ArcNews

Esri | Winter 2022 | Vol. 44, No. 1

Briefly Noted

Microsoft and Esri Bring Geospatial Analytics to Spaceborne Data
ArcGIS Image is now available for Microsoft Azure customers to use natively in Azure Orbital, Microsoft's cloud-based ground station that enables organizations to more easily communicate with their satellites and other spacecraft. Accessible as both single-tenant and multitenant software as a service (SaaS), ArcGIS Image is a complete system for hosting, analyzing, and streaming imagery and raster collections. This new partnership will streamline spaceborne data workflows and empower Azure customers with access to near real-time satellite data combined with ArcGIS geospatial analytics software.

CDC Chooses Esri to Help Promote Confidence in Vaccines
To assist in boosting vaccine uptake across the United States, the Centers for Disease Control and Prevention (CDC) selected Esri to provide technology and services for its expanding outreach and education work. The CDC's Vaccinate with Confidence strategy will employ digital tools to give communities more resources for communicating the value vaccines hold in stopping the spread of preventable diseases.

Esri Education Manager Receives Prestigious Award
Esri education manager Tom Baker was given the National Council for Geographic Education (NCGE) President's Award for 2021. The award, bestowed at the discretion of the organization's president, honors Baker's service in promoting and improving geography education. It also recognizes his recent collaboration in creating the NCGE Resource Library (library.ncge.org), which features curated geography education content from teachers around the United States.

Geospatially Enabled BIM Data Proves Useful Beyond Construction

The Walk Bridge in Norwalk, Connecticut, carries four tracks of the Metro-North Railroad line over the Norwalk River. But this swing bridge, which currently swivels to accommodate boat traffic, was built in 1896 and has outlasted its intended life-span, according to the Connecticut Department of Transportation (CTDOT). It is being replaced by a vertical lift bridge that will ascend and descend to let ships pass through. And the entire bridge replacement project will be done while maintaining railroad traffic over the existing bridge—a complex undertaking, to say the least.

Infrastructure solutions firm and Esri partner HNTB has been working on the replacement design for Walk Bridge for several years. One of the challenges the team has faced is connecting disparate data and systems during the design process. After becoming an early adopter of Esri's new ArcGIS GeoBIM on another project, leaders at HNTB realized that the solution could be used to quickly connect geospatial and building information modeling (BIM) data on the Walk Bridge project. Not only that, but by incorporating ArcGIS Velocity to monitor live sensor data on the existing bridge during key parts of the construction process, the team recognized that ArcGIS GeoBIM could be useful well beyond the design and construction phases of the project. It could help with operations and maintenance on the new bridge as well.

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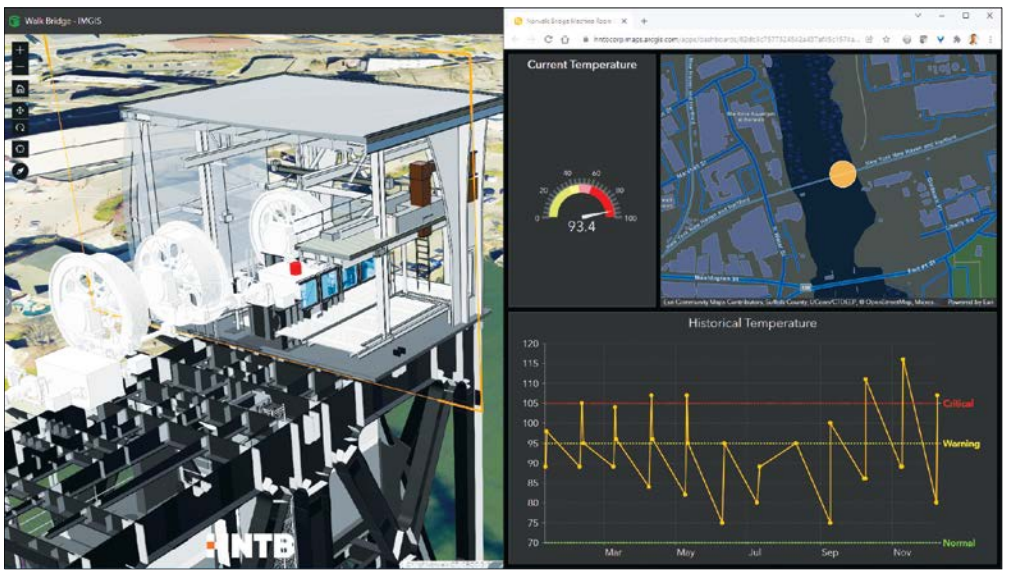
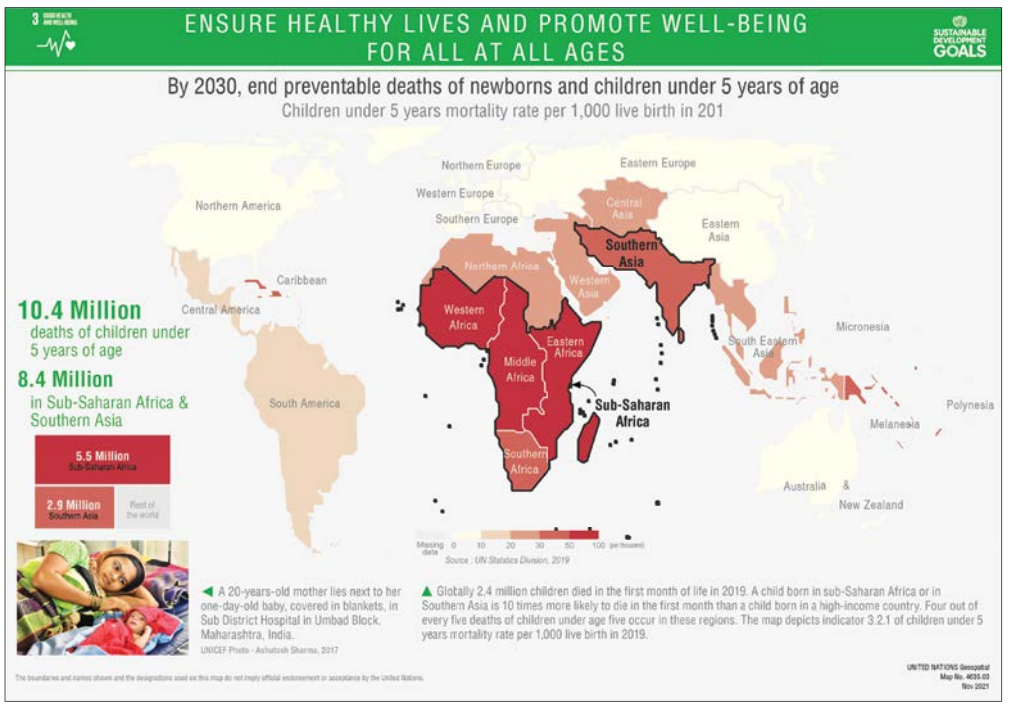


→ Together, ArcGIS GeoBIM and ArcGIS Velocity could be used in the new Walk Bridge's machine rooms to monitor critical metrics, such as temperature and tilt, well after construction.

Maps Serve as a Compass for the SDGs

By Guillaume Le Sourd, United Nations



↑ In too many regions of the world, the mortality rate for children under age five is too high. There is still a lot of work to do to achieve Sustainable Development Goal (SDG) 3: ensuring good health and well-being.

The Sustainable Development Goals (SDGs) were adopted in 2015 by United Nations (UN) member states as the overarching blueprint for addressing vital, global challenges to ensure a better, more equitable, and viable future for all. They are the essence of the UN's 2030 Agenda for Sustainable Development, which seeks to eradicate poverty, heal and stabilize the planet, and build a peaceful world. But look at that date: 2030. The deadline is closing in on us—probably faster than many of us realize.

That's why UN Secretary-General António Guterres declared 2020 as the start of a Decade of Action for achieving the 17 SDGs. Today, with less than eight years to go to reach these goals, all sectors of society need to mobilize to take both global and local action. Yet it can be difficult to understand where and how we've progressed in alleviating poverty, reducing inequality, supplying clean and affordable energy, and more—let alone comprehend what else we need to do.

Thus, maps are taking on an even greater importance in striving to realize the SDGs. They can help everyone—from governments to individuals—better understand each SDG and monitor progress toward assuaging the problems associated with them.

To this end, the UN recently prepared 17 maps of each of the SDGs that illustrate where we are in our quest to accomplish them. They follow on the release of *Mapping for a Sustainable World*, a free

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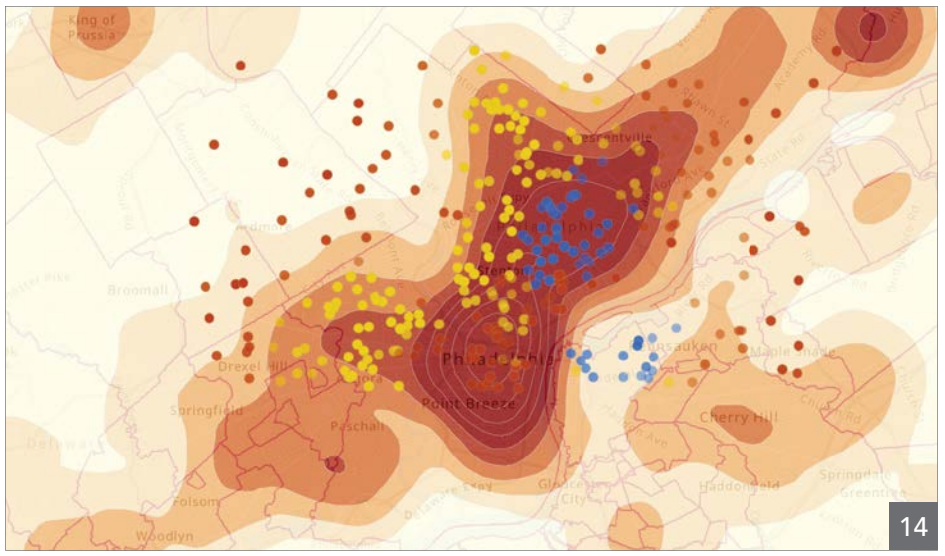

The high school students who participate in the Massachusetts Institute of Technology's (MIT) Online Science, Technology, and Engineering Community (MOSTEC) get six months of hands-on experience in science and engineering. And thanks to one visionary instructor, they can now learn GIS while working to find solutions to social issues that affect their communities—from food insecurity to the digital divide.

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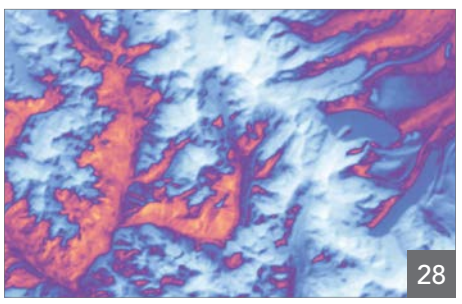

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ArcNews (ISSN 1064-6108) is published quarterly by Esri at 380 New York Street, Redlands, CA 92373-8100 USA. *ArcNews* is written for the Esri user community as well as others interested in mapping and geographic information system (GIS) technology. It contains material of interest to planners, foresters, scientists, cartographers, geographers, engineers, business professionals, and others who use spatial information.

Updates to ArcGIS Online Web Apps Give Users a More Modern Experience

The interactive web apps available in ArcGIS Online allow users to create engaging maps and apps to share spatial insight with their teams; communities; and, in some cases, people all over the world.

One of the great benefits of making web maps is that users can reuse their maps in many ways—for example, as the foundation for additional analysis or as the centerpiece of an experiential web app. And web apps help end users focus on the story that a map intends to tell. Some are also key for building digital workflows, even if those workflows aren't mapcentric.

ArcGIS Online offers a growing set of web app configurations that help users deliver compelling and valuable digital experiences along with their maps. Several teams at Esri continually update the interactive web apps available in ArcGIS Online to provide users with the best and most modern app-building experiences. Here are highlights from recent releases of some of the most popular app builders in ArcGIS Online.

ArcGIS Dashboards

With ArcGIS Dashboards, users can present location-based analytics as intuitive and interactive data visualizations to help people monitor situations in real time, detect trends, and keep communities and teams informed. Recently, Esri added a Table element to Dashboards, allowing users to visualize their data in rows and columns. Tables support advanced formatting and data interactions so that, for example, when a user clicks a particular field, the dashboard zooms to a point on a map. Additionally, the interface for authoring dashboards has been redesigned and now includes a layout panel that users can employ to view and manage their dashboards' visual compositions.

ArcGIS Experience Builder

ArcGIS Experience Builder gives app creators the ability to transform data into captivating web apps, either by starting with a template or from scratch. In both cases, widgets help creators follow best practices and save time.

Two new widgets are available in Experience Builder. First, the Elevation Profile widget generates and displays an elevation profile from an input path that's made by drawing or selecting multisegment lines on a web map or scene. The widget has the profiles property configured so it can display two elevation profile lines—one for the ground and one for the selected features.

The other new widget, the Suitability Modeler widget, finds the best location for an activity, predicts susceptibility to risk, and identifies where something is likely to occur. This widget allows users to combine and weight layers to evaluate multiple factors at once. It employs fast weighted raster overlay (WRO) services to generate models based on user input. Users can publish their own WRO models or choose from publicly published services. To define the analysis, users choose their layers, assign weights to them, and adjust the layer suitability values. The results can then be used to find areas of opportunity or threat. This Suitability Modeler widget is the enhanced version of the widget of the same name in ArcGIS Web AppBuilder and mimics the general functionality of the Modeler tool in ArcGIS GeoPlanner. Users can explore basic sketching and charting capabilities in the Suitability Modeler widget as well. And the results from the models can be exported to do additional suitability evaluation in products such as GeoPlanner.

Other recent enhancements to Experience Builder include support for pie charts and the ability to display page and view names instead of numbers in URLs.

ArcGIS Instant Apps

When users need to transform maps into apps, ArcGIS Instant Apps has the solution. The templates described below, which are all now out of beta, make it easy to build a single-purpose app to fulfill specific workflows.

The Basic Instant App is the quickest way to share a map with any audience. It's a general-purpose app that offers a core set of map navigation and exploration tools, along with a clean and simple layout that makes the map the main focus. Like all Instant Apps, Basic allows app creators to make mobile-friendly apps and is ready to use across most browsers and devices. In fact, all Instant Apps are built to be as accessible as possible to all users.

The Sidebar app template provides a range of tools that help end users explore, understand, and manage data. A panel containing these tools—which range from data editing and feature filtering to bookmarks and a layer list—displays next to the map. If the map has editable feature layers, they appear in the Edit panel with options to add new features or edit the geometry and attributes of a selected feature. App creators can also preconfigure one or more filters that app viewers can use to gain a better understanding of the information on the map.

Chart Viewer allows app viewers to explore a map alongside bar charts, histograms, line charts, and/or scatterplots that are related to the underlying data. App creators can configure up to 10 charts in Map Viewer to include in the app, and each chart can be viewed beside the map or side by side with other charts to allow for comparison.

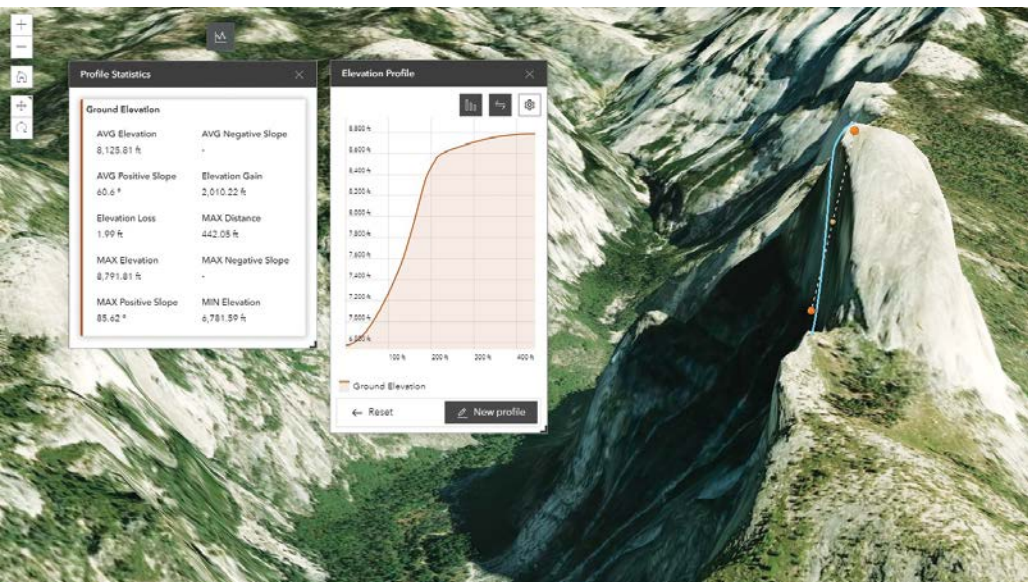
The Slider template allows users to animate their data based on numeric values or changes over time. Creators can configure the app to display historical, live, or future data over any interval of time, including hours, days, months, years, and intermittently. Viewers can move the time slider to interact with the data and understand how it evolves, or they can filter the data by value.

The Countdown app displays a list of locations in a map ranked by value for specified fields, which can be used to create things like best-of lists. The Zone Lookup and Nearby apps allow app users to export their search results as a PDF. And the Attachment Viewer template makes feature-by-feature browsing in the gallery more intuitive by focusing on those with attachments only.

Additionally, app creators can now add the Find tool to most apps to let end users detect their physical location in the app and zoom to it. App creators can also use Instant Apps to build apps directly from Scene Viewer. And when browsing content in their ArcGIS Online organizations, users can quickly locate any existing apps by employing the new Instant Apps filter.

ArcGIS Solutions

Built for many industries—ranging from utilities and telecommunications to state and local governments and conservation—ArcGIS Solutions offers out-of-the-box configurations that are quick to set up and deploy. Recent updates to ArcGIS Solutions include several improved configurations that help teams develop asset inventories, understand asset conditions, respond to winter weather events, promote opioid prevention and treatment resources, and understand inequities in their communities. A new product gallery is available as well that lets users browse the entire collection of ArcGIS Solutions before signing in to ArcGIS Online. Once users find a solution, they can read about its capabilities and the value it provides before signing in and deploying the solution directly from the gallery.



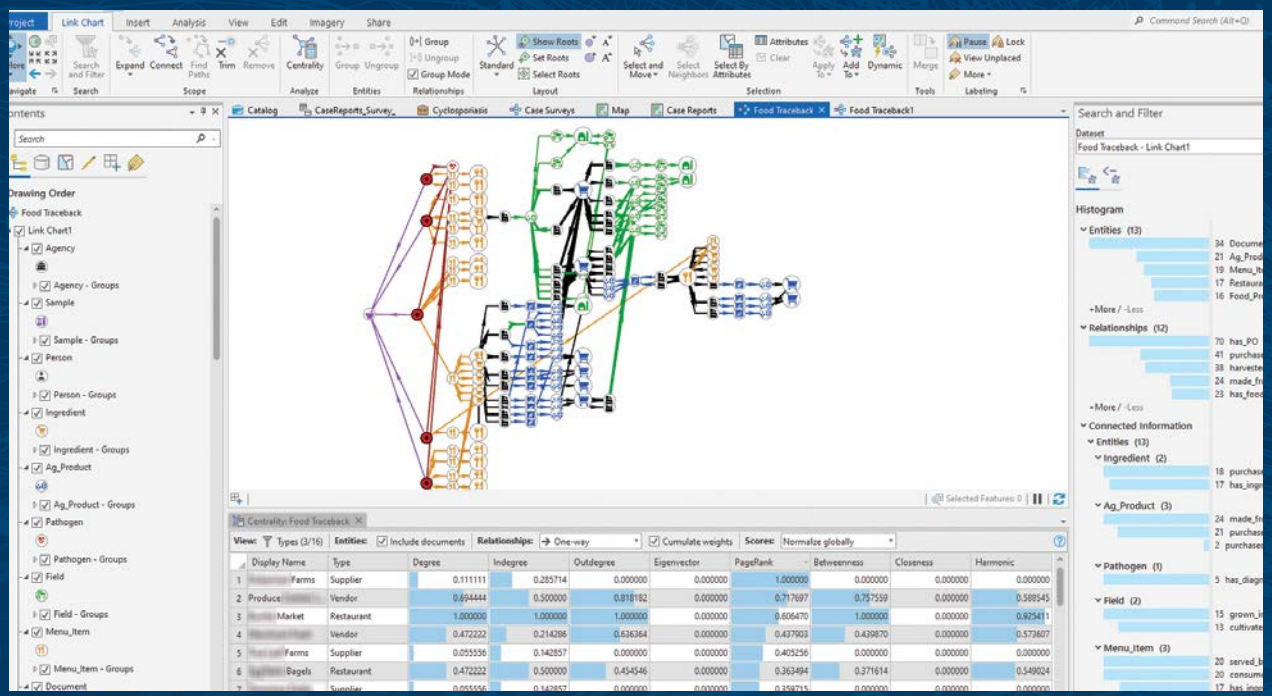
← The new Elevation Profile widget in ArcGIS Experience Builder displays two elevation profile lines, one for the ground and one for the selected features.

For more information about ArcGIS Online and its latest features and capabilities, go to esri.com/arcgisonline.

A New Way to Trace Relationships in Complex Datasets

Supply chain networks and airline companies analyze vast transportation networks to optimize their routes for speed, efficiency, and cost. Oil and gas companies need to account for the hidden risks associated with the types of equipment they use, the manufacturers they partner with, and the myriad conditions they operate in. And in a world of ever-growing e-commerce, marketplaces and financial institutions need to be able to identify behaviors that might indicate fraudulent activity connected to any of the countless transactions they oversee in a day—and they need to do it quickly.

To manage such complex issues, it is invaluable to be able to conduct graph-based analysis. Knowledge graphs connect data from multiple sources and generate traceable networks of relationships among different entities, revealing patterns that would otherwise be difficult to discern. And now, Esri offers a knowledge graph-based analytics product that users can implement in their ArcGIS Enterprise 10.9.1 environments: ArcGIS Knowledge. This new product enables users to connect ArcGIS Pro to Esri's enterprise graph data store to visualize spatial, nonspatial, structured, and unstructured data in multiple ways—in maps, link charts, cards, histograms, and more.



↑ Entity datasets, such as this one of restaurants and food suppliers, can be viewed in a table.

A Use Case for Knowledge Graphs: Tracing Food Contamination

To illustrate the value of ArcGIS Knowledge, consider a hypothetical use case in which a local health department needs to investigate several reports of food contamination in a small town. Using knowledge graphs, public health officials can create associations among the reports and trace the contaminated food through the supply chain and back to its point of origin. This can be done by learning about the four central components of ArcGIS Knowledge: entities, relationships, maps, and link charts.

Entities

An entity is a type of item in a knowledge graph, such as a person, building, or vehicle.

To record a case of food contamination in ArcGIS Knowledge, a public health official would note a person's report of foodborne illness and document any restaurants associated with that, along with the menu items the person ordered and the ingredients in those dishes. Each of those would be its own entity. The public health official would repeat this for each subsequent report of foodborne illness. This allows staff members at the public health department to drill down into which restaurants served menu items that might have been contaminated.

Relationships

In ArcGIS Knowledge, a relationship is an association that connects two entities.

A reported case of foodborne illness can be connected to the various restaurants that the person recently visited, the menu items the person ordered, the ingredients included in those menu items, and the suppliers of those ingredients. Being able to see this information graphically can elicit connections that otherwise might not have been obvious. For example, health department officials could see that one person who reported a foodborne illness went to a

← Viewing knowledge graph data on a map shows where some entities are clustered together, indicating, in the hypothetical food contamination example, areas that warrant further investigation.

restaurant and ordered a salad with lettuce, tomatoes, and carrots in it, and that another reporter had a bacon, lettuce, and tomato sandwich from a different restaurant. Perhaps there's a connection among those ingredients.

Maps

For entities that are associated with a location, ArcGIS Knowledge allows users to add these to a map. This can reveal spatial relationships that might not be apparent in a nongeographic view.

In the hypothetical food contamination example, analysts can plot on a map the restaurants that have reported cases of foodborne illness, the farms that supply those restaurants with ingredients, and where each farm's crops are located to narrow down the geographic context of the problem. The map interface allows users to create new entities and edit the items' properties. Once analysts have the entities spatially connected on a map, they can see where there might be clusters of entities associated with the problem—say, a vendor that supplies several restaurants in town with lettuce and tomatoes.

Link Charts

All entities and relationships can be added to a link chart in ArcGIS Knowledge. Link charts enable users to visualize how entities are connected, or linked, in a nongeographic view. This can help users determine associations among entities, such as finding a path through entities or determining which entities are central to the network.

In the hypothetical food contamination example, health department officials can use the link chart in ArcGIS Knowledge to visualize the supply chains associated with the reported cases of foodborne illness, from restaurant to menu item to vendor to farm to crop. So about those suspect veggies: based on the link chart, it looks like there might be a problem with some crops at a farm that provides lettuce, tomatoes, and other vegetables to a few local restaurants.

To sum up, using ArcGIS Knowledge, analysts at the local health department can investigate reported cases of foodborne illnesses as entities. They can store and display the entities in a graph network that shows their connections, or relationships, to other entities. From there, analysts can identify which restaurants are connected to the highest number of reports of foodborne illness and then further analyze the menu items and ingredients that those cases are related to. Once they identify common denominators, they can trace the ingredients back to food shipments, vendors, and farms, eventually finding the source of contamination, such as a common crop or storage environment.

Key Features of ArcGIS Knowledge

Several key features make ArcGIS Knowledge an asset to the decision-making process. Those features include the following:

- **Connected data:** By employing a shared graph store, users can more easily discover and connect data and contribute new information to reveal entities and the relationships among them. ArcGIS Knowledge makes it possible for numerous analysts to furnish and find data. All information in a knowledge graph is connected during the data creation process, which allows analysts to see data within the context of other data that an organization has.
- **Turnkey graph data management:** The graph store that deploys with ArcGIS Knowledge is fully integrated with an organization's ArcGIS Pro and ArcGIS Enterprise investments. It facilitates efficient data storage and makes it easier to pinpoint relationships among entities.

Get Started

To learn more about ArcGIS Knowledge, sign up for product announcements at go.esri.com/subscribe. To add ArcGIS Knowledge to your organization's ArcGIS Enterprise deployment, get in touch with an Esri representative at go.esri.com/arcgis-knowledge.

ArcGIS for Microsoft 365 Gets a More Seamless User Experience

For business professionals who have little to no training in GIS, ArcGIS for Microsoft 365 offers a suite of mapping tools with user interfaces (UI) and user experiences (UX) that are consistent with the Microsoft 365 products they use every day.

The latest releases of ArcGIS for Power BI, ArcGIS for Office, and ArcGIS for SharePoint come out of more than six months of design exploration that sought to give users an experience similar to each of these Microsoft applications. The result is a set of tools that makes mapping and GIS more accessible to people who are more comfortable working in documents and spreadsheets than with points, lines, and polygons.

The Benefits of an Integrated UI/UX

An integrated user experience is critical for technologies that span different products. This complementary method of development is a major trend in UI/UX design, and it has the potential to enhance how users perform various tasks in an app or on a website.

