial request either by calling on the phone or by submitting a paper form in person, in the mail, or via email. The request is then passed from team to team as it makes its way through the system. One team reviews it, another team works on it, another team approves it, and yet another team delivers the results to the requestor. Challenges within this process include maintaining multiple forms of intake, tracking the request from start to finish, and assigning the steps to the right team or person to do the job.

With ArcGIS Workflow Manager in ArcGIS Online, users can orchestrate, standardize, and centralize the submission and intake process. For example, if the request intake process leverages ArcGIS Survey123, once the form is submitted, it can automatically trigger the creation of a job in Workflow Manager through the Survey123 webhook. Each step in the process can then be automatically assigned to various teams, whose members get notified when it is their turn to execute a step in the process. Managers can use dashboards to oversee how projects are progressing. And if needed, a public-facing dashboard can pull information directly from Workflow Manager to provide the requestor with the latest information about the project. When a request is approved or denied, Workflow Manager can be configured to send updates to key stakeholders.

Licensing Requirements and Future Releases

ArcGIS Workflow Manager in ArcGIS Online is licensed as a user type extension. There is also an optional ArcGIS Workflow Manager Server Advanced extension for anyone who needs additional capabilities, such as scheduling workflows to run at convenient times. In future releases, ArcGIS Workflow Manager in ArcGIS Online will get more webhooks and geoprocessing tools.

For more information on this new release of Workflow Manager, head to go.esri.com/ArcGISWorkflowManager.

continued from cover

Developers Push GIS Beyond Its Current Limits

server-based ArcGIS technology to the browser. The SDK enables developers to work with data in 2D and 3D, build interactive experiences using client-side processing, and create user-friendly interfaces.

"The one area we focus on is really helping you bring the meaning out of your data in a beautiful way," said Julie Powell, Esri's principal product manager for web development technologies.

New data aggregation capabilities in JavaScript Maps SDK help developers do this while working with dense datasets. For example, clustered data can now be rendered as pie charts, enabling users to see, at a glance, the attributes and values that are included in a cluster.

An improved web editing experience in the SDK helps ensure data integrity while increasing productivity. Esri software developer Jonathan Uihlein showed the audience an app that a 3-1-1 call center operator could use to process a report concerning a downed streetlamp. The simple, form-based app makes the workflow straightforward—from finding the location of the incident to adding dynamically generated details to the report. And most of the app was built with components from Calcite Design System, a collection of design and development resources for creating easy-to-use, cohesive experiences across apps.

The JavaScript Maps SDK team also has been bringing the visualization and analytical capabilities of ArcGIS to the browser for raster data—most recently, by enabling client-side processing of raster functions. And new 3D web capabilities in the SDK enable developers to add livestreaming layers to their apps.

"*[Developers]* can really build some powerful information products…which hopefully leads to better understanding and then better decision-making," said Powell.

→→ New SDKs Enhance the Native App Developer Experience

Building native apps for desktop, mobile, and embedded environments gives developers access to all the capabilities on the devices that they're developing for, including the camera; GPS; and the gyroscope sensor, which tracks a device's rotation.

Esri provides five API technologies to aid with native app development, and two of the newest ones—ArcGIS Maps SDK for Swift, for developing apps on the iOS platform, and ArcGIS Maps SDK for Kotlin, for creating Android apps—simplify the developer experience for those who build apps on these platforms.

In a demonstration for the Plenary Session audience, Esri product engineer Jennifer Merritt showed how to use Swift Maps SDK to easily add elements to an app and preview the updates. With a few clicks and keystrokes, Merritt included a map in an app that, previously, only displayed text. A preview pane allowed her to not only see what the app would look like but also pan and zoom within the map.

She then explored features of the new Swift API by adding reverse geocoding and a current-location display to the app. Using the open-source toolkit that's part of Swift Maps SDK, Merritt also added a few more elements to the app: a basemap gallery, a search view, and a custom floating panel that shows feature information in a pop-up window.

"Looking at this in the application, I can now easily select a different basemap with the basemap gallery, I can query my feature layer using the search tool, and I can display feature information within a pop-up view," Merritt explained.

As Euan Cameron, Esri's chief technology officer (CTO) for developer technology, said at the conclusion of Merritt's presentation, "These new *[programming]* languages can truly revolutionize your mobile app development."

→→→ Extending, Integrating, and Automating ArcGIS

According to Jay Theodore, Esri's CTO of ArcGIS Enterprise and artificial intelligence (AI), ArcGIS Enterprise offers "a trifecta of opportunities to extend, integrate, and automate *[GIS]*."

For example, the ArcGIS Enterprise team recently announced custom data feeds, which allow users to create feature services from any data source that can be used throughout the ArcGIS system and beyond.

"This lets you extend and connect new data sources that are not yet supported by ArcGIS," said Theodore.

Shreyas Shinde, group development lead at Esri, showed the audience how to access data that's not readily available in ArcGIS to analyze the Supplemental Nutrition Assistance Program (SNAP) within a community. To get started, he obtained a list of authorized local retailers that accept SNAP tokens. The list was kept in a MongoDB database, which allows users to curate the federal and state agency-maintained data. Shinde also acquired a list of crowdsourced attributes, such as reviews and price points, for retailers from the online business directory Yelp.

"While ArcGIS is able to connect to a variety of geospatial data stores, it cannot natively connect to MongoDB or to Yelp," said Shinde. "This is where custom data feeds come into play. Developers can now write data providers in JavaScript that can extend the reach of ArcGIS and bring these datasets into the server as read-only feature layers."

Shinde showed the audience how to do this. Using ArcGIS Enterprise SDK, he built and packaged the data providers and then deployed the packages to the server. Acting as an administrator, Shinde received the files and converted them to feeds. He wrapped up by showing how analysts and publishers can then search or browse the feeds to find specific item types and bring them into Map Viewer to query their properties.

"*[Using]* custom data feeds is a very powerful developer workflow that can bring to light these datasets that were harder to reach before, making them accessible…for mapping and analysis," Shinde said.

↑ Developers continually provide product teams at Esri with important feedback.

→→→→ A New Generation of Scalable, Resilient Enterprise GIS

ArcGIS Enterprise on Kubernetes is a fully automated, cloud-native geospatial infrastructure that's scalable, resilient, and ready for automation. It is built on a collection of microservices that represent foundational workflows, such as mapping, analysis, collaboration, and sharing. It is delivered as a set of container images that run in a distributed operating system called Kubernetes. And it can run on Amazon Web Services (AWS), Microsoft Azure, Google Cloud, and OpenShift.

An ArcGIS Enterprise on Kubernetes deployment ensures that an organization's enterprise GIS is resilient, maintaining the desired state of operations and remaining highly available during disruptions. It is scalable both vertically—by adding more central processing units or memory to a deployment's current set of pods—and horizontally, by manually or automatically adding more pods to a service deployment when needed. An ArcGIS Enterprise on Kubernetes deployment allows for rolling updates, which eliminates downtime.

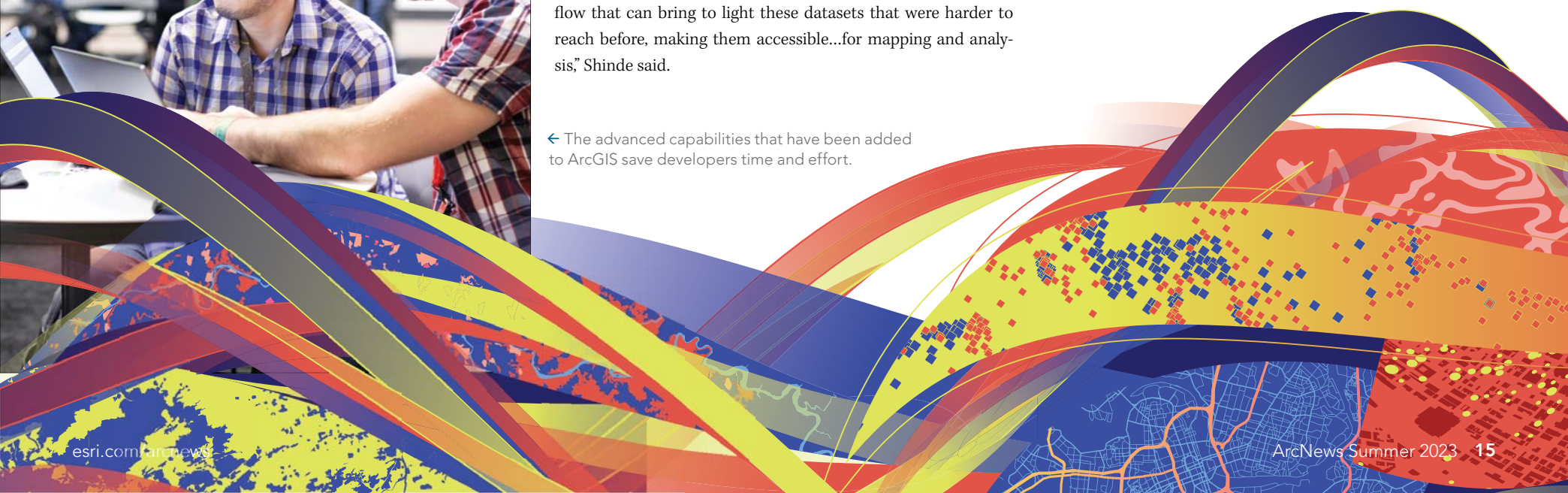
To demonstrate how resilient ArcGIS Enterprise on Kubernetes is, senior product engineer Chris Pawlyszyn let a chaos monkey loose within a cluster of virtual machines.

"A chaos monkey is a tool frequently used by infrastructure engineers to introduce disorder into a running cluster," said Pawlyszyn. "The chaos monkey has privileges to terminate nodes at random, without any notification to the control plane or associated workloads."

As the chaos monkey terminated nodes, a dashboard showed that even as the deployment's capacity was brought down below 100 percent, average response times remained within the organization's normal range of tolerance and the rates of successful responses didn't appear to be altered at all. A number of workloads were redistributed throughout the cluster, which quickly added nodes to replace the terminated ones.

"Throughout this intentional sabotage, the distribution and elasticity of our cluster, coupled with the scalability of our published service, instills confidence that organizations' critical services can remain up and running," said Pawlyszyn. "From a user perspective, work is business as usual. And the underlying system recovers without any manual intervention."

To watch the rest of the Plenary Session presentations, go to **links.esri.com/devsummit2023**.



← The advanced capabilities that have been added to ArcGIS save developers time and effort.

GIS Underpins Mission to Rescue Surplus Food and Deliver It to People in Need

"Technology is important, but it's the power of collective action that will drive massive change."

Leah Lizarondo, Founder, Food Rescue Hero

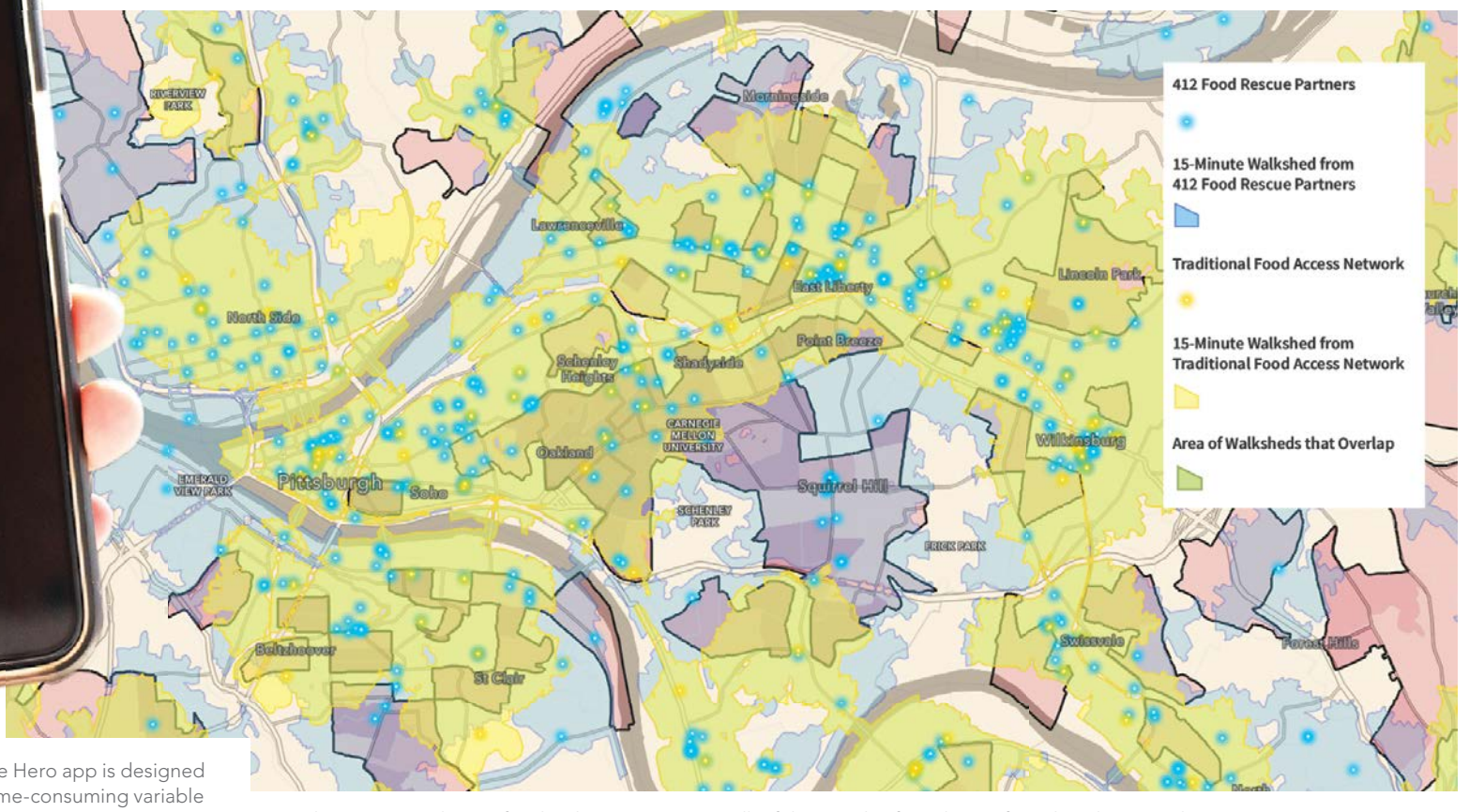
Last summer, more than 21 percent of adults in the United States reported experiencing food insecurity in their households—an increase of more than 6 percent over the previous spring, according to the Robert Wood Johnson Foundation (RWJF), a health-focused philanthropic organization.

While food banks provide an essential service in supporting people experiencing food insecurity, reliable transportation is often required to get to and from the distribution facilities. Yet this is sometimes unavailable to food bank users.

In 2016, Food Rescue Hero developed an ArcGIS technology-based system to provide delivery services of surplus food from food shops and restaurants to nonprofit organizations that serve those experiencing food insecurity. Using ArcGIS Pro and ArcGIS Online, the nonprofit has provided fresh food to tens of thousands of people living in its pilot city of Pittsburgh, Pennsylvania, according to Leah Lizarondo, founder of Food Rescue Hero.

"More importantly, the distribution facilities are within an easy walking distance of just 15 minutes from their homes," said

↑ The Food Rescue Hero app is designed to automate the time-consuming variable of coordinating food recovery.



↑ Food Rescue Hero brings food within a 15-minute walk of thousands of residents of Pittsburgh, Pennsylvania.

→ Food Rescue Hero volunteer Hilda Valdespino delivers food to a senior housing center in Pittsburgh.

Lizarondo. "This is because Esri's geospatial technology has allowed us to be more precise in determining the exact locations of those that are underserved by traditional food banks."

A Novel Use of Standard Food Delivery Technology

The organization's volunteer drivers pick up surplus food from restaurants, grocery stores, and other food suppliers. They then deliver it to nonprofit organizations and community centers for distribution, or directly to households in need.

Food Rescue Hero modeled its service on the technology used by notable for-profit companies that specialize in food delivery. Volunteers get push notifications when surplus food is available nearby. The Food Rescue Hero app then guides them through every step of the process, giving them pickup instructions and allowing them to use delivery verification tools.

The process provides same-day service to people who lack food and eliminates the need for distribution centers to store it, allowing perishable food to be consumed while it is still fresh.

"Traditional pantries serve many people, but for the 35 percent of people living in poverty who don't have access to reliable transportation, an additional—and sometimes insurmountable—difficulty is faced," said Lizarondo. "In Pittsburgh, we used ArcGIS to activate nontraditional food access sites, filling in the gaps left by traditional pantries. We used data from the US Census Bureau, the US Department of Agriculture, and Pittsburgh Regional Transit."

Pinpointing Priority and High-Risk Areas

To map public transportation deserts in the Pittsburgh area, Food Rescue Hero used a methodology outlined in *Transit Deserts: The Gap between Demand and Supply* by Junfieng Jiao, an associate professor at the University of Texas at Austin, and Maxwell Dillivan, now a senior planner at The Rapid, the transit authority in Grand Rapids, Michigan. In their 2013 study, Jiao and Dillivan developed procedures for quantifying and calculating transit supply and demand using census data.

The data that Food Rescue Hero's staff extracted using Jiao and Dillivan's methodology was then overlaid with the locations of traditional food pantries and nonprofit food distribution sites to determine the areas in Pittsburgh where food deserts occur.

The three datasets—poverty rates, food deserts, and transit deficits—are used to identify the populations most in need of food access. The Food Rescue Hero platform and database provide detailed metrics and analytics of the targeted areas and populations in which the organization works.

"We mapped low-income areas, food deserts, and transit deserts and identified priority and high-risk areas," said Lizarondo.

Staff also used ArcGIS Online to calculate walking distances within these areas to better understand the footprint of Food Rescue Hero's partners. The team then compared that to the walking distances around traditional food pantries.

"This is a new way of looking at food access and delivery," said Lizarondo. "Using Esri's geospatial tools, we have provided 40,000 people living in the Pittsburgh region with access to nutritious food that they wouldn't be able to access if they were limited to the traditional food pantry system."

Expanding the Service's Reach

Food Rescue Hero is now licensing its food recovery system to similar organizations.