For example, online shoppers for years have used third-party payment systems that are integrated into popular e-commerce websites to pay for goods and services. Financial institutions took notice, and many have introduced their own versions of extensible online payment methods that can be embedded in websites and used in mobile banking apps. The difference between a third-party system and one developed by a bank is that the latter is tied to the user's financial institution, making it easier to access funds and eliminating the need for that third party. This is one benefit of a fully integrated user experience: that customers would want to use their bank's UI/UX on an e-commerce website rather than that of a potentially unfamiliar third party.

A More Seamless Experience for Power BI Users

To begin the process of making the UI/UX of ArcGIS for Microsoft 365 more consistent with the latest Microsoft design patterns, the location analytics team at Esri started with ArcGIS for Power BI. This product allows business intelligence analysts to geoenable their data and add interactive maps to their reports, providing insight into where things are happening in the real world.

Based on customer feedback, the team at Esri focused on making the two technologies more seamless. For instance, the ArcGIS app now leverages Microsoft Power BI's field wells, which help users manage their data to visualize it on a map. Building on Power BI's native UI/UX, users of ArcGIS for Power BI can now select what map tools are accessible using the Power BI visualization pane. This allows more of the map to be visible.

The new version of ArcGIS for Power BI also introduced the concept of radial menus, or pie menus, which offer a more intuitive menu experience that maximizes the map area. With radial menus, users can complete a task in three or fewer clicks, whereas before, it wasn't uncommon to have to engage that mouse or track pad four or more times to carry out a task.

The Power BI community gave the overall UX of this new version of ArcGIS for Power BI positive reviews. Taking that, the location analytics team at Esri forged ahead with creating a consistent look and feel across all the Microsoft 365 products that ArcGIS technology integrates with. The team wanted to make it easier for users to leverage the power of location intelligence in ArcGIS for Office and ArcGIS for SharePoint, too.

Expanding the New UI/UX to Other Products

Whether users are working in Microsoft Excel with data that needs to be visualized on a map, or they're in Microsoft SharePoint trying to geoenable data stored in lists and connect files in document libraries to locations on a map, the team at Esri wanted the GIS experience in these Microsoft products to be consistent.

To maintain a visible and usable map area, the location analytics team introduced the concept of map tools to ArcGIS for Office and ArcGIS for SharePoint as well. The map tools were redesigned using square buttons with rounded corners to give them more of the button appearance used natively in Microsoft Office and Microsoft SharePoint. There are also options to expand and collapse the tools. All this allows for a more integrated experience, making it easier for Microsoft users to perform mapping and location analytics tasks.

Additionally, the team designed and built an internal library of common UI components that are fully customizable for ArcGIS for Microsoft 365 products. Not only did the library help with the redesign of the entire ArcGIS-Microsoft integration—to make it more modern—but it also makes it easier for the team to implement changes across all ArcGIS for Microsoft 365 products in the future. When any new features are developed, they'll become part of this common library, too, so that all ArcGIS for Microsoft 365 products inherit them. The library is extensible as well, meaning that while the features and elements can be used across Microsoft 365, they can also maintain the look and feel of the individual products.

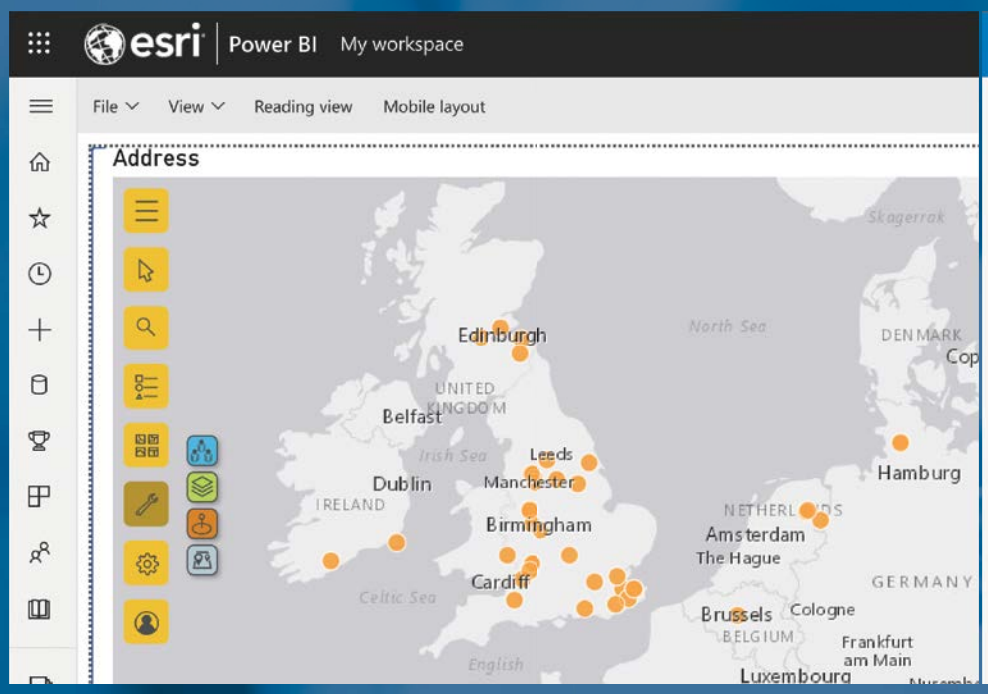
Consistent Design Changes Across the ArcGIS-Microsoft Ecosystem

The most important design change that Esri made to its ArcGIS for Microsoft 365 suite of products was using Microsoft's Fluent UI—a set of open-source UX frameworks for apps that share code, designs, and functions—to provide a smoother user experience. This design language is employed extensively across the Microsoft 365 apps, so it made sense to implement the same color schemes, shapes, patterns, textures, and layouts in ArcGIS for Power BI, ArcGIS for Office, and ArcGIS for SharePoint. Fluent UI's rich set of APIs for various platforms also makes it easier to incorporate accessibility options, support globalization, and improve performance.

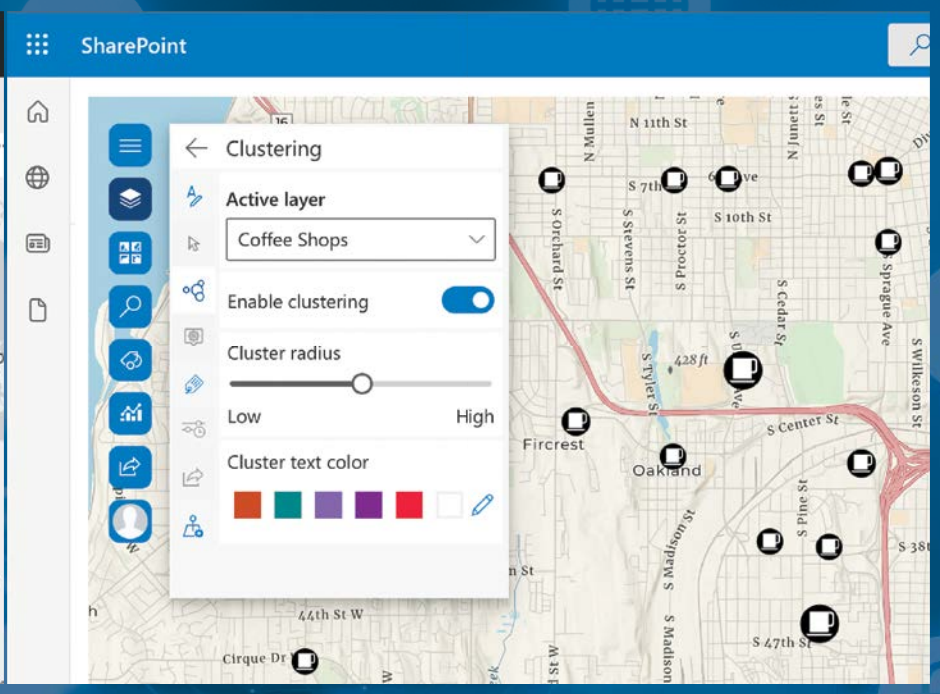
Indeed, in ArcGIS for Office and ArcGIS for SharePoint, users now see very similar map tools. The Clustering tool, for example, which helps users cluster together points in a map to make the data more legible, is almost identical in both programs. That's because it's based on the design components from Fluent UI. Users will also see that the updated labeling feature has a complementary style that even shows more of the map, making it easier and more intuitive to use than it was before.

Positive Feedback Drives an Ongoing Process

The latest designs for ArcGIS for Office and ArcGIS for SharePoint were released in August 2021, and so far, the user response has been positive. Esri's location analytics team will continue to evolve the products' design according to updates Microsoft makes to its design patterns, as well as user feedback.



↑ ArcGIS for Power BI now contains menu buttons that are designed like radial menus (like what's next to the tools icon), which help users complete tasks in just a few clicks.



↑ The Clustering tool in ArcGIS for SharePoint is based on design components from Fluent UI, Microsoft's open-source user experience (UX) frameworks for creating cross-platform apps.

Interactive Dashboards Enhance Truck Route Planning in Colorado

Commercial truck drivers stay safe on the road by preplanning their trips so they're aware of construction, weather, road conditions, and detours. Some noncommercial navigation systems, however, don't provide information about commercial vehicle restrictions, such as height and weight limitations on certain roads. That's why the Colorado Department of Transportation (CDOT) has an office dedicated to giving truck drivers, dispatchers, and individuals who plan trips for truck fleets the guidance they need to design sound and efficient routes that also comply with federal regulations.

CDOT's Freight and Permitting Office issues more than 60,000 permits per year—with a focus on trucking, railroad, and air freight—through its permitting website. The small team includes five permit writers who issue permits to drivers transporting oversize or overweight loads and hazardous materials. One of Colorado's statutory mandates is to share restrictions and hazmat routing requirements with the commercial trucking industry.

The office's permitting system has 21,000 registered companies, and each one can have anywhere from 1 to 500 big rigs. Historically, the freight office offered a public-facing website and provided drivers with a printed map that showed ongoing road construction projects and vertical clearance and weight limits for passing under or over bridges. The system was outdated, though. So Craig Hurst, freight office manager for CDOT, worked with Esri to build a digital dashboard—developed using ArcGIS Dashboards and hosted on ArcGIS Hub—that displays current data, maps, and photos to provide a better user experience and more real-time information.

The Need to Better Communicate Restrictions

The problem with having the commercial transport industry use paper maps and a website that contained outdated documents was that it was ultimately unsafe, according to Hurst.

"If we don't communicate *[restrictions]* as effectively as possible, we're really putting a lot of people in danger," he said. "I spent a decade in the trucking industry before coming to *[CDOT]*, so I just had a different perspective and wanted to find a better way to tell a story."

CDOT's chief data officer, Barbara Cohn, agreed that updating the commercial trucking permitting process needed to be a top priority, so she made it one of the first projects the agency undertook with its newly acquired Esri technology.

"As the government, we are here to provide the tool *[for route planning]* because we hold that *[data and knowledge]* of potential challenges," said Hurst. "I was looking for a solution to visualize what we already knew we had as datasets but *[was wondering]*, how could we use them to better communicate?"

Hurst wanted to digitize the existing paper maps to improve accessibility for drivers. Because his office manages an entire network of roads, though, it wasn't going to be easy to build 100 different maps for 100 different roads, as he put it. Thus, he needed a digital solution that contained all the maps in one place and made them available on mobile devices and computers.

This was completely new for CDOT, and according to Hurst, Esri technology afforded him and his team the opportunity to push some boundaries.

Developing a New Digital Solution

To start the process of converting its paper map system to a digital solution, Kimberly Johnston, permit technician IV/GIS at CDOT's Freight and Permitting Office, created multiple layers of data for the new digital map. This enabled Hurst's team members to have everything in one place so they could easily add more layers.

Johnston then worked with Julia Levermann, a platform engineer and configuration specialist at Esri, to produce a new solution.

"We had all of our layers built, and we had already sourced the data to make sure it was *[from]* a good source that we were able to publicize," said Hurst. "Because we had done some of that prework, we jumped in. Esri showed us options to select for our path forward."

Hurst's team held discovery meetings with Levermann, which she said yielded a robust picture of CDOT's data infrastructure, systems of record, and business processes. Levermann thought ArcGIS Dashboards would work best for the initial application.

As Levermann built the custom dashboards, getting frequent feedback from Hurst and his team, Johnston created a vertical clearance map using the map layers she had already built. This helped get the layers ready for public use.

"Julia and Kim worked really well together, taking the idea and expanding it and making it more than I ever anticipated it being," said Hurst. "*[The map layers]* help us focus our primary communication to the industry by managing these maps on a daily basis."

The final solution, called the Freight Asset Map, features different layers so users can choose the details they would like to see on the maps. The icons on the map are easy to read to help drivers stay focused on the road. And the signage used on it follows the Federal Highway Administration's *Manual on Uniform Traffic Control Devices* (MUTCD) booklet to ensure consistency.

Eight different dashboards in the solution display various regulations like weight limits for bridges and approved routes for transporting hazardous materials. The maps in these dashboards include key roadway information, such as width restrictions, full road closures, and temporary construction disruptions. Hurst's teams can also turn the layers on and off, depending on the season—to show snow closures in winter, for example.

ArcGIS Hub was used to embed the dashboards into the Freight and Permitting Office's new website. The final dashboards include a Freight Restrictions dashboard, a Seasonal Restrictions dashboard, a Bridge Weight Limits dashboard, a Vertical Clearances dashboard, an Oversize/Overweight (OSOW) Restrictions dashboard, a Hazardous and Nuclear Routes dashboard, a Pilot Escort dashboard, and a Long Vehicle Combinations (LVC) dashboard. The team also used ArcGIS StoryMaps to put together a simple tutorial for how to use the dashboards, and that's available front and center on the new website.

Interactive Planning Creates a Safer System

The digital map and dashboard solution makes Hurst and his team feel like they can now provide efficient and effective customer service to the 225 or so people who call CDOT's Freight and Permitting Office each day.

"We refer to the maps on our website regularly to answer questions," Hurst noted.

Johnston agreed, saying, "For me, the maps are a quicker resource to find information and locations with the data on the map. I think ArcGIS *[Dashboards]* makes viewing and finding data more efficient, with *[the ability to]* search for specific data with the filters and the autozoom."

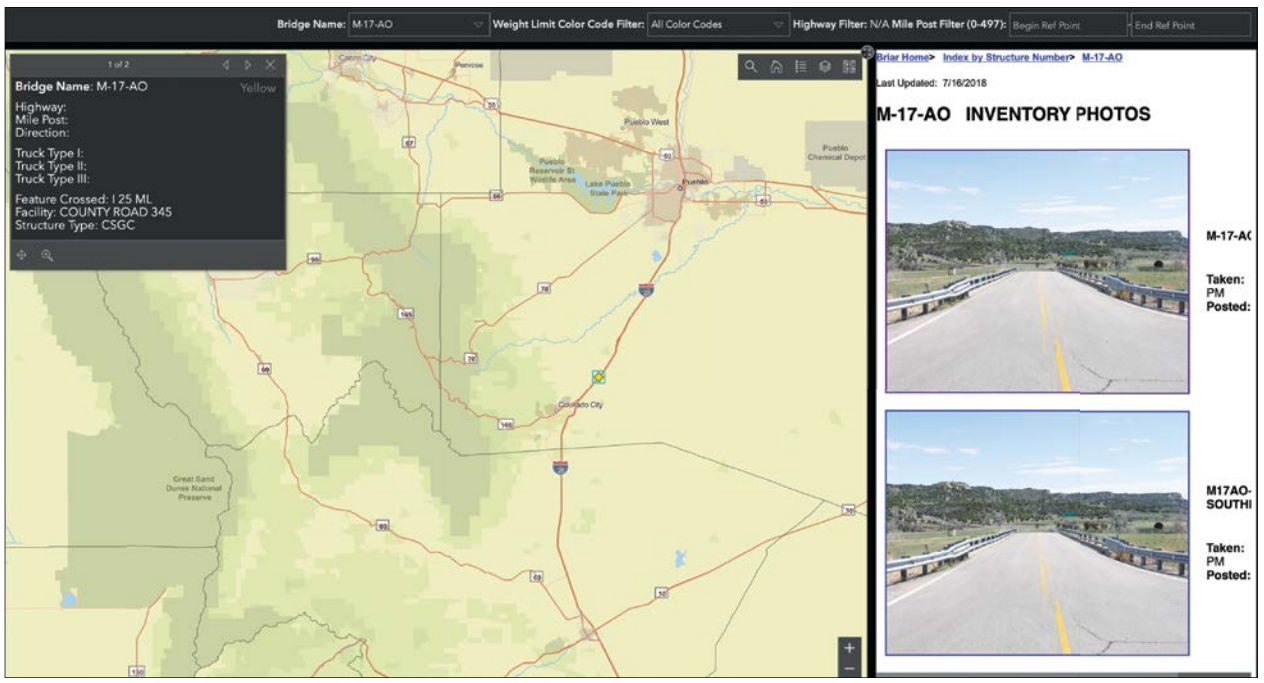
The interactive tools also, of course, make it easier for truck drivers, dispatchers, and those who plan trips for fleets to get personalized information for their drives through Colorado. For example, on one dashboard, users can enter a vehicle height in inches, and the system will bring up every bridge on a route that the vehicle can't go under. Drivers can also view individual structures and highways and break down their routes into each mile to do precise trip planning.

The dashboards include photos as well, which Hurst believes adds value by letting drivers know ahead of time what structures will look like.

"By having this picture, you can dig in further and see, 'Oh, that bridge is not an issue for me,'" he said. "It helps you decide if that's something that you have to plan for or not."

In streamlining communication with commercial truck personnel—and making it available on interactive maps and dashboards rather than via static, text-based resources—CDOT's Freight and Permitting Office is guiding truck drivers directly to the critical roadway information they need.

"I want them to look at the stuff that should matter when they're making their route," said Hurst. "Bringing the map to them, showing them the problems that they need to plan and accommodate for, *[creates]* a safer system."



↑ Photos included with some of the dashboards show drivers what certain structures, like bridge crossings, will look like so they can determine what restrictions they'll face, if any.

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Geospatially Enabled BIM Data Proves Useful Beyond Construction

"ArcGIS GeoBIM isn't just a design tool; it's something that owners and operators need to be thinking about using as part of their digital twin framework," said Darin Welch, associate vice president for geospatial and virtual engagement solutions at HNTB's Technology Solutions Center. "If they see the value in monitoring the tilt, movement, and temperature of the existing bridge during construction, then it's a logical next step to use this technology to monitor bridge conditions during normal operations."

Integrating Different Tools and Systems for a Major Airport Project

For HNTB, bridge work is its bread and butter—and has been since the company was founded more than 100 years ago. But the transportation-focused consulting firm has worked on other major projects as well, including a multibillion-dollar passenger terminal upgrade at one of the largest international airports in the United States.

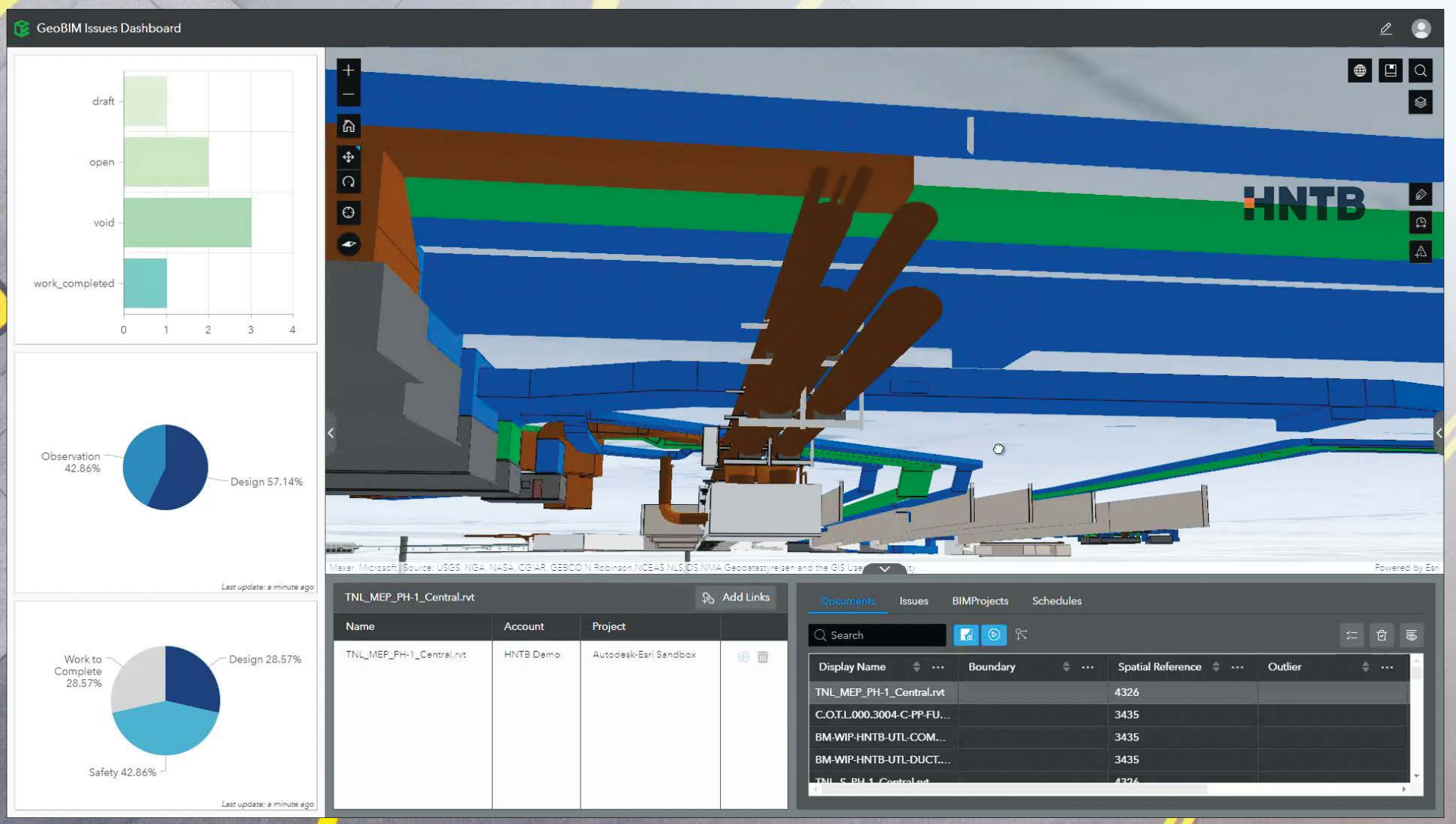
The airport expansion and redevelopment project consists of adding new concourses; replacing and expanding airport gates; and developing a new central tunnel system to convey utilities, baggage, and passengers to satellite concourses. To understand how each of its design proposals would impact the airport's surrounding infrastructure, the team at HNTB took a model-first approach to the project and built a digital twin—a 3D model that allows stakeholders to visualize real-world outcomes and collaborate more easily. This was the first time HNTB team members had employed ArcGIS GeoBIM to produce a digital twin and ensure that their infrastructure designs also supported location-based intelligence.

ArcGIS GeoBIM, a software as a service (SaaS) solution, integrates project information from Autodesk BIM 360—part of the Autodesk Construction Cloud that connects data across a project's life cycle, from design to hand over—and blends it with geospatial data from ArcGIS. For the airport project, Welch said he knew that integrating different tools and systems was going to be important, so the opportunity to explore ArcGIS GeoBIM came at the perfect time.

"We saw ArcGIS GeoBIM as a great opportunity to help visualize *[design variations]* because the subsurface utilities were in both CAD *[computer-aided design]* and GIS formats," said Welch. "And because of the model-first design approach of the tunnel and how that connects to the new concourse and terminals, we needed a way for the team to better visualize changes and conflicts with the 3D subsurface utilities…like the air duct system."

One of the big advantages to using ArcGIS GeoBIM is that it relieves the team at HNTB of having to translate various types of data into formats that can be used in one program or another.

← For the airport project, team members can generate and review dynamic drawings and plan sheets from the Autodesk Forge Viewer directly in ArcGIS GeoBIM.



↓ For the airport's new central tunnel system, HNTB uses ArcGIS GeoBIM to evaluate how design changes would affect the underground utility network.

"You're losing efficiency in the need to constantly translate those things," said Welch. "And you risk accuracy if you're not using the correct data or *[if]* somebody is using something that was translated and didn't realize it should have been retranslated."

Thanks to the recent partnership between Autodesk and Esri, ArcGIS GeoBIM works with various Autodesk Construction Cloud products, including Autodesk BIM 360, allowing BIM and GIS data to be used together in collaborative workflows.

"When we first heard about the partnership, it excited us because we could finally integrate the two solutions without having to do continual translation," said Welch.

Now, for the airport project, the team at HNTB connects ArcGIS GeoBIM users in a web-based environment directly to the project data on Autodesk BIM 360, no matter where the data is coming from. Stakeholders can access project materials, like live working files and the latest maps, in a single location, which enables them to understand how the most recent designs for the airport's underground tunnel would affect things like utilities.

According to Welch, ArcGIS GeoBIM also introduces the concept of a data cooperative that gives users confidence that they are accessing the most accurate information regardless of system or source.

"*[We're]* able to see GIS data and 3D civil CAD design, 3D architecture, subsurface GIS 3D utilities, *[and more]* in a single application that also lets people be notified of conflicts or item markups coming from the field," said Welch. "ArcGIS GeoBIM is like the ultimate aggregator of information. We often find *[data]* silos in our work, and this solution lets us bring information together into that single interface."

An Opportunity to Use ArcGIS GeoBIM After Construction

Once team members at HNTB saw how well ArcGIS GeoBIM worked for the airport redevelopment project, they began to explore other ways to employ the technology.

"We started as a movable bridge firm, so we challenged ourselves to consider, is there a bridge design project where we could use ArcGIS GeoBIM?" recalled Welch.

The team also wanted to demonstrate the value of ArcGIS GeoBIM for bridge information modeling, or BrIM—a type of BIM that functions horizontally, for bridges, instead of vertically, for buildings.

"We felt that if we could prove *[the value of ArcGIS GeoBIM]* for BrIM, it could open the door to other aspects of design engineering that we do," Welch continued. "If we can prove it on a large scale like an airport, which is almost like a small city, and we can prove it on a smaller-footprint project, like a bridge that still has lots of complexity, we feel like that spans the gap of any design, construction, engineering scenario we would encounter."

"We're trying to really modernize our design processes and workflows here at HNTB and take a 3D model-first *[BIM]* and web-first GIS approach," added Adam Horn, civil integrated solutions team lead at HNTB. "The lightbulb moment was, holy cow, *[ArcGIS GeoBIM]* is the realization of web-first and model-first in one application. And we've never had that."

Because the team at HNTB was already modeling Walk Bridge in 3D, using both CAD and GIS file formats, it made sense to start employing ArcGIS GeoBIM on the project. But what's really innovative—and moving ArcGIS GeoBIM into serious consideration for continued use beyond the design and construction phases—is how HNTB is thinking about incorporating ArcGIS Velocity, which enables users to process and visualize real-time data from sensors, into the solution.

"One of the challenges during construction of the new bridge is going to be monitoring the existing bridge, since *[CTDOT]* is going to maintain revenue train service on the existing bridge during construction," Horn explained. "The existing bridge already has sensors installed on it, so what we're proposing to do with *[CTDOT]* is to use ArcGIS GeoBIM with Velocity to integrate that live sensor data and monitor the existing bridge during critical construction periods. If there's any movement on the existing bridge that exceeds the threshold values of baseline activity that we set during ground truthing, that would…stop service immediately."

Velocity stores historical and current data from the sensors, which not only makes it useful during construction but also worthwhile for CTDOT to employ for normal bridge operations and maintenance.

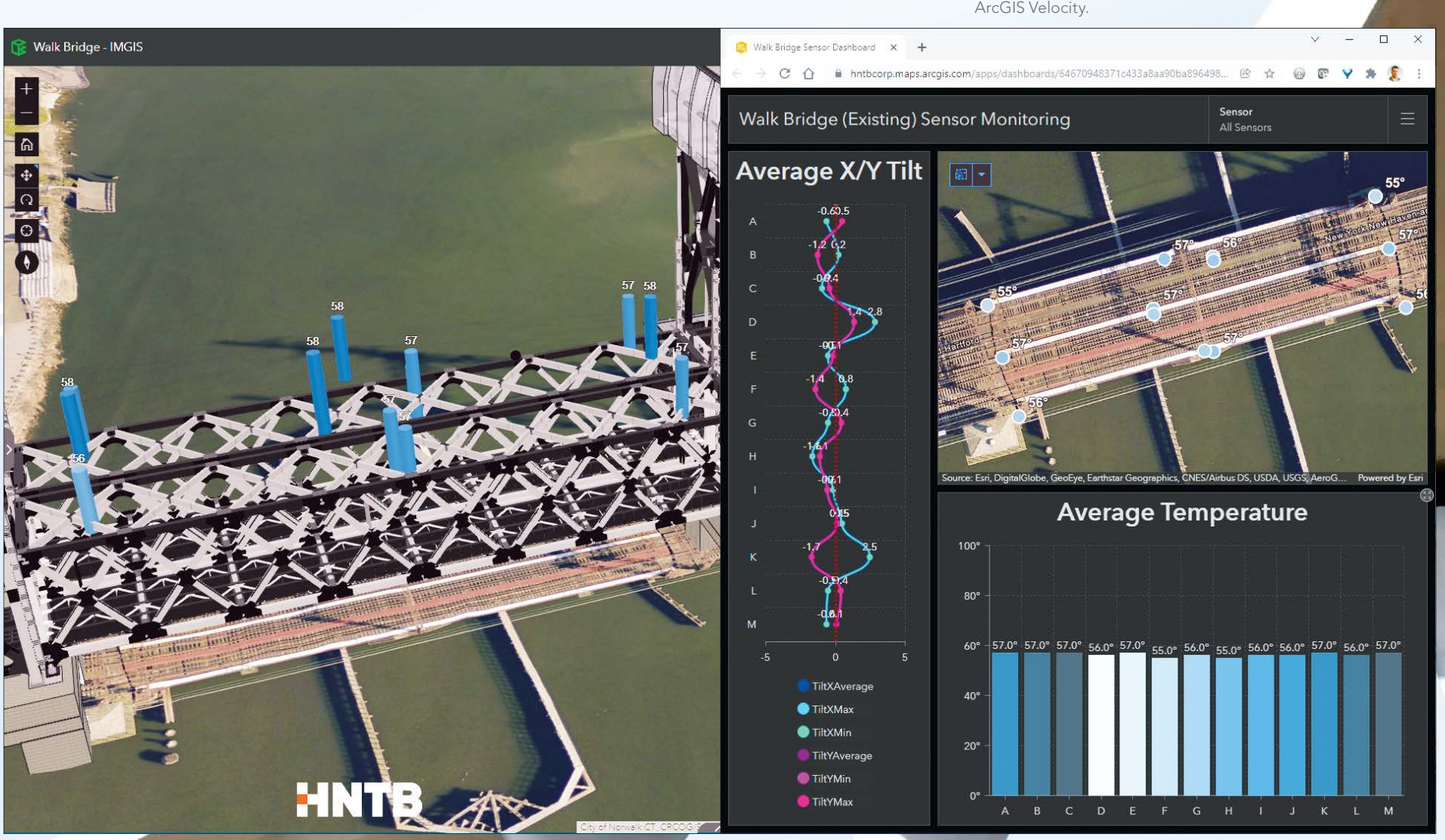
"When we proposed ArcGIS GeoBIM as the single solution to bring all *[the design and construction]* data together, it seemed like a no-brainer to incorporate another Esri product that is built to ingest and harvest and manage live sensor data," said Welch.

He thinks that ArcGIS GeoBIM and Velocity could ultimately be used together in the new Walk Bridge's machine rooms, which control the bridge's ascents and descents.

"Temperature gauges in the machine rooms, for example, cannot exceed a certain threshold," said Welch. "Because Velocity is the means to share both current and historical information like that and…users can see *[all this]* from a single place—ArcGIS GeoBIM—it seems like a logical continued integration."

According to Welch and Horn, team members at CTDOT are already brainstorming ways to use ArcGIS GeoBIM and Velocity to associate their inspection data and full maintenance history with all the different elements of the bridge.

"You don't have to limit yourself," said Welch. "We're trying to show everyone that ArcGIS GeoBIM can be the single location where you make design, construction, operational, and maintenance decisions. It can carry you all the way through all those steps."



↓ 3D cylinders represent sensors that the existing Walk Bridge already has. A dashboard, made with ArcGIS Dashboards, shows the bridge's tilt, which is being monitored using ArcGIS Velocity.

Scientific Currents

By Dawn Wright
Chief Scientist, Esri

TO SAVE EARTH'S CLIMATE, MAP THE OCEANS

Thirty years ago, I had the privilege of seeing the deep ocean up close. For my PhD research, I dropped 1.5 miles in the *Alvin* submersible above the East Pacific Rise, southwest of Acapulco, Mexico. Beyond illuminating the oceanographic process I was studying—the connection between plate tectonics, volcanic eruptions, and deep-sea vents—that one shaft of ocean opened my eyes to a larger truth: humans are largely blind to this enormous and lively part of the world that covers more than two-thirds of Earth.

It is worth repeating that scientists know more about Mars, Venus, and the dark side of the moon than they know of Earth's ocean depths. To date, less than 20 percent of the ocean floor has been mapped—13 percent in just the past four years. But scientists would like to map it all by 2030. It's an essential undertaking, but it's going to take dedicated effort, public support, and government funding. Such a project can be accomplished only through dedicated global cooperation.

The payoff stands to be tremendous—for everything from ship navigation to climate modeling. A clear view of the ocean floor's topography would allow for optimal siting of undersea cables and offshore wind turbines. It would show where deep-ocean fishing can be done safely and where it cannot. And with a clear three-dimensional understanding of ocean volume, meteorologists could better understand how typhoons and tsunamis travel and intensify as they cross the ocean, bringing storm surges to the shoreline. In addition, climate scientists could better measure the circulation of heat in the ocean and thus build better models of climate change.

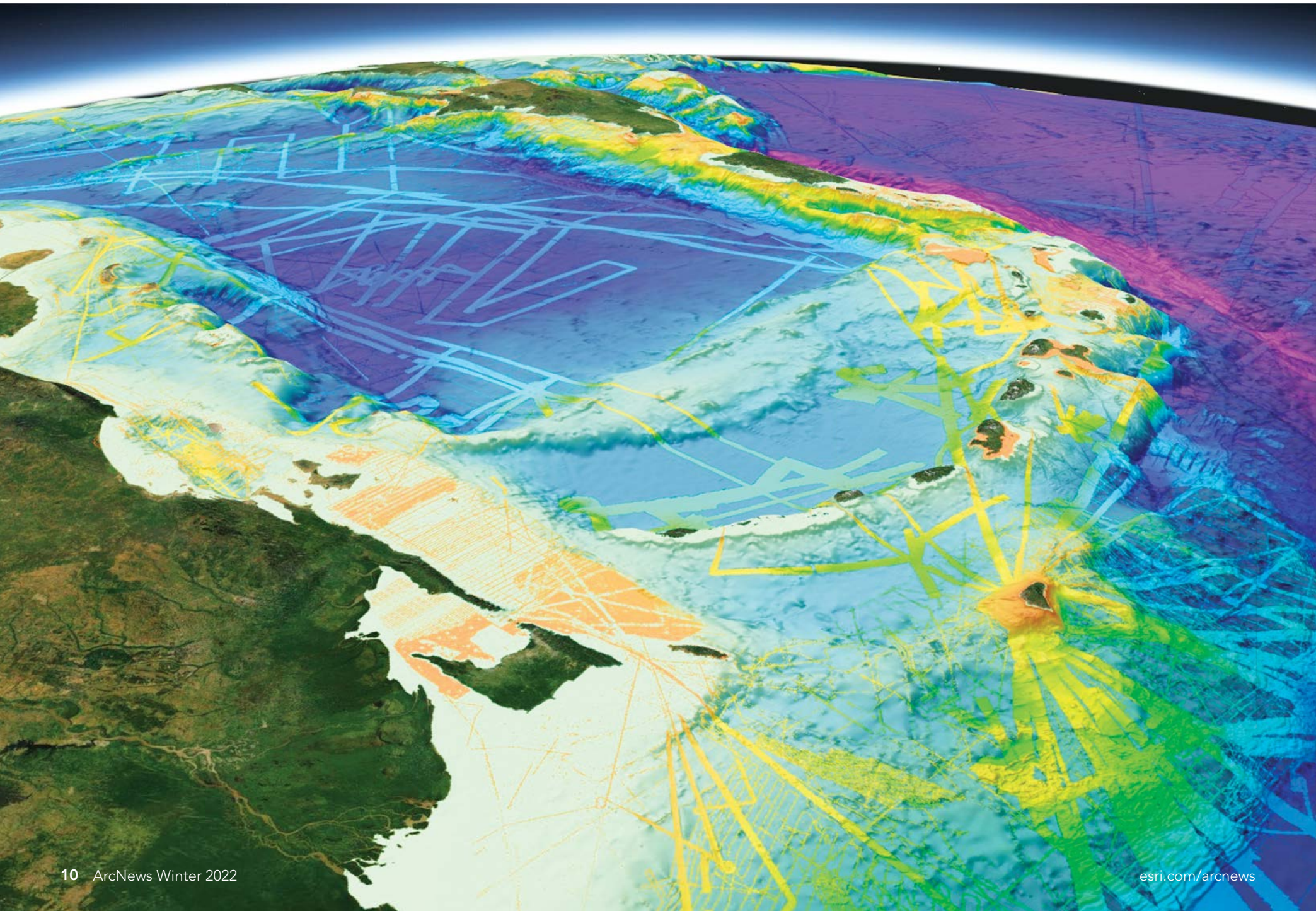
Climate change is the most basic and urgent reason to map the ocean as quickly as possible. Healthy oceans play an outsize role in minimizing climate change because they capture carbon emissions. But this capacity has limits. Excess carbon acidifies ocean waters, making life difficult for coral reefs and shellfish (oysters, mussels, snails, and clams). It also lowers the oxygen content of the water, impairing the ability of all sea life to breathe. Human practices that disturb the ocean floor—chiefly trawl fishing—make matters worse by releasing carbon from the ocean floor. Deep-sea mining, if it is allowed to go forward unmanaged, would have a similar effect and further disturb undersea ecosystems.

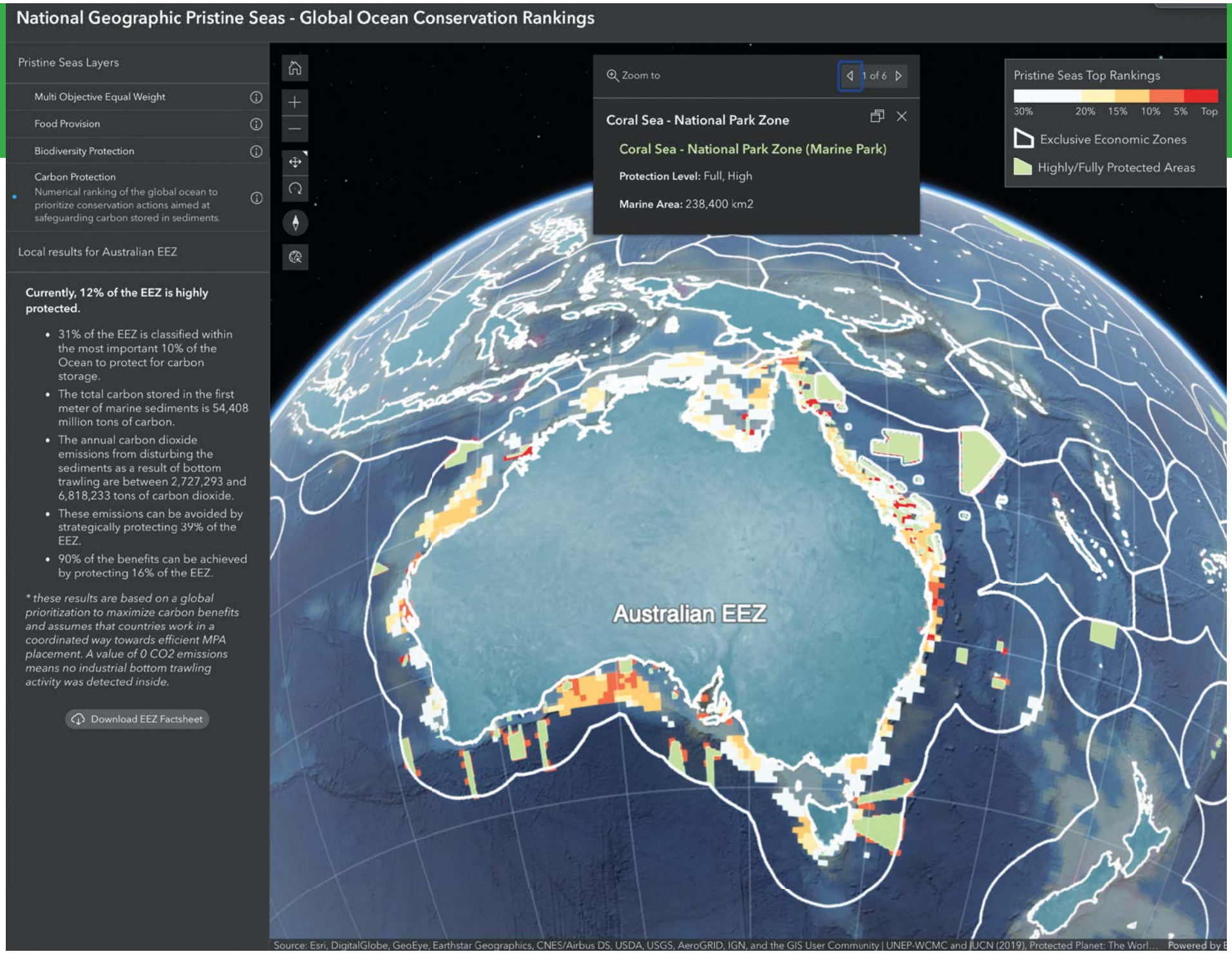
To measure the progress of climate change and study the ocean processes and human activities that affect that progress, it is essential to assemble a detailed picture of the undersea world. Too many people are still thinking of the ocean as "out of sight, out of mind" and not relevant if they don't live near it. This is a luxury we can no longer afford. The ocean floor is still too invisible—even to many people who work on climate change issues!

For example, the original 1994 United Nations (UN) Framework Convention on Climate Change—on which all subsequent UN climate change frameworks are based—only recognized three marine and coastal ecosystems: mangroves, sea grasses, and salt marshes. To date, the shallow and deep parts of the ocean floor are still excluded from this framework, even though scientists now know what a huge storehouse of carbon the ocean floor is, despite having mapped only 19.7 percent of it in detail. In the fight against climate change, the UN and global governing bodies must include the ocean floor in global carbon accounting—the process of quantifying the greenhouse gases emitted in the atmosphere—and ocean scientists must continue to learn more about this storehouse for the sake of scientific and policy guidance. To gain this understanding, we must map, and we need all hands on deck.

Scientists have the technology to get the job done. Today's sonars are sensitive enough to map features of ocean water above the seafloor, including wave action, schools of fish, and changes in coral reefs that can indicate marine oxygen levels. GIS is now

↓ An ArcGIS Earth visualization by the University of New Hampshire's Center for Coastal and Ocean Mapping/National Oceanic and Atmospheric Administration (NOAA) Joint Hydrographic Center that shows track lines for the 20 percent of the ocean floor that is already mapped in sufficient detail, with the remaining areas to be mapped represented in bluish purple.





↑ A 3D web app built using ArcGIS Online allows users to interactively explore the results of "Protecting the global ocean for biodiversity, food and climate," published in *Nature*. The article presents a framework for identifying the places in the ocean that, if protected, would yield the biggest benefits for biodiversity conservation; food provision; and, as shown, carbon storage.

routinely used to analyze data from an array of sources—including sonar, satellites, submersible craft, and underwater cameras—to put together a three-dimensional picture of the underwater world and to study how best to manage and protect it.

The Seabed 2030 initiative, an effort fully sanctioned by the UN and supported by the Nippon Foundation to map the ocean floor, has collected bathymetric (depth) data from governments and other data owners. Sensors carried aboard transoceanic cruise ships and cargo ships have gathered more data. And robots have been engaged to survey the ocean floor, similar to the way robots have been used to map the surface of Mars and other planets.

To finish the job in due time, though, the initiative will require an extended commitment and further funding. Private sector partners are chipping in, including Vulcan, a philanthropic company founded by the late Paul Allen of Microsoft, and the Schmidt Ocean Institute, launched by Wendy Schmidt and Eric Schmidt of Google. But the amount of work ahead requires the kind of funding that only governments can provide.

Larry Mayer, director of the Center for Coastal and Ocean Mapping at the University of New Hampshire, has calculated that $3 billion to $5 billion will be needed to finish this job. It's a big price tag, but compare it with outlays for space travel and exploration—the National Aeronautics and Space Administration (NASA) is spending nearly $3 billion on the *Perseverance* Mars rover—and the dollar for dollar value is obvious. All the major seagoing science powers of the world—including the United States, the United Kingdom, France, Germany, and China—must contribute.

Climate change—so vividly illustrated by a summer of fire and floods on land and documented by the Intergovernmental Panel on Climate Change's (IPCC) recent historic report—has greatly increased the urgency to see the entire ocean in detail. The job can be done by the end of this decade if countries step up to the challenge.

This, in great part, means embracing the vision of a planetary GIS that's composed of a coordinated constellation of hubs and geoportals distributed both geographically (across regions and nations) and thematically (e.g., connecting teams that are tackling global mapping projects, such as Seabed 2030, and local organizations that have data and reporting about specific, in-country UN Sustainable Development Goal indicators). For the ocean and coastal user communities, these hubs and geoportals can catalog information items in a well-organized way and connect them to related maps, apps, analytical models, and other relevant data. And all this is built around a series of best practices adopted from a wide range of communities and events, including those that incorporate indigenous knowledge systems. Learn lessons (learn.arcgis.com) and other resources present the workflows, approaches, and stories needed to bring these best practices to light.

The technology is there. The time to use it to map Earth's oceans is now.

Editor's note:
Most of this column is based on a letter of the same title originally published in Bloomberg Opinion *at ow.ly/aM2n50GtwRE.*

About the Author

As chief scientist of Esri, Dr. Dawn Wright aids in strengthening the scientific foundation for Esri software and services while also representing Esri to the scientific community. A specialist in marine geology, she is an elected member of the National Academy of Sciences and has authored and contributed to some of the most definitive literature on marine GIS.

ArcGIS StoryMaps Helps Students Show How Far Beach Litter Travels

The town of Gisborne, New Zealand, located on the east coast of the northern island, is endowed with stunning waterways and beaches. But as in most beach towns these days, residents and visitors often see trash strewn across the sand.

This made it an ideal place for Sustainable Coastlines—a nongovernmental organization (NGO) that helps clean up beaches—to set up a litter intelligence pilot program at a local high school. In 2019, Sustainable Coastlines began working with students at Campion College to measure and analyze beach litter and take steps to solve the problem by using geospatial technology.

Campion College participates in the GIS in Schools program run by Eagle Technology, Esri's distributor in New Zealand and the South Pacific, which Sustainable Coastlines is part of. It encourages young people in New Zealand to use GIS to develop geographic literacy, spatial awareness, critical thinking, and analytical skills.

The litter intelligence project culminated in students using ArcGIS StoryMaps to build narratives that show just how far their local beach litter can travel. And their work made it all the way to the United Nations (UN) as an example of how citizen scientists around the world can contribute to achieving the Sustainable Development Goals (SDGs).

Litter Audit Reveals Common Offenders and Spatial Patterns

The 12 students who participated in the citizen science project picked a defined patch of sand at Big River (also known as Waipaoa River) on Waikanae Beach—close to their school—to carry out a litter study. Wearing high-visibility vests, they measured out a 100-by-20-meter (328-by-66-foot) transect near Big River to audit the litter there. Their task was to identify the most common types of litter found in this cross section of beach, using methodology put forth by the UN to ensure that the data they collected was as accurate and reliable as possible.

They used their smartphones to collect and record data in Sustainable Coastlines' Litter Intelligence app, which employs artificial intelligence (AI) and Microsoft Azure's Cognitive Services suite to quickly classify litter. The students then uploaded the results to New Zealand's national litter database, which published them as an official survey and provided valuable insight into how to create a litter-free New Zealand. This enabled the students to compare their discoveries with the amount and type of litter typically found at other beaches and waterways across the country.

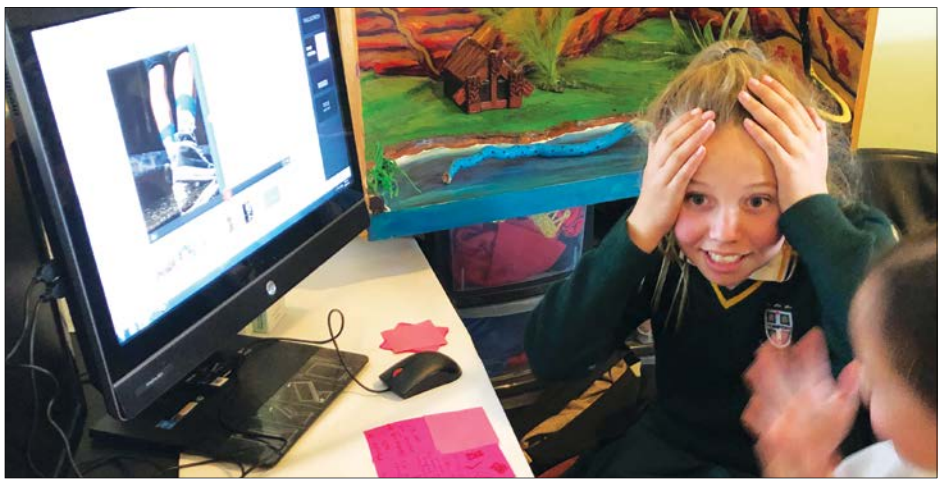
After finishing three surveys, which lasted two and a half hours each, the students saw that the items they collected included fragments of glass, bottle tops, food wrappers, cigarette butts and filters, lollipop sticks, polystyrene insulation or packaging, construction materials, and various unidentifiable scraps of plastic. The most common offender was chippie wrappers, or chip bags.

The students then used simulation software to identify where else this litter might end up throughout Gisborne and even farther up the coast, based on wind patterns and ocean currents. They learned that there was a high probability that some of the litter would travel 80,000 kilometers (about 50,000 miles) to the South Pacific Garbage Patch, meaning that their town—among many other places in the world—contributes to this global marine pollution problem.

Students Develop a Plan of Action Based on Storytelling

Now that these citizen scientists understood the extent of the litter problem that plagues their local beaches, they wondered how they could play a part in trying to solve it. So they developed a plan of action. It included publicizing the issue using the data they had collected to back up their claims. The students also came up with the idea of staging a wearable arts show in which they and their teachers wore garments made from the waste they found to raise awareness about the problem within the community.

Because storytelling was going to be the most powerful way to convey their message, the students took an intensive storytelling course, hosted by Sustainable Coastlines, to find out how to effectively influence people. Using ArcGIS StoryMaps, the students documented their investigation and beach cleanup stories by combining text, interactive maps, and other multimedia content into compelling narratives. They also employed Map Viewer in ArcGIS Online to showcase local places of importance, such as their homes and school, and add context to where the litter in their study was found.



↑ Year 11 student Georgia Jobson got a crash course in how to use storytelling to persuade people to take action.

↑ In her ArcGIS StoryMaps narrative, Jobson recorded photos of some of the litter she and her classmates found, including pieces of plastic, clothing items, and cigarette butts.

↑ The litter intelligence project became part of another ArcGIS StoryMaps story that was presented at the United Nations (UN) as an example of how citizen scientists can help achieve the Sustainable Development Goals (SDGs).

Finally, these citizen scientists took to the streets to ask locals if they would help the town move to paper wrappers for food packaging when possible. One student, Georgia Jobson—who at the time, was a year 11 student at Campion College—contacted the local newspaper, the *Gisborne Herald*, to ask if it would cover the beach survey story. Sure enough, a journalist picked up the pitch and, instead of putting the article in the student section of the newspaper, made it a lead feature.

"It's great to see organizations like Sustainable Coastlines taking an active approach to using GIS within schools that goes beyond the core curriculum," said Ted Taylor, GIS account manager for Eagle Technology. "We're keen to continue supporting exciting use cases of GIS and to push the boundaries of what can be done through the GIS in Schools program."

According to Jobson, there's really no end to her story because "*[i]*t must go on until we solve the problem," she noted in her ArcGIS StoryMaps narrative. "I'm going to use my strengths to make the beaches clean again, and most of all, I'm going to continue to protect the things I love," she concluded.

Wider Access to Data Encourages Young People to Solve Big Problems

Thanks to the success of Sustainable Coastlines' litter education program with Campion College, the NGO is rolling it out to more students in New Zealand. In total, 60 schools across Aotearoa (the Maori name for New Zealand) are now involved in the project. And the fact that Sustainable Coastlines provides these communities with the training, equipment, and technology they need to collect high-quality, authoritative data means that the results of the projects can be used for regional, national, and even international reporting on litter abatement.

"It's so important that we all have equitable access to scientific data and information to enable informed decisions for our communities," said Becky Taylor, the education coordinator at Sustainable Coastlines. "Young people now have access to this data. They also have the agency to be part of producing it. This is exciting. Having ownership of the data is enabling young people to take direct action to solve the problem of reducing the consumption and production of single-use plastics in their communities."

To express interest in Sustainable Coastlines' New Zealand Litter Intelligence program, email shawnelise@sustainablecoastlines.org. To learn more about Eagle Technology's GIS in Schools program, visit eagle.co.nz/gis-schools or email gisinschools@eagle.co.nz.

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Maps Serve as a Compass for the SDGs

ebook written jointly by the UN's Geospatial Information Section and the International Cartographic Association (ICA), that aims to democratize access to open data and cartographic techniques that people can use to better analyze the work being done toward achieving the SDGs. (For more information about *Mapping for a Sustainable World*, see "New Book Highlights Importance of Cartography in Achieving SDGs," in the summer 2021 edition of *ArcNews* at ow.ly/v7Bj50GQvUC.)