"I'm really proud to say that Food Rescue Hero is now helping food rescue organizations in 25 cities and towns across the US and Canada scale their operations," Lizarondo concluded. "With our partners, we've been able to mobilize a growing network of 39,000 volunteers that deliver food to more than a million people each year. Our goal is to bring the technology to new cities each year and reach 100 cities worldwide by the year 2030."

↑ Food Rescue Hero founder Leah Lizarondo completes a food rescue pickup. (Image by Laura Petrilla.)

WILDLAND FIRE GIS SPECIALISTS CONNECT ON ESRI COMMUNITY

Each year as the days turn warmer and drier, a breed of GIS specialists across the United States begins to stir: the thousands of geospatial technology professionals who help protect land and lives from catastrophic wildfires.

When it comes to public awareness of the people who battle wildland fires, the firefighters who go toe-to-toe with flames are the most readily seen—and for good reason, since they directly square off with the threat. But there's more behind wildfire response than meets the eye.

Geospatial tools and data sharing are paramount to planning and managing wildfire response, helping reduce devastation while saving lives and livelihoods. GIS specialists protect, update, and disperse this data. And thanks to the National Interagency Fire Center (NIFC), these professionals—who hail from all over the country—now have a central place to go to get answers to GIS-related questions, troubleshoot issues, find new geospatial solutions, and get relevant training updates: the Wildfire Response GIS user group on Esri Community.

AN EXPANSIVE COLLABORATION

NIFC has an office in Boise, Idaho, where eight of the nation's biggest wildland firefighting federal and state agencies—including the United States Forest Service, the Bureau of Land Management, and the National Park Service—send staff members to work together on large wildfire response efforts. With coordination aided by their representatives at NIFC, these agencies tend nearly 700 million acres of federal public land on which fire can, and does, spread.

Many of the nation's GIS specialists who focus on wildland fire are distributed among those agencies, and they use their skills to update and maintain interagency geospatial content that's available on an expansive instance of ArcGIS Online called NIFC Org. This content—which includes data, maps, and dashboards—serves numerous wildfire response needs, from collecting data in the field and tracking wildfire perimeters to showing the results of fire suppression efforts and providing information to the public.

Katie Hansen and Walker Henry are two of four ArcGIS Online administrators at NIFC who position themselves within quick reach of these GIS specialists. Hansen, Henry, and their team members ensure that the specialists are equipped with both the training and the resources they need to wield ArcGIS technology on behalf of the federal and state agencies they work for while managing active wildfires.

Assisting a group of specialists as large as the one that Hansen, Henry, and their colleagues do is no easy task—not only because of the sheer amount of information the GIS specialists need but also because everyone is scattered across the country. It is imperative that NIFC communicate effectively, in a way that holds up in a variety of contexts.

A SOLUTION CLOSE AT HAND

For years, the team at NIFC communicated with its ArcGIS Online users via email, which had its shortcomings. The challenges only grew when NIFC began scaling up its work in 2016.

"Since our users are so diverse in their GIS skills, the information that we needed to relay to them required customized messages and multiple distribution lists," Hansen recalled.

The team faced the typical pitfalls of emailing such a large group at once, including invalid email addresses, overzealous spam folders, and people missing important communication when they were out of the office. GIS specialists also often sent individual emails to the NIFC team to ask the same questions, which meant Hansen, Henry, and their colleagues relayed the same responses over and over.

"We needed to reach a larger audience with answers to the same questions," said Hansen.

What the NIFC team wanted was a platform where important communication could be shared with the whole ArcGIS Online organization at once and where users could see and search for information at any time, regardless of when the communication went out.

The solution was much closer than anyone on the team realized.

In 2019, when NIFC hosted its official wildfire incident management course for GIS specialists in Sacramento, California, it had to combine two classes.

"There were over 60 students and 15 instructors conducting the scenario-based training," said Henry. "Communication and organization were at the forefront of everyone's mind."

Sean Triplett, the tools and technology lead for the US Forest Service, was in Sacramento to assist with the training, and he had recently heard about Esri Community, Esri's free online platform where GIS professionals and enthusiasts from around the world connect to share ideas, collaborate, and find solutions to problems. He had learned about the resource through a family member who was serving as a community manager in Esri Community. During one of the training breaks, Triplett, the NIFC team, and others got on a call with Triplett's family member to learn about what the platform could do for NIFC.

The team was impressed. Within weeks, Hansen, Henry, and their colleagues had set up a user group and began adding users.

"The information sharing then just came naturally," Henry remembered.

A GROWING COMMUNITY

In just four years, NIFC's Wildfire Response GIS user group on Esri Community has grown to nearly 1,500 users, with more joining all the time. The group is private, which gives the NIFC team control over who can access it. Any professionals who are involved in wildland fire response can ask to join the group, but all requests undergo an approval process. This is one of several key features that the NIFC team uses to protect the conversations and ensure membership relevance.

Another invaluable tool within Esri Community is the ability for administrators to label posts, according to Henry.

"The group serves as our official notification and information system," he said. "Users are required to follow an Announcements label so that they receive immediate notifications for critical information and updates."

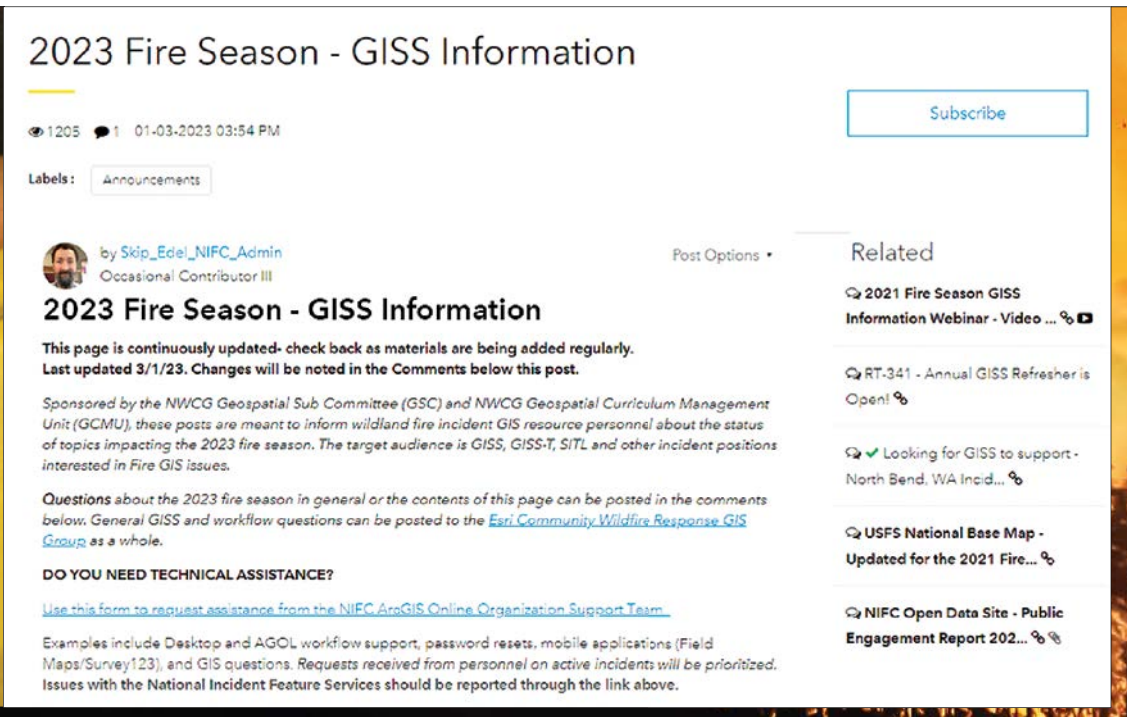
Group members don't just go to Esri Community to receive information from the NIFC team, however. They also log in to ask questions and crowdsource answers from other community users, such as how to install software on incident computers that organizations often rent during response operations.

Hansen, Henry, and the other group owners receive notifications when new messages are posted to the group and are ready to assist when needed. But as can happen when a large community of peers works together in a common digital space, other members often jump on requests for help before the NIFC team can get there.

"It is always refreshing to us as *[administrators]* to see our users engage with each other *[and]* feel comfortable enough to ask questions and search for answers from us and from their peers," said Hansen.

Each spring, the Wildfire Response GIS user group on Esri Community receives a wave of new members who are fresh from their NIFC trainings. With this, Hansen, Henry, and their teammates hope that people not only know summertime for its formidable wildfires but also increasingly recognize the impressive teamwork that the GIS community engages in to face them.

↑ Wildland fire GIS specialists make maps that field personnel use to plan and manage wildfire responses.



↑ The National Interagency Fire Center (NIFC) posts annual fire season information in its Esri Community group and makes that required reading for all members.

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GIS Reveals the Details of Versailles' Past to Help Plan for the Future

The Palace of Versailles and its surrounding estate stretch across nearly 2,000 acres. The estate comprises 120 buildings, including the King's Apartment, the Royal Chapel, and the House of Mirrors. Deeper in the park, visitors will find the Petit Trianon estate; the Versailles Orangerie; and several parks and gardens designed by King Louis XIV's gardener, André Le Nôtre.

For much of the estate's existence, the finer details of managing its parks mostly survived unofficially as institutional knowledge passed down through the years. For example, only a few people at any time understood the water network and which keys operated the extraordinary hydraulic system.

In 1995, France's ministries of culture and budget formalized park operations under the Palace, Museum, and National Estate of Versailles (known by the acronym EPV), a public corporation with administrative and financial autonomy. EPV now employs 900 people.

In the mid-2000s, EPV took steps to implement a new management plan. One of the goals was to design a GIS-based tool that would help visitors understand the estate's history and heritage. Its sheer size proved daunting.

"The estate occupies 140 plots, spread over eight cities, with roads and even railways," Élise Legrand, EPV's GIS specialist, said during a talk at a GIS event last year. "This presents management difficulties and *[consistency]* problems. EPV had access to digital databases, but there was no common link between them."

In 2017, EPV launched a garden management plan for the estate that called for a GIS solution. The agency partnered with Arx iT, a GIS services company and longtime Esri partner based in France and Switzerland. ArcGIS Enterprise provided the tools to create and publish web maps, web apps, and web services.

The GIS infrastructure became operational in 2022. Arx iT integrated existing data from multiple sources. A basemap was gradually assembled by looking at historical documents.

"It's a fantastic challenge to digitize and assemble dozens of Cassini maps in Lambert projection," says David Boillée, a project manager and GIS architect at Arx iT.

Boillée's team discovered that some of the gardens, waterways, and flowerbeds had remained virtually the same over the centuries. These served as reference points for much of the geographic data.

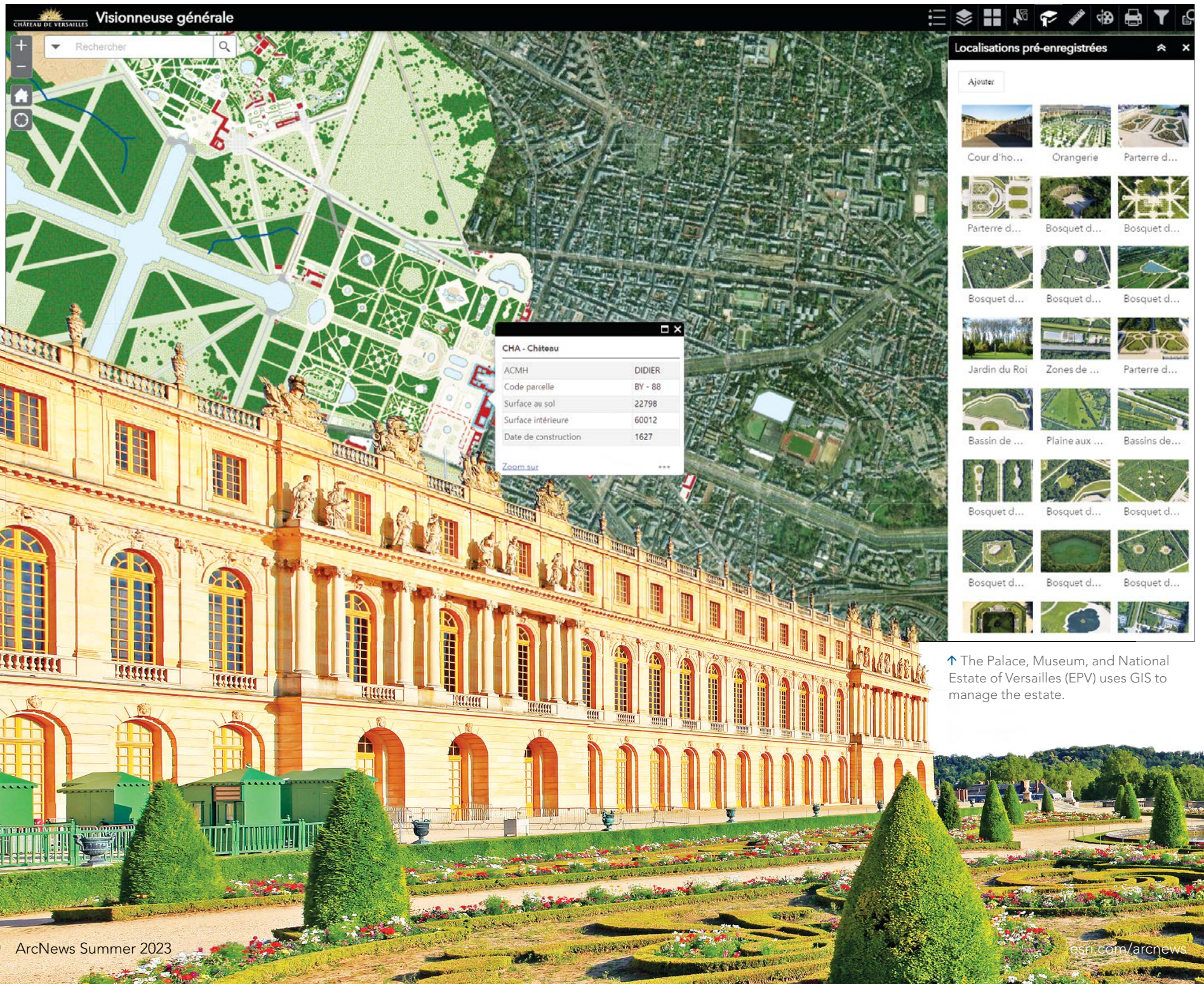
EPV uses two GIS applications as part of its management plan.

Si Versailles m'était tracé (which translates as *if Versailles was drawn for me*), the first app, overlays aerial imagery with 14 georeferenced old maps of the Versailles estate, dating back as far as 1699, and allows users to swipe between the new and the old. The app offers a unique opportunity to discover the estate from a historical perspective, see the evolution of its buildings and the layout of its land, and examine previously inaccessible map archives. From an operational perspective, it is used for architectural studies, archaeological excavation, and historical reconstruction.

The second application is solely for internal use and forms the backbone of the management plan. A global viewer within the app uses a dedicated basemap that provides details of the grounds, including the wooded areas, walkways, and buildings, as well as the walls and fences that mark the boundaries of the estate.

"For example, the queen's grove was restored in 2020," Legrand said. "With the global viewer, we can see the gap between what currently exists and what existed before restoration work was underway."

Dedicated map layers provide more specific information relevant to the maintenance of the park. These include details on the gardens, driveway conditions, sculptures, benches, and trash receptacles. Clicking on a pop-up window reveals related details for every attribute.



↑ The Palace, Museum, and National Estate of Versailles (EPV) uses GIS to manage the estate.

Xavier Fodor, editor in chief of *SIGMAG SIGTV.FR*, the largest quarterly French-language magazine dedicated to GIS and French-speaking users of ArcGIS technology, contributed to the reporting of this article.

"A user can examine the maintenance history of an individual bench," Legrand noted.

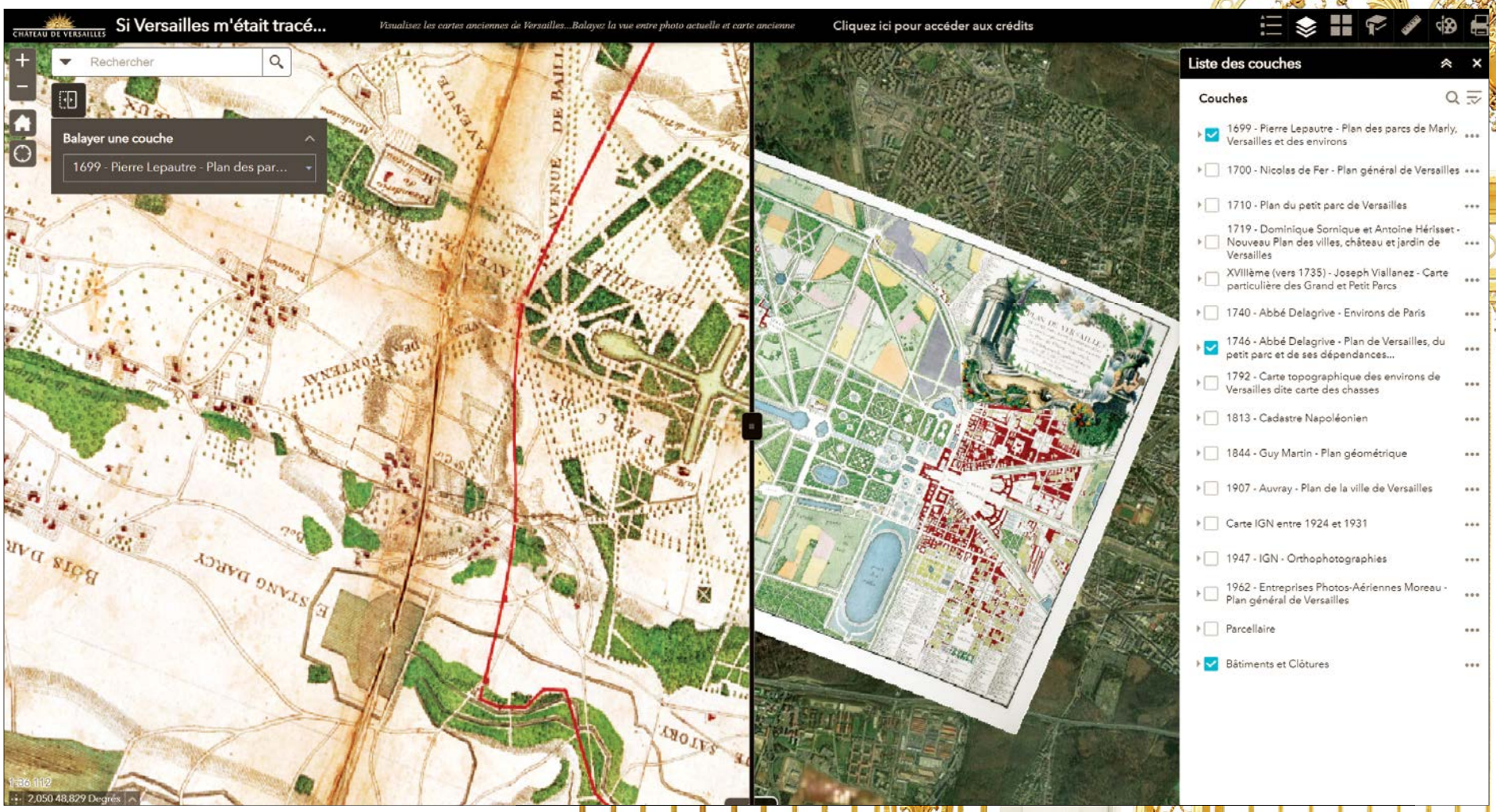
Over time, she added, the viewer will evolve as more data and layers are added to the map.