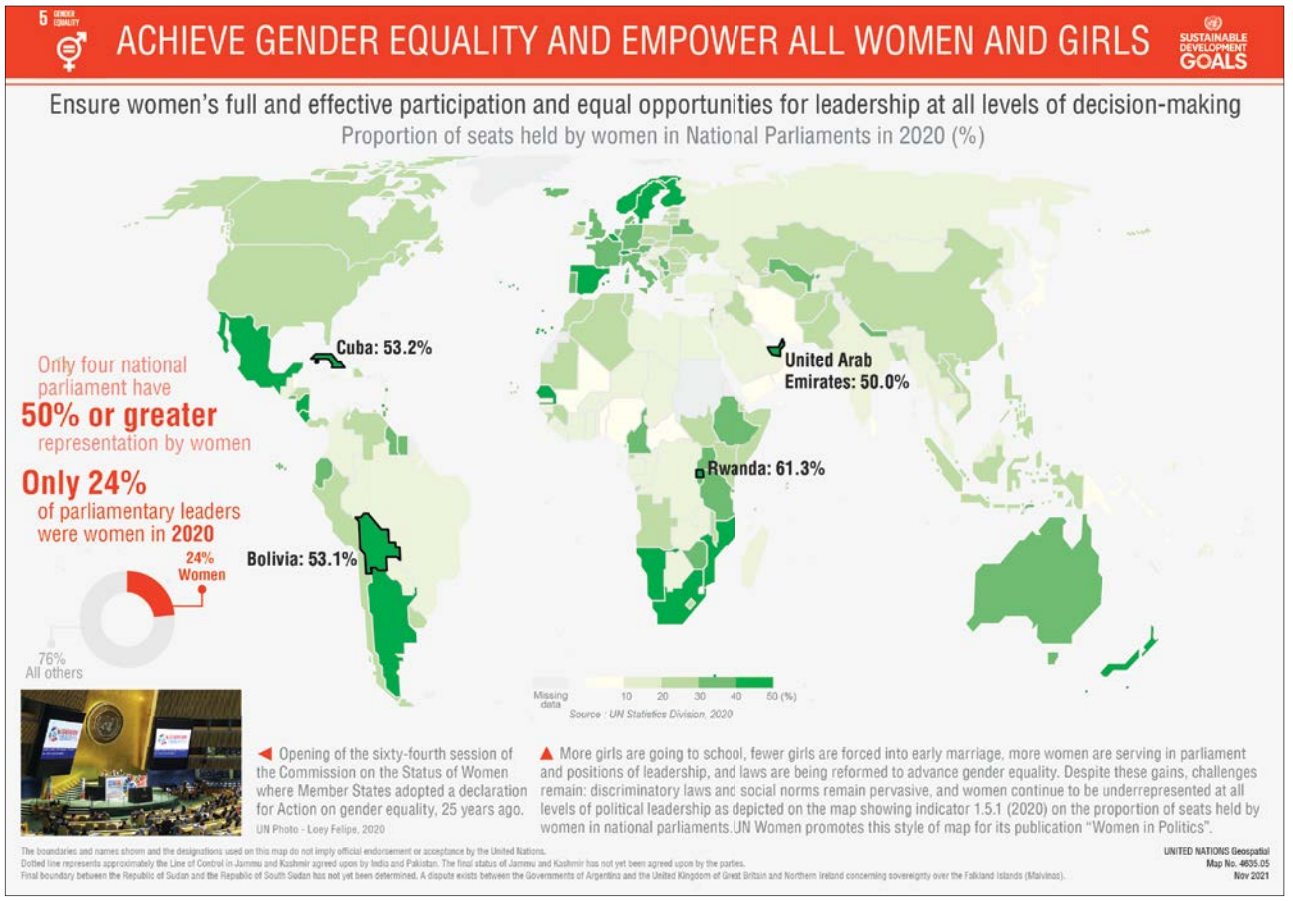
Well-designed maps and diagrams effectively illustrate where there have been breakthroughs on the SDGs and where we need to focus on making more gains. Indeed, as Kyung-Soo Eom, chief of the UN's Geospatial Information Section, advocates in the foreword of *Mapping for a Sustainable World*, it is imperative to use the power of cartography "to raise awareness and understanding on priority agendas for a better world, and to provide science and data for action and decision-making in moments that matter most."

Mapping the 17 SDGs helps people appreciate the stories behind the goals, as well as the implications of each SDG for every country and the world. The 17 maps that the UN has produced tell compelling stories about the challenges the world faces regarding population growth, social disparities, climate change, food insecurity, economic inequalities, global health emergencies, natural hazards, and threats to peace and security.

For example, with regard to SDG 5—achieving gender equality and empowering all women and girls—many countries have made significant advances in sending more girls to school; forcing fewer girls into early marriage; and, as shown by the map below, gaining greater representation from women in national governments. But despite these gains, challenges remain. Discriminatory laws and social norms are pervasive, and women continue to be underrepresented in all levels of political leadership. Indeed, in 2020, only 24 percent of parliamentary leaders were women, and countries with substandard representation run the gamut of industrialized and developing nations. So there is still a ways to go before we achieve this goal.

The maps in the series are meant to spark awareness for the beginning of this Decade of Action and show people what we have left to do to achieve the SDGs by 2030 and create a better world. They should serve as both a testimony of the work that has already been done and as a compass for what challenges lie ahead. Yet these maps are only part of the story.

The expertise that GIS practitioners, data and geospatial scientists, cartographers, and others in this orbit have is critical for evaluating progress on the SDGs and the 2030 Agenda for Sustainable Development. We only have eight more years to fulfill our promise for a more equitable and sustainable future. So join us in mapping the 17 SDGs, and let's see where else that can take us!



↑ Myriad indicators can be used to show gender equality. The proportion of seats held by women in national governments reveals that progress has been made on this front in many countries.

Contributors to the maps of the 17 SDGs include, from the Geospatial Information Section at UN Headquarters, the Cartographic Unit's officer in charge Guillaume Le Sourd, geospatial information officer Mina Lee, associate geospatial information officer Fleur De Lotus Ilunga, associate geospatial information officer Gakumin Kato, and GIS intern Paul Fabre; from the UN Global Service Centre's Service for Geospatial, Information and Telecommunications Technologies, chief of data and visualization Javier Neme-Lozano, associate geospatial information officer Selamawit Gebreselassie, associate geospatial information officer Oliva Martin Sanchez, GIS consultant and graphic designer Dana Alnaji, GIS consultant Michael Montani, and GIS consultant Marilena Picci; and from the UN Interim Force in Lebanon, GIS chief Ayako Kagawa.

About the Author

Guillaume Le Sourd currently leads the Cartographic Unit of the UN's Geospatial Information Section. He has worked at the UN for more than 15 years, starting out in the UN Environment Programme and the World Health Organization Office at the UN before moving to the UN's peacekeeping operation in Burundi. Le Sourd also worked in the Division for Ocean Affairs and the Law of the Sea in the UN's Office of Legal Affairs. He studied geography at the University of Lyon, sustainability at the University of Geneva, and GIS at the University of Southampton.

New Book Explores Pandemic-Induced Land-Use Changes

Many land-use patterns that seem normal today were triggered by past pandemics. After cholera spread throughout Asia and Europe in the 19th century, investments in water infrastructure enabled the development of high-density, mixed-use urban spaces. And the tendency toward social distancing that emerged out of the 1918 flu pandemic led to investments in transportation infrastructure that precipitated the rise of the automobile and suburban sprawl.

The Past Pandemic World, a forthcoming book from Thomas Fisher, director of the Minnesota Design Center at the University of Minnesota and leadership chair of the International Geodesign Collaboration, explores not only how past pandemics have affected cities but also how the current COVID-19 pandemic is rebalancing both the physical and digital worlds. Fisher examines the transformative effects that remote, in-person, and hybrid versions of working, shopping, and learning have had on office, retail, and educational spaces and on transportation, land use, and outdoor areas. The current pandemic has given people more choices when it comes to what activities they'd prefer to do in person and what they would rather do online. That will change traffic patterns on roads, parking requirements near business centers, and interior space needs for all kinds of workplaces, among other things. And GIS will play a critical role in mapping these changes and helping to create a very different postpandemic world.

The Past Pandemic World is scheduled to be published by Routledge in May 2022.

Students Take to GIS to Build Solutions for Their Communities

The Massachusetts Institute of Technology's (MIT) Online Science, Technology, and Engineering Community (MOSTEC) is a free, six-month program for rising high school seniors from across the United States to get hands-on experience in science and engineering. And thanks to one former participant who is now an instructor, current MOSTEC students have the opportunity to learn GIS with a social justice slant.

"Whether or not they're going *[to work in]* tech *[or]* business or *[at]* a local community organization, I think this education is needed," said Nick Okafor, the creator of MOSTEC's Mapping Justice: Designing Geospatial Tools for Social Change course. "I want them to be mindful of the implicit biases that are present and the role we can play in making an impact."

Students in MOSTEC take a variety of courses that equip them with skills and contacts in science, technology, and engineering. They generally do not have experience using GIS, according to Okafor. But within the six weeks that they're in his course, students learn to employ ArcGIS Online, ArcGIS StoryMaps, ArcGIS Dashboards, and other ArcGIS products to build interactive maps and apps that address topics they're interested in.

> "For all students, I work to make sure they have a baseline understanding of how to find data and how to use the ArcGIS tools in front of them."
>
> **Nick Okafor**
> Creator of Mapping Justice: Designing Geospatial Tools for Social Change

The students in MOSTEC today have grown up in a world that's saturated with technology, data, and analysis. Now, they are using this almost innate knowledge to shape their own narratives for how to effect change.

Teaching the Geographic Approach for Solving Big Problems

Okafor has a special connection with MOSTEC. He was a student in the inaugural MOSTEC class in 2011 and, since then, has maintained involvement by being a mentor and now an instructor.

He got the idea for developing a course focused on GIS and spatial analytics when, as an associate at the Boston Consulting Group, he did an externship at Planned Parenthood. While there, he used the technology to help Planned Parenthood embed market analytics into its strategy and operations by creating internal tools and leading capacity-building efforts. This allowed him to see the power of GIS and the role it has in telling stories and creating solutions to big problems.

At MOSTEC, Okafor likes to have his students work on projects they care about. He believes that teaching really begins when students get excited about a subject area. In his course, Okafor encourages students to take stock of things they see that need to change and then figure out how that change can happen. He stresses the importance of spatial data and how the geographic approach—essentially, integrating geographic data into problem-solving—can be used for just about everything.

"An assignment they do in the first week is called everyday spatial analysis, where they just try and figure out *[questions like]*, Where do I see *[spatial analysis]* coming up? Is it a map that I saw on the news around *[COVID-19]* rates in my area? Is it an infographic? *[Is it]* clickbait on Instagram?" Okafor explained. The point is to have students see where data and space are connected and what the implications are.

Okafor, who is Black and Nigerian, said that his overarching goal at MOSTEC is to have his students—many of whom are also Black or from other typically underrepresented communities—carry the work they do in his course with them to college and beyond.

"Representation, especially within STEM *[science, technology, engineering, and mathematics]*, is key. Students can go far in their educational journeys without seeing someone who looks like them as a teacher," he said. "I make it a point to bring in peers from diverse backgrounds—people of color (POC) and people from the femme and queer communities—for our speaker series to touch on elements critical to the class, like data science, policy, and design, hoping the students can see a future in those fields themselves."

Going from Nothing to Web Apps in Six Weeks

At the beginning of the Mapping Justice course, Okafor encourages students to think about a big idea that impacts their communities.

"Their first assignment *[asks]*, 'What's your big idea?' to get them thinking about what social issues are important to them and how they would go about solving them," said Okafor.

Topics have included transportation inequities, climate change, discrepancies in food access, gentrification, the digital divide, and disparities in education. Okafor then pairs students up based on their ideas so they can work together on their projects.

"STEM is extremely collaborative, so I want them to start building these skills early," he said.

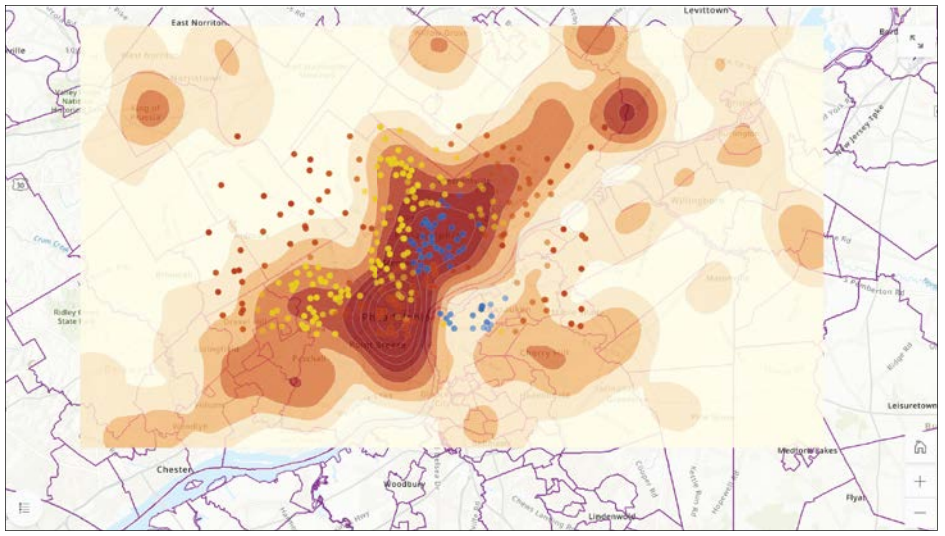
Throughout the course, students learn how to use a variety of Esri products to discover and analyze data and present their creative solutions in compelling ways. They employ ArcGIS Online and ArcGIS Living Atlas of the World to find and pull census and other open data and then map it. When they figure out what story they want to tell, they use apps such as ArcGIS StoryMaps and Dashboards to create interactive displays that explain the problem and demonstrate their proposed plan of action.

As the course progresses, Okafor enjoys seeing his students make strides in GIS.

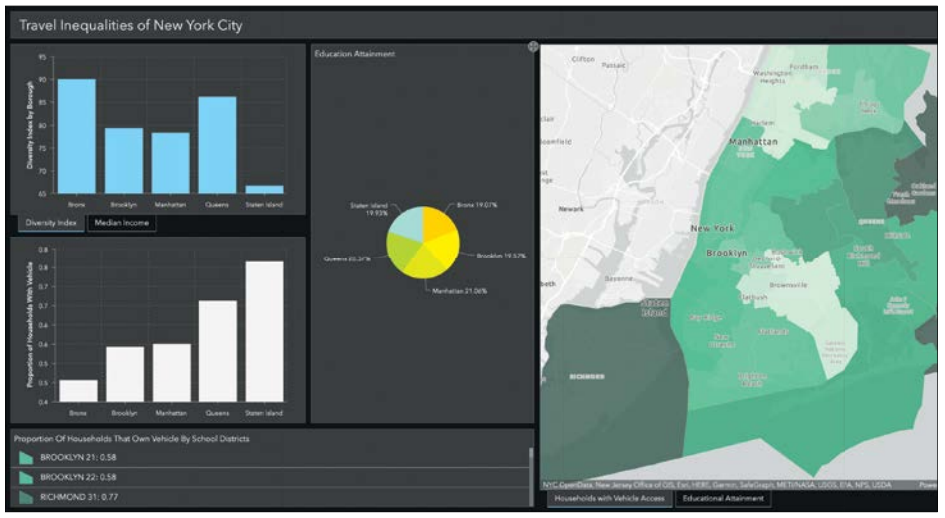
"When you think about *[them]* starting from zero *[and having]* dashboards, maps, and web apps in less than six weeks, they're researching what is GIS," he said. "Suddenly, they have a dashboard that talks about gentrification in San Diego, showing historical elements, or they're pulling up historical maps about redlining in North Carolina."

Okafor said that he is inspired by his students' use of GIS technology and that he never stops learning from the teens.

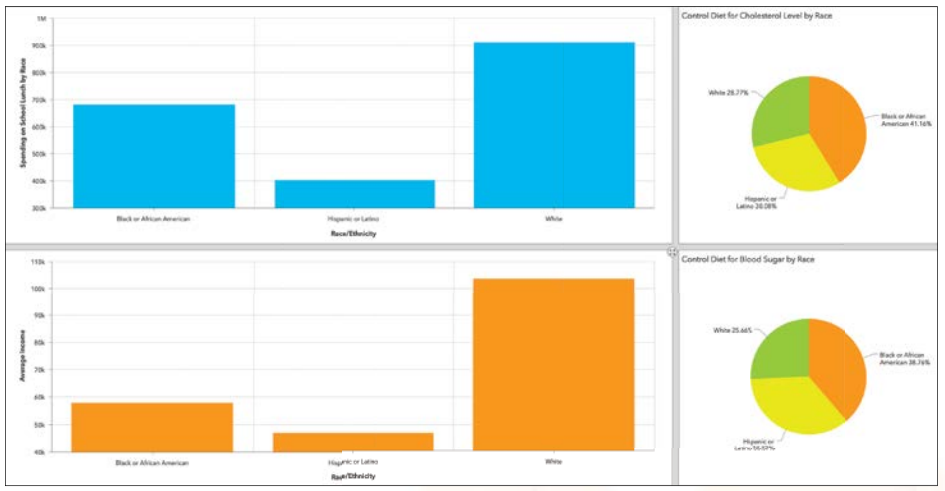
"This year, one of my students was able to really put forward the data she found in this tool that was honestly beyond me," he said, referring to ArcGIS Insights, which was new to him. "I didn't include *[Insights]* in our lessons because I hadn't used it before, but when she asked if she could, I said any Esri tool is open for use. She



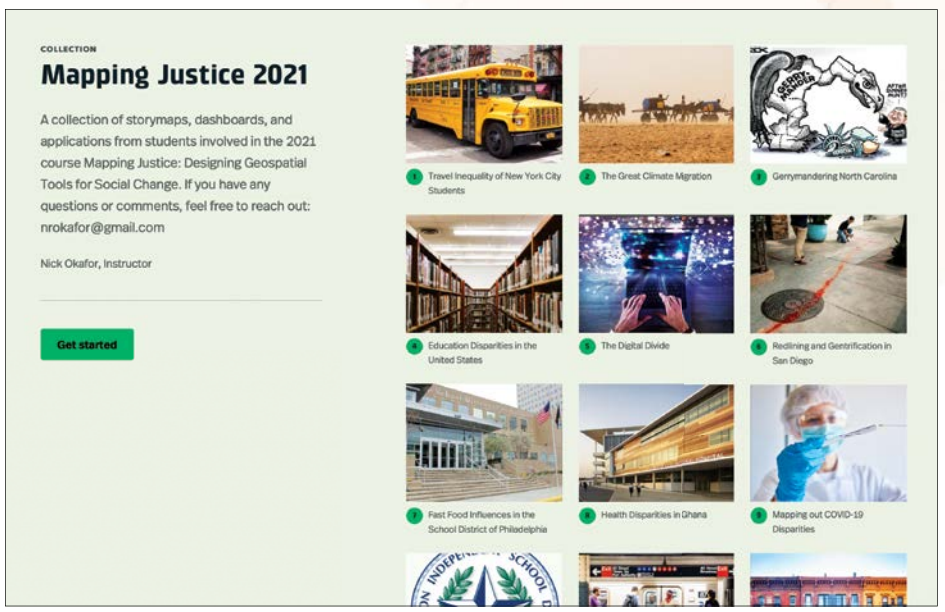
↑ Two students found that young Hispanic and Latinx people in Philadelphia are more affected by the presence of fast-food culture around their schools than other racial and ethnic groups they analyzed.



↑ At the beginning of the course, students think about big ideas that impact their communities and then develop projects, in pairs, to confront those problems.



↑ Within six weeks, students go from knowing virtually nothing about GIS to building dashboards, maps, and web apps about problems affecting their communities.



↑ Students do projects on topics that range from transportation inequities and climate change to gentrification and the digital divide.

then showed some great data science visualizations using Insights—something she must have taught herself."

Two other students in the 2021 cohort, Oluwaseun Ogundimu and Ruhe Solomon, used ArcGIS StoryMaps to create an interactive narrative (available at arcg.is/19ri0X) that evaluates where fast-food restaurants in Philadelphia are located relative to schools that enroll largely communities of color versus schools that enroll primarily white students. Their research—presented via maps, charts, graphs, and text blocks—shows that schools with large populations of African American/Black and Hispanic/Latinx students are in areas with a high density of fast-food restaurants compared to schools with large populations of white students. In addition, Ogundimu and Solomon found that Hispanic/Latinx students in Philadelphia are more affected by the presence of fast-food culture around their schools than any other racial or ethnic group they analyzed. The two students' solution is to have nonprofits that promote healthy eating focus their efforts in these areas of the city.

"For all students, I work to make sure they have a baseline understanding of how to find data and how to use the ArcGIS tools in front of them. But there are additional 'soft' skills that are harder to learn in such a short time," said Okafor. "Oluwaseun and Ruhe not only did well in creating a clear story line around their issue, but they also weaved in data points that successfully supported their argument."

Encouraging Students to Lean into Their Experiences

Okafor has found that an effective way to teach students about GIS and the powerful analytical tools that come with it is to encourage them to lean into their own experiences and cultural backgrounds. This gets them interested in their research so they become serious about finding authoritative data to support their work. And when combined with project-based learning, this method of teaching gives students the space they need to draw their own conclusions about how to apply the geographic approach to solving problems.

"I got into STEM because I like math, science, and building things," Okafor said. "But what kept me in it was the fact that I saw the power I could have in fixing issues that were important to me."

Okafor believes that the diversity of the students in his course gives them all an advantage, since each person's ethnic and geographic background influences what they are exposed to and, ultimately, what they're interested in.

"We're born into identities, into networks, into communities that will shape us," he said. "How we continue to present to the world is always going to be affected by that."

Beyond teaching students spatial awareness, Okafor's Mapping Justice course "brings that quantitative nature to social problems that sometimes can be missing from leaders' decision-making," he said.

It sure sounds like he's setting his students up for long-term success, whether they pursue professions in the field of GIS or take another route.

To learn more about Mapping Justice and how Okafor is planning to scale the course up, visit trubel.co.

A Go-Getter Encourages Other Women to Level Up Their Careers

Over the last few months, Eva Reid has taken her own advice to pursue challenges and try new things. After 14 years at Washington, DC's Office of the Chief Technology Officer (OCTO), where she'd worked her way up to senior GIS analyst and GIS trainer, Reid started a new position in December as data manager for the Washington, DC, Department of Health, known as DC Health.

"I had to use the knowledge and encouragement that I have given other people through my business to really even consider doing this," she said, referring to her career coaching business, Eva Reid Consulting, through which she provides professional development services to women in technology and other fields where they're underrepresented. "It was a really good feeling! You know, I can't suggest that someone else do it if I haven't tried it myself, right?"

In her new role, Reid is helping subject matter experts at DC Health build a framework around the datasets they're already developing to make it easier for staff members across the agency to understand what data is available and how to work with it.

"They need people thinking about, how should things work together? How should we be connecting different databases? How can the different parts of the agency work together in terms of collecting and using and managing data?" Reid explained. So that's now her job.

While this is an entirely new position that puts Reid a little bit out of her comfort zone—in a good way—she is not unfamiliar with the work. One of the big projects she led at the OCTO was building the organization's Enterprise Dataset Inventory, an internal data catalog with a corresponding public-facing open data system that guides users through how to use and map the data.

"I managed that project, essentially working with all the agencies to help people tease out what datasets they were using every day and then creating this giant metadata-like app," Reid said.

One of the agencies Reid liaised with regularly was DC Health. And because she has a long-standing interest in public health, taking on this new role seemed like a natural fit.

"It's a really good situation to be in because it's an organization that I knew a little bit, and I knew a lot of the people in it, so there's support there," she said.

Reid has always been called to public service, and she believes that government agencies are a good place for people to spread their wings and try new things, even if it's often up to employees to find ways to do so. Seeking out new opportunities and taking on challenges are things she's always strived to do, even if—like many women—Reid has, at times, needed encouragement to take those chances.

Reid grew up on the East Coast and knew she wanted to attend a small liberal arts college after high school. When a guidance counselor mentioned that several alumni from her school had gone to Macalester College in Saint Paul, Minnesota, Reid looked into it and decided that it was a good fit.

While at Macalester, she fulfilled her natural science requirement by taking a geography course, and she was enthralled. She has always been interested in the world around her and had often wondered about things like why people live where they live. So when she found out that Macalester offered a computer-based cartography class, combining two of her nascent interests, she was in. And that was it—geography became her major.

Following graduation, Reid moved to Arizona on a whim, where she got a job at the Arizona Geographic Information Council. She stayed in Arizona for 10 years, eventually getting a master's degree in public administration from Arizona State University, working in the private sector for a while, and then landing an entry-level technician position at the Arizona Department of Transportation (ADOT). Up to this point, things had sort of just fallen into place. But at ADOT, she carved out her first big opportunity when a GIS manager position opened up.

"One of my coworkers came to me and said, 'I really think you should apply for this. You might not get it, and that's okay. No one's going to judge you for that. But you really owe it to yourself to try,'" Reid recalled.

So she applied, and she got it.

"I was fairly young and was like, 'What am I doing in a management position?'" she said with a laugh. "But then they wouldn't have hired me if they hadn't thought I could do it."

To many women—and members of other groups that are underrepresented in fields like technology—that is a familiar thought pattern. It's one reason Reid later felt compelled to seek connections with more women in GIS. Another reason was that, at times, she has felt quite alone in her career.

"For a very long time, I was one woman on a team of, I don't know, 25 people," Reid said. "I knew there were other women, and I knew they were around, but we just didn't see each other."

So she started creating spaces where women could talk to each other and learn new things without feeling judged for having different career needs than some of their male peers.

"I want to connect women so we can help each other and lift each other up in a world that, honestly, doesn't do that enough," she said.

That was the impetus for starting Eva Reid Consulting a few years after moving to Washington, DC, and beginning her career in city government. She initially set out to target women in GIS, but soon she found that women in other fields—from sports communication to aeronautical engineering—were interested in her services. Now, she coaches people in a range of industries and hosts events, both in person and virtually, that encourage attendees to learn something new about themselves and level up their careers.

"I want to help people develop themselves and feel confident so they can go do what they set out to do," Reid said.

This propensity for supporting people and helping them learn new things comes naturally to Reid and dovetails with another major component of her career: teaching. Not only did she train her OCTO colleagues in GIS, but she also spent time as an adjunct associate professor in the Geospatial Studies program at Northern Virginia Community College (NVCC).

While there, she unintentionally helped some students start a Women in GIS group on campus. Reid was substitute teaching another professor's GIS class one day when a female student came up to her and said, "I don't think I belong here. No one looks like me." And it was true: there were no other women in her class. They all happened to be in Reid's class.

"She was going to quit," Reid recalled. "So I said, 'I realize it's hard, but if I could get a group of people together to just kind of sit around and chat, would that be helpful?' And she said, 'Oh, my God, that would be amazing.'"

Reid set it up, and with support from colleagues, it became a more formal organization. Although Reid is no longer with NVCC, having given the program all she felt she could, the Women in GIS group is still going strong and now includes GIS professionals and students from other universities. And Reid currently runs a Women in GIS group in the Washington, DC, area.

That's one thing Reid finds remarkable about being in the GIS field: that the community is so nurturing and stimulating at the same time.