In the coming years, EPV will focus on the behind-the-scenes networks—such as electricity, water, and fiber optics—that are essential for the ongoing management of Versailles. EPV also plans to create a history of the landscaping of Versailles, displaying the evolution of trees and plantings over the years. A mobile app is also in the works.

As information accrues and layers are added to the map, details of Versailles' past are revealed, helping to ensure its future.

"In effect," Legrand said, "GIS helps different sources of information exist in a dialogue with one another."

→ In the global viewer, each sculpture has an ID card.



↑ *Si Versailles m'était tracé* overlays current aerial imagery with georeferenced historical maps of Versailles, allowing users to swipe between new and old.

13 TIPS to Make the Most of the Esri User Conference

By Sydney Young, Sid Pandey, Wanmei Liang, Jordan Carmona, and Brooke Hatcher, the Urban and Regional Information Systems Association's Vanguard Cabinet

Managing GIS

A column from members of the Urban and Regional Information Systems Association

URISA Fostering Excellence in GIS www.URISA.org

Walking through the doors of the San Diego Convention Center for the first time during the annual Esri User Conference (Esri UC) can be exciting, overwhelming, awe-inspiring, and unnerving. Here are some tips from members of the Urban and Regional Information Systems Association's (URISA) Vanguard Cabinet for what to do before, during, and after the conference to make the most of your time in San Diego, California, at the largest gathering of geospatial professionals in the world.

The URISA Vanguard Cabinet is an advisory board made up of young, passionate geospatial professionals who strive to engage with other young practitioners, increase the number of up-and-coming professionals within the larger URISA organization, and better understand the concerns facing future leaders in the geospatial community.

Before the Conference

1. Create your schedule ahead of time using the Esri Events app. The conference app makes it easy to mark and save presentations and events that you would like to attend. The app also provides a floor plan of the San Diego Convention Center, so you can map out where your selected sessions take place and find the quickest route to get from one to another.
2. Pack the essentials. Over the years, we have learned that there are some key items you'll want to pack to make your conference experience as enjoyable as possible.
   a. A light jacket or sweater—It might be hot outside, but the air conditioning will be blasting in the convention center.
   b. Snacks—The lines for food can get long, and it's a bit of a trek to get to the restaurants in downtown San Diego. You'll want to have some quick bites on hand.
   c. Business cards—You're going to meet lots of people at sessions, in workshops, at social gatherings, and even in restaurants and cafés around town. Make sure you have some business cards ready to hand out so you can stay connected. There are also free apps you can download to create digital business cards, and the LinkedIn mobile app has a QR Code that you can use to stay in touch with people you meet.
3. Prepare an elevator pitch. This is a concise summary of your skills and experience that you can use to introduce yourself to people. Having a prepared pitch can help you feel more confident and in control of the conversation. For guidance on how to construct a good elevator pitch, see URISA past president Tripp Corbin's fall 2022 *ArcNews* article, "The Importance of a Good Elevator Pitch," at links.esri.com/elevator-pitch.
4. Attention, job seekers: Do your homework in advance! Check out the list of exhibitors that will be attending the Esri UC and identify which ones you'll want to talk to. Peruse their websites ahead of time to help you start a conversation with their representatives in the Expo Hall. Look at their job postings as well to see which ones are hiring. And don't forget to bring copies of your résumé.

During the Conference

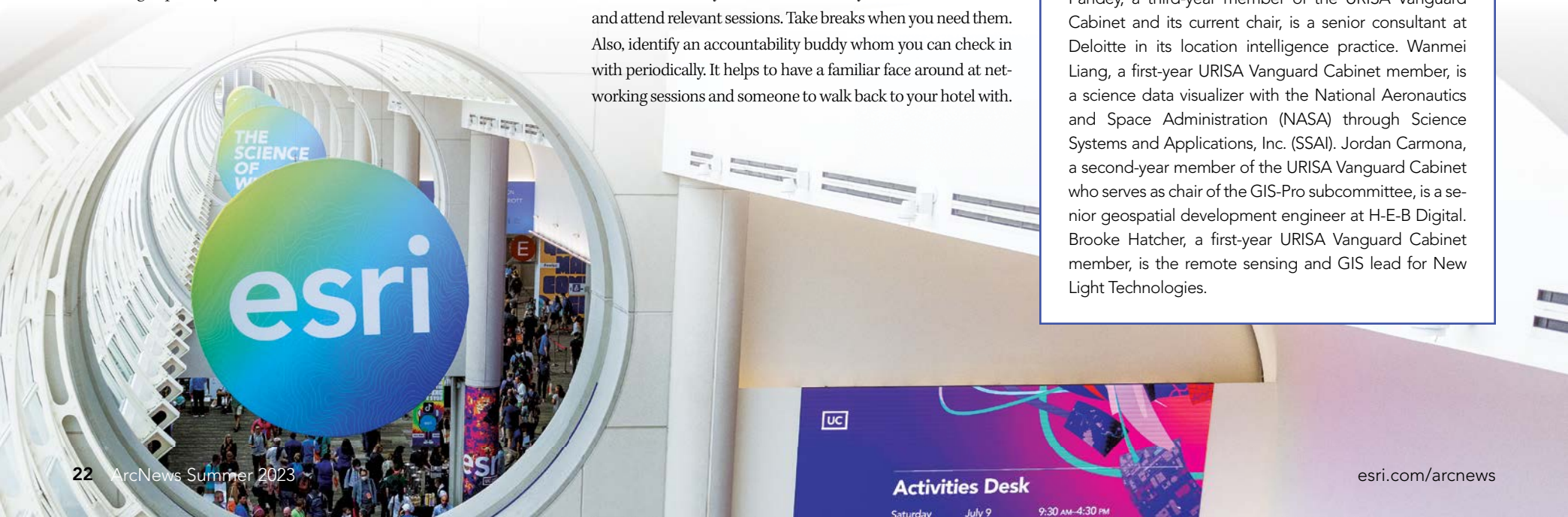
5. Don't miss the Plenary Session. It's our favorite part of the Esri UC. Hearing about the latest advancements in GIS from a range of users is amazing and inspiring. By listening to Esri president Jack Dangermond, Esri product developers, and highly qualified geospatial technology professionals from around the globe, you are bound to come away with great ideas about what using geospatial technology can achieve.
6. Get to the presentations and workshops early. Space fills up quickly! Some of the topics are so interesting that there ends up being standing room only—especially at the talks being given in the Expo Hall. Aim to arrive 10–15 minutes early so you can grab a seat.
7. Make time for networking. It can be intimidating to be surrounded by so many geospatial technology professionals, especially if you're attending the Esri UC by yourself or just getting started in the industry. Take things at your own pace, but be sure to attend at least a few networking events to connect with others. Recommendations include the following:
   a. Attend the Map Gallery on the first day, go to the end-of-conference party at Balboa Park, and make an appearance at the Esri Young Professionals Network (YPN) social.
   b. Stop by the URISA booth to talk to members of the Vanguard Cabinet, and chat with YPN members at their booth. They can help you get connected to people and organizations if you need some support.
   c. Take time in the Expo Hall to speak to the exhibitors and learn about what they do. That's what they're there for!
   d. Visit the product and industry areas that Esri places throughout the Expo Hall. They are staffed by GIS experts, solution engineers, and product managers who can give technology demonstrations and answer questions.
8. Be strategic with your time and effort. Set goals for yourself at the conference. Rather than trying to meet as many people as possible, focus on connecting with a few key individuals whose experience is relevant to your career goals. Make sure you know what information you want to walk away from the Esri UC with and attend relevant sessions. Take breaks when you need them. Also, identify an accountability buddy whom you can check in with periodically. It helps to have a familiar face around at networking sessions and someone to walk back to your hotel with.

After the Conference

9. Go sightseeing! Visiting San Diego's hot spots is what makes the Esri UC unique and attractive. It's also a good way to connect with current coworkers or network with new GIS colleagues. If you do this during the conference, be careful not to overdo it, as you don't want to miss out on all the great content and opportunities the Esri UC has to offer.
10. Go through your notes. It's easy to get overwhelmed at conferences. If you've taken notes during the sessions—which you should do—go over them at your own pace when you get home.
11. Follow up with people you've met. You're going to have made a lot of new GIS friends and connections with potential employers, colleagues, and partners. You've probably exchanged business cards, email addresses, and phone numbers with them. Follow up with everyone to keep the conversation going.
12. Rest and relax. You'll have just walked many miles every day for a week and talked to loads of new people. Take some time to rest and recharge. You'll be better equipped to then take all that new information and inspiration back to your job and colleagues.
13. Prepare for next year. By the end of the week, you'll be an Esri UC expert. You'll know the best places to stay, eat, and hang out. So start planning your next trip to the Esri UC as early as possible. Tell the leaders at your organization how much you gained from the experience and why you should go again next year. Before you know it, Esri will put out the call for abstracts. Start thinking about what kinds of projects and topics you could present about next year and get your abstract in as soon as possible. Don't miss out on an opportunity to showcase your work and give back to the GIS community.

About the Authors

Sydney Young, a first-year member of the URISA Vanguard Cabinet, is a GIS technician at the Chatham County, Georgia, Department of Engineering. Sid Pandey, a third-year member of the URISA Vanguard Cabinet and its current chair, is a senior consultant at Deloitte in its location intelligence practice. Wanmei Liang, a first-year URISA Vanguard Cabinet member, is a science data visualizer with the National Aeronautics and Space Administration (NASA) through Science Systems and Applications, Inc. (SSAI). Jordan Carmona, a second-year member of the URISA Vanguard Cabinet who serves as chair of the GIS-Pro subcommittee, is a senior geospatial development engineer at H-E-B Digital. Brooke Hatcher, a first-year URISA Vanguard Cabinet member, is the remote sensing and GIS lead for New Light Technologies.



Scientific Currents

By Guest Columnists **Dr. Michael Gould**, Esri, and **Dr. John P. Wilson**, University of Southern California

A Longstanding Collaboration in GIScience Persists at the Esri User Conference

Geographic information science, or GIScience, became a recognized discipline in the early 1990s when Dr. Michael Goodchild of the University of California, Santa Barbara, gave a seminal presentation at the 1990 International Symposium on Spatial Data Handling and published a follow-on article in the *International Journal of Geographical Information Systems* in 1992 entitled "Geographical Information Science." By 2000, Goodchild's colleague, Dr. David Mark of the University at Buffalo, presented the following often-quoted definition of GIScience:

> *Geographic Information Science (GIScience) is the basic research field that seeks to redefine geographic concepts and their use in the context of geographic information systems. GIScience also examines the impacts of GIS on individuals and society, and the influences of society on GIS. GIScience re-examines some of the most fundamental themes in traditional spatially oriented fields such as geography, cartography, and geodesy, while incorporating more recent developments in cognitive and information science.*

This definition paints GIScience as an enabling discipline that draws on cartography, remote sensing, spatial analysis, modeling, and even philosophy to explore and explain the patterns and processes that shape a continuously changing world. GIScience includes multiple research topics that help motivate and guide the development and use of GIS software. GIScience spans novel concepts and methodologies that can be programmed in software in multiple ways, as well as best practices to help guide and refine how spatial scholars and practitioners use the software.

Esri has supported GIScience in many ways over the years, including by collaborating on research on topics such as cartographic visualization, spatial data management, remote sensing, spatial analysis, modeling, and big data. Esri president Jack Dangermond served on the board of directors of the National Center for Geographic Information and Analysis (NCGIA) in the 1990s, and today, Esri is a leading force in pushing geospatial science and software forward.

In continuing this tradition, there will be two special sessions dedicated to innovative research in GIScience at the 2023 Esri User Conference (Esri UC). These sessions—which take place in the morning on Tuesday, July 11—have been a regular part of the Esri UC since 2008, thanks to a collaboration between Esri and the international, peer-reviewed journal *Transactions in GIS*, which publishes a special issue or section each year that features these conference presentations. This collaboration offers geospatial science scholars and practitioners the opportunity to share new ways of using spatial methods to address problems across a wide variety of academic disciplines or use cases.

At the beginning of every year, Esri and the journal publish an open call for papers that highlight innovative GIScience research. Papers that are preselected go through the normal peer-reviewing process, and the articles that make it through get published in the journal. Also, the authors of the published papers are invited to present their research results at the Esri UC in San Diego, California. To date, *Transactions in GIS* has published 123 of these peer-reviewed articles, which cover a wide array of GIScience topics and are cited frequently in additional scientific publications.

Citations are an indication of the importance that other researchers place on the ideas that an article contributes. When a researcher cites a previously published scientific article, it reveals the slow yet concrete demonstration of scientific progress. This exemplifies what the English scientist Sir Isaac Newton meant when he said, "If I have seen further, it is by standing on the shoulders of giants."

The following list shows some of the most-cited articles published in *Transactions in GIS* from 2008 to 2022, with the number of Google Scholar citations shown in parentheses as of May 25, 2023:

- A Space-Time GIS Approach to Exploring Large Individual-Based Spatiotemporal Datasets (161)
- Accuracy of iPhone Locations: A Comparison of Assisted GPS, WiFi and Cellular Positioning (629)
- Discovering Spatial Patterns in Origin-Destination Mobility Data (195)
- Integrating the Huff Model and Floating Catchment Area Methods to Analyze Spatial Access to Healthcare Services (165)
- Extracting Urban Functional Regions from Points of Interest and Human Activities on Location-Based Social Networks (319)
- Traffic Transformer: Capturing the Continuity and Periodicity of Time Series for Traffic Forecasting (121)

Many of these top-cited articles focus on new types of spatiotemporal data and the development and testing of methods for exploring human-centered activity; they do not tend to focus on physical geographic phenomena. This research serves to advance people's understanding of how scientific and technological decision-makers can build more inclusive, healthy, sustainable, and resilient communities.

GIScience is helping to contribute to the academic knowledge base not only in geography but also in many other academic disciplines and fields of practice. Again, this is reflected in the number of citations the *Transactions in GIS* articles have garnered, as well as in the cross-disciplinary topics that contributors have covered. The 123 varied topics that have been presented in this context at the Esri UC include urban residential dynamics, improving the accuracy of geocoding, the completeness of OpenStreetMap, modeling spatial flows, semantic search, methods for analyzing human interaction using movement data, and modeling armed conflicts.

The Geographic Approach is a cyclical process that starts by posing a question about the world—such as, How do tourists in a city behave while using mobile phones?—and continues through gathering and analyzing data; visualizing the results; and, ultimately, taking some action in the world. GIScience is partly responsible for creating the analysis and visualization methods; GIS then implements these methods in software. Sometimes, the journey from ideation (and theory) to testing to software takes decades. But that labor does bear fruit. Indeed, today's advanced enterprise GIS software contains many ideas that have germinated in GIScience research.

So at this year's Esri UC, pay special attention to the topics covered in various science and research sessions, as well as at the Science Symposium, which is also being held on July 11. Then, continue to follow these topics' progress. The Esri UC presentations offer conference attendees a unique opportunity to hear from and converse with GIScience specialists whose ideas may eventually be found inside GIS software. A brief hallway discussion about a budding idea has the potential to affect research methodologies and even GIS technology down the road.

← From left to right, Dr. Karen Kemp, Dr. John P. Wilson, and Dr. Michael Goodchild converse at the GIScience sessions at the 2016 Esri User Conference (Esri UC).

This article is dedicated to the memory of Dr. David Mark, who passed away in September 2022.

About the Authors

Dr. Michael Gould is an education manager at Esri, where he works with more than 80 Esri offices that serve over 10,000 universities worldwide. He studied GIScience and received his PhD from the University at Buffalo. Gould has been a professor at Jaume I University in Spain since 1998 and was cofounder of the European Union-funded international master's and PhD degree programs there. Dr. John P. Wilson is a professor and founding director of the Spatial Sciences Institute at the University of Southern California, as well as the founding editor of *Transactions in GIS*. He has published on a variety of GIScience topics, including design, engineering, health, and the sciences. Wilson holds faculty appointments in USC's departments of civil and environmental engineering, computer science, population and public health sciences, and sociology, as well as at the USC School of Architecture.

From the Meridian

By Dr. Risha Berry
American Association of Geographers

A Course of Action for Creating a More Just Geography Discipline

In late 2022, the American Association of Geographers (AAG) welcomed Dr. Risha Berry as its first director of diversity, equity, and inclusion. Central to her new role is her work with AAG's Justice, Equity, Diversity and Inclusion (JEDI) Committee—bringing to life its 32-point plan to transform the discipline of geography and AAG into more inclusive places of belonging and opportunity for people of many backgrounds and experiences. (For more on JEDI's three-year action plan, go to links.esri.com/jedi-plan.) In this edition of From the Meridian, Berry reflects on AAG's intentions and work and invites you to join the organization in advancing them.

From the Meridian is a regular column from AAG, a nonprofit scientific and educational society whose members, from nearly 100 countries, share interests in the theory, methods, and practice of geography. Find out about AAG's programs and membership at aag.org.

In geography, knowledge of positioning in space is what helps us grasp the characteristics and relationships of places so we can determine our direction and priorities. There is a very similar need to connect to positionality when we work to develop a more just, equitable, diverse, and inclusive discipline. Individuals and institutions must reckon with their own life experiences, history, and expectations to see where they are so they can determine where to go next.

A Zulu greeting encodes this important awareness in our social and professional relationships: *sawubona*. It means "we see you." One possible reply, *sikhona*, means "I am here to be seen," underscoring the spatial connections in our identities and relationships. This seemingly simple and factual exchange of greetings speaks directly to the work of creating a more just geography discipline. First and foremost, the greeting is spoken in the plural first person, even when only one person is saying it—a nod to the rich and complex ancestries and histories we all bring to life in our being. Second, to truly see someone else, you must be grounded in the ability to see yourself. Thus, the act of seeing is also an act of revealing. The knowledge of our personal, professional, and institutional identities and histories is the foundation for informing our work together. That's why a hallmark of AAG's JEDI Committee is being relational and participatory.

Building on more than a decade of recommendations, work, and insight from previous committees and staff initiatives at AAG, we have created a plan for celebrating and representing all identities and intersectionalities of identity within geography and to greatly increase representation in the discipline. I am excited to share our call to action and ask for your input and ideas. In particular, I invite you to share your insights with one of our seven new working groups at links.esri.com/jedi-groups. Through this input, the JEDI Committee intends to shape AAG's approaches to governance, management, advocacy directions, membership goals, and more. To continually inform our progress, AAG will report the outcomes through identified metrics.

What JEDI Means

AAG uses the following JEDI framework to define goals and operationalize progress:

- Justice is an umbrella concept that acknowledges the vitality of multiple truths instead of a single historical narrative and current conditions. It champions dismantling systems and structures that create inequality and supports replacing them with systems that promote fairness. Fostering a culture of justice creates opportunities for diverse groups of people to thrive together.
- Equity emphasizes fair and equal treatment, access, opportunity, and advancement for all people while, at the same time, identifying and eliminating barriers that have prevented some formerly excluded groups from fully participating. Improving equity involves increasing justice and fairness by critically examining the existing procedures and processes of institutions or systems.
- Diversity creates the conditions for more meaningful exchanges of information and more equitable opportunity. It is a multidimensional acknowledgement of all the ways in which people differ across race, gender, ethnicity, age, national origin, religion, disability, sexuality, socioeconomic status, education, marital status, language, and physical appearance. Many of these differences have been constructed or amplified to enable powerful groups to maintain wealth, influence, and standing. The goal is not to remove differences but rather to address systems of oppression and exploitation based on differentiation.
- Inclusion is the attitude and act of cultivating a positive environment in which all individual groups feel welcomed, respected, supported, and valued to fully participate. An inclusive and welcoming climate embraces differences and offers respect for all people via words and actions.

Breaking Down Barriers and Lifting Up Opportunities

The State of Geography for 2022, AAG's most recent report analyzing geography education in the United States, found that geography degree conferrals at the undergraduate and graduate levels have grown among students from historically excluded populations. In fact, it is these students who have contributed to new growth in geography in recent years. This is good news for the discipline.

But that growth is nowhere near the levels needed for people who have historically been excluded from the field to have full, representative equity in the discipline of geography. So while the data in the report (available at links.esri.com/aag-geo-2022) offers a signpost that the field of geography is becoming more diverse, it is also a reminder that those of us already in the field must redouble our diversity and inclusion efforts.

Tackling this challenge will mean more than simply recruiting or hiring more diverse students and faculty members or professional candidates. We must also invest in holistic approaches to belonging. The University of California, Berkeley's Othering & Belonging Institute defines the notion of belonging as "more than a feeling of inclusion or welcome. Its full power is as a strategic framework for addressing ongoing structural and systemic othering, made visible, for example, in the wide disparities in outcomes found across a variety of sectors and identity groups."

A Vision for Communities of Belonging and Care in Geography

AAG's vision is to be a vibrant, welcoming, and just professional organization of geographers that puts justice, equity, diversity, and inclusion at the center of its work and commits to the recognition, dignity, belonging, and engagement of all people. At AAG, we take seriously the goal of creating a relational approach to dismantling oppression, discrimination, and marginalization that addresses multiple and intersectional barriers to inclusion and equity.

We intend to make collaboration a primary approach for integrating the JEDI principles into our work. Leaders at AAG will focus on building and strengthening relationships within and beyond the discipline of geography over time—with the hope that this enriches opportunities to demonstrate geography's relevance in solving urgent, real-world problems in inclusive and just ways.

What this means is, we need you! Read AAG's JEDI plan at aag.org/jedi and send us your comments, thoughts, and reflections at helloworld@aag.org.

About the Author

Dr. Risha Berry is the director of diversity, equity, and inclusion for AAG. She has 30 years of research and leadership experience in addressing structural inequalities and racism and their collective impact on people's educational attainment and opportunities for economic mobility.

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Professor Cultivates a Framework for Exploration

In the late 1970s, Dr. Josef Strobl envisioned cartography as a field that was well-suited to computers. He didn't think that the manual processes of drafting and scribing would need to dominate mapmaking for much longer.

During his first two years as an undergraduate student at the University of Vienna in Austria, Strobl—who was studying geography in hopes of becoming a cartographer—picked up computer programming on the side.

"It was just for the fun of it," Strobl said. "And then, of course, I thought, 'Why not use the computer to do maps?' And I ended up with that combination."

For someone who initially didn't plan to go to college and who just wanted to spend time climbing mountains, Strobl's thinking about where his chosen fields of study—cartography and geography—were headed was quite progressive for the time. Now, as a professor of geoinformatics at the University of Salzburg, Strobl gets to shape the future of digital mapmaking through his research and collaboration with people who work in fields that range from forestry to the steel industry, as well as via the students he teaches.

"I love to observe where graduates go, what they do, and what they achieve," Strobl said. "More and more, I am motivated by seeing what former students or partners or colleagues can achieve—and that always brings up new questions. It's a cycle of curiosity."

A Mountaineer Who Loved Maps

Strobl was a devoted mountaineer in his teenage years. He guided groups on mountain climbing adventures, where he was responsible for planning routes and preparing the equipment.

"In those days, there was no GPS, no digital maps," he said. "I spent quite a long time doing traditional navigation tasks, guiding people based on paper maps."

That's what initially got Strobl interested in mapping. After he completed his compulsory military service in the Austrian army, he decided to go to university and study cartography. At the University of Vienna, he had to begin his education with two years of geography before starting down the cartography track, and he ended up liking geography a lot.

"I graduated with a degree in geography, full stop," he said. "I did not complete the cartography track because I would have had to do a lot of manual drafting and scribing."

Strobl completed both a master's and a PhD in geography. For his master's, Strobl applied statistical methods to study the relationship between a location's climate and its agricultural production potential. His PhD work revolved around studying glacier dynamics, which allowed him to spend summers in the mountains.

"I found a PhD adviser who was happy to supervise me but let me work independently, which was good," Strobl said. "I had the opportunity to go explore and use new technology."

Strobl was the only geographer on a team of meteorologists and geophysicists who were examining glacier mass balances.

"They were naturally asking me, 'Well, you could do the maps, right?' And of course, I wanted to apply my newfound coding skills by doing this in a reproducible way," said Strobl.

He started producing the maps by hand, but he soon moved to creating digital maps of annual glacier mass balance—the net gain or loss of glacier mass each year.

"To estimate the impact of solar radiation on glacial melt, I created my own elevation models from digitized contours by coding my own routines," he said.

Those maps ended up being a big part of his PhD dissertation.

Taking a Foray into GIS

After Strobl completed his PhD, he became an assistant professor at the University of Salzburg. He liked that he could live so close to the mountains and be adventuring in them within 15 minutes.

Shortly after joining the university, Strobl worked with a geographer who was using GIS at Berchtesgaden National Park in Germany. That was Strobl's introduction to the technology.

"As far as I know, that was the first ARC/INFO installation in Germany," Strobl said of the implementation. "And this guy was asking me, 'Why don't you get into this instead of just digital mapping?'"

Strobl's university didn't have the funding to get a full ARC/INFO license, but when PC ARC/INFO was announced right around that time, Strobl jumped on the chance to use it. This new product took GIS from operating on mainframe computers to functioning on personal computers.

"When PC ARC/INFO was announced, I used my first funded research project to get the license," Strobl said. "It took nearly two years until it was actually delivered."

Strobl believes that he had one of the first PC ARC/INFO licenses in the German-speaking world.

Building on his graduate work of creating digital elevation models for glaciers, Strobl began using PC ARC/INFO to expand on his earlier models so they could be used to analyze terrain for different purposes.

"At the time, we were happy to be able to explore what could be done with different functionalities or pieces of software," Strobl said. "Doing terrain modeling and analyzing physical processes in the real world—like, where does the water go after the snow and ice melt—was always the frame for the work. Analyzing the interaction between atmospheric and astronomic parameters, terrain, land use, and land cover—that was the broad field I was interested in."

Cartography as Communication

What Strobl and his GIS-using colleagues were producing back then were maps as an end product, as Strobl puts it.

"The map was the product," he said. "But I have an entirely different view today of what a map should be, and it involves much less automation of a production process and more focus on maps being media for communication and knowledge creation."

Before, according to Strobl, users had data, created symbology for it, and put that on a map. Then map readers would decode the information and hopefully arrive at the conclusions the mapmaker intended to communicate. It was a one-way transfer of information.

"Today, it's dynamic and interactive," Strobl said. "I wouldn't try to put everything onto a map. I make the map a framework for exploration. We have widgets and pop-ups and let the map reader select layers and symbology and adjust the study area. So now, the map serves as a frame for interaction; dialogue; exploring; and, ultimately, participation."

Strobl has always tried to make GIS, geospatial science, and geoinformatics more approachable to people. Thirty years ago, he worked with colleagues in the Netherlands and the United Kingdom to found UNIGIS, which was the first distance-learning program to offer degrees in GIS. It is geared toward professionals who want to learn more about GIS and apply the technology to their work.

"In those days, there was a huge number of people who, in their studies, did not have the opportunity to learn GIS," he said. "Now, the majority of students in UNIGIS may have had a little taste of GIS in their programs and are exposed to it in their professions, and they want to future-proof their careers."

Strobl has founded several community-based events and organizations over the years as well, including GI_Salzburg, an amalgamation of two originally separate symposia—the GI_Forum and the German-language Applied Geographic Information Technology (AGIT) conference.

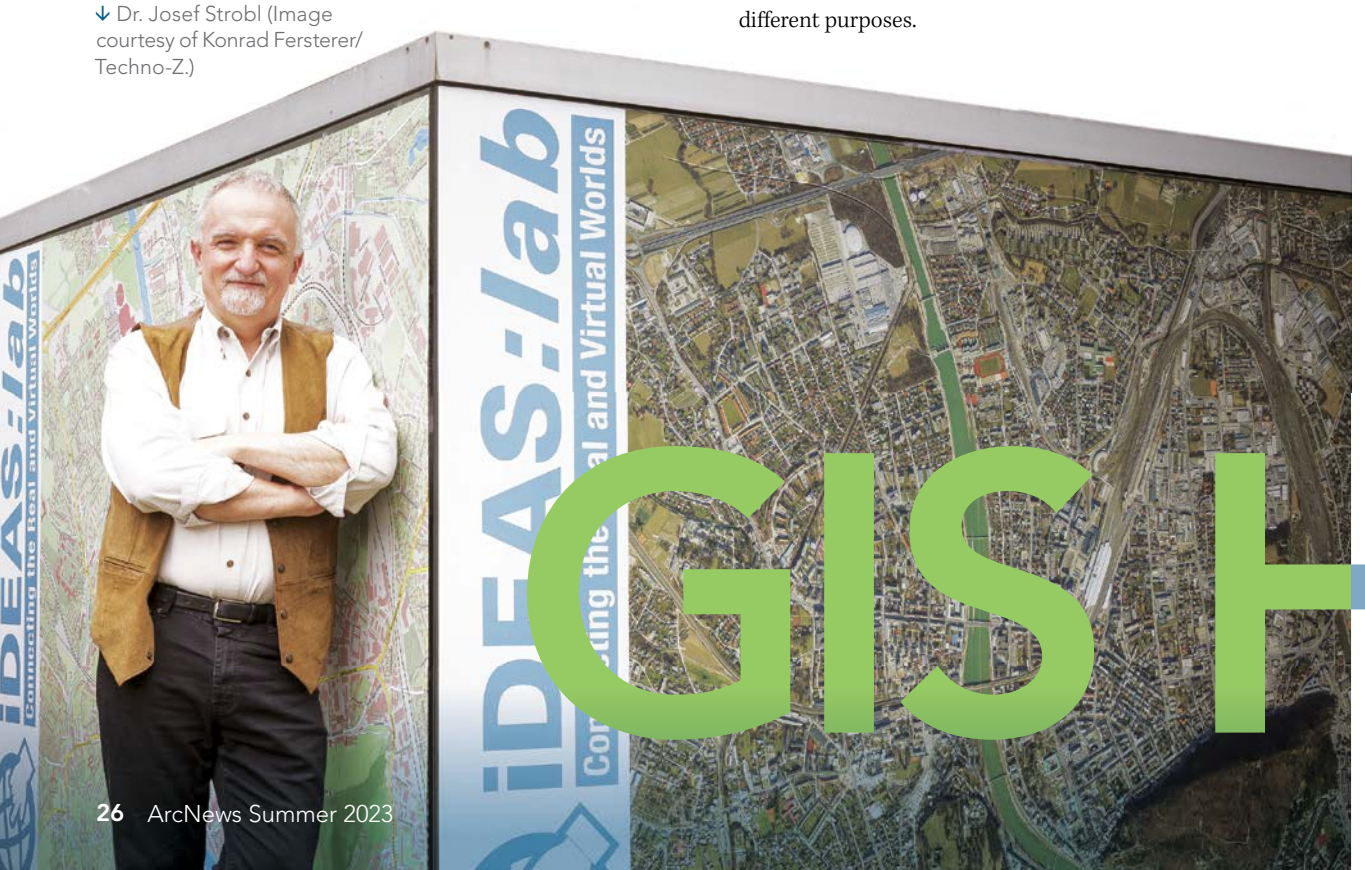
"We wanted to put together an event where the focus was not just on technology," Strobl said. "People get to talk to peers, compare notes, and exchange experiences. Of course, there are also workshops, lectures, and presentations."

Strobl was also instrumental in establishing the Salzburg iDEAS:lab, named for integrated digital earth applications and science. The lab provides a way for the public in Salzburg to learn more about science, GIS, and using geomedia as everyday tools. It hosts teacher education workshops and offers hands-on activities for pupils.

Most of Strobl's current work focuses heavily on community science and fostering public participation. In these settings, he uses the term *digital earth* to reach an extensive spectrum of people who might be turned off by the "geo" or "information science" labels associated with these fields.

"Using the term *digital earth* gives us the opportunity to reach out to a broader audience because 'digital' and 'spatial' are pretty much everything in life today," Strobl said. "It's about being more inclusive and bringing more people into the fold but not requiring them to identify as GIS people."

↓ Dr. Josef Strobl (Image courtesy of Konrad Fersterer/ Techno-Z.)



GIS Hero

Teaching Geospatial Technology in Bite-Size, Culturally Relevant Nuggets

By Dr. David Andrews and Dr. Sheila Lakshmi Steinberg, University of Massachusetts Global

Think about the last time you tried to learn something new. Perhaps you wanted to hike to the top of a mountain or start using artificial intelligence (AI) tools at work. Did you climb to the peak on your very first hike? Did you outsource your entire job to AI within the first hour? Probably not.

You likely approached your learning goal via smaller, more familiar steps. You probably went for a 30-minute nature walk first and built up to your all-day ascent gradually, until you had the aha moment when you knew exactly how much water, food, and training you would need to make it to the top of the mountain. To learn about the latest AI tools, you likely started by reading articles and talking to colleagues about various AI platforms, got free trials for a few of them and poked around, and then had the aha moment when you realized which one would work for you. Only then did you begin implementing AI into select workflows.

When learning something new, it is helpful to start from a place of relative familiarity and break the learning process down into bite-size nuggets. This moves learners closer to that aha moment, when they recognize how their new knowledge can be applied to other contexts.

At the new Institute for Geospatial Education at the University of Massachusetts Global (UMass Global), that is how instructors educate students about geospatial technology. They meet students where they are—culturally, socially, and geographically—and hook into the knowledge and experience they already have before working to extend students' understanding of the technology to new heights and realms.

Consider Culture

Culture, according to anthropologists Lara Braff and Katie Nelson, is "a set of beliefs, practices, and symbols that are learned and shared." Culture is the lens through which people observe, discover, and act. Anytime groups of people come together, they bring their different cultures with them. So culture is important to consider when teaching people how to use geospatial tools.

Learning modules at UMass Global's Institute for Geospatial Education actively regard students' cultural and social norms and incorporate them into the learning process. The curriculum also includes real-world examples of how culture intersects with the use of geospatial tools in various contexts around the globe.

For instance, to help the Indigenous Martu people of Australia's Western Desert manage their land and water systems in a modern context, GIS had to be implemented in a way that complemented the community's cultural conceptions of space and place. As noted in *Resilient Communities Across Geographies*, edited by Dr. Sheila Lakshmi Steinberg and Steven Steinberg, the Martu's traditional way of life centers on knowledge systems that are built around geography—and song and storytelling are key to keeping those knowledge systems intact. Thus, as researchers Sue Davenport and Peter Johnson discovered, GIS is best used in this context to preserve and enhance the cultural knowledge that the Martu already possess.

Teaching people how to learn new tools involves understanding different cultural patterns. This is true within any organization, school, or business. The way a particular group conceptualizes space and place is directly tied to what that group values and focuses on in the learning process. Members of the group orient themselves to the topic and interpret teachings based on cultural values and norms, as well as what is familiar in their own local cultures.