"The GIS community is a place where you can try things and, generally speaking, not get in trouble for it," she said. "And heck, someone might be really excited by it and want to talk to you about it! I've always felt very supported by the community, and I can't say how much that has meant to me."

Eva Reid

GIS Hero

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Where the Bats Go

To Locate Potential Habitats in Abandoned Mines, Organization Employs a High-Accuracy GIS-Based Workflow

Caves hold a special place in human history. Once a common home for people, caves today have become a destination for hikers, spelunkers, and other hobbyists. But they're also used by another set of residents: bats.

Unlike humans, who have mostly abandoned their long-term leases on caves, bats today thrive in certain subterranean environments. And in a twist of fate, society has created a new type of sanctuary for bats: abandoned mines.

Not all old mines make great bat homes, though. Bats require a particularly ideal combination of moisture, temperature, lack of predators, and other factors. Only a choice subselection of abandoned mines allows bats to thrive.

That's where Bat Conservation International (BCI) comes in. For 40 years, the organization has worked to prevent the extinction of bats by protecting their habitats. And now, thanks to a new high-accuracy mobile workflow based on GIS, BCI can locate and safeguard bat-friendly mines more precisely than ever before.

To Protect Bats, BCI Surveys Abandoned Mines

There are more than 1,400 species of bats all over the world, and although they are critical to the ecosystems in which they live, bats are among the world's most vulnerable wildlife.

In much of the United States, bats are essential to controlling insect populations—their primary prey—and even consume crop pests in large quantities, reducing the need for large-scale pesticide use. In many other parts of the world, bats serve as important pollinators and seed dispersers for numerous fruits, cacti, and other plants—all of which would disappear without the bat species they depend on.

"Bats lead us to the best opportunities to protect nature anywhere in the world," said Mike Daulton, executive director of BCI.

A collaborative and data-driven nonprofit organization, BCI's work is largely funded by grants and relies heavily on the aligned goals of both federal and regional land management organizations, such as the Bureau of Land Management (BLM). BCI's staff of about 30 employees works on preserving 35 critically endangered bat species, 3 of which are found in the continental United States.

As part of an ongoing project that started more than 10 years ago, BCI has been working with BLM to survey thousands of abandoned mines across the western United States to determine which ones offer the best bat habitat. BCI staff members are specifically trained and qualified to safely enter and assess abandoned mines, which present unique hazards and should not be entered by the public. After evaluating the conditions inside a mine, BCI employees learn if and how bats use the mine so they can recommend specific actions BLM can take to allow bats to thrive there, such as installing gates that discourage human entry.

"A big part of our work is to survey abandoned mines so that we can recommend appropriate action," said Priyesh Patel, geospatial products and data manager at BCI. "We're contracted to do this for many public land agencies, including the BLM."

In the past, BLM and its regional partners provided BCI with the locations of abandoned mines as either shapefiles or in spreadsheets. BCI would then load this data into ArcGIS Pro to create web maps. Mobile crews could use the web maps to visit and record the conditions at each mine.

But recently, BLM asked BCI to create its own inventory of abandoned mines for a project in New Mexico. Patel, who leads BCI's geospatial work, had to create an entirely new workflow for this.

The Process of Finding and Safeguarding Bat Habitats

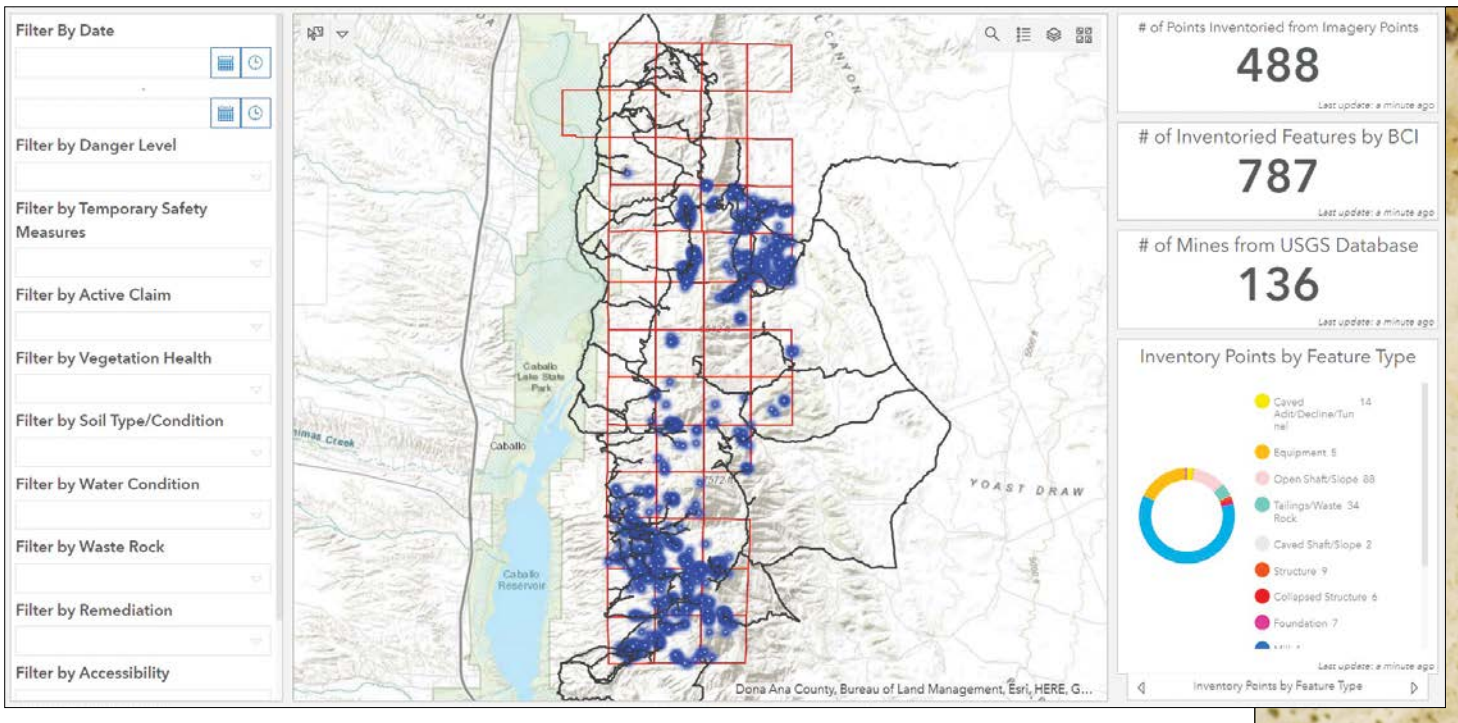
First, Patel used a topographic map of public lands from the United States Geological Survey (USGS) to try to determine known entrances to abandoned mines. After spotting patterns in the maps that indicate probable mine entrances, Patel used ArcGIS Pro to digitize these openings into points. To supplement his topographic map detective work, Patel also referenced satellite imagery, which allowed him to identify more potential mine locations.

The next step was to visit and verify the mines. Patel knew his mobile crew would need submeter accuracy to do this because abandoned mines often have multiple entrances located close together.

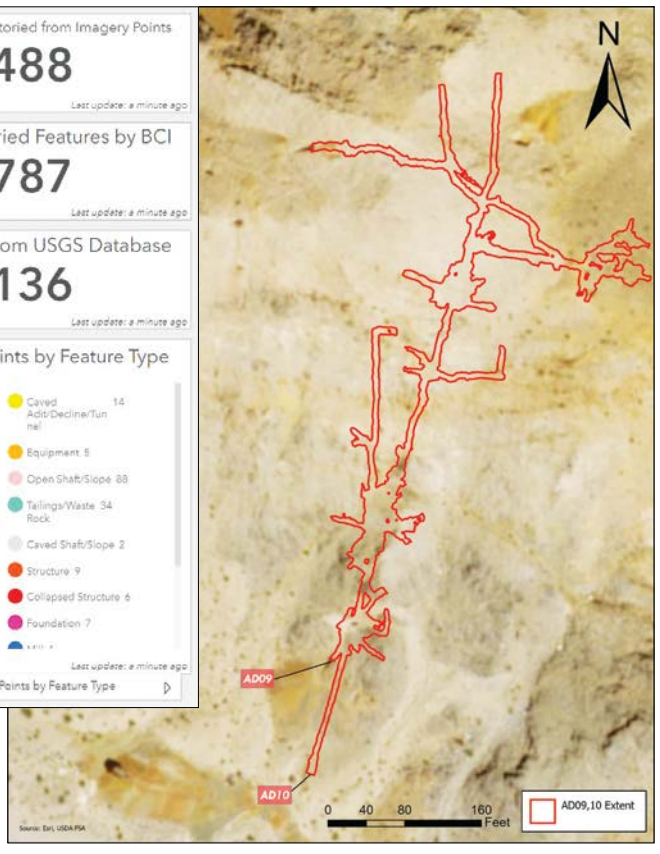
"Some mines are clustered together because they follow a common vein of ore," Patel said. "Due to this clustering, it's actually not that uncommon to have two or more mine openings that connect a few feet in. Using cell phone GPS, *[which]* is often off by several feet and sometimes up to 20 meters,…wouldn't result in accurate mapping of features, especially when in a cluster. This caused us to realize that we needed to verify each unique mine opening within a few feet."

Patel purchased two Arrow 100 Global Navigation Satellite System (GNSS) receivers from Esri partner Eos Positioning Systems to use for data collection along with ArcGIS Collector and ArcGIS Survey123. The Arrow 100 allowed Patel's crew members to navigate precisely to the points he had digitized and either verify, reject, or update the mine locations. If crew members deemed a point valid, they then used Collector to create the final inventory of the mines, and Survey123 to record rich attribute data for each mine, including its temperature, humidity measurements, and whether crew members detected insect parts or guano (bat droppings).

From this data, Patel can easily run a query on the mines BCI crews have visited to determine which ones constitute excellent, good, moderate, and poor bat habitats. Using ArcGIS Online, Patel also created web maps and dashboards that visually display this data so anyone can see the status of each mine.



↑ Web maps and dashboards built by Bat Conservation International (BCI) make it easy to see the status of each of the mines that mobile crews inspected.



→ Mines follow a common vein of ore, so the extent of an underground mine can be vast. BCI verified the area of this underground mine—depicted in red—using lidar data, Arrow 100 GNSS receivers, ArcGIS Collector, and ArcGIS Pro.

→ Abandoned mines now serve as habitats for bats. But not all abandoned mines have the ideal mix of moisture, temperature, and lack of predators for bats to thrive.

Any mine designated an excellent, good, or even moderate habitat for bats is recommended for long-term protection, triggering action by BCI's land management partners. This often means protecting the mine from human interference, usually by erecting barriers that close off the mine entrances—especially for mine openings that are near roads.

"That simple gesture can lower disturbance and help provide bats with an undisturbed environment in which they can thrive," said Patel.

Early Successes Give Hope for the Future

So far, Patel and his team have verified the locations of 785 mining-related features in New Mexico using their high-accuracy mobile surveys. Of these, about half—or 308 features—have been fully surveyed. Out of those 308 surveyed locations, only 8 show signs of being live bat habitats. That in itself emphasizes how difficult and critical it is for bats to thrive in unprotected areas.

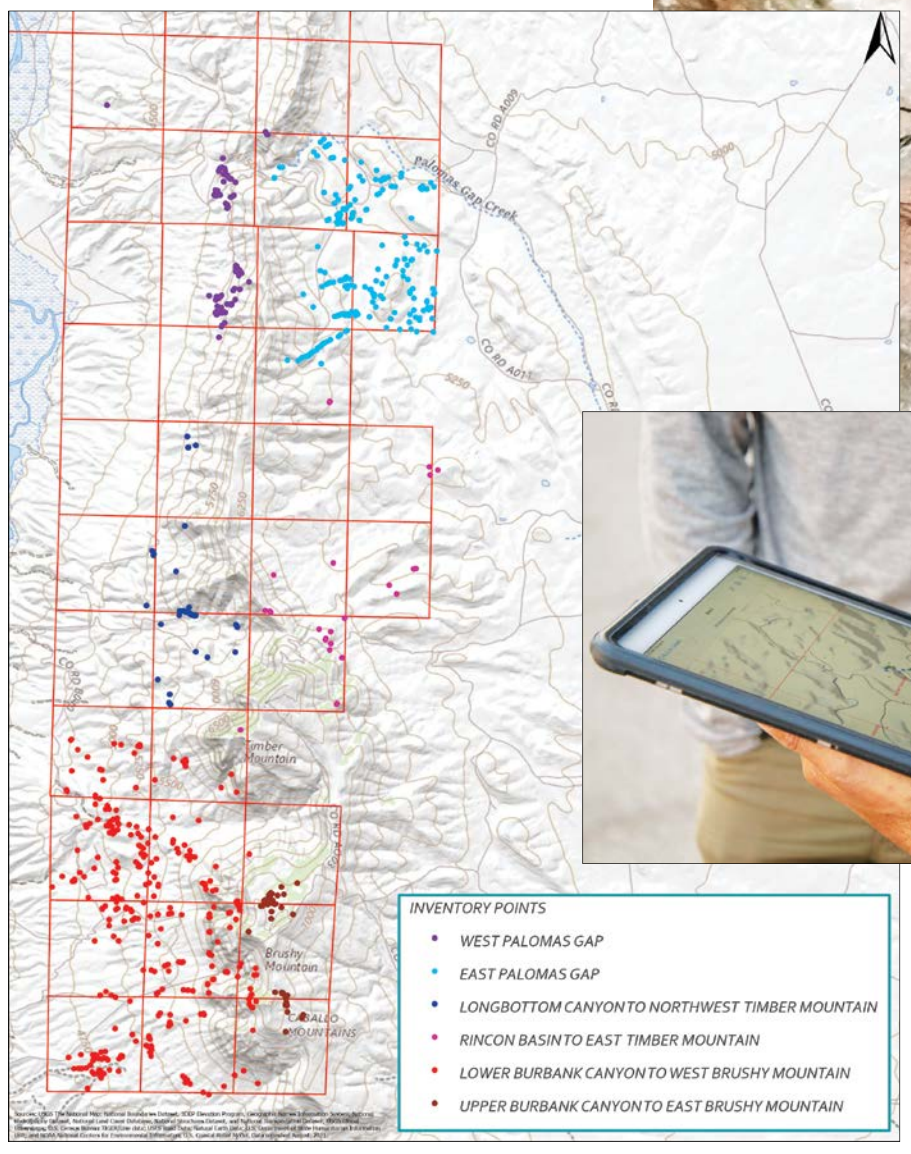
Initial feedback from BLM has been positive. Patel hopes that in addition to recommending meaningful closures to ideal mines, BCI staff members will be able to revisit the mines years from now to determine if the closures have had a positive impact on bat populations.

"I hope that one day we can *[return]* to monitor the area and see if this work has helped to improve bat habitat," said Patel.

In the meantime, BCI has expanded its high-accuracy mobile mapping workflow to assess raptor nests related to mine closure work in southeastern Utah. The team is also using the Arrow 100 GNSS receivers with ArcGIS Field Maps to georeference point clouds, taken with terrestrial lidar, that don't have built-in GPS capabilities.

"It's been fun experimenting with what is possible," said Patel. "Our goal is to get us to the point where land managers can look at data from afar and make good decisions based on the data."

For more information about BCI, visit batcon.org.



↑ By the end of the project, all the mines BCI had inventoried fit into six distinct geographic regions, represented on this map by different colors.

↑ BCI crew members used Arrow 100 Global Navigation Satellite System (GNSS) receivers from Eos Positioning Systems, along with ArcGIS Collector and ArcGIS Survey123, to validate potential mine entrances.

What It's Like to Enter the Subterranean Environment Bats Call Home

By Jason Corbett, Director of Habitat Protection and Restoration, Bat Conservation International

Editor's note: Not many people know what it's like to enter a cave looking for bats. It's a special slice of the world. Here, Jason Corbett, Bat Conservation International's (BCI) director of habitat protection and restoration, describes what it feels like to descend into a potential underground bat habitat.

Approaching the entrance, there are so many thoughts whirling through my mind.

First and foremost, I'm keeping an eye out for any snakes, which enjoy sunning themselves on the jumble of limestone rocks surrounding the small black hole I'm about to enter.

A palpable tingle of excitement hits me as I lower myself down. The rock I'm using is sharp and very grippy, which allows me excellent purchase from where I can stare directly into this seemingly endless blackness.

I let my eyes adjust. Now level with the entrance, I notice a gentle breath coming from the earth. I was expecting the air to be dank and unpleasant. Instead, it is cool and rich, earthy and loamy, even fragrant—akin to a handful of garden soil teeming with life. The coolness of the air contains a hint of dampness, and the tiny ferns and spray of mosses on the rock here attest to a life-giving moisture.

Just two feet behind me, where moments ago I stood, the environment is hot and dry—inhospitable to most life.

In front of me, however, the utter visual blackness of this hole complements the silence I hear, the nothingness carried forth on the cave's breath as it hits me. No sound greets me. No drip, drip, drip of water; no flutter of wings; no squeak of a rodent; and no chirp of a bird. It is black, cool, still, silent, and unknown. It's the type of place only a particular species could thrive in.

At this moment, I feel invited to enter.

↓ Mobile crews from BCI visited mines in New Mexico to determine whether they might be bat habitats.

A New Way to Navigate the Slopes: With Real-Time Geospatial Data

Offering sunny blue skies, the periodic blizzard, freshly groomed slopes, and a chance for family bonding time, ski resorts across the United States attract skiers and snowboarders of all ages and abilities from late fall through early spring. Even in the midst of the COVID-19 pandemic, the 2020/21 winter season brought an estimated 10.5 million snow enthusiasts to US ski areas—making it the fifth-best year on record—according to the National Ski Areas Association.

When visiting a new ski resort or taking to the slopes with people of different skill levels, it can be difficult for everyone to find the right meeting spot, stay on trails that aren't too technical, and navigate through a whiteout. But with Snow Mappy, a new mobile app from Esri startup partner Mappy (bemappy.io), skiers and snowboarders can now use location intelligence to find their way around the mountain. The app also provides resort operators with anonymized user movement patterns so they can get a better idea of how visitors traverse the slopes and engage with resort services.

Snow Mappy has three primary functions: find, navigate, and interact. Users can search for amenities and locate their friends and family on interactive 2D and 3D maps. And the app, which is available for download on iOS and Android devices, provides network routing based on user-defined skill levels.

"Snow Mappy is perfect for anyone who needs to see where they are on the mountain when they are not near a trail sign, wants route planning ideas tailored to their level, and wants to meet up with friends or family at a specific location," said Karyn Nolan, cofounder and CEO of Mappy.

The company, which Nolan founded in 2019, develops mobile apps and provides geospatial analytics to revolutionize the guest experience at ski resorts and other attractions. Snow Mappy is the company's first app and was inspired by Nolan's personal experience of trying to keep up with her skilled snowboarding husband.

"My husband is from Utah and is an expert skier and snowboarder. I grew up in California and am at an intermediate level, at best. Often, we would go to the top of the mountains, he would disappear down a run, and I would suddenly find myself confused, knowing I could inadvertently end up on a double-black diamond or the wrong part of the mountain," she said. "I've been in the geospatial industry for 25 years, and as I was pulling out large, unwieldy paper maps, I thought, there has to be a better way!"

Bringing the Mappy Vision to Life

Nolan leveraged her experience in the geospatial industry to find experts to create the app. First, she needed to build the technical architecture leveraging ArcGIS software. This led her to attend a technical workshop for developers at the 2019 Esri User Conference (Esri UC). Given that Nolan was not a developer by trade, the instructor recommended that she attend the developer clinic hosted by Esri Services at the Esri UC Expo. There, Nolan connected with Josh Peterson, a developer consultant at Esri, for a face-to-face discussion about her ideas.

"I felt like this light bulb had gone off over my head when I was sitting with Josh, sharing my big idea. I wasn't sure it was doable, and I was trying to figure out if I could afford to jump in with both feet. Josh gave me the confidence to give it a whirl," Nolan recalled. "He outlined the specifics of how to develop the app in a way that felt doable, so it began to be more than just an idea."

Nolan's vision for the app was to modernize the winter sporting experience by blending the fun of skiing and snowboarding with geospatial technology in a platform that provides real-time navigation and connection. But for her, leveraging GIS technology in an app environment for consumer use was no easy feat.

"It's very rare to find crossover between app developers and GIS," said Nolan. "Esri's technology is very powerful, but making sure that app developers are utilizing all the tools properly has been a challenge."

To overcome these foundational obstacles, Nolan got connected with the Esri Startup program, which provided the Mappy team with discounted Esri products and account support. For a startup like Nolan's, gaining access to technical experts who can help make key technology decisions and connecting with business partners that can augment the work is vital—and is often something startups lack. Peterson put Nolan in touch with Esri Services as well for GIS consulting and technical guidance.

"It isn't a role most would think of Esri Services playing, but we do it all the time," said Peterson.

"I was relieved to find out that Esri had professional services and that I could access expertise to help me with the overarching vision and the implementation," said Nolan. "It was amazing."

For a year and a half, developers collaborated to assemble the app's technical architecture. To create 2D and 3D maps of the ski lifts and runs (rather than roads), the developers used ArcGIS Pro with ArcGIS Network Analyst. They built custom network datasets that equip the app with turn-by-turn navigation and real-time location sharing via mobile map packages, mobile scene packages, and ArcGIS Enterprise. They also employed ArcGIS Runtime SDKs to integrate the GIS data and capabilities with the native iOS and Android mobile apps.

Nolan hired FreshWorks Studio to build the user experience (UX) and manage the iOS app deployment. Esri partner GEO Jobe, which creates custom ArcGIS technology-based solutions, was brought in to assist with implementing the ArcGIS Runtime SDKs. GEO Jobe developers initially focused on fixing critical bugs within the app, such as the loading and rendering of 2D and 3D scenes, and then they stayed on to provide frontline support for launch day. Esri partner SpatialMax joined the team as well to help with Android development. Together, all these collaborators helped build Snow Mappy's initial operating capabilities and ensured that it had sound architecture for future growth.

"Several aspects of this partnership have been rewarding—working directly with the Esri Services team, gaining exposure to the ski resort industry, and integrating with a startup organization," said Eric Goforth, director of professional services at GEO Jobe. "Mappy intends to scale up rapidly…and we are happy to be part of the team that is enabling that growth."

In addition to the consumer side of Snow Mappy, Nolan's vision includes a business-to-business component that provides data analytics and visualization tools to ski resorts to help them improve services and support data-driven decision-making. Mappy leverages ArcGIS Velocity, a cloud-native add-on capability for ArcGIS Online, to provide real-time processing and analysis of anonymized user data captured during the ski season. This enables resort managers to determine guest movement patterns so they can improve operations. For example, Mappy and GEO Jobe employed big data analytics in Velocity to evaluate skier days (an industry metric that shows how many people visit a ski resort over time), guests' spatiotemporal trends, and skier and snowboarder speeds in conjunction with datasets for on-mountain assets, such as ski lifts, runs, and snowmaking machines. The collected data is then made available on dashboards, built with ArcGIS Dashboards, for resort staff to visualize.

"It has been a long journey—a lot more than I anticipated," Nolan reflected. "But I am grateful for the whole team, the Esri Startup program, and all the account managers who have guided me through the process."

Navigating the Slopes Ahead

Snow Mappy on iOS launched in beta in February 2021 at five resorts in California, Colorado, Oregon, and Utah. Nearly 1,500 iOS users downloaded Snow Mappy, generating close to 7.5 million real-time skier data points. For the 2021/22 ski season, Mappy is supporting almost 20 resorts across the United States and Canada on both iOS and Android.

"People have been super excited about Snow Mappy," said Nolan. "While we thought that the interactive map would be the biggest draw, users have told us they enjoy the 3D view of the slopes and being able to identify runs, lifts, and their location on the mountain. We have also had consistent feedback that the ability to find your family and friends is very helpful."

Inspired by user testimonials, Nolan hopes to expand Snow Mappy's functionalities to include itinerary planning, bragging rights, social feedback, and fitness tracking. Future goals include implementing indoor resort navigation using ArcGIS Indoors and enhancing the app's UX with augmented reality (AR). Nolan also has plans to expand Mappy apps to markets such as relay racing, mountain biking, music festivals, and theme parks.

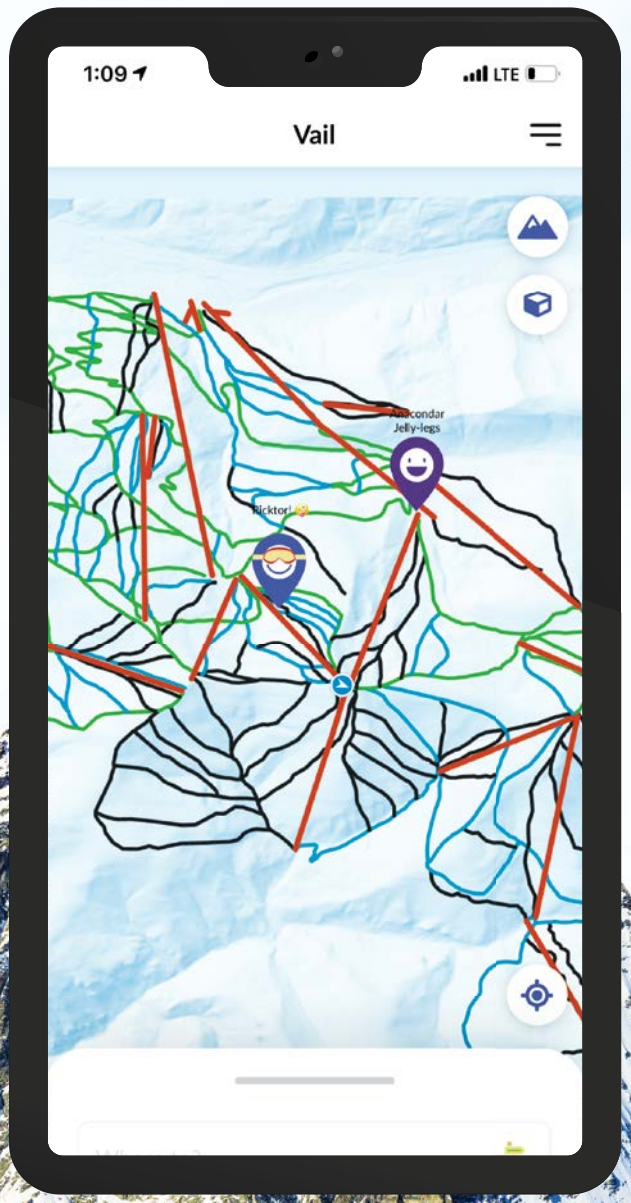
"Mappy mobile apps, map services, and data analytics can be easily rebranded and repurposed to a variety of markets," said Nolan. "The interface and functionality stay basically the same, while the customized map services and design elements change."

Nolan and her team are currently developing a companion app to Snow Mappy for hiking and biking that can be used at the same mountain resorts during the summer months. But one thing she is excited for in the near term is for GIS professionals to use the app.

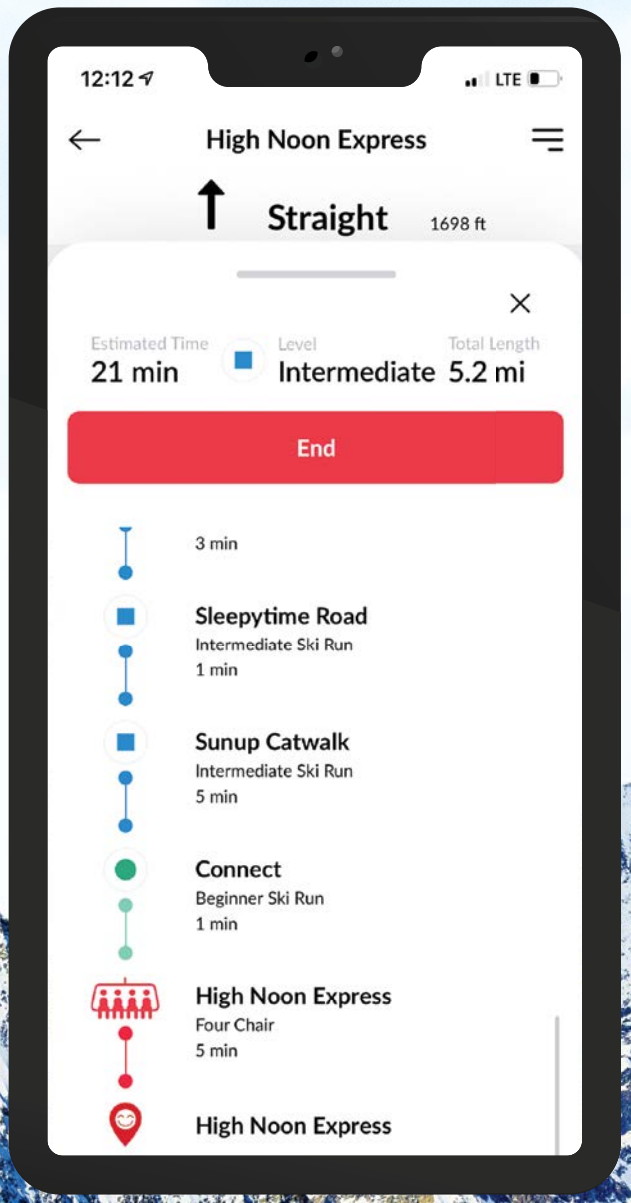
"It is one thing to have the general public use the app, but it's another to have GIS professionals and the community of Esri technology users to play around with it," she said. "We hope they enjoy using it, and we are looking forward to receiving their feedback."

The Esri Startup program gives emerging businesses an edge by helping them integrate spatial functionality into their products and services. Learn more about the program at developers.arcgis.com/startups.

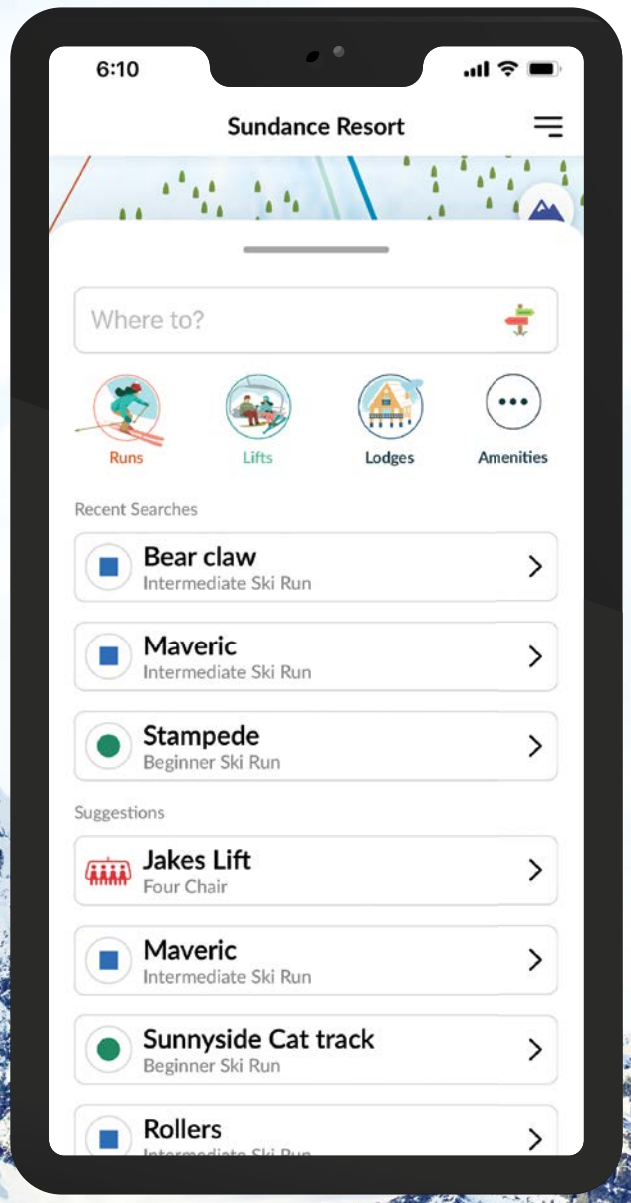
↓ Snow Mappy users can locate their friends and family on interactive 2D and 3D maps.



↓ Skiers and snowboarders can use turn-by-turn navigation to ensure that they stay on routes that match their skill levels.



↓ Snow Mappy suggests certain runs based on user-defined skill levels.



Esri Partners Set Industry Standards

With their expertise in implementing GIS solutions that incorporate advanced analytics, 3D modeling, and state-of-the-art data management systems, Esri partners are helping their clients set examples in their own industries. Read on to find out how three partners are blazing trails in aiding utilities with location-based risk analysis, building digital twins for sustainable development, and slimming down still-robust imagery operations.

A Novel Way to Determine Risk of Failure

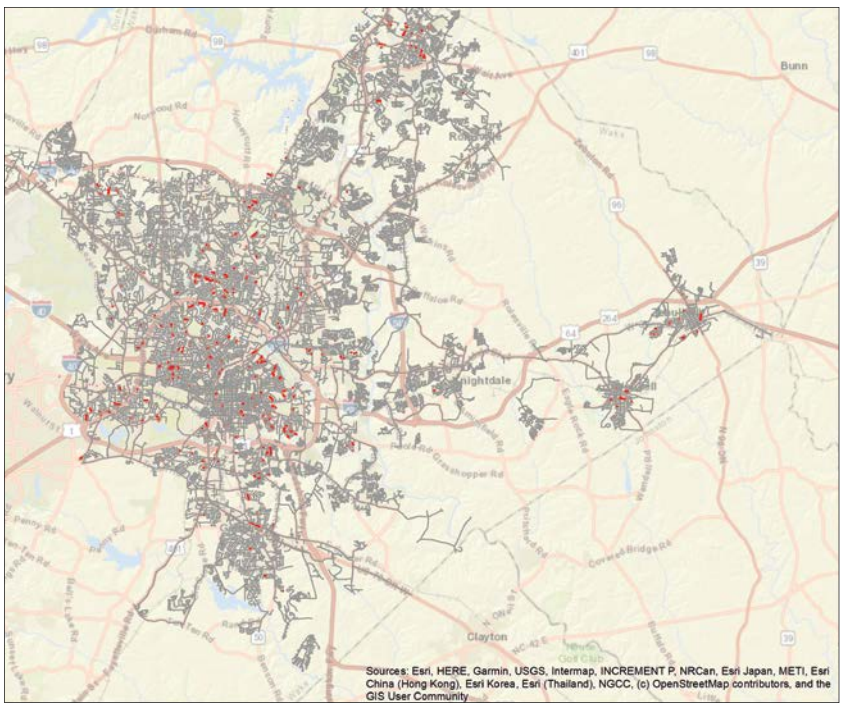
In Raleigh, North Carolina, it was becoming increasingly difficult for the city's public utilities department, known as Raleigh Water, to conduct efficient risk management on its 2,340-mile pipeline network. Utility leaders sought a partner that could help them gain greater visibility into water pipeline conditions, more accurately predict which pipes were in danger of breaking, and more efficiently prioritize capital works projects. **Xylem** (xylem.com), which delivers innovative solutions to solve water problems, fit the bill.

Using its Asset Performance Optimization solution, Xylem's team of industry and technical experts conducted a probability analysis on Raleigh Water's entire network, which includes more than 88,000 individual pipe segments. The team combined historical data on pipeline breaks with other infrastructure information that the utility maintains in ArcGIS Enterprise—including the location, size, length, and material of all of Raleigh Water's pipelines—to identify 16 specific 1.5-mile sections of pipeline that contain the greatest number of pipe segments at risk of failing.

Incorporating location intelligence into advanced risk analysis provided Raleigh Water with a more accurate, predictive, and targeted view of its network's potential trouble spots than it could have achieved through traditional analysis methods. To date, Raleigh Water has used Xylem's probability-of-failure and cluster analysis results to plan six capital renewal and smart meter projects—and the utility continues to employ the solution to develop more efficient asset management strategies. It is estimated that the work done with Xylem has reduced project planning time at Raleigh Water by about 75 percent, saving the organization up to five days for just this part of the process. The implementation has also cut down on the number of pipe breaks that have occurred across the network.

In addition, Raleigh Water is using this data-driven understanding of pipe failure risk to place smart sensors that gauge water pressure on key pipe segments. This removes any potential for bias when determining where to do capital improvement projects, ensuring that no communities are neglected when it comes to upgrading infrastructure.

As one of the first utilities in North Carolina to use advanced risk analytics, Raleigh Water is proactively working on behalf of its customers, using data to achieve new levels of network visibility and drive asset intervention plans that reduce breaks and increase operational efficiency.



↑ Pinpointing clusters of pipe segments (in red) that have similar risks for failure is helping Raleigh Water build more equitable asset management plans.

A Digital Twin for City Planning

In Karlskrona, Sweden—a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Centre—the Environmental and Public Works Administration has set out to establish a digital twin of the city by 2030. The goal is to use the digital twin as a 3D city information model (CIM) and data-driven test platform for city planning, which will help city leaders better consider ecological, social, and economic sustainability options.

The city called on its long-term partner **S-GROUP Solutions** (sgroup-solutions.se), which specializes in building GIS solutions for local governments, to help make the digital twin. Because the City of Karlskrona has invested in an Esri Enterprise Agreement (EA), along with GEOSECMA for ArcGIS, a commercial off-the-shelf (COTS) solution from S-GROUP Solutions, the Environmental and Public Works Administration was able to use ArcGIS technology as the foundation for its digital twin. ArcGIS Pro and ArcGIS Urban are particularly important for visualizing the 3D model.

GEOSECMA for ArcGIS provides the CIM with Karlskrona's domain data, which covers the city's road networks, its water and sewer grid, comprehensive zoning plans, tree inventories, playground inspections, and more. Not only that, but GEOSECMA for ArcGIS also has built-in and continually updated support for Swedish regulations, helping the city ensure that its designs correspond to national planning laws. This enables staff at the city to use the data in the CIM to perform accurate, scenario-based GIS analyses—which can be used to model city silhouettes, conduct studies on noise and shadow changes, determine construction rights, and more—to help leaders make smarter decisions about sustainability. Together, the CIM and digital twin allow staff in the Environmental and Public Works Administration to create, test, and build everything in a virtual environment. When the results correspond to Karlskrona's sustainability goals, construction of the physical environment can begin.

Thus, using GIS allows city leaders to increase citizen services; optimize building rights; decide on the most suitable locations for new schools, housing, and industry; and consider the environmental effects, people's safety, the perspectives of children, and other important factors of city plans.

This kind of thoughtful urban design has made the City of Karlskrona a role model in Sweden for the use of digital twins, which is especially important considering that the Swedish government has set goals for developing digital community building processes. The aim is to create simpler and more transparent, democratic, and efficient planning and construction processes that benefit residents and private companies—something that Karlskrona is already doing.

↑ Using GEOSECMA for ArcGIS helps the City of Karlskrona ensure that its designs correspond to the Swedish laws that regulate planning.

A Streamlined Imagery Management Strategy

The United States Marine Corps (USMC) Installation Geospatial Information and Services (IGI&S) program, known as GEO*Fidelis*, needed a new imagery management strategy to support the transition to an enterprise implementation with increased analysis and dissemination capabilities. The program's existing imagery holdings were managed locally in various storage formats without set naming conventions or common standards and procedures.

To help with this endeavor, **geocgi** (geocgi.com) worked with GEO*Fidelis* to implement imagery management standards and design a corresponding solution based on ArcGIS Image Server and mosaic datasets. Initially, the team at geocgi focused on reducing the storage footprint of the 500 million acres of raster coverage that GEO*Fidelis* had. Implementing mosaic datasets reduced storage space while allowing for easier user access, more visualization and analysis options, more flexible data management, improved performance, and enhanced dissemination of imagery and raster datasets across the USMC.

After the storage issues were remediated, the geocgi team analyzed the program's existing raster datasets to determine gaps in coverage, currency, or format, as well as how users typically accessed raster data. This enabled the team to specify where to direct service resources and how they should be utilized. geocgi deploys and manages a fluctuating number of image services that it analyzes and reviews quarterly for usage to maintain server stability, averaging about 80 services per quarter. Based on frequency of use and importance, certain image services can be demoted, or stood down, to reduce storage costs.

To better manage its imagery in the future, GEO*Fidelis* is focused on acquiring imagery by leveraging collections from small unmanned aircraft systems (sUAS) and mosaic datasets. The goal is to figure out where GEO*Fidelis* can save on costs for imagery while still meeting the program's requirements for refreshing imagery. To this end, GEO*Fidelis* is concentrating image capture on areas that have changed rather than on entire installations. This allows imagery updates to be delivered to end users quickly to support functions such as emergency management, facilities management, and construction. In addition, the sUAS technology and mosaic datasets support on-the-fly processing, which makes it possible to get new imagery acquisitions to decision-makers without delay.

Through scripting and batch process development, geocgi has increased the raster services that are available to the USMC by 588 percent and improved service load times by 29 percent.

↑ High-resolution imagery can be used to do detailed assessments of pavement conditions to refresh facilities maintenance plans.

Esri partners represent a rich ecosystem of organizations around the world that work together to amplify The Science of Where by extending ArcGIS technology and implementing it in distinct ways. Search for and discover partners, solutions, and services that meet your needs at esri.com/partners.

São Paulo Optimizes Economic Growth with Spatial Intelligence

The state of São Paulo produces nearly one-third of Brazil's gross domestic product (GDP), according to the Brazilian Institute of Geography and Statistics. Its capital city, also São Paulo, is considered an alpha city by the Globalization and World Cities Research Network, meaning it links important economic regions to the rest of the world. Key industries in the state include aerospace and defense, agribusiness, automotive production, oil and natural gas, health care, financial services, and communications.

To sustain economic growth, the state's Department of Development created a division called the Investment Promotion Agency for the State of São Paulo (InvestSP) in 2008. The focus of InvestSP is to act as a gateway for new investors and support companies that are already established in the state.

One of InvestSP's primary roles is to help investors and entrepreneurs select sites for their new or expanding businesses. While the government organization started out employing a manual, statistics-based method for this, leaders at InvestSP quickly realized that they needed to employ GIS to a greater degree to spatially inform their decision-making. That's where ArcGIS Pro and several powerful extensions now come into play.

A Statistical Process Has Limits

Location intelligence is central to InvestSP's three primary services, according to Pedro Fittipaldi, investment manager for the environment at InvestSP.

"First, we help entrepreneurs identify the best locations in the state to invest, according to the needs of their activity, including workforce, infrastructure, incentives, logistics, availability of suppliers, size of consumer market, and the environment, among other factors," he explained. "Second, we assist potential investors in their dialogue with public agencies, with the intent to facilitate the decision-making process and the implementation of new projects. Lastly, we provide specific and strategic information on the best locations to invest, depending on our investor's requirements, in the state of São Paulo."

Initially, teams at InvestSP used a statistics-based process to conduct site selection for new businesses in São Paulo. They would take economic data and cross-reference it with generic sector needs to help identify suitable municipalities for each project. After investors agreed on a short list of locations, InvestSP employees would contact each municipality with a list of potential sites for the project to work out more details and whittle the list down to a final location.

This process was effective for many situations. But after a while, its shortcomings became clear—especially when it came to considering site characteristics that don't necessarily follow municipal boundaries, such as zoning, surrounding infrastructure, available natural resources, and environmental restrictions. So in 2012, InvestSP began working with Imagem, Esri's distributor in Brazil, to develop an ArcGIS Desktop software-based spatial intelligence system for site selection.

"Imagem has always provided us with valuable updates, insights, and help in the development and implementation of GIS solutions," said Fittipaldi.

ArcGIS Technology-Based System Improves Site Selection

ArcGIS Pro is now the foundation of InvestSP's system, which also makes heavy use of ArcGIS Data Interoperability, ArcGIS Spatial Analyst, and ArcGIS Business Analyst Desktop. The data maintained in the system, which includes hundreds of demographic and economic characteristics at the municipal, regional, and state levels, is regularly updated by business intelligence specialists. This allows the investment projects team to create dozens of political, economic, and environmental maps.

For site selection, ArcGIS Pro is used to "filter municipalities and locations according to project criteria to produce cartographic materials, which are used in the presentations we send to investors and other decision-makers," Fittipaldi explained. "It is also extensively used in our environment and infrastructure consultancy processes, which encompass evaluations such as energy connections, environmental restrictions, and so on."

The typical site selection process for a project now starts by forming a list of potential locations based on parameters that the investors set. InvestSP has a database of more than 1,000 sites that are suitable for development throughout the state of São Paulo. The business intelligence team takes this, together with additional criteria provided by the investors, and cross-references it using ArcGIS Pro to pare down the initial long list of potential sites into a final list of up to five sites that are appropriate for that specific development. The investors then evaluate these sites in greater detail until they reach a decision.

Spatial Analyst has been particularly useful for producing customized multidimensional cartographic products that the business intelligence team at InvestSP can use to display a single layer.

"For instance, InvestSP was recently requested to support a strategic regional telecom infrastructure investment initiative in one of São Paulo's least-developed municipalities as part of *[the state's]* Vale do Futuro (Valley of the Future) Program," said Fittipaldi. "We did this by creating a weighted overlay map to highlight areas which should be prioritized considering population, schools, medical clinics, tourist attractions, presence of traditional peoples, and other characteristics."

Fittipaldi and his team find Data Interoperability to be very useful for integrating spatial data from varied sources into a single, coherent database. Business Analyst Desktop helps them choose commercial and service-based sites in intraurban settings, thanks to its high level of granularity in analyzing income and expenditure data. Additionally, they use ArcGIS Geostatistical Analyst to interpolate surfaces and make predictions about what the final development might look like to facilitate the decision-making process.

Most of the data used in the system is obtained from official public sources, though InvestSP does develop some internally based on specific project needs. In particular, the business intelligence team generates data about where potential suppliers and customers are located, among other information, and geocodes this on demand.

"Our most commonly used indicators include population and general demographics, the *[United Nations']* Human Development Index and other quality-of-life indexes, workforce availability, education data, health-care indicators, police force and criminal activity, environmental indicators, and industry-specific information," Fittipaldi noted. "Usually, the indicators are used as filters,

and the specific criteria is provided by the investor companies at the initial stage of project facilitation. For instance, a company with large industrial operations will normally require cities with an adequately educated workforce, close proximity to suppliers, easy access to utilities, etc."

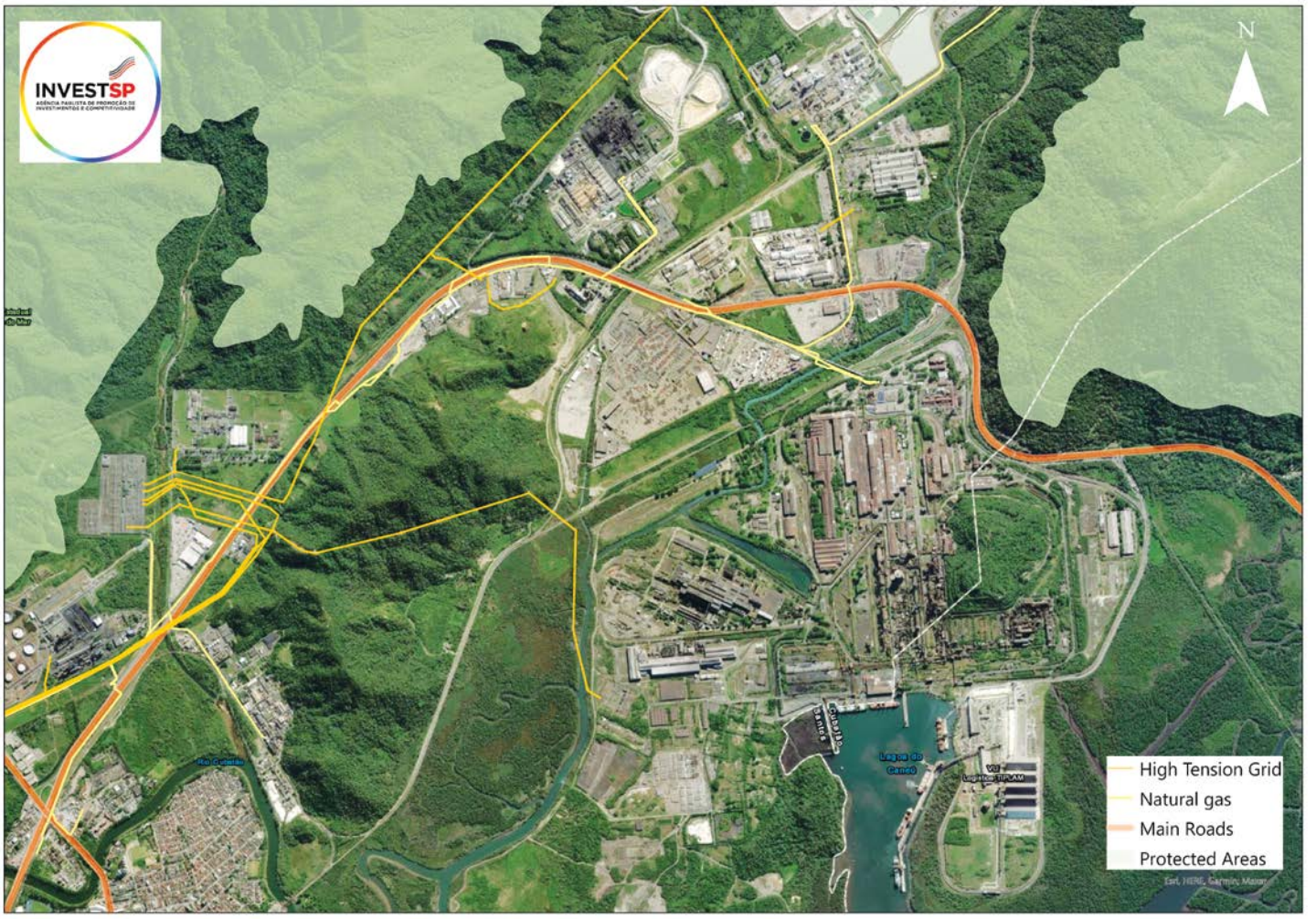
The project team at InvestSP then trims down and adjusts the criteria to match the available data, which, according to Fittipaldi, facilitates an exact selection process of potential operational locations.

Spatial Intelligence Finds Additional Uses

So far, the primary focus of InvestSP's spatial intelligence system has been on project development for investment. But the teams at InvestSP also often use it to support training activities and communication.

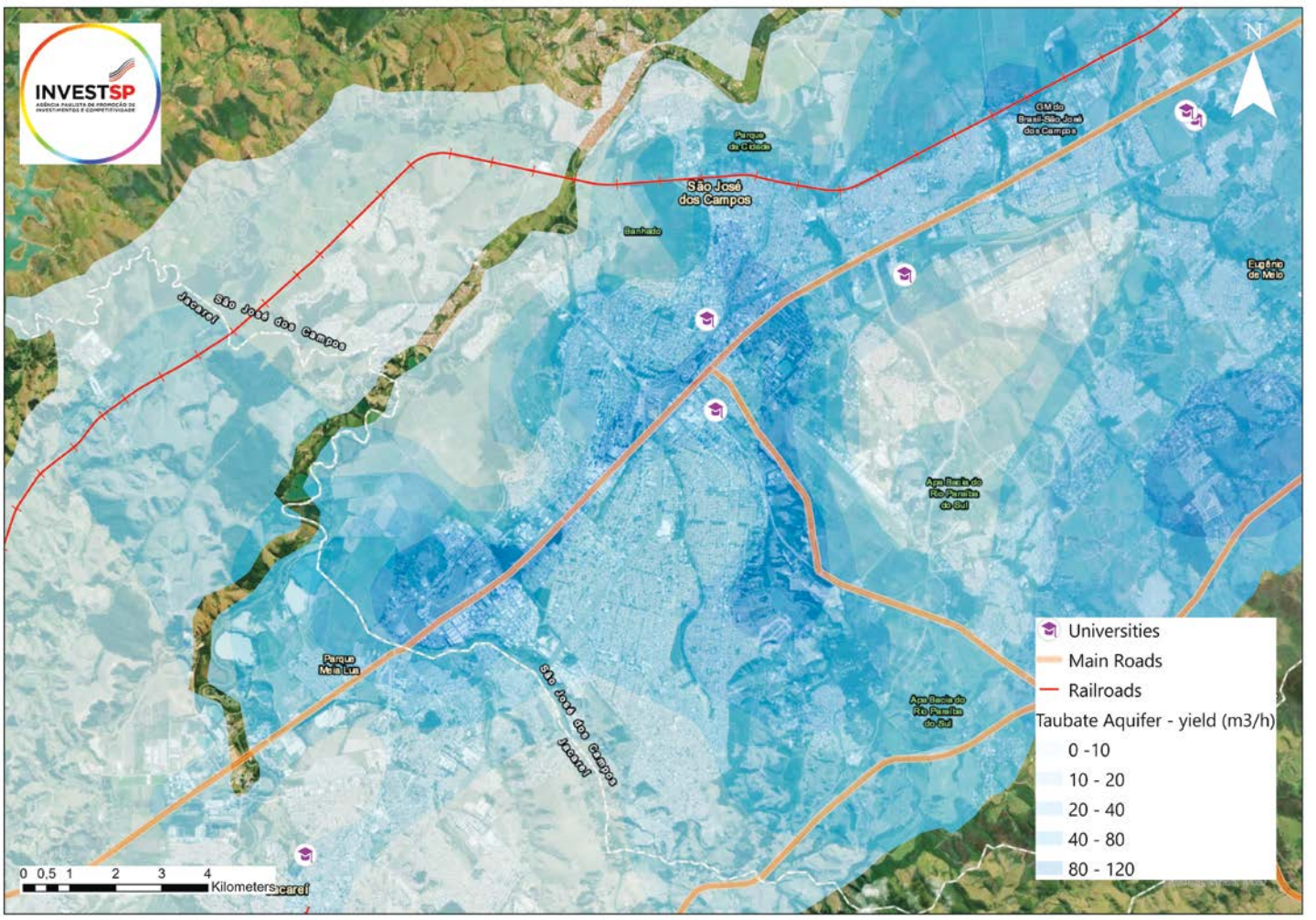
"InvestSP is always looking for ways to use the power of spatial intelligence to attract investment and perform associated initiatives," said Fittipaldi. "For instance, InvestSP provides investment promotion training for the state's 645 municipalities. In the training processes, the system is used as a support tool to demonstrate geographic features such as zoning and infrastructure. However, it is also used to highlight the importance of spatial intelligence as a key component of a benchmark investment promotion strategy. ArcGIS *[technology]*-based spatial intelligence tools are an efficient and cost-effective way to help drive both strategic planning and the process of attracting new investment."