Bite-Size Nuggets

One of UMass Global's goals is to provide people all over the world—many of whom have previously lacked access to education—with the opportunity to learn GIS in an applied environment. A big focus of that objective is to ensure that they are able to learn the technology through bite-size, culturally relevant nuggets.

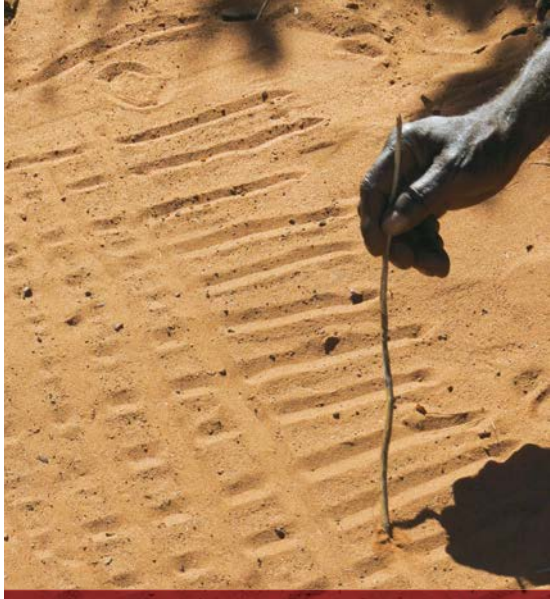
To do this, UMass Global is collaborating with Esri to break learning down into specific ideas or facts—nuggets—that can be taught in a few minutes to an hour. Students can then take the key concepts that they learn and build toward earning microcredentials, certificates, and degrees. UMass Global incorporates ArcGIS technology, materials from Esri Academy, *ArcGIS Blog* posts, and more to teach students how to use GIS in ways that positively impact leadership, communication, strategic thinking, and decision-making.

Through conversations with interdisciplinary geospatial leaders, including members of the Institute for Geospatial Education's advisory board, instructors have created a big-picture view of the geospatial skills that students need to acquire. These include not only technical experience but also soft skills that are critical to achieving success. Students stack learning units on top of one another to amplify their existing competencies and create a new line of knowledge within their disciplines. This helps learners discover how to use geospatial tools in business, for emergency management and economic development, in concert with other technology such as AI, and in a host of other situations.

UMass Global teaches the Geographic Approach, a methodology that encourages learners to ask location-based questions; acquire, examine, and analyze data; and act on the results. This method ensures that the goal of using geospatial technology is to encourage action, aid with problem-solving, and influence policymaking. Because what good is studying a technology or challenge if it doesn't lead to progress?

As Esri director of product engineering and Institute for Geospatial Education advisory board member Clint Brown said about the program, "You rapidly become part of an ever expanding group of problem-solvers capable of addressing the big challenges that face our planet."

Esri education manager Michael Gould, an affiliate of the institute, echoed that sentiment.



When using GIS with the Indigenous Martu people of Australia's Western Desert, the technology had to be implemented in a way that complemented the community's cultural conceptions of space and place. (Map drawn by Martu man. Photo courtesy of Sue Davenport.)

"Organizations are looking for more than people who know what GIS is," he said. "They are looking for decision-makers who are capable of using geospatial thinking for problem-solving."

The Aha Moment

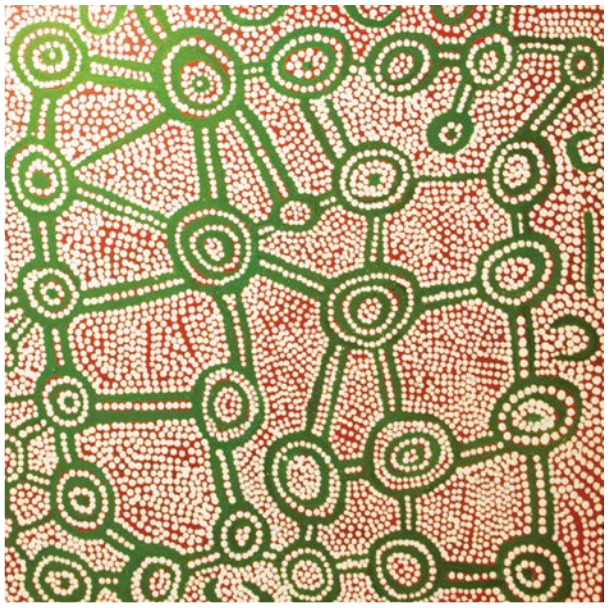
Meeting students where they are acknowledges their lived experiences as well as their existing knowledge and skills. It creates a framework for engagement and provides learners with a launchpad for success, whatever their backgrounds may be.

Packaging instruction into bite-size nuggets increases the accessibility of education and improves learners' confidence that they can achieve their goals. This is because of assimilation, a process wherein people integrate new learning with knowledge they already have. When students acquire new skills by participating in authentic problem-solving via a culturally familiar frame of reference, they are more likely to retain that knowledge and apply it in novel contexts.

Teaching GIS this way crosses global geographies. As students acquire more skills, the problems they are asked to solve become more complex and occur in different environments. And along the way, they receive recognition—in the form of microcredentials—of their growing skill sets. This motivates students to keep learning and ties credentials to competencies, which gives employers confidence that potential employees do indeed have the skills they claim to have.

Many people around the world can learn how to use GIS by first applying the technology in small ways to issues that they already understand. Once they achieve that aha moment, they can take their skills and start on the path to tackling more complex problems.

↓→ The Martu map out important places by using songs and storytelling, as shown by thes artistic renderings of land near Western Australia's Canning Stock Route (below) and tracks that connect special water places (right). (Image below courtesy of artist Kumpaya Girgiba, and image at right courtesy of artist Nyari Morgan.)



About the Authors

Dr. David Andrews is the chancellor of UMass Global. He has extensive experience in developing innovative, online-based higher education initiatives. Dr. Sheila Lakshmi Steinberg is the director of the UMass Global Institute for Geospatial Education and a professor of GIS, social, and environmental sciences. She is also an Esri Press author.

Using GIS for Asset Inspections Pays Off When It Matters Most

At Oklahoma-based engineering consulting firm Meshek & Associates, GIS manager Michael Couch and his team know a thing or two about helping communities that have little more than a goal and a tight deadline to complete complex GIS projects. The firm, an Esri partner, supports a multitude of municipalities across Oklahoma with their water, sanitary sewer, stormwater, flooding, and emergency management needs.

Some of the water, sewer, and drainage infrastructure in Oklahoma predates the state's even achieving statehood in 1907. In dealing with municipalities of varying sizes and capabilities, with infrastructure that varies significantly in age and form, it helps that the GIS team at Meshek can be creative in delivering solutions. The ArcGIS system—including ArcGIS Online and ArcGIS Field Maps—is central to that flexibility.

A Range of Asset Inventory Systems

Many of Meshek's clients have no digital data for their infrastructure. Clients often only have handwritten notes and aging paper maps that show where their assets are. Other customers rely on an assortment of spreadsheets and fragmented computer-aided design (CAD) files from various years. Some clients have no formal records of their assets at all; instead, key information resides solely in the mind of a single worker. This, of course, presents great risk if that worker were to quit or retire, leaving these organizations scrambling to quickly create a digital inventory of their infrastructure.

Whether starting with no records at all or trying to connect disparate pieces of existing information, the GIS team at Meshek uses ArcGIS technology to record asset locations and details, following a process that has proved to be both efficient and effective. Depending on the resources that clients have at their disposal, this process can involve training municipal staff members on how to use GIS to capture and update asset data both in the office and in the field. Other clients have the team at Meshek do all the data collection and receive a fully documented, ready-to-use map and digital inventory of their system. In both types of situations, Couch and his team employ Field Maps, since it is an easy-to-use, comprehensive solution for mobile work.

"Being able to go out and locate and inspect features is something that Field Maps is ideal for," Couch said.

A Faster, Better, and Easier Process

The communities that Meshek works with use GIS to meet their specific needs, whether that's demonstrating regulatory compliance; assessing economic development opportunities; preparing for and recovering from natural disasters; or improving the routine management activities associated with water, sewer, and stormwater systems. Therefore, scoping out a project is often the first hurdle that the GIS team must surmount.

"One of the challenges is that so many *[municipalities]* are reliant on pen and paper or things in the memory of staff," said Couch. "That's how they have always done it. But they can do it faster, better, and easier using ArcGIS Online."

The city government of Catoosa, just outside Tulsa, provides a case study for how to go from a paper-based asset inventory system to a GIS-based one.

"For the City of Catoosa, we were able to take a completely paper*[-based]* process for stormwater quality outfall inspection and make it all digital using Field Maps," said Couch.

Prior to working with Meshek, the city completed annual inspections of its stormwater assets by printing out a stack of inspection forms and maps and having city employees walk the terrain to locate and identify the assets. The employees would mark the asset locations on the maps and make handwritten notes of the inspection results. Back at the office, someone would manually input the inspection results into a digital form.

"But now, Catoosa has a digital inventory of its stormwater outfall system that accurately reflects *[the assets']* locations and can be used in annual inspections," said Couch. "This can all be done within one single app on mobile devices. The city was thrilled to be able to see the data so rapidly."

Digital Data Aids in an Emergency

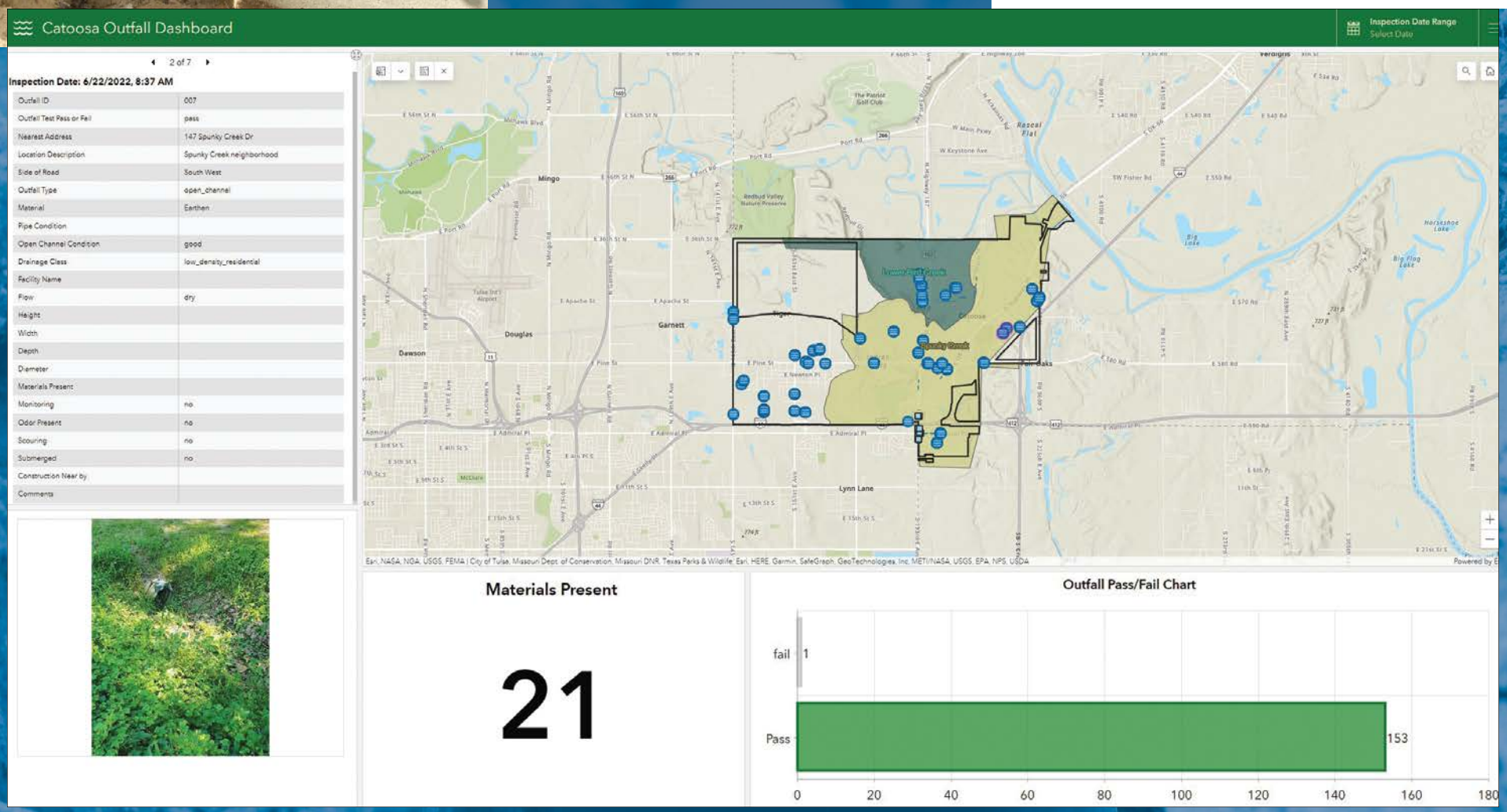
Some of the GIS implementations that Meshek has helped put in place have paid dividends to municipalities at critical times.

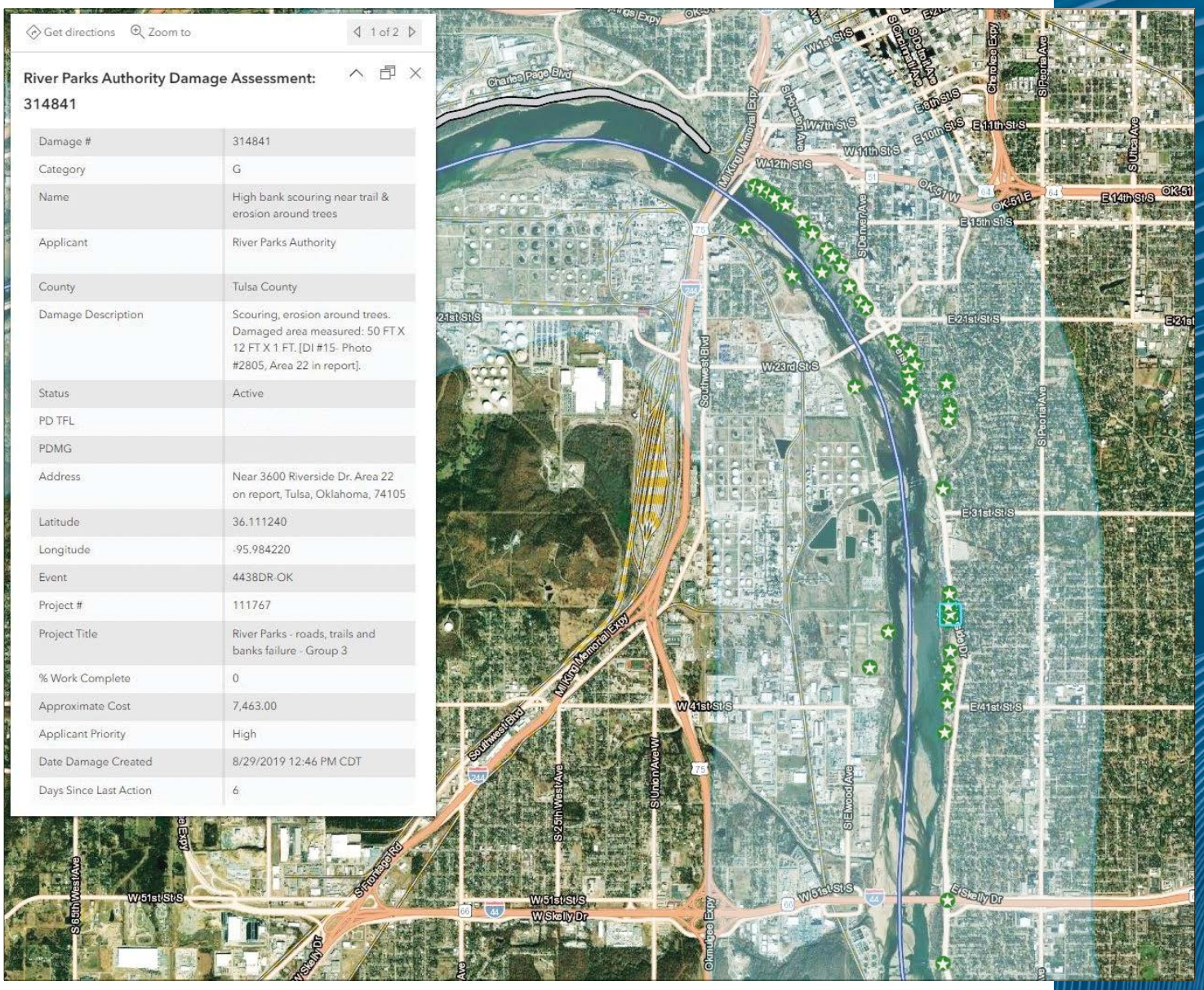
For example, Couch and his team worked with the City of Tulsa for several years to move its asset inspection process to GIS. When historic floods struck the region in May 2019, the city's GIS-based field data collection efforts proved extremely valuable, according to Couch.

The flooding caused five fatalities and an estimated $3 billion in damage, according to the National Centers for Environmental Information. Most of the destruction occurred along the Arkansas

← The City of Tulsa had easily accessible photos and videos that showed each asset before and after historic flooding.

↓ The City of Catoosa, which used to have a paper-based asset inventory system, now has an accurate, digital inventory of its stormwater outfall system.