The success of InvestSP's spatial intelligence system is best demonstrated by its results. Since its implementation about a decade ago, the agency has attracted 281 new investment projects that total US$27 billion. This has added 181,000 new jobs to the workforce in the state of São Paulo.



↑ São Paulo's coastal region is a particularly challenging place to start new ventures, so projects in these areas require sophisticated planning.

↓ As climate change becomes the norm, new projects require investors to carefully consider complex spatial issues such as the availability of water.



Property Tax Overhaul in Finland Relies on Advanced Spatial Analysis

Finland is one of the few countries in the world where there are separate tax rates for a residence and the land on which it sits. The tax on the structure is based on its replacement cost, while the land tax is based on its market value. Currently, the nominal tax rate for structures varies between 0.41 and 2.0 percent, while the tax rate for land ranges from 0.93 to 1.9 percent.

But this system of property taxation, which was introduced in 1993, is out-of-date. So the government of Finland is reforming property taxes, revising both its valuation methods and property tax values. Based on the current schedule, the new values will be published in 2023.

Key to this property tax overhaul is the National Land Survey of Finland (NLS), which has been tasked with determining new land value zones throughout the country. To perform the complicated analyses required to redo a whole country's property tax system, the team at NLS is relying heavily on ArcGIS Pro and ArcGIS Geostatistical Analyst. According to Arthur Kreivi, chief expert at NLS, incorporating these powerful geospatial tools in conjunction with classic statistical modeling methods has sped up the reevaluation process and improved the quality of NLS's work.

"The old valuation system used for taxing land was very outdated," said Kreivi. "For example, the land value zone maps, on which we base our property tax, were made more than 20 years ago. The new methodology we have developed provides far more accurate land value estimates. The process combines an intensive use of market information; traditional hedonic models, which calculate property values; and spatial analysis."

The team at NLS that is designing Finland's new land value zones uses ArcGIS Pro extensively to develop and maintain what's called the Value Zone database.

"ArcGIS makes it easy for us to analyze both point- and area-based data," said Kreivi. "We also use it to create thematic maps, as well as *[meet]* other mapping requirements."

The methodology for the new property valuation system is divided into four steps: collecting data and checking its quality; calculating the Constant Quality Price (CQP), which corrects price changes on properties in relation to an established baseline; performing GIS analysis; and calculating unit values and premiums.

To determine a property's value, team members primarily use data collected from public registers, although in some cases, they employ nonpublic databases that are maintained by taxation authorities. Three different types of price data—plots, detached houses, and apartments—are then used to estimate the value of land. Before the data is exported for use in the Value Zone database, it undergoes extensive preprocessing for standardization.

Team members then use the hedonic model to produce the CQP. The results of this part of the process include the location of a property, its price point, and its CQP value.

The GIS analysis that the team performs is based on the results of the hedonistic model and the formation of microregions. A microregion is created by combining elements from the NLS's topographical database—such as roads, waterways, railways, and city plan areas—to create a small area of land in which real estate transactions take place. The team then calculates the median CQP of the price points for land and residences in each microregion, producing a preliminary land value zone.

"Land value zones are formed by combining microregions as a starting point. Thus, they are very similar *[to one another]*," Kreivi explained. "The most significant difference, of course, is size. Microregions are small areas that may not include many real estate transactions. The aim is to make the largest possible homogenous land value zones. These zones must be large enough to obtain a sufficient number of transactions to obtain accurate appraisal data."

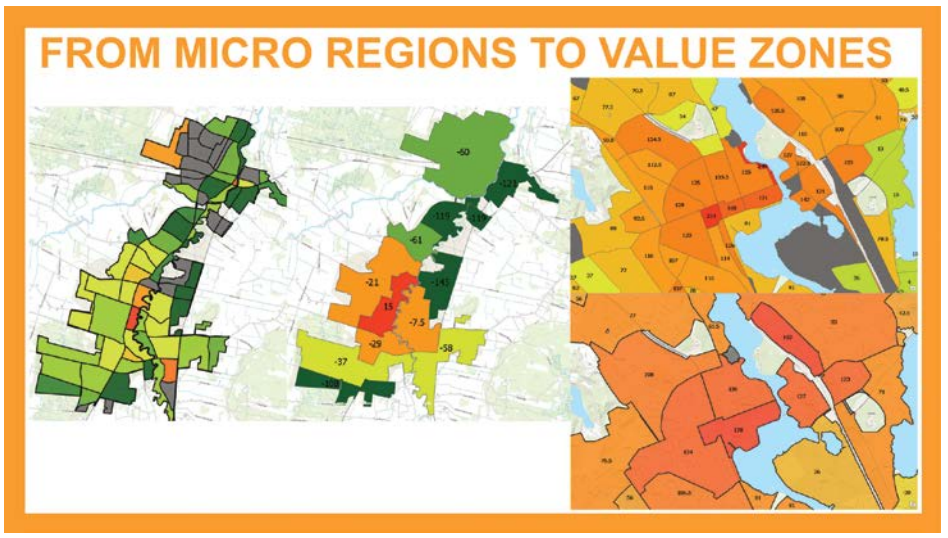
Another method of analyzing price data that the team at NLS uses is empirical Bayesian kriging (EBK), a geostatistical interpolation method that automates the most difficult aspects of building a valid kriging model. For this, the team employs Geostatistical Analyst, which automatically calculates parameters by grouping subsets of data together and performing simulations. According to Kreivi, this allows the team to quickly determine how real estate prices vary in different areas.

The final part of the analysis involves doing a mix of standard hedonic regression analysis and spatial analysis to identify the property sales in value zones and calculate the weighted median, or mean price of properties, in a value zone over a specified period.

"The calculation gives more weight to the plots compared to other data sources," said Kreivi. "Newer sales also get more weight. By combining all of these analyses, we form the final land value zones and related maps on which the land values and taxation *[are]* based."

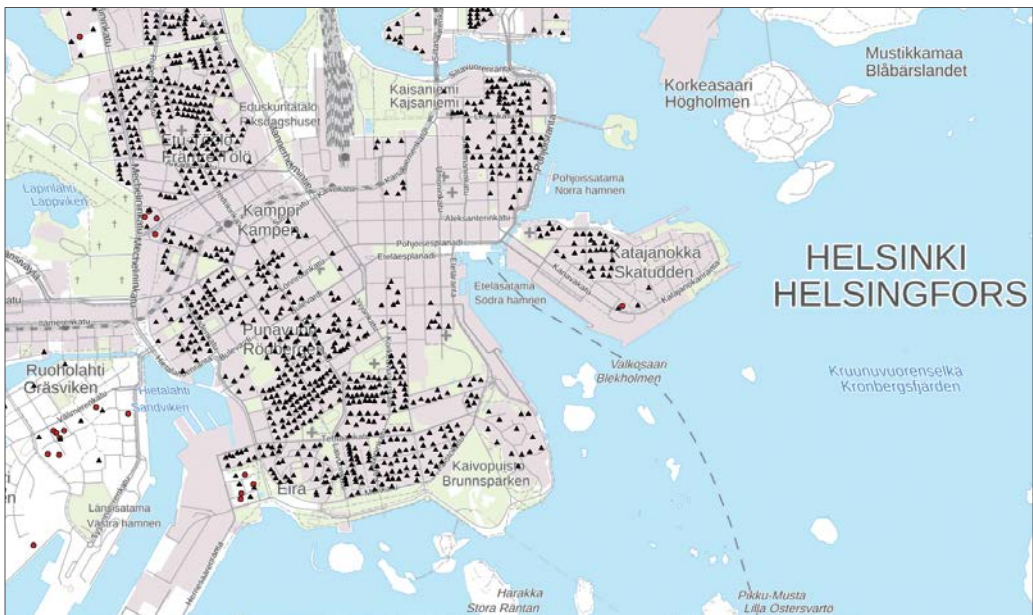
Using ArcGIS technology to help create Finland's new property valuation methodology has been immensely successful, according to Kreivi.

"It allows our land value zones to be produced more quickly and effectively compared to traditional real estate appraisal. A team of 10 professionals can now estimate the land value of approximately two million properties in one year," he said. "Implementing spatial analysis as part of our property tax valuation process has increased efficiency and improved the quality and accuracy of our evaluations. In modern property tax systems, such as ours, GIS plays an important role both in the valuation phase and in providing information to the client."



↑ After the team performs advanced statistical and spatial analyses, microregions (left) become the new value zones (right) on which Finland's new property tax system will be based.

↓ For big cities, apartment prices play a significant role in determining the value of land.



To Find Success in the Geospatial Industry, Be Consistently Engaged

By Siddharth Pandey, Dewberry

Managing GIS
A column from members of the Urban and Regional Information Systems Association
URISA Fostering Excellence in GIS
www.URISA.org

When I think back to the early days of my geospatial career, I remember feeling overwhelmed by all the things I could do with my GIS degree. The industry has grown extensively since I graduated from college in 2014—and continues to do so. Just in the last two years, awareness of geospatial technology and analysis has flourished, largely due to their use in monitoring the COVID-19 pandemic.

With the applications of geospatial technology continually increasing, there will likely be more budding geospatial practitioners embarking on new careers, along with other kinds of professionals from a range of industries picking up fresh geospatial skills. So how will you ensure that you stand out from the crowd?

One way is to always be engaged. When you're first starting out, be proactive about your career and take every chance to build your personal brand and network. Then keep doing that! Don't let your age or years of experience hold you back from pursuing opportunities that are interesting to you. After all, we are our own greatest advocates.

Here are some ideas for how to consistently stay involved in the GIS community, no matter which career phase you're in.

Identify Where—and How—You Can Add Value

To effectively build your personal brand and promote yourself while creating new opportunities, it's important to develop a good understanding of the organizations you belong to, from the school you attended and the company you work for to any professional societies you belong to.

Take time to learn about what each organization does and the roles and responsibilities of the people within it. Do you hear your coworkers discussing a process they'd like to improve? If so, think about how your unique skill sets and qualities might contribute to solving that problem. Then find a way to offer them up. Perhaps your colleagues would like to automate a time-consuming task, and you know a Python script that could help. Tell them about it!

Getting to know your peers—especially people who aren't on your team or in your department—can be beneficial. While that might sound intimidating, you can take things at your own pace. Start slowly, if you'd like, by challenging yourself to reach out to at least one new person every month or quarter. Learn about what your peers do, their goals, and even the obstacles they face. You might not be able to do anything for them right away, but that information can help you better understand how your work and experience fit into an organization and where you might be able to provide support in the future.

The beauty of the GIS industry is that there are countless ways to apply geospatial technology. A good approach for exploring these options is to familiarize yourself with the people around you—especially those who don't use GIS in their daily work. Learn what they do and how they do it. That can shed light on why they're not using GIS. Is it because they don't know that GIS would work for their situation? If so, that's something you can help with, so don't hesitate to share your thoughts.

Put Yourself Out There

Developing connections with others in your network can take time. It can also feel daunting, especially when you're just beginning your career. But it's important to build your list of contacts and share the value you bring to an organization.

I remember the first Esri conference I attended, the 2015 Esri Federal GIS Conference. I was completely overwhelmed with the idea of walking around the Convention Center among hundreds of other GIS professionals who all seemed to know each other, introducing myself to try to make connections. Thankfully, with some encouragement from the Esri Young Professionals Network, I spoke with employees from a few companies in the Expo hall. I got comfortable with initiating conversations with potential employers, talking about what I was looking for in a job, and describing what I could bring to their organizations. These conversations opened additional opportunities, and several weeks later I was hired by one of the companies I pursued in the Expo hall.

In the workplace, explore special teams, assignments, and events that your organization offers, including employee resource groups, volunteer days, open positions, upcoming projects, and other means of collaboration. Find ways to get your name out there—perhaps through your company's intranet or message boards, by participating in an internal group or activity, and even by posting on a career-focused social network like LinkedIn. Be consistent about reaching out and contributing to discussions and activities. It can help you cultivate your internal network; be informed about new opportunities; and, ultimately, get noticed.

If you're unsure about what to share with your network, don't be discouraged. I was, too, when I first thought about using my company's intranet. It's all right to start small. But it's also important to think about the information you share and how your colleagues can benefit from it. You could begin by sharing something interesting you learned that has helped you with your work. By posting just one thing, you'll break the ice and put together your first piece of content. You'll then start to establish yourself as someone who's willing to jump in and help out. And if you consistently share helpful information, others will develop trust in you!

Additionally, if your colleagues reach out for support on an issue, don't hesitate to respond with your ideas—even if you're not an expert on the subject. Sometimes a new perspective, or someone to bounce ideas off of, is exactly what they need to problem-solve. The content you share can determine what people view you as a resource for and increase the likelihood that they will reach out to you with questions or opportunities.

Remember to Branch Out

It's easy to become content within an organization, so make sure you keep yourself open to new opportunities. Pursuing activities outside your organization can be very rewarding and even help you grow within your current role.

Consider joining a professional organization, such as the Urban and Regional Information Systems Association (URISA) or another professional organization in your area. These groups encourage their members to engage with other professionals, build leadership skills, volunteer their time, and learn new things that are applicable to a range of projects. For example, URISA offers multiple webinars and training programs, including the Geospatial Leadership Academy, which helps attendees hone both their leadership and technical skills. The URISA Mentoring Network, managed by the Vanguard Cabinet, enables participants to learn from other geospatial professionals while supporting those just coming up in the industry. URISA is also a great place to present your work and build a network that will help you throughout your career.

Regardless of how or where you interact with your network and people in the GIS industry, it's important to get engaged and stay consistent. Actively participate in activities within your organization and the larger industry. Jump at new opportunities, even if you aren't sure you're ready for them. And help others when you can. Take these risks—or risk missing out on great opportunities.

→ Talking to people at industry events like the Esri User Conference (Esri UC) can build your network and open doors to new opportunities.

About the Author

Siddharth (Sid) Pandey is a senior associate and senior geospatial technology manager at Esri partner Dewberry in Fairfax, Virginia. He has extensive experience helping organizations use geospatial technology to analyze, collect, manage, and visualize data to make informed decisions. Pandey is a member of URISA's Vanguard Cabinet, where he currently serves as the vice-chair. In 2018, he was recognized in *xyHt* magazine's 40 Under 40 list of Remarkable Geospatial Professionals, and *Geospatial World* named him one of its 50 Rising Stars in the geospatial industry in 2021.

Remote Sensing and GIS Now Evolve Together

By Karen Schuckman, American Society for Photogrammetry and Remote Sensing

GIS, remote sensing, and photogrammetry have long been related fields in the geospatial profession. But throughout their histories, and in terms of both science and technology, these fields have evolved on parallel timelines yet distinctly separate tracks—until now.

It is widely acknowledged that the conceptual origin of GIS was British physician John Snow's mapping of the cholera epidemic in London in 1854. Just four years later in Paris, Gaspard-Félix Tournachon—more commonly known by his pseudonym, Nadar—became the first person to capture aerial photographs from a hot-air balloon. The National Aeronautics and Space Administration (NASA) launched the first Landsat satellite in 1972, and Esri released the first commercial version of ARC/INFO 10 years later, in 1982.

Throughout the four decades that followed, great strides were made in the geospatial sciences and industry overall. However, the geospatial workforce remained largely divided in separate GIS and remote sensing camps due to incompatibilities in data, analysis methods, and software.

Now at long last, we are seeing these parallel evolutionary tracks converge. On September 27, 2021, in partnership with the United States Geological Survey (USGS), NASA launched Landsat 9 from Vandenberg Space Force Base, ensuring the continuity of a 50-year legacy in land remote sensing. And just a few weeks later, the 2021 Esri Imagery Summit was held a mere 225 miles away in Redlands, California, where attendees learned about new and robust remote sensing data management tools that will forever change the way the GIS community uses Landsat and other remote sensing data.

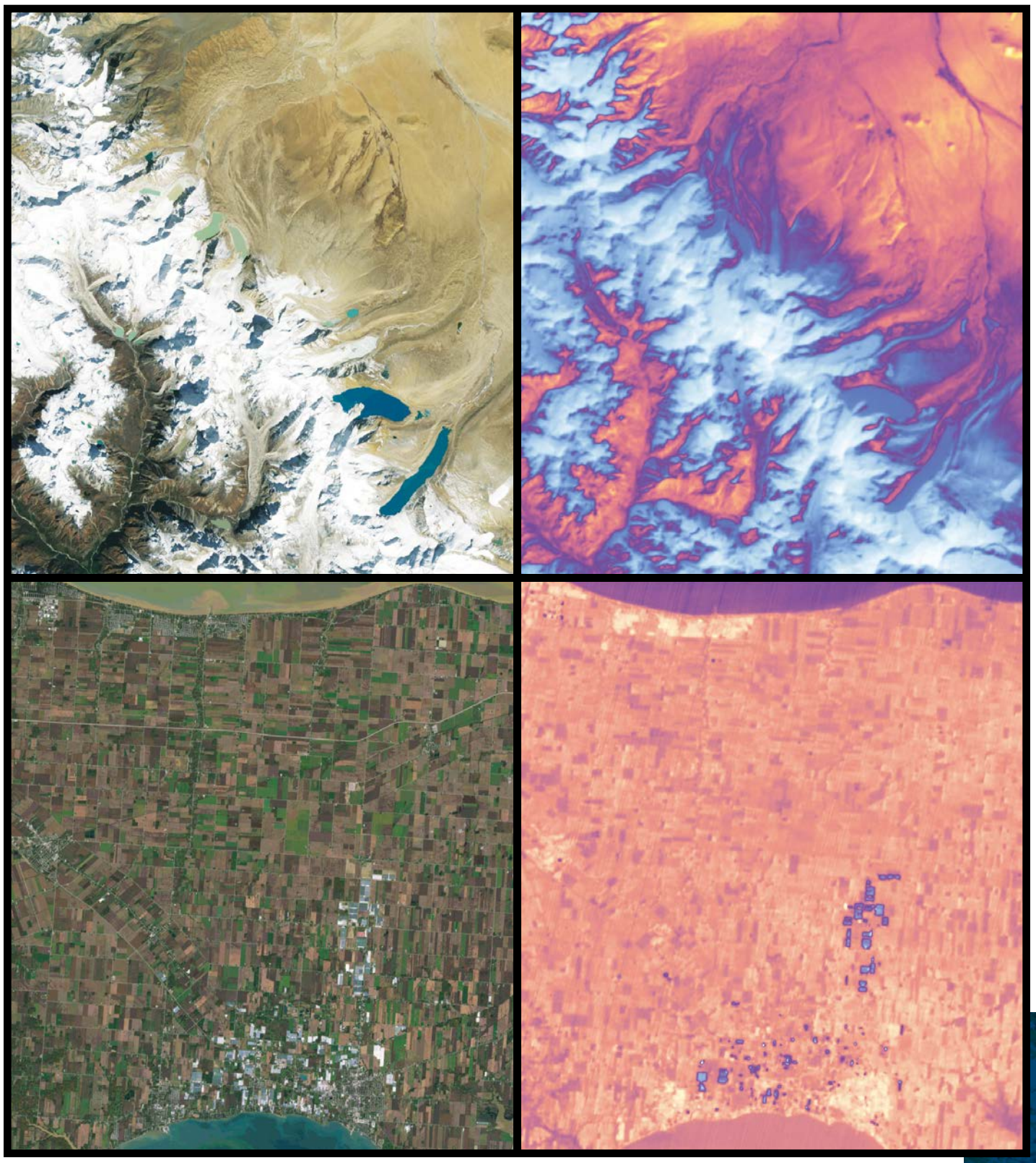
During the Plenary Session at the Esri Imagery Summit, Richard Cooke, director of imagery and remote sensing at Esri, used a lighthearted holiday dinner analogy to announce the new remote sensing capabilities in ArcGIS. He said that, after decades of being seated at the kids' table, the remote sensing profession has finally grown up and joined the GIS community at the adults' table.

In a panel discussion later that day, I challenged the audience to turn that analogy upside down. Perhaps the GIS profession has been seated at the kids' table while the remote sensing community has been at the adults' table, watching geospatial technology mature.

For as long as GIS has been growing and developing from its earliest form of attributed points, lines, and polygons, the technology has been fed and nourished by products derived from remotely sensed data. Even before the software was able to display or perform analysis on raster data, many of the fundamental layers used in early GIS were digitized from USGS topographic maps. The data that underpinned the National Spatial Data Infrastructure (NSDI) of the United States—including road centerlines, topography (think contour lines and digital elevation models), hydrography, and building footprints—was collected from aerial photographs. Just as adults select and process food from their table before feeding it to their children, so remote sensing data is systematically processed in a palatable form to ensure that the GIS digestive system (i.e., software and computing systems) and taste buds (i.e., educators and the workforce) are able to ingest it.

The technology demonstrations at the Esri Imagery Summit clearly show that GIS has grown up. Not only is this former kid capable of eating most of the dishes on the adult table, but it has also developed a ravenous appetite. The remote sensing community is now driven to produce enough food on an ongoing basis to feed this hungry new adult. This is good reason to celebrate with the whole family at the big table. The convergence of GIS and remote sensing technologies offers hope for—and a way to help create—a more sustainable future.

I hope this can inspire and motivate all of us. But a few words of guidance—or perhaps even caution—are appropriate. While robust imagery management and analysis tools are now available in ArcGIS, along with application prototypes and tutorials provided by Esri developers, GIS users still need to have a fundamental grasp on the science of remote sensing to be able to apply these technologies correctly. I encourage those who are eager to tap into the rich repository of Landsat imagery that's



Landsat 9 detects thermal data, shown on the right, for the Himalayas that lead to the Tibetan Plateau (top) and farm fields in southern Ontario, Canada (bottom). (Image courtesy of the National Aeronautics and Space Administration [NASA]/the United States Geological Survey [USGS].)

now available in the cloud to read *Landsat's Enduring Legacy*, from the American Society for Photogrammetry and Remote Sensing (ASPRS), to gain a more complete appreciation of the knowledge and expertise that go into creating useful and accurate analysis products.

I also implore GIS practitioners to make use of the wide variety of education resources that go beyond software tutorials and user manuals. While it is critical that Esri continue to create resources like this, users need to have enough conceptual understanding of the science behind remote sensing to know whether or not they are producing valid results.

Many institutions of higher learning offer degree-granting and certificate programs for people who want to take a deep dive into structured curriculum. AmericaView, a nationwide network of university and public sector experts in remote sensing, provides resources about Earth observation, at no cost, to help people and organizations with applied research, workforce development, and community outreach.

Additionally, since 1934, ASPRS has brought together photogrammetry and remote sensing researchers, educators, and practitioners of all ages and experience levels at conferences and workshops to learn more about different types of image analyses, new data and metadata standards, positional and thematic accuracy assessments, drone mapping, and more. ASPRS is now providing an increasing number of virtual learning options, along with an accredited certification program for anyone who wants to validate their professional qualifications.

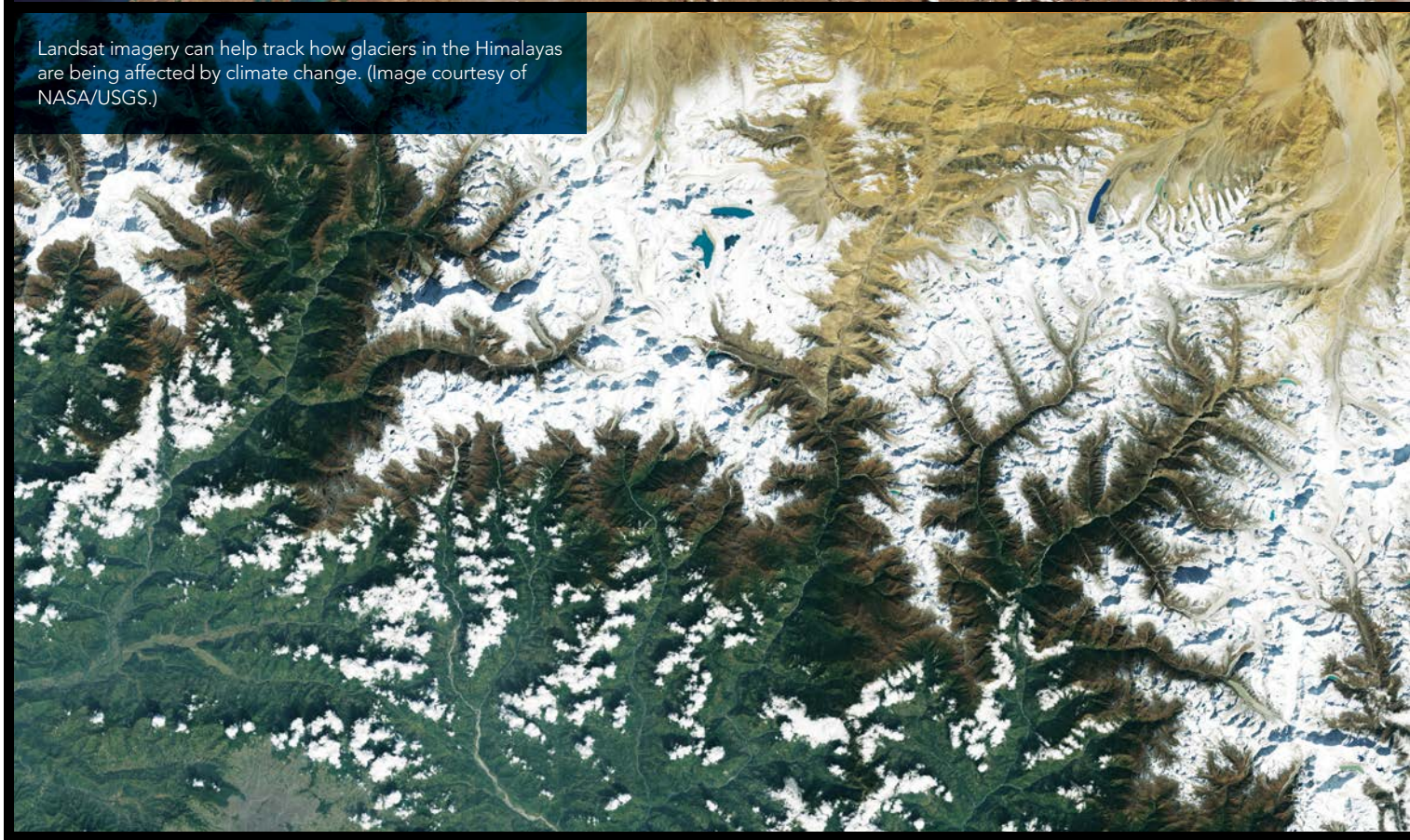
As GIS, remote sensing, and photogrammetry continue to evolve—now, more closely together—there are many remote sensing experts who are eager to support their GIS specialist colleagues. GIS users might just need to reach beyond their familiar networks of resources to get connected. In turn, the remote sensing community will be looking for opportunities to meet with the GIS community both virtually and in person at future Esri events.

For more information about ASPRS programs, email office@asprs.org.