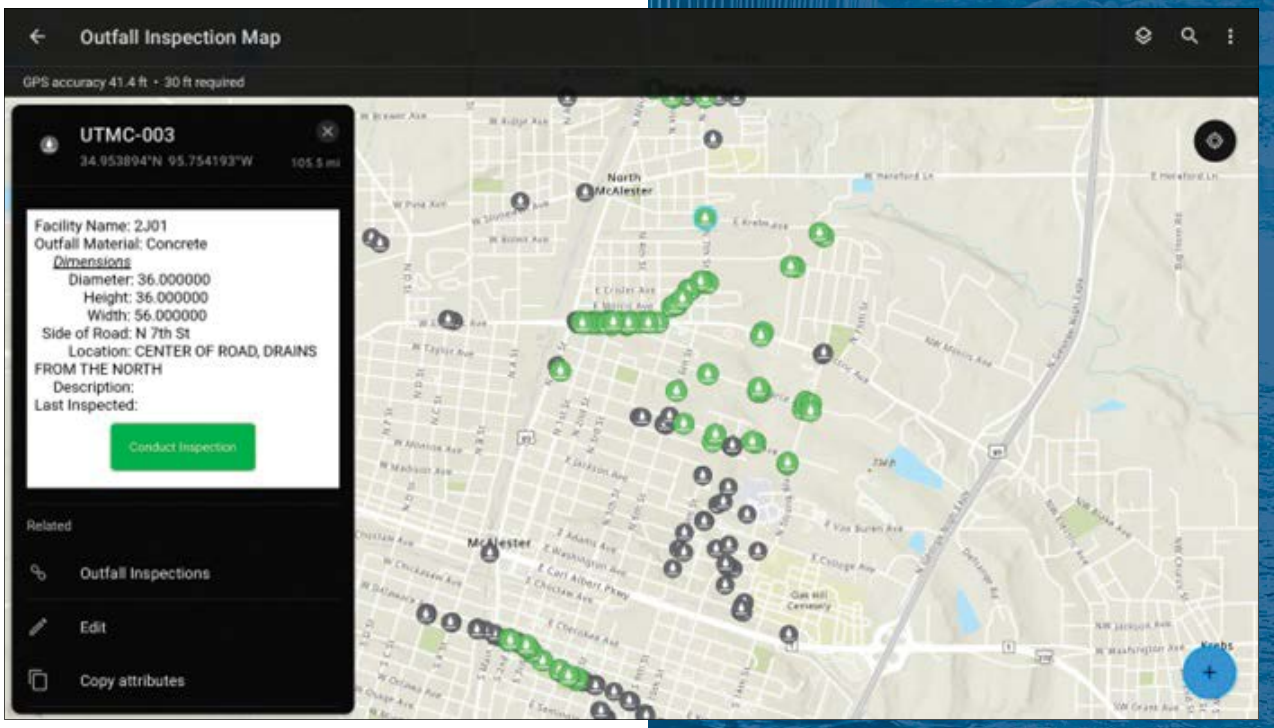
← When Tulsa, Oklahoma, experienced historic floods, the city was able to prove—thanks to its digital history of asset inventory—that infrastructure was damaged during the storms.

River and not within the city proper, thanks to Tulsa's history of investing in flood risk mitigation strategies. As is typical after a natural disaster, the city had to submit claims to the Federal Emergency Management Agency (FEMA) to get federal funding to fix the damaged infrastructure around the river.

"Communities submitting claims must prove that the damage was from the disaster and not a lack of maintenance or something else, which often can't be done because of a lack of records," Couch said. "In this case, the city could *[prove it]*."

By 2019, Couch and his team had captured a significant amount of inspection data about the conditions of Tulsa's storm sewers, including outfalls to the Arkansas River. Because the digital records showed system conditions both before and after the floods, the city was able to substantiate its FEMA claims and receive funds to repair and restore the damaged infrastructure.

"We had all this inspection data, and we could say, 'This is what this exact feature looked like a year ago and two years ago,'" Couch recalled. "We had photos and videos linked to the features that showed that, before the flooding, a feature was in good shape *[and]* wasn't ruined or scoured away. We were able to prove that the storm caused the damage, and that was helpful to the city."



↑ Staff at the City of McAlester conduct asset inspections using ArcGIS Field Maps.

Small Municipalities See Big Gains

For smaller municipalities with limited staff, the benefits of having a GIS-based system of record and engagement are multifaceted. For McAlester, a city in southeastern Oklahoma with a population of just over 18,000 people, using Field Maps to digitally document water, sanitary sewer, and stormwater infrastructure was pivotal.

The paper-based system that the town relied on before was riddled with errors and inefficiencies, according to Couch.

"Once we deployed workflows using ArcGIS Field Maps and ArcGIS Online, a mobile worker could find and document an asset that had previously been marked 40 feet in another direction," Couch said. "They're able to just move that feature in their mapping *[app]* exactly where it should be because they're standing on it."

In addition to boosting accuracy, having digital maps of water infrastructure that are fed by reliable data has enabled the City of McAlester to be more efficient and improve correspondence with third parties. City staff are now using web apps created with ArcGIS Experience Builder and ArcGIS Web AppBuilder to share utility asset locations with contractors to minimize accidental damages during construction.

A Record of Success

The flexibility and scalability of the ArcGIS system have enabled Meshek to provide many GIS-based water infrastructure solutions to a wide range of customers with a record of success.

"If you can do it on a clipboard, you can do it in Field Maps so much easier, with *[such]* better record keeping," Couch concluded.

Managing a Changing Workforce with GIS

By Linda Foster, Esri

Record numbers of workers are expected to retire in the next decade in what the United States Census Bureau and others have called the "silver tsunami" or "gray wave." The baby boomer generation—those born after World War II, between 1946 and 1964—is retiring, with approximately 10,000 people turning 65 years old in the United States each day, a pace that will continue until 2030.

The challenges that all industries—but especially government agencies—are facing with this departure of workers have only been exacerbated and even accelerated by a yearslong pandemic. Employee retention is suffering, and competition is fierce for attracting young people into careers. As of March 2023, the public sector still had a net loss of 650,000 positions three years after the start of the COVID-19 pandemic, while the private sector has not only recovered its job losses but also filled nearly 900,000 new jobs in the same period, according to a recent article in *American City & County*, a news website for state and local government officials.

So how are governments adapting to this worker shortage to ensure that their communities remain safe and sustainable while continuing to meet their customer's needs? Many of them are turning to GIS to capture seasoned workers' knowledge, boost efficiency, and improve accessibility and transparency.

Proactively Safeguarding Knowledge

Many of the baby boomers who are retiring proudly proclaim two, three, and sometimes four decades of service to their organizations—often in the same department and, at times, even in the same position. While these achievements are worthy of celebration, the colleagues of soon-to-be-retiring employees are often left with a sense of doom as they prepare for decades of legacy knowledge of infrastructure, systems, and regulations to walk out the door.

Some organizations are taking a proactive approach to safeguarding this knowledge by working closely with long-standing individuals to capture as much of their expertise and know-how as possible in GIS. A public works department in one midwestern city, for example, took advantage of the functionality provided by GIS to transfer seasoned staff members' knowledge about assets and undocumented processes into digital, GIS-based systems prior to their retirement.

For some organizations, the process involves locating and organizing paper documents for digitization. For others, it requires conducting oral interviews with people who are planning to retire soon. And at other organizations, it entails implementing a full campaign to collect data digitally in the field. By capturing this legacy knowledge in digital formats, these organizations will retain a clearer picture of their operational circumstances and will be better positioned to move into the future than their counterparts that don't take action as workforce turnover continues.

Doing More with Less

In a survey conducted by the National Association of State Chief Information Officers (NASCIO), state-level CIOs ranked workforce concerns—including preparing for the future of work; reimagining the government workforce; and transforming knowledge, skills, and experience—as third. In part, this is because as public sector organizations face workforce shortages, there's also increasing demand for government services due to climate change, accelerating rates of development, and regulatory alterations. Thus, governments must be savvy in managing the resources they have by doing more with less.

Many government agencies are turning to GIS to accomplish this. Implementing GIS can relieve demand on remaining staff members by making common processes and requests self-service. The technology can also provide a level of transparency to other departments and the public.

"GIS is the key that unlocks the doors to making incredible amounts of data available to anyone in the world," said Larry Stein, the assessor for Oklahoma County, Oklahoma. "For Oklahoma County, it means *[that]* more than 25 million visitors to our website every year *[get to see]* information about more than 325,000 parcels online anytime, instead of having to travel to the courthouse to get the information they want."

Stein also stressed how important it is to make data available to ensure that government services are transparent.

"Transparency is key in public agencies, particularly the assessor's office," he said. "By delivering fair, uniform, and equitable valuations, the public can see and use the data available."

When government agencies employ GIS, customers can find the data they need in easy-to-locate and convenient formats, often in modern web-based experiences. For instance, the app that the Oklahoma County Assessor's Office made available to the public (accessible at links.esri.com/ok-assessor) enables people to search for detailed property information. Having apps like this is also becoming a standard expectation for customers and residents.

The fact that GIS can be a real-time solution also reduces the amount of time that staff members need to spend updating and maintaining data to ensure that leaders have the most current information to support critical decision-making. Increasingly, artificial intelligence (AI) and machine learning (ML) are being used to automate the time-consuming data conversion and input tasks associated with performing property inspections, converting documents, and more. When AI and ML are used to alleviate these responsibilities, agencies only need to engage staff members in these tasks to provide quality assurance and control.

Weathering the Workforce Climate

Today's workforce tends to have a higher turnover rate than past generations, making it especially important for organizations to have stable and secure means of storing and sharing critical data. When an employee leaves an organization, operations and decision-making must continue. Leveraging GIS answers this call.

GIS provides an easily accessible, scalable, and centralized system for recording and then using data that was previously siloed or hidden from public view. It is also flexible technology that is capable of handling rapid change.

Many government agencies are also employing GIS to attract new talent. By modernizing tired or outdated workflows using cutting-edge technology, government organizations are striving to entice younger professionals to build careers in public service. In some instances, existing junior staff are being called on to help bring their organizations into alignment with modern expectations, creating growth opportunities and encouraging retention through direct engagement.

By employing GIS in a vast array of processes and projects, government organizations can achieve the stability they need to weather the current workforce climate.

About the Author

Linda Foster, GISP, oversees Esri's strategic vision for land records, cadastre, surveying, and land administration. Prior to joining Esri, she spent nearly 20 years in private consulting, advancing the use of geospatial technology in the land management industry. She is a professional land surveyor (PLS) and has a master's degree in GIS.

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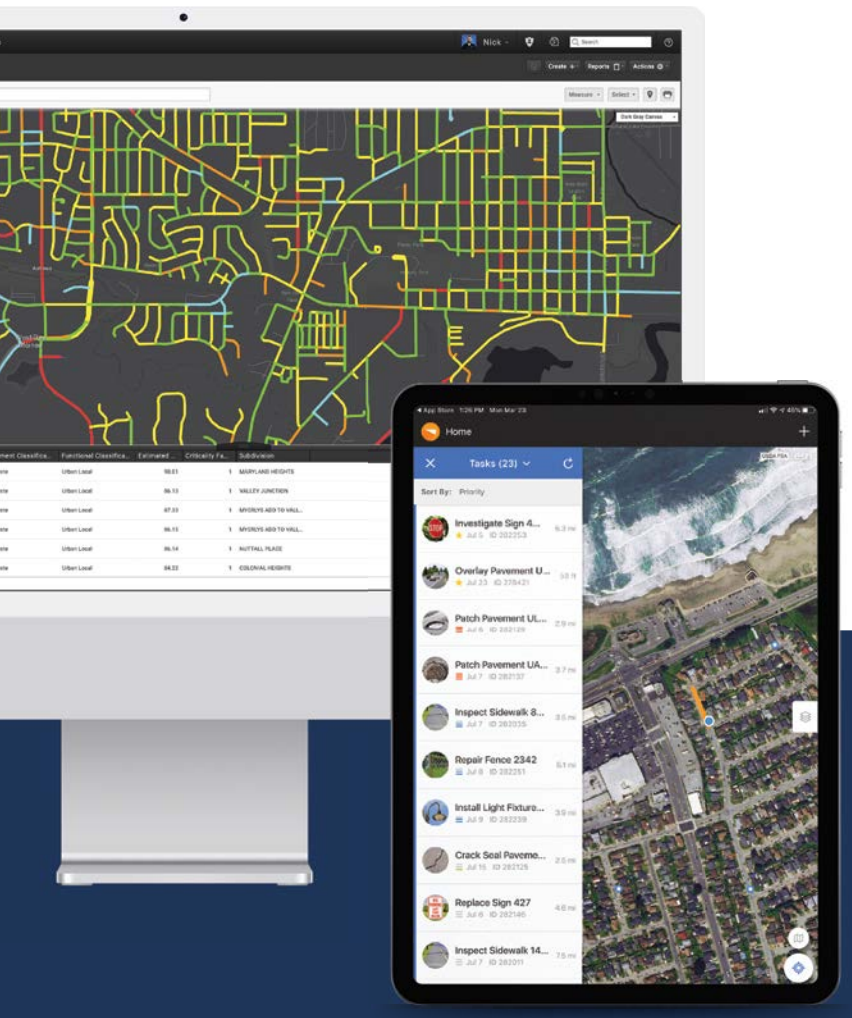

"Cartegraph Asset Management is easily one of the most user-friendly systems on the market. The fact that it so cleanly integrates with your GIS data is a huge plus."

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Multnomah County, OR

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Startup Helps Vineyard Refine Irrigation to Adjust to Climate Change

Washington State is the second-largest producer of fine wine in the United States. Its vineyards thrive in the long daylight hours and warm, dry climate that are characteristic of certain regions in the state. But climate change is producing new challenges.

Shaw Vineyards manages 800 acres of property on Red Mountain, which carries the designation of being an American Viticultural Area. The vineyard supplies grapes to several well-known wineries while also producing its own vintages.

As the summer days in Red Mountain have steadily grown hotter, Shaw Vineyards and other growers have been looking for ways to improve their harvest quality and resource efficiency while optimizing water usage. To do this, Shaw Vineyards has turned to GIS and aerial imagery.

Gaining Insight Before It Blows Away

Esri startup partner Pollen Systems (pollensystems.com) was founded in 2018 to help farmers grow better crops by leveraging aerial imagery, advanced agricultural analytics, and digital agronomy consultation services. Over the last five years, Pollen Systems has worked with vineyards, nurseries, orchards, and field researchers to help them use new technology to improve their data-driven decision-making.

Clients can gather data on their own or have Pollen Systems do data collection. Whichever data gathering route they choose, they can then view and act on the data via Pollen Systems' PrecisionView Manager apps, which facilitate effective management of field issues based on the latest data. PrecisionView runs on ArcGIS technology, and using it doesn't require having experience in GIS.

"To us, Pollen represents data, visible and invisible, that pervades farmlands worldwide," said Keith McCall, Pollen Systems founder and CEO. "Pollen Systems harvests that data and turns it into actionable insight before it blows away."

For Shaw Vineyards, PrecisionView offered a powerful tool to use for irrigation monitoring.

← Vineyards in Washington are cultivated on sandy soils, requiring specialized irrigation.

An Irrigation System That Needed Upgrading

The land that Shaw Vineyards cultivates is situated on a range of soil types, including silt loam and loamy sand—two different mixtures of sand, silt, and clay that, in general, hold moisture but drain well. With an aging irrigation system, Shaw Vineyards wasn't able to deliver water to the vines at the precise intervals that are appropriate to each of the different types of terrain in its vineyards. Under these conditions, vines planted in sandier areas suffered greater heat stress while vines situated in silt loam often received excess water. This resulted in some rows having vigorous, flourishing canopies while others were severely wilted.

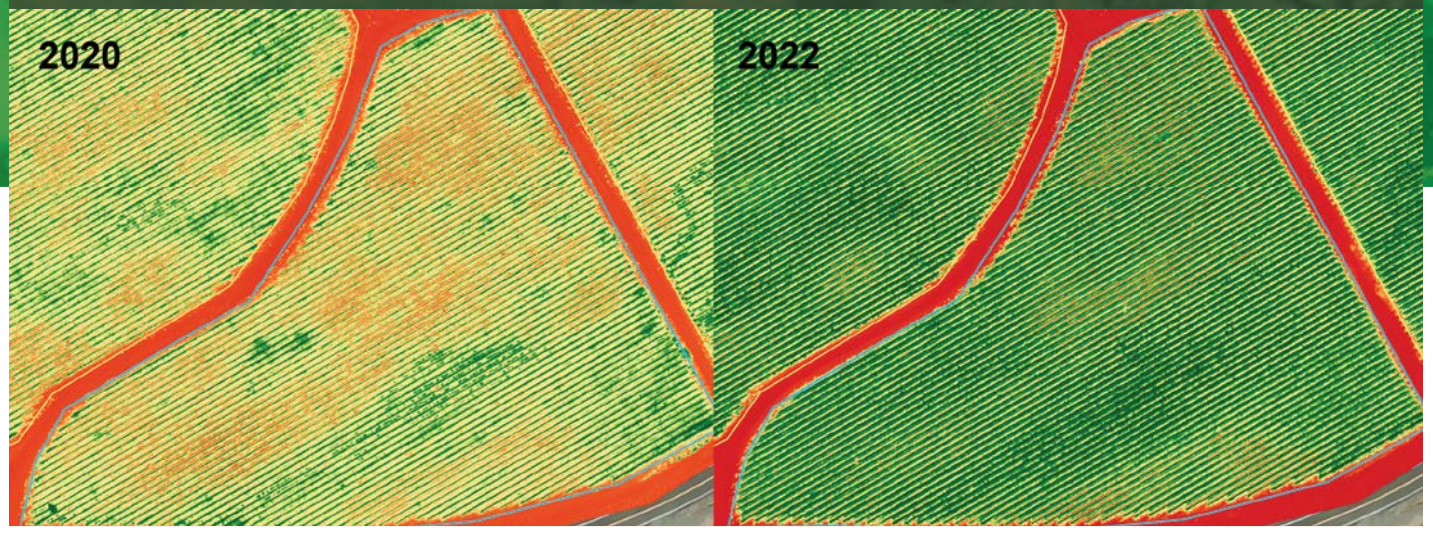
Additionally, the original irrigation system that Shaw Vineyards used often experienced leaks, which are notoriously difficult to identify from a field's edge. It was impractical to have someone drive by each row during irrigation, trying to identify leaks. With vineyard canopies fully opened early in the season, this risked leaks going unidentified for days or even weeks.

Shaw Vineyards needed a fast and reliable leak detection solution to save as much water as possible. And once the new irrigation system was properly calibrated, staff at Shaw Vineyards wanted a way to measure the new system's impact on vineyard vigor and uniformity.

A 360-Degree View of Vineyard Data

In July 2020, Shaw Vineyards began conducting monthly drone flights in a 68-acre trial area. This provided a baseline against which future irrigation management could be measured. A digital agronomy team at Pollen Systems then reviewed the aerial imagery and augmented it with crop-specific algorithms to identify potential issues that needed to be addressed with the grower.

After each data collection session, the team at Pollen Systems discussed the identified issues with staff at Shaw Vineyards to help guide their field management response. The growers were then able to use the observations stored in the PrecisionView platform to delegate tasks, such as investigating vines in stressed areas and fixing irrigation leaks, to field-based employees. The team at Shaw Vineyards regularly compared the multispectral imagery of its fields to



↑ In 2020, stressed vines were widespread, as indicated in orange. By 2022, these areas had become vigorous, as indicated by green.

identify irrigation leaks and changes in canopy strength and consistency.

"Receiving and processing raw aerial imagery without guidance could be very daunting for a grower," said Drew Falabella, director of agricultural solutions at Pollen Systems. "But our solution is powered by ArcGIS Enterprise and doesn't require any prior GIS experience to use. It's an effective turnkey solution for agricultural professionals in need of a 360-degree view of their fields."

The PrecisionView platform serves as a distributed computing and data storage system that allows staff at the vineyard to act on the insight that industry-specific experts at Pollen Systems garner from imagery and other remotely sensed data. The platform, which leverages Esri products such as ArcGIS Enterprise and ArcGIS Image Server, renders the analysis results as feature layers and charts that coordinate with aerial imagery. The advanced capabilities of Image Server allow the team at Pollen Systems to employ large collections of overlapping, multiresolution imagery and raster data from different sensors, sources, and time periods. PrecisionView web and mobile apps are enabled through ArcGIS Maps SDK for JavaScript and the iOS-friendly programming language Swift.

"We're using Pollen Systems' aerial flyovers to help promote vineyard uniformity and to quickly identify and address irrigation issues," said Marshall Edwards, vineyard operations manager at Shaw Vineyards. "Our goal is to produce the highest-quality wine grapes possible so our customers can produce world-class Red Mountain, Washington, wines."

With other customers, Pollen Systems is also employing Deep Learning Studio, an ArcGIS Enterprise web app, to enhance agricultural analytics and provide further insight into crop yield and quality.

Improved Vine Vigor and Uniformity

After using Pollen Systems' solutions to track irrigation issues through the summer of 2020, Shaw Vineyards began installing a new irrigation system in 2021. Throughout 2021 and 2022, Pollen Systems continued collecting data to assess the irrigation improvements.

Each month, the digital agronomy team at Pollen Systems analyzed multispectral normalized difference vegetation index (NDVI) and normalized difference red edge index (NDRE) aerial data to monitor areas in the vineyards that had abnormally high vigor. This indicated likely irrigation leaks.

With this information, Shaw Vineyard's field-based employees were then able to navigate directly to where the irrigation issues were marked on a map, reducing the time it took them to search for these spots on their own. They were then able to fix the leaks by replacing the damaged sections of irrigation hose. These efforts resulted in a 68 percent decrease in leaks between August 2020 and September 2022.

By early autumn of 2021, the vigor detected in NDVI data had improved by 22 percent on average, including in regions of the vineyard that were planted in problematic sandy soil. Canopy variability also decreased by 46 percent, indicating that while the vigor increased, the canopy became more uniform. Moving forward, staff at Shaw will continue to fine-tune the irrigation rates to balance the sandy and loamy areas for each season.

Shaw Vineyard's new GIS- and imagery-informed approach to irrigation promptly began proving useful for managing the effects of highly variable temperatures. In June 2021, the northwestern United States experienced an unprecedented weeklong heat wave, and in 2022, there was a monthlong delay in the growing season due to cool temperatures. Thanks to the aerial imagery analysis that Pollen Systems performed, Edwards and his viticulture team were able to adjust their irrigation output to weather these conditions.

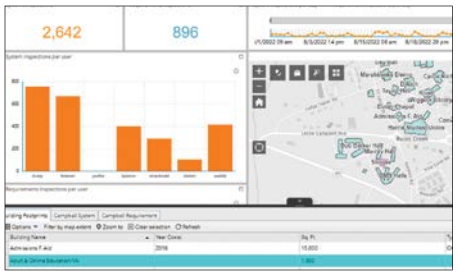
In 2023, Shaw Vineyards is scaling up with Pollen Systems to refine irrigation delivery across all 800 acres that it cultivates on Red Mountain, using both drone and satellite imagery. With data captures now occurring three times per month, Shaw Vineyards properties are optimally positioned to save field hours, promote vineyard canopy balance, and responsibly calibrate the irrigation system to meet each year's production goals.

Esri Partners Recognized for Excellence

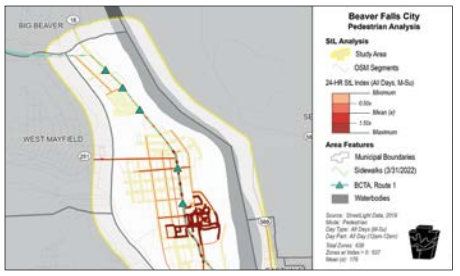
At the 2023 Esri Partner Conference, held in March in Palm Springs, California, Esri acknowledged 27 partners with awards for their innovation and excellence in helping customers succeed with ArcGIS technology. Find out about these noteworthy partners and what they can do for myriad organizations and projects.

Provides analytics and insight to users through location intelligence

Dewberry | dewberry.com
DimensionalView, Dewberry's GIS platform for delivering projects, makes it easy to share spatial data and removes the burden of having to purchase software. The company's clients have immediate access to this software as a service (SaaS) and can use its maps, charts, media, and custom reports on demand.



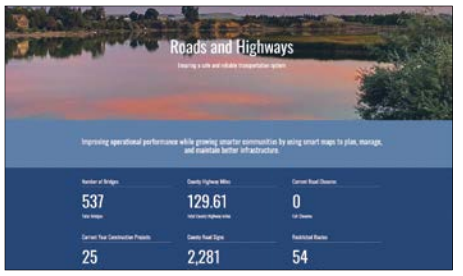
StreetLight Data | streetlightdata.com
Clients leverage StreetLight Data's industry-leading transportation metrics with ArcGIS technology to understand how roads, sidewalks, and transit interact. The Southwestern Pennsylvania Commission employed these mobility metrics to visualize pedestrian activity and infrastructure in Beaver Falls, Pennsylvania.



Uses software as a service to bring customers and solutions to ArcGIS

Pandell | pandell.com
Pandell's GIS solutions for land help pipeline, utility, renewable energy, and oil and gas companies make faster, more informed decisions. They enable teams to better manage acquisition and land asset data in concert with corporate GIS layers from ArcGIS Enterprise, ArcGIS Online, and ArcGIS Platform.

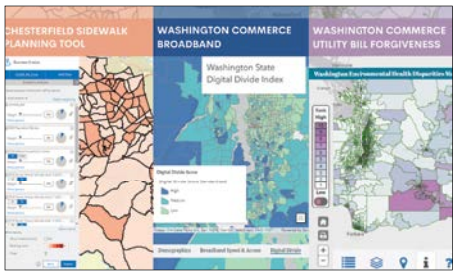
Pro-West & Associates | prowestgis.com
Pro-West & Associates empowers governments and businesses to get started with GIS and leverage the technology to improve efficiency and better serve their customers. Supporting land records, utilities, public engagement, and more, Pro-West staff use ArcGIS Online to collaborate with organizations and meet their needs.



Employs GIS in service of diversity, equity, inclusion, and belonging

GISetc, a division of Critical Think | gisetc.com
GISetc's innovative work leverages maps and ArcGIS StoryMaps stories to teach communities and classrooms about the effects of systemic racism around the United States. The organization provides materials to teachers, students, and community members to help them grapple with issues of diversity, inclusion, and belonging.

Timmons Group | timmons.com
Timmons Group leverages Esri technology, including ArcGIS Pro and ArcGIS Online, to help clients create inclusive experiences for their communities. The firm provides solutions that improve transportation equity, address the digital divide, and tackle other systemic barriers that have marginalized groups of people.



Employs the ArcGIS system in an innovative or disruptive way

vGIS | vgis.io
vGIS is a high-accuracy, augmented reality-based visualization platform that powers digital twins. The system, which is built for utilities and infrastructure projects, brings spatial data from a construction site into a unified, always up-to-date 3D view that stakeholders can access at any time, on any device.

Houseal Lavigne | hlplanning.com
Houseal Lavigne is a leading urban planning and geospatial firm that provides innovative solutions for public and private sector clients. The company's experts employ Esri technology to develop comprehensive plans, zoning codes, GIS-enabled apps, and digital twins that facilitate evidence-based decision-making.

Has an outstanding presence on ArcGIS Marketplace

VertiGIS North America | vertigisstudio.com
VertiGIS North America works across industries to help organizations that rely on ArcGIS technology accomplish even more by going beyond the out-of-the-box capabilities. With VertiGIS Studio, users can build powerful, purpose-driven apps at a fraction of the cost and development time that are normally required.

Demonstrates substantial opportunities for growth with Esri

ICEYE | iceye.com
ICEYE provides building-level natural catastrophe data, including flood extent and depth measurements, via ArcGIS Enterprise and ArcGIS Online in near real time. This helps public sector organizations and insurers execute spatial analyses that improve critical decision-making during disaster events, such as hurricanes, wildfires, and earthquakes.

Develops highly aligned solutions built with ArcGIS products

GEO DATA AG | gis-geodata.com
To revolutionize land planning and management, GEO DATA AG empowers governments with innovative geospatial solutions. The team recently worked with Angola's ministry of urbanization and environment to establish the Angolan National Cadaster system by using ArcGIS Pro and ArcGIS Enterprise to map 450,000 urban parcels.

Arora Engineers | aroraengineers.com

Drives increased use of Esri technology through commercial solution sales

VertiGIS GmbH | vertigis.com
VertiGIS offers spatial technology and Web GIS-based solutions to help organizations manage their spatial assets. The company's enterprise-wide spatial management solutions are centered on use cases, empowering customers across industries to overcome complex business challenges and build their own geospatial deliverables that make a difference.

Motorola Solutions | motorolasolutions.com

Helps customers meet their targets for the Sustainable Development Goals

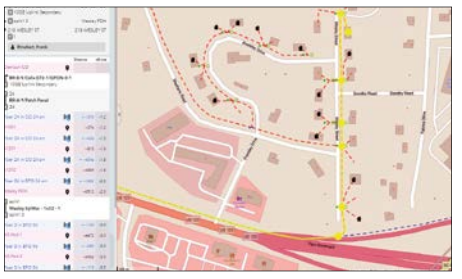
Blue Raster | blueraster.com
Blue Raster develops innovative geospatial solutions to help organizations achieve their Sustainable Development Goals (SDGs). The company recently collaborated with the World Resources Institute to use ArcGIS to build the Land Emissions and Removals Navigator (LEARN) Tool, which aids communities in reducing their greenhouse gas emissions.

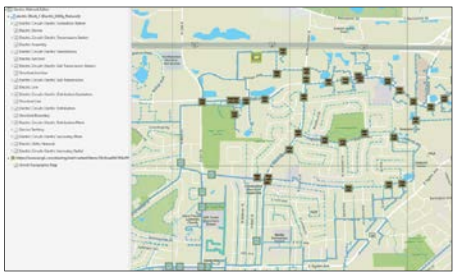
Codex Remote | codex.com.br
Staff at Codex employ Esri technology and data intelligence to develop solutions that foster data-driven governance on environmental issues, climate change, and sustainability. Clients include the Brazilian Institute of Environment and Renewable Natural Resources, the Brazil Ministry of Finance, the Inter-American Development Bank, and private companies.

Influences the adoption of Esri technology through solution sales, software implementation, and/or consulting engagements

GEOGRAPH Technologies | geograph.tech
CrescentLink, by GEOGRAPH Technologies, is a fiber management software system that puts GIS managers in control of their networks. An extension for ArcGIS Desktop, CrescentLink creates a digital twin from network data, becoming the single source of truth—a proven way to improve operational efficiency.

SSP Innovations | sspinnovations.com
SSP Innovations delivers solutions for ArcGIS Pro to electric and gas utilities, telecommunications providers, and pipeline operators around the world. Staff have deep technology expertise and comprehensive knowledge of industry best practices, enabling them to design solutions that help customers meet their unique business challenges.





Ensures customer success by comprehensively implementing the ArcGIS system in the cloud

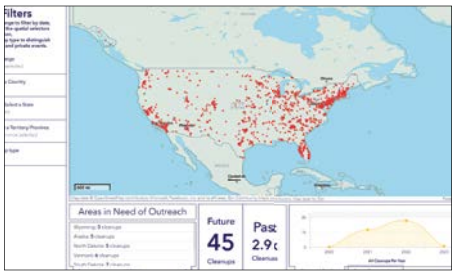
Axim Geospatial | aximgeo.com
Axim Geospatial, an NV5 company, makes the world a smarter, safer place by putting clients' GIS in the cloud and managing it long term to support digital twins. The company's global customers include intelligence and defense organizations; federal, state, and local governments; and commercial entities.

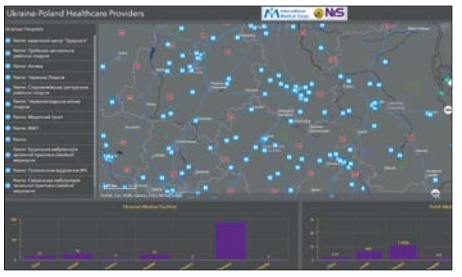
ROK Technologies | roktech.net
ROK Technologies helps organizations scale and modernize their GIS by architecting, migrating, and managing ArcGIS Enterprise and ArcGIS Desktop solutions in Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP) environments. This reduces project risk and downtime.

Generates compelling use of Esri technology to impact global current events

dymaptic | dymaptic.com
With a customer return rate of 92 percent, women-owned dymaptic provides GIS-centric software development and administration services across industries. To help EarthDay.org prepare for World Cleanup Day, dymaptic used Python scripts to automate data processing and map creation, plus ArcGIS Hub to display results.

Nelson Intelligence Solutions, LLC | nelsonintelligencesolutions.com
Nelson Intelligence Solutions (NiS) provides geospatial services to International Medical Corps to support its aid efforts in Ukraine. NiS used several Esri products to develop a location intelligence solution to help the organization provide effective humanitarian assistance.

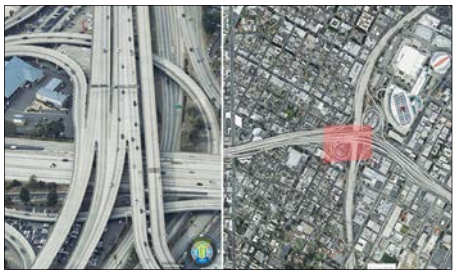




Delivers creative content to ArcGIS users

Nearmap | nearmap.com
By conducting proactive captures up to three times a year, Nearmap delivers current, clear, high-resolution aerial imagery and comprehensive location intelligence that fuel digital innovation and sophisticated analysis. Nearmap's vertical and oblique imagery, city-scale 3D data, and artificial intelligence (AI) content seamlessly integrate with ArcGIS.

Vexcel Imaging | vexceldata.com
Vexcel collects high-resolution aerial imagery and geospatial data in 30 countries. It publishes, on average, 100,000 images per day—including orthomosaics, oblique imagery, and digital surface models—to help insurers, government organizations, and other entities get instant access to accurate imagery within ArcGIS products.

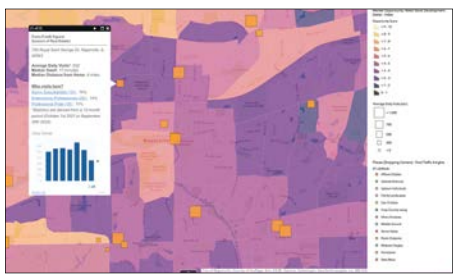


Fosters innovative technical or business collaborations among partners

Datastory | datastoryli.com
MapDash, Datastory's turnkey market and consumer insight solution, combines best-in-class data from Esri partners with powerful analytics grounded in industry expertise. As business leaders use MapDash to see location-based connections, they enter the Esri ecosystem and typically begin an accelerated journey toward location intelligence maturity.

GeoMarvel | geomarvel.com
GeoMarvel is a geospatial software development company specializing in GIS managed services, cloud infrastructure, data analysis and computation, and custom app development. With more than 30 years of experience in both the public and private sectors, GeoMarvel can confidently build scalable infrastructure and software solutions.

SymGEO | symgeo.com
SymGEO provides GIS solutions for state and local governments across the United States. The company leverages ArcGIS technology for data analysis and visualization and app configuration and deployment. SymGEO's mission is to engage with communities and inform diverse audiences by telling memorable stories with data.



Esri partners represent the rich ecosystem of organizations around the world that work together to amplify The Science of Where by extending the ArcGIS system and implementing it in distinct ways to solve specific problems. Search for and discover partners that meet your needs at **esri.com/partners**.

The Relevance of Cartography

A Cartographer's Perspective

By Tim Trainor
President, International Cartographic Association

Getting Geospatial Data to Meet the Needs of Today and Tomorrow

Cartographers have always made decisions about what should be included on a map. With paper maps, they had to decide on the size of the paper, the map scale, and the symbols used to represent content, among other things. General-use maps were typically derived from the topographic maps made by national mapping organizations, which meant that the derivative maps were always produced at a smaller scale and with less detail than those topographic maps.

When mapmaking underwent automation—which happened in stages—source data had to be organized into similar categories or themes, generally in large databases. These databases could handle a lot of detail, some of which gets presented as additional content on a map. Thus, with digital mapping, it is now possible to create a map from a national mapping organization's database that is larger in scale and contains more detail than the typical maps produced by national mapping organizations—as long as the resolution of the geographic data is sufficient for the purpose of the map. Again, this decision rests with the cartographer.

In the United States, the creation of the National Spatial Data Infrastructure (NSDI) in the 1990s came out of efforts to transform topographic map data into digital formats. The primary focus of a spatial data infrastructure (SDI) was to organize geospatial data in a way that ultimately expanded the number of geographic datasets available. The idea was to increase the use of authoritative data while minimizing the complexities involved in trying to wield it.

But the current use of geospatial information under the SDI structure often falls short of the project's original intention. SDIs were initially national in scope, and data needs at the regional and global levels have been growing for some time. What's more, countries have taken uneven approaches to maintaining the geospatial information needed for SDIs. Therefore, cartographers need to participate in discussions about SDIs, since they understand the nature and uses of data in the digital age.

In many instances, the potential benefits of SDIs were underutilized. Different organizations had varying levels of success in collecting and organizing the data that needed to be included in an SDI. Some countries were never able to create or implement their SDIs for various reasons, including lack of data and insufficient funding. For people who worked in this domain, the NSDI construct seemed to be stuck. It wasn't delivering what was needed or expected.

For example, user segments and their demands grew with the automation of mapmaking—particularly when users of personal devices like mobile phones became such heavy consumers of map data. The increased use and importance of location-based data led to greater expectations and larger demands. Ultimately, the exclusive focus of SDIs on managing geospatial data neglected other factors necessary for their use.

As mapmaking moved toward automation, the International Cartographic Association (ICA) led in supporting research and development for making that transition possible. One of the ICA's first efforts was forming the ICA Commission on Advanced Technology, which identified topics that were important for the emergence of digital geographic data and cartographic apps for mapping. Leaders of this commission laid out an agenda that guided the research community, along with national mapping organizations, in addressing the fundamental requirements of transitioning to digital mapping. Two other ICA commissions, the Commission on Data Standards and the Commission on Quality of Spatial Data, developed standards that made the exchange of digital geographic data possible and defined the characteristics for ensuring that digital spatial data was useful and dependable.

Even after many years, ensuring the quality of geographic data is a work in progress. Over time, new functions for the use of SDI data have included research on themes such as generalization and visualization. Whereas paper maps contained all their content in a single view, the digital age offers layers of spatial data themes and forms from which to choose, depending on a map's purpose and user requirements.

The era of the NSDI brought great changes to national mapping and geospatial organizations as well as to international societies like the ICA. National mapping agencies were no longer confined to the limitations of a map sheet, since a database of geographic information could be used for so many different applications. And that limitless potential offered new research opportunities for organizations including the ICA.

However, the vision for how to use national SDIs has failed to meet expectations. This is primarily because national SDIs have largely revolved around geospatial data—that is, themes, assets, layers, and more. What national SDIs should focus on is the interests of the expanding user base of location-based data, as well as ensuring the sustainability of geospatial data and services.

In 2011, the formation of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) sought to improve how nations manage their geospatial information in the face of changing needs. The group defined 14 fundamental geospatial data themes that most countries typically need; delineated common geodetic reference frames; and outlined how to integrate statistical and geospatial data to address global needs, such as national-level responses to the United Nations (UN) Sustainable Development Goals (SDGs) and climate change.

These functional efforts uncovered the need to take a more holistic approach in guiding geospatial data management locally, nationally, regionally, and globally. National mapping organizations are dependent on local spatial data. Once a country has comprehensive geospatial capabilities in place, its contributions to regional collaboration can help in responding to collective needs such as security, health, and economic development.

The United Nations Integrated Global Geospatial Information Framework (UN-IGIF), which was created in 2018, specifies nine interrelated strategic pathways that provide a basis for developing, integrating, strengthening, and maximizing geospatial information management. While each pathway contributes to successful geospatial information management, all are linked in one or more ways, resulting in a more holistic approach to delivering geospatial information that is relevant and useful. The UN-IGIF aligns with national priorities and circumstances, making it clear how important geospatial information is to each country. Additionally, the UN-IGIF has inspired related frameworks, including the Strategic Framework on Geospatial Information and Services for Disasters, the Global Statistical Geospatial Framework, and the Framework for Effective Land Administration. All of this is helping countries take a common approach to geospatial data management, increasing the likelihood of developing workable solutions to global problems.

Communication, collaboration, and partnerships are needed to make national geospatial data management work in a global context. Communicating information about the UN-IGIF has resulted in many nations endorsing it, using it as a guide, and even transforming their existing SDIs into the UN-IGIF. If different levels of government can collaborate and partner with each other as well as with the business and academic communities, this elevates stakeholder involvement and ensures wider participation by all sectors. Additionally, increased engagement of national mapping organizations with the UN thematic networks—including the UN-GGIM Geospatial Societies (which the ICA participates in), the UN-GGIM Academic Network, the UN-GGIM Private Sector Network, and the UN Geospatial Network—can boost successful implementations of the UN-IGIF.

What lies before the geospatial community—and particularly cartographers—is a challenge to continue making contributions to geospatial information management and use. Attention is needed at local, national, regional, and global levels. Geospatial information is related to location, and location is best seen via maps. Maps have always been important, and they continue to be relevant for daily use and problem-solving. National mapping agencies need to be supported as they manage geospatial data and work to develop integrated approaches for maximizing the value of using this data in preparing for the future.

About the Author

Tim Trainor is a part-time consultant to the UN and is the former chief geospatial scientist for the US Census Bureau. He is a member of the US Federal Geographic Data Committee's National Geospatial Advisory Committee, has served as cochair for the UN Committee of Experts on Global Geospatial Information Management, and was the senior agency official for geospatial information for the US Department of Commerce.

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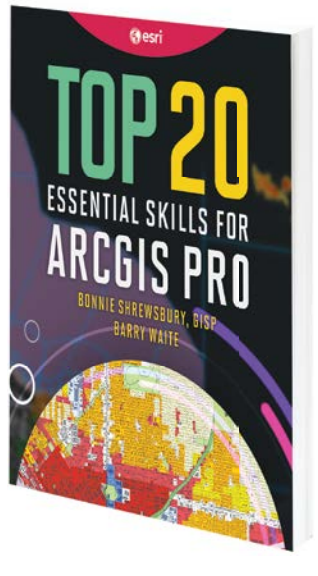
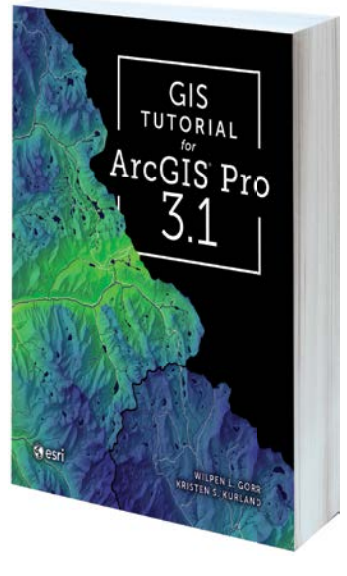
Top 20 Essential Skills for ArcGIS Pro
By Bonnie Shrewsbury and Barry Waite

Get on the fast track to using desktop GIS with *Top 20 Essential Skills for ArcGIS Pro*. The book, written at an introductory level, features simple, step-by-step exercises that teach readers how to work with spatial data, create maps, and perform basic analysis. Each chapter introduces a useful skill, lets readers practice it, and includes a user story to show how these competencies are used to answer important questions and solve real-world problems. By the end of the book, readers understand what ArcGIS Pro is and how to use it and can use their newfound knowledge to continue their GIS journeys. May/September 2023, 190 pp. Ebook ISBN: 9781589487512 and paperback ISBN: 9781589487505.



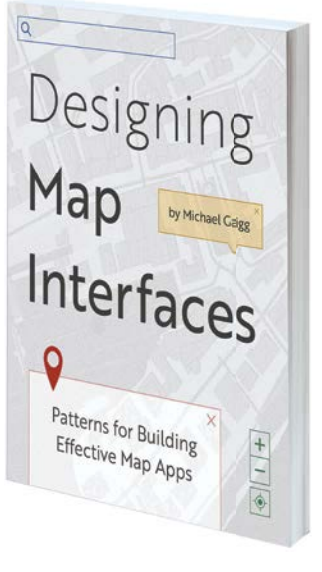
GIS Tutorial for ArcGIS Pro 3.1
By Wilpen L. Gorr and Kristen S. Kurland

GIS Tutorial for ArcGIS Pro 3.1—the fifth edition in a series—is the book of choice for classroom-based and self-taught learners who seek to develop their expertise with Esri's premier desktop GIS technology. Revised for ArcGIS Pro 3.1, the book features new datasets, exercises, and instructional text to guide readers through the latest tools and workflows. Authors Wilpen L. Gorr and Kristen S. Kurland use current, real-world scenarios to demonstrate how to make maps and find, create, and analyze spatial data using ArcGIS Pro and ArcGIS Online. May/September 2023, 370 pp. Ebook ISBN: 9781589487406 and paperback ISBN: 9781589487390.



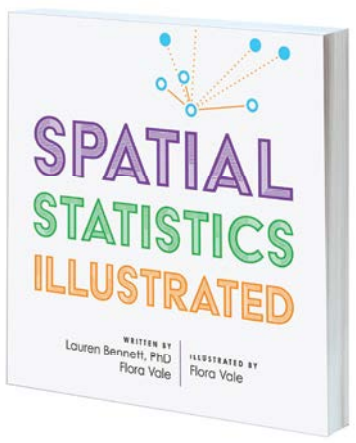
Designing Map Interfaces: Patterns for Building Effective Map Apps
By Michael Gaigg

Designing Map Interfaces: Patterns for Building Effective Map Apps is the essential guide to creating geospatial app interfaces that are usable, efficient, and stunning. Whether configuring an out-of-the-box solution, building an app with an app builder, or working on a custom app project, readers can employ the book's practical tips to assemble a meaningful user interface (UI). Intended for GIS professionals, solution engineers, developers, and designers, *Designing Map Interfaces* identifies several recurring problems in UI design and outlines specific UI patterns to employ to fix them. December 2022/March 2023, 173 pp. Ebook ISBN: 9781589487260 and paperback ISBN: 9781589487253.



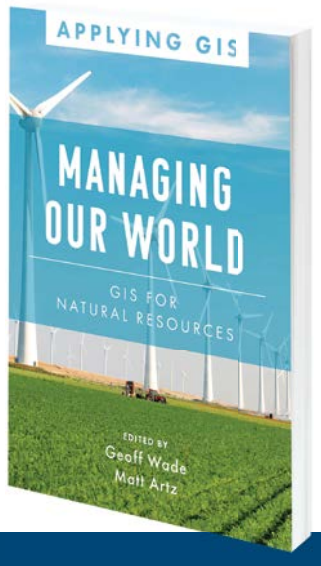
Spatial Statistics Illustrated
By Dr. Lauren Bennett and Flora Vale, illustrated by Flora Vale

Thanks to the vast amounts of data and incredible computational power that are now at people's fingertips, data science has permeated nearly every aspect of life. But with so many algorithms and buzzwords floating around, it can be difficult to figure out where to start with solving complex problems. The good news is, there has never been a more exciting time to learn about spatial statistics, which employs geography to help quantify patterns, trends, and relationships. *Spatial Statistics Illustrated* helps readers learn the concepts behind the spatial statistics tools that are part of the ArcGIS system. Dr. Lauren Bennett and Flora Vale rely on approachable explanations and simple drawings to explain widely used spatial statistics methods, including how they work and when to use them. May/September 2023, 150 pp. Ebook ISBN: 9781589485716 and paperback ISBN: 9781589485709.



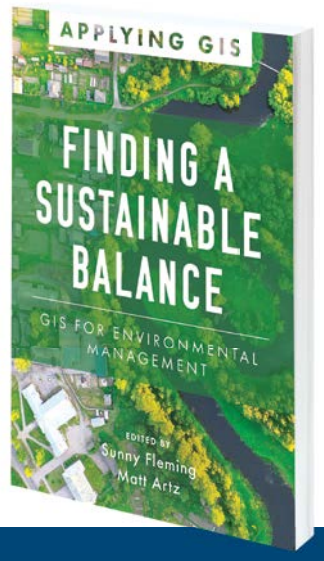
Managing Our World: GIS for Natural Resources
Edited by Geoff Wade and Matt Artz

In *Managing Our World: GIS for Natural Resources*, readers can explore how applying a geographic approach to managing natural resources boosts efficiency and advances sustainability. The book spotlights real organizations in the agriculture, forestry, mining, energy, pipeline, and renewable energy sectors that are using GIS to streamline workflows, gain competitive insight, improve their sustainability efforts, and more. It shows how these organizations are equitably balancing current demands for earth's natural resources with preserving those resources for future generations. Examples in the book demonstrate how to increase profitability, improve environmental protections, and expand societal benefits while improving organizational efficiency. January/April 2023, 184 pp. Ebook ISBN: 9781589486898 and paperback ISBN: 9781589486881.



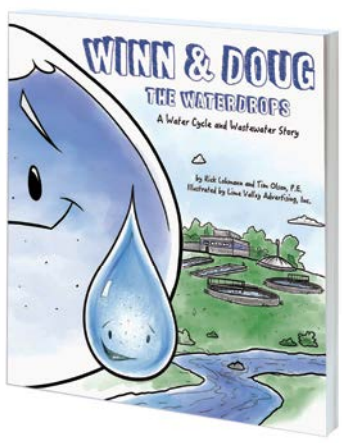
Finding a Sustainable Balance: GIS for Environmental Management
Edited by Sunny Fleming and Matt Artz

As humans continue to uncover and learn about the ecological challenges being faced by the planet, environmental and natural resource management jobs are becoming increasingly difficult. *Finding a Sustainable Balance: GIS for Environmental Management* shows how GIS can improve operations across land and wildlife management, outdoor recreation, and environmental regulation. The book is a collection of real-life stories about how several environmental and natural resource management organizations successfully use GIS to monitor environmental assets in real time, prevent environmental hazards from turning into disasters, and provide transparency that produces better outcomes for everyone. June/September 2023, 125 pp. Ebook ISBN: 9781589487598 and paperback ISBN: 9781589487581.



Winn & Doug the Waterdrops: A Water Cycle and Wastewater Story
By Tim Olson and Rick Lohmann

Written for children in grades 1–5, *Winn & Doug the Waterdrops: A Water Cycle and Wastewater Story* shows kids where water comes from and what happens once it gets used. Part of a career-themed science, technology, engineering, arts, and mathematics (STEAM) picture book series, the book invites young readers to explore the different phases of Winn the Raindrop's life through the water cycle, from vapor to runoff, before following Doug the Waterdrop to see how water gets cleaned after it is used. Perfect for encouraging critical and creative thinking and spatial analysis skills, *Winn & Doug the Waterdrops* highlights the incredibly important jobs that water resource engineers and wastewater operators have and how they make the world a better place. In-book activities and a glossary are included. April 2023, 56 pages. Ebook ISBN: 9781589487208 and paperback ISBN: 9781589487192.



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

Training

New Instructor-Led Courses

Developed and delivered by in-house experts, Esri's instructor-led courses serve GIS professionals and novices alike and are great for anyone who uses ArcGIS software to support their daily workflows, enhance projects with geographic context, and create information that supports better decision-making. To learn how to efficiently share data and maps using engaging apps and visualizations, take a look at the following courses:

- **Building Web Apps with ArcGIS Experience Builder:** This course is ideal for GIS professionals, web designers, and others who want to create immersive web apps without writing code. Attendees learn how to take advantage of modern web design principles to interactively create, configure, and publish map- and datacentric web apps that feature GIS content. View upcoming classes at go.esri.com/experience-builder-class.
- **Mapping and Visualizing Data in ArcGIS:** Get started with creating high-impact maps and data visualizations. This two-day course guides participants through cartographic techniques and the ArcGIS Pro and ArcGIS Online workflows that are used to create and share a variety of professional-quality information products. These include printed maps, web maps, 3D scenes, animations, and charts. Explore course details and register at go.esri.com/arcgis-mapping-class.

Build Spatial Data Science Skills in a No-Cost MOOC

Analysts increasingly leverage spatial data, algorithms, and analysis methods to augment traditional data science workflows. Spatial Data Science: The New Frontier in Analytics is a six-week massive open online course (MOOC) that explores how to employ spatial data science to uncover hidden patterns in data. The course opens via Esri Academy on August 30.

Participants work with a suite of ArcGIS software provided by Esri as they explore advanced analytical techniques, including machine learning and deep learning.

"There is so much information packed into this six-section course, and very rarely did I feel lost," said Jessica Gibson, a previous participant in the course. "Directions are step-by-step, thorough, and easy to follow."

Spatial Data Science: The New Frontier in Analytics includes videos by Esri subject matter experts, software exercises, quizzes, and discussion forums. Everyone who finishes the course is awarded a certificate of completion.

To build in-demand analytical skills, join this free MOOC at go.esri.com/sds-mooc. Registration is open through September 13.

ArcGIS Labs: The Latest Way to Learn at Esri Academy

ArcGIS labs are self-paced e-Learning resources that emphasize hands-on practice through step-by-step exercises. Each lab includes one or more scenario-based exercises, the data needed to complete each exercise, a quiz to measure learners' understanding of the workflows taught, and a certificate of completion for successfully passing the quiz.

ArcGIS lab topics are varied and range from introducing key functions in specific ArcGIS products to more advanced concepts such as predictive modeling. As with Esri Academy web courses, learners need to have the software used in the lab exercises to complete them.

Check out ArcGIS labs to explore interesting new topics and ArcGIS workflows. Get started at go.esri.com/arcgis-labs.

Certification

The Esri Technical Certification Program enables GIS practitioners to validate their experience with ArcGIS Pro, ArcGIS Enterprise, ArcGIS Online, and related technology.

The certification team is designing several new exams this year, and users can contribute to their development. ArcGIS users from around the world are invited to participate in blueprint surveys, which describe an exam's minimally qualified candidate. Blueprint surveys include an extensive list of specific proficiencies that candidates should have, as well as the tasks they should be able to perform with ArcGIS technology. They also list the skills and knowledge that the minimally qualified candidate is not expected to have. So survey participants help verify an exam's target audience, objectives, and content.

For anyone who would like to help shape the next series of certification exams, be on the lookout for blueprint survey announcements on the Esri Technical Certification Exam Development page in Esri Community at go.esri.com/certification-exams.

Explore all Esri technical certification exams at go.esri.com/certification. To get help choosing one, watch *Preparing for an Esri Technical Certification* at go.esri.com/cert-prep-video.

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