About the Author

Karen Schuckman is an associate teaching professor of geography at Pennsylvania State University, where she teaches remote sensing and geospatial technology for the university's online GIS programs. Schuckman is also the executive director and an emeritus member of ASPRS. She is an ASPRS-certified photogrammetrist, with 30 years of experience in the field; an ASPRS-certified mapping scientist in lidar; and a professional land surveyor.

The first image collected by Landsat 9 on October 31, 2021, shows coastal islands in Western Australia. (Image courtesy of NASA/USGS.)



Landsat imagery can help track how glaciers in the Himalayas are being affected by climate change. (Image courtesy of NASA/USGS.)

Imagery from Landsat 9 is helping people monitor drought conditions in places like the Navajo Nation in the western United States, shown here. (Image courtesy of NASA/USGS.)

From the Meridian

By Shaowen Wang
University of Illinois at Urbana-Champaign

A Grand New Experiment: Advancing CyberGIS

In 1854, British physician John Snow took up his grand experiment, the now-famous study of spatial patterns related to the cholera outbreak in London that year. In a notable early example of cross-disciplinary spatial investigation, Snow combined public data about residential neighborhoods and infrastructure with personal interviews to show that the disease was caused by a polluted water supply. This was a monumental event in the history of epidemiology and health geography that demonstrated the power of geospatial analysis to help end disease outbreaks.

Fast-forward to today. The world is deeply trapped in another public health crisis: the COVID-19 pandemic that has killed several million people and infected hundreds of millions more around the world. The fields of geography and public health have progressed significantly since Snow's work, with GIS and GIScience playing essential roles in enhancing our understanding of the spread and impacts of infectious diseases. But despite this progress—and, in part, because of it—obstacles remain when trying to harness the complex and massive geospatial data that has been collected rapidly during the fight against COVID-19.

These challenges are both technical and social. The complexity of geospatial data can make it difficult to choose and integrate datasets and tools for rigorous analysis and modeling. It can also be challenging to build collaboration across disciplines and with stakeholders who are interested in solving problems associated with COVID-19. Furthermore, any advances made via collaborations need to be readily accessible to other researchers so that the results can be reproduced and used by people—such as GIS app users and decision-makers—who might not have easy access to advanced cyberinfrastructure and high-performance computing resources.

In Snow's day, data integrity, sound study design, and reproducibility were already a challenge. These can still be really difficult—sometimes more so—to achieve in today's data-intensive and multidisciplinary science ecosystem. We need to bridge the digital divide in GIS and ensure that everyone benefits from science by democratizing access to advanced cyberinfrastructure and high-performance computing resources. That's the goal of CyberGIS 2.0.

Geospatial Fellows Expand the Use of CyberGIS to Enhance Reproducibility

To tackle these challenges, I am leading several efforts at the University of Illinois at Urbana-Champaign's (UIUC) CyberGIS Center for Advanced Digital and Spatial Studies (cybergis.illinois.edu). One such effort, funded by the National Science Foundation (NSF), is being done in partnership with the American Association of Geographers (AAG); the National Opinion Research Center (NORC) at the University of Chicago; the Open Geospatial Consortium (OGC), Inc.; and the University Consortium for Geographic Information Science (UCGIS). From 2020 to 2021, this project supported 16 geospatial fellows who work in diverse geospatial communities—from public health and the spatial sciences to geography and urban and regional planning—in exploring solutions to technical and social issues that might impede the use of cyberinfrastructure-based GIS and GIScience to respond to a public health crisis like COVID-19. Fellows were provided with resources that enabled them to combine geospatial software and data at scale to conduct cutting-edge COVID-19 analyses on things like human mobility patterns and the effects evictions had on the virus's spread. The idea was to have the fellows use cyberGIS to analyze big data, support critical spatial thinking, and develop educational materials—all in ways that made the results reproducible and accessible. By the end of the fellowship, participants produced a rich set of geospatial resources, such as software modules, open data, reproducible computational notebooks, and research publications.

With support from the AAG, the CyberGIS Center hosted a free webinar series in 2021 that brought together people from the geospatial community to learn more about the fellows' projects. The series centered on how employing cyberGIS can enable better research on and education about COVID-19, and presenters paid particular attention to the challenges of reproducibility. Video recordings of all the webinar presentations and subsequent discussions are available at ow.ly/bUE650GOPuG.

For example, Dr. Jayajit Chakraborty, professor of geography at the University of Texas at El Paso, presented his research on the relationship between people's disability status and COVID-19 vulnerability to highlight some of the spatial and social inequities that underlie the spread of the disease in the United States. Chakraborty's work was subsequently reported on by multiple news outlets, including *USA TODAY*.

Given the rapidly evolving landscape of COVID-19 research and the increasing need for open and accessible educational resources about the disease, we at the CyberGIS Center expect the topics addressed by the geospatial fellows to serve as the initial focus of our continued community engagement. As future obstacles and opportunities arise, we also hope to expand the scope of intellectual exchange into new areas, such as how to make the results of geospatial artificial intelligence (AI) studies more interpretable and reproducible.

New Program Integrates Diverse Disciplines to Solve Pressing Problems

I am excited to further the CyberGIS 2.0 vision through a new endeavor as well: the recently funded NSF Institute for Geospatial Understanding through an Integrative Discovery Environment (I-GUIDE). The goal of I-GUIDE (iguide.illinois.edu) is to revolutionize how data-intensive geospatial analyses are performed. I-GUIDE seeks to synergistically advance cyberGIS and cyberinfrastructure capabilities to address the most pressing resilience and sustainability challenges the world is currently facing, from biodiversity loss to food and water insecurity.

With a nearly unprecedented investment of $15 million from the NSF, plus the support of many partners, including the AAG, I-GUIDE will bring together about 40 researchers initially to integrate AI and cyberGIS, develop reproducible data-intensive analytics and modeling, explore the principles of FAIR (findable, accessible, interoperable, and reusable) data, and create innovative education and workforce development programs. This transformative research and educational approach has the capacity to catalyze new relationships among geospatial industries and government entities in support of better convergence science—the integration of diverse disciplines to gain greater problem-solving capabilities. Such partnerships are necessary to drive advances across many fields, ranging from computer, data, and information sciences to atmospheric sciences, ecology, economics, environmental science and engineering, human-environment and geographic sciences, hydrology and water sciences, industrial engineering, sociology, and statistics.

None of these efforts would be possible without strong, dedicated partners and colleagues. Among those are the organizing committee members of the Geospatial Fellows Webinar Series, including AAG executive director Gary Langham; AAG senior geography researcher Coline Dony; University of California, Santa Barbara, professor emeritus Michael Goodchild; UIUC professor Anand Padmanabhan; and UIUC PhD student Rebecca Vandewalle.

We welcome any comments about and expressions of interest in the webinars and other related activities. Feel free to email me at shaowen@illinois.edu, get in touch with members of the organizing committee for the webinar series, or contact any of the geospatial fellows.

From the Meridian is a regular column from the 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 the AAG's programs and membership at aag.org.

About the Author

Shaowen Wang is the founding director of the CyberGIS Center for Advanced Digital and Spatial Studies at UIUC, where he is also a professor and head of the Department of Geography and Geographic Information Science. Wang is an affiliate professor in several other departments at UIUC, including the Department of Computer Science, the Department of Urban and Regional Planning, and the School of Information Sciences. He is also the director of and principal investigator for I-GUIDE.

Energy Company Optimizes Fuel Deliveries with Real-Time GIS

Argentina is among the top 30 crude oil producers in the world. The country's Pan American Energy (PAE) Group is the leading private sector energy producer in the southern region of South America. It's an integrated oil company that manages upstream, midstream, and downstream operations; generates electric energy; and is part of the renewable energy sector.

To achieve greater efficiency among its vast operations, leaders at the company decided to optimize PAE's fuel delivery services. These go to retail petrol stations and other customers, such as airports that distribute jet fuel, located throughout the country.

"Argentina is a large country with a varied terrain, so geography plays a big part in efficient fuel delivery," said Gonzalo Fernandez Grossi, who served as senior IT project manager at PAE. "Since improving fuel delivery services is a geospatial problem, we decided to use our ArcGIS expertise to solve it."

A Comprehensive Fuel Distribution Platform

PAE has used Esri technology for 15 years. So for this project, the company relied heavily on ArcGIS Enterprise and ArcGIS Online.

"We have more than 1,000 customers that are serviced by about 280 tanker trucks," said Fernandez Grossi. "The fuel distribution to our customers is an outsourced service."

For invoicing and distribution planning, PAE uses software from SAP and other complementary solutions. However, company leaders were concerned that they couldn't monitor and control fuel distributions as they were happening. In addition, PAE was collecting very little transit information.

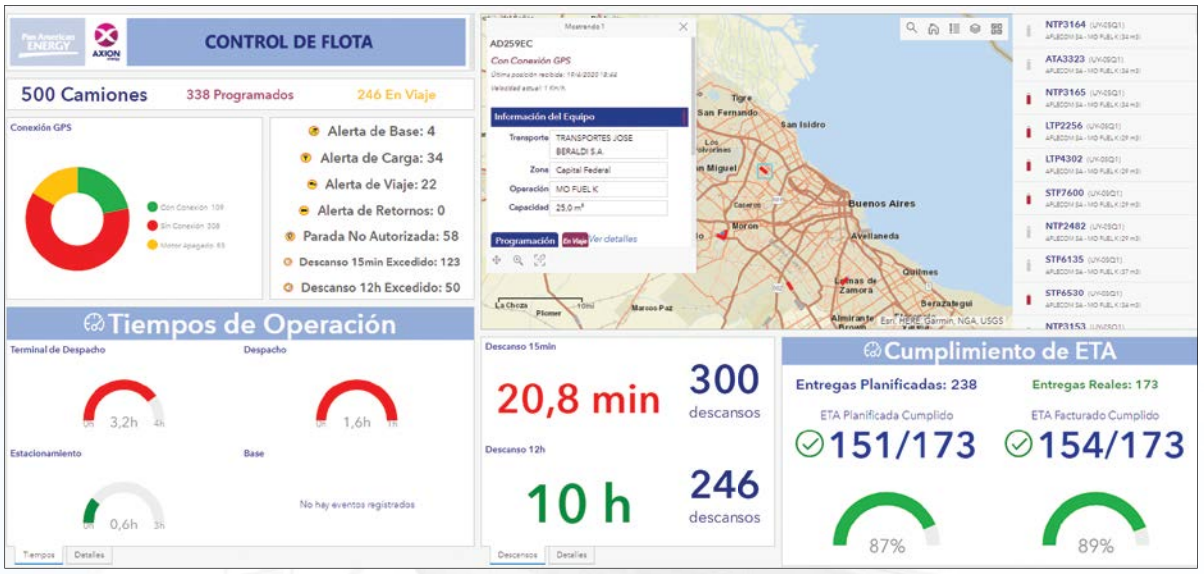
"The theoretical timeline that we originally created provided our customers with a five-hour delivery window, which was very difficult for them from a business perspective," Fernandez Grossi explained. "So we decided to use Esri software—particularly ArcGIS GeoEvent Server—to resolve the lack of complete, accurate, and reliable information during the fuel distribution process. This helped us optimize costs and improve our customer relations and experience."

PAE uses a comprehensive stack of Esri technology in its fuel distribution platform. ArcGIS Enterprise manages connections to PAE's Oracle geodatabase and provides REST endpoints for published data and geoprocesses. The ArcGIS Enterprise portal is the content manager and the system's security management node. This is because it integrates the Lightweight Directory Access Protocol, which is used for directory services authentication. The portal also hosts dashboards and apps that PAE's IT team builds for end users. And ArcGIS Data Store provides an agile and stable repository for storing analysis.

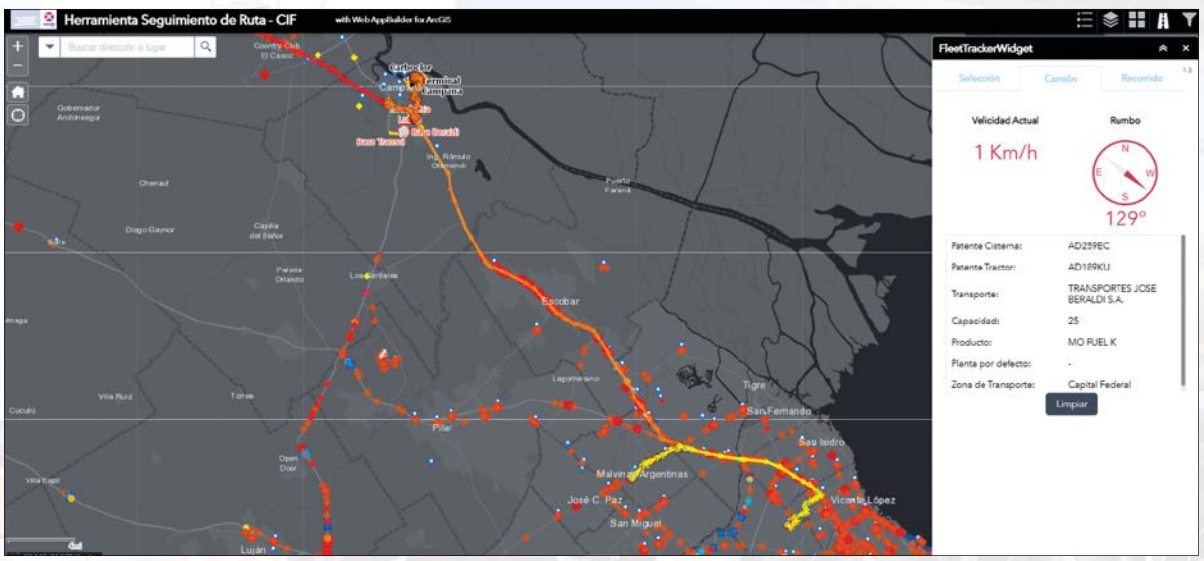
The key to the system is GeoEvent Server, which ingests information—including truck positions, commercial master data, and scheduled deliveries—in real time. It analyzes events such as fuel drop-offs and driver rest stops based on business rules, generates alerts, and sends data to ArcGIS Enterprise or Data Store. GeoEvent Server also integrates with email and the WhatsApp messaging service to provide alerts via push notifications.

Another critical component of PAE's new fuel distribution monitoring system is the Origin Destination (OD) Cost Matrix, a ready-to-use service from Esri that can be integrated into apps using ArcGIS REST APIs. The OD Cost Matrix is used to determine the least-cost paths in a transportation network from multiple origins to multiple destinations and to calculate estimated arrival times—in this case, for PAE's fleet of tanker trucks. Additionally, the Node.js web server runs highly complex processes using the OD Cost Matrix to determine the particularities and logic of each trip. Node.js also synchronizes certain data from SAP endpoints (master data and delivery programming) and returns this information to GeoEvent Server for further analysis.

"The system we have developed provides us with complete, accurate, and reliable information during the fuel transportation process and quickly identifies deviations in the transport, allowing us to take corrective actions when necessary," said Fernandez Grossi.



↑ The Pan American Energy (PAE) Group's new system for optimizing and monitoring fuel distribution benefits staff and customers.



↑ Staff at PAE can track where tanker trucks are during their deliveries, which makes it easier to ensure compliance.

PAE Gets More Control, and Customers Get Better Service

PAE's new fuel distribution monitoring system has proved very effective in optimizing its vehicle routing network. It enables staff at the company to oversee the daily distribution of fuels, lubricants, chemicals, and biofuels that are scheduled in SAP. It also allows them to check on the availability of hired trucks, monitor how long it takes to load and unload fuel, keep track of travel and driver rest times, and more.

"In the first few months, we determined that more than 50 hours each day were lost due to the microunavailabilities *[small gaps in contractors' work hours]* identified. This is the equivalent of losing the use of more than two trucks per day," said Fernandez Grossi. "Now, we obtain better information for the analysis of delays and easily identify optimization opportunities for the trucking fleet."

This includes planning out downtime; making improvements to operations at production facilities, service stations, and carrier bases; optimizing loading and unloading processes; and better defining travel times. The system also supports implementing penalties for noncompliance, and it alerts PAE staff when drivers exceed their rest time or make unauthorized stops. In addition, it informs PAE staff when contracted trucks are available to make new deliveries.

One of the best benefits to PAE's customers, according to Fernandez Grossi, is that the system sends them an estimated time of arrival for their deliveries using real-time traffic data alongside the OD Cost Matrix.

"We also send a WhatsApp message to the customer an hour before the arrival time," Fernandez Grossi added.

In the future, PAE plans to extend the solution to its upstream operations and provide greater efficiency and cost-optimization for work order programming and monitoring.

"We would also like to promote 'where' as the foundational element in our business," said Fernandez Grossi. "This will include integrating location in our other projects to develop synergy among them. We think that the 'where' is a key factor in the implementation of an effective digital transformation for the Pan American Energy Group."

A Small City Develops Enterprise GIS in a Big Way

The City of Hobart, Indiana, which lies along the banks of Lake George, is one of Lake County's oldest municipalities. With a population of about 28,000 people, Hobart provides a close-knit community in which residents and visitors enjoy a lively downtown, thriving retail opportunities, and great schools just 40 miles outside Chicago, Illinois.

In early 2019, a small cadre of experienced and visionary staff members in the Hobart Sanitary and Stormwater District (HSD) recognized that geospatial technology and location intelligence could transform the city. The team reached out to Esri partner Geographic Technologies Group (GTG) to write and implement a GIS-specific strategic plan. Using this as a guide, HSD staff members quickly developed a phased, multiyear, citywide GIS road map; secured buy-in from all stakeholders; and found funding for the modernization project. They are now successfully building a sustainable, resilient, and scalable enterprise GIS for the whole city.

A Phased Approach to Developing a GIS Strategic Plan

Staff members at the City of Hobart were facing growing pressure to deliver geospatial data to both internal and external customers and integrate GIS with other supported business systems. Additionally, the city's GIS needed to align more closely with and support the overall vision and goals set by the mayor and the city council.

The process for creating the GIS strategic plan was broken down into three phases. The initial phase revolved around assessing the current GIS that HSD and the City of Hobart were using. Project team members from GTG interviewed key stakeholders; performed a strengths, weaknesses, opportunities, and threats (SWOT) analysis; identified gaps in key performance indicators (KPIs); and presented a report to stakeholders, including city employees and HSD board members, that established KPI benchmarks for the plan. In phase 2, the GTG team focused on systems design, which included laying out technological recommendations and best practices not only for the entire city government but also for each department, based on the needs identified in the first phase. For phase 3, the team at GTG assessed the returns on investment (ROIs) the city would realize with its new enterprise GIS and presented the formalized GIS strategic road map to city staff members, HSD board members, and Hobart's city council.

Each phase of the process, along with the accompanying deliverables, adhered to GTG's Six Pillars of GIS Sustainability:

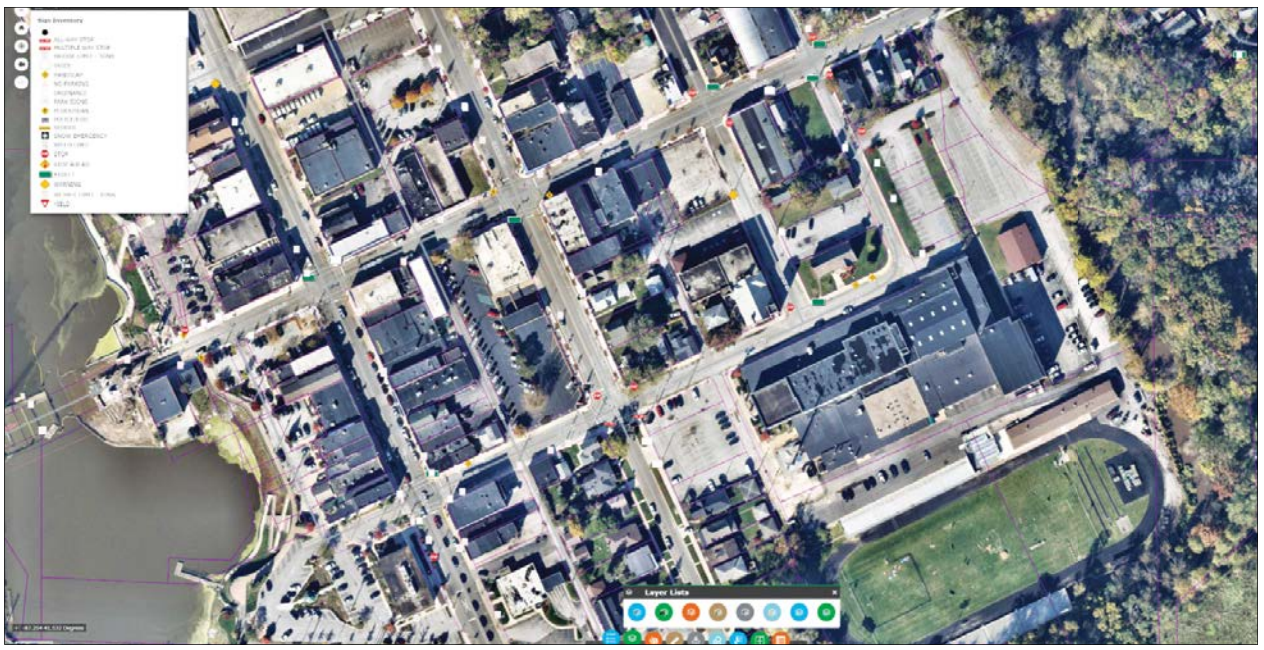
- Supporting good GIS governance
- Having accurate and reliable GIS data and databases
- Making procedures and workflows interoperable
- Developing a cohesive and robust ecosystem for GIS software
- Establishing well-designed infrastructure
- Providing training and education in GIS to ensure its sustainability

Once a strategic implementation plan was put in place, staff members from HSD and the City of Hobart worked with GTG's team to bring items in the plan to fruition. They deployed an ArcGIS Online organization and began using Microsoft Azure Virtual Machines to host the city's custom GIS apps and other media. Team members also employed ArcGIS Hub to develop internal and external hub sites, which serve as open data portals. Additionally, they built a variety of viewers, dashboards, and stories made with ArcGIS StoryMaps to better present data and communicate important city initiatives.

A GIS Viewer That Integrates with Key Resources

One of the most important web apps that GTG helped the City of Hobart develop was its GIS Viewer, which has both an internal interface and a public-facing one. Built using ArcGIS Web AppBuilder, the team at GTG equipped the viewer with user-friendly controls and customized it to address HSD's needs.

A key customization for the GIS Viewer was integrating it with Esri partner Nearmap, which provides accurate aerial imagery for more than 430 markets in North America. HSD commissions Nearmap to collect high-resolution aerial imagery of Hobart three times each year, so it was crucial for GTG to make this resource more readily available to city staff.



↑ Aerial imagery from Nearmap is integrated into the City of Hobart, Indiana, GIS Viewer, allowing both internal and external users to search imagery by flight date and evaluate change over time.

"Our range of high-resolution aerial content…acts as a valuable component *[of]* the strategic planning services offered by GTG," said Karl Terrey, director of global alliances at Nearmap. "Our imagery is refreshed multiple times per year and, when combined with GTG's technology, *[it]* allows cities, towns, counties, and state governments to make decisions based on conditions in their communities in near real time, at a fraction of the cost."

With assistance from a Nearmap technician, the team at GTG created a custom widget that allows users of the GIS Viewer to see available imagery according to the date a flight was taken, going back to 2015.

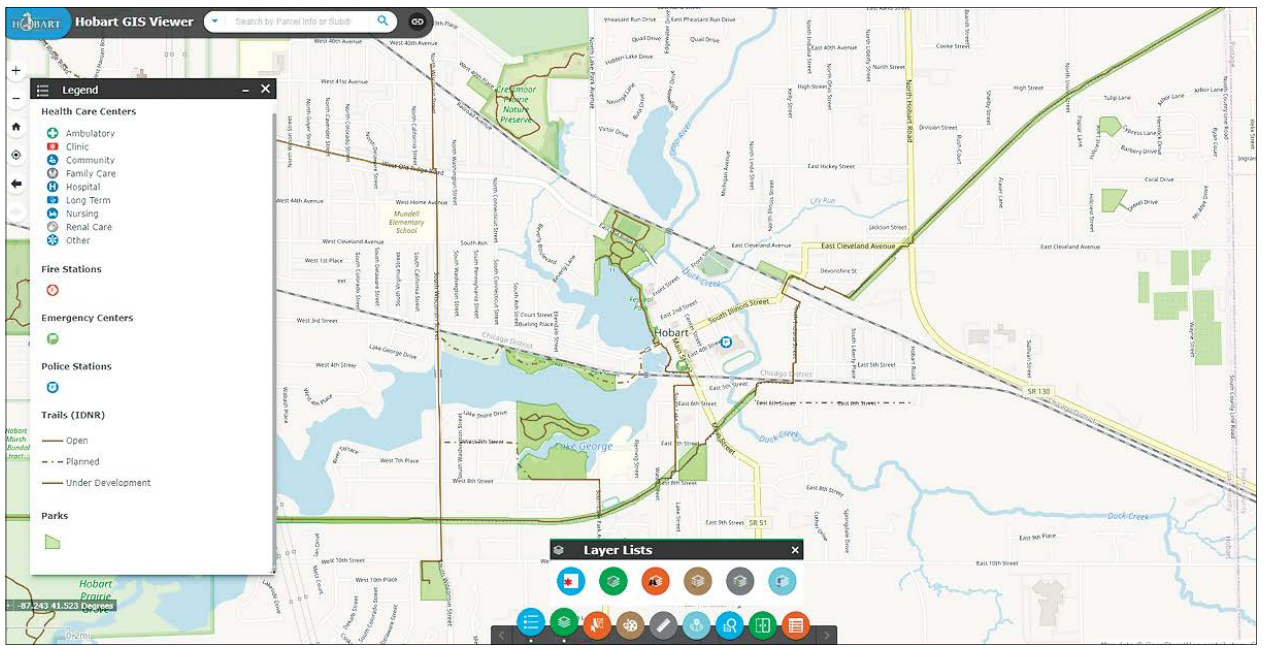
One other significant integration for the GIS Viewer involved connecting it more seamlessly with data from the County Assessor's office. To help staff at the city's Planning and Economic Development departments find and view official parcel records, the GIS Viewer links directly to the assessor's website, which has historical ownership information, engineering sketches, and photos for parcels throughout town. All users have to do is click on a parcel on the map, and that takes them directly to the associated web page on the County Assessor's website.

Internal and Public-Facing Hub Sites Increase Transparency

Another central piece of the City of Hobart's GIS strategic plan was creating two sites with ArcGIS Hub—one for use by internal teams and one for engaging with the public.

The internal hub page, which is fully customizable, includes links to Nearmap's high-definition imagery, access to other GIS apps, and additional departmental information that needs to be communicated. The main page of the internal hub highlights key apps that all city staff can use, while subpages are more specific to various departments, including HSD, Planning, Economic Development, Police, Fire, and Parks and Recreation. Staff members in each department can view other departments' subpages and the apps linked from there, which increases transparency and communication among teams. As the city's use of GIS grows, staff members can also add new pages to the internal hub site. And GTG plans to continue developing solutions that will get placed on each department's own hub page so team members can use them.

The external hub site essentially acts as an open data portal for the public. People can visit the site to download any GIS files from Nearmap's archives that the city has identified as open data. For instance, a student doing a school project can retrieve shapefiles related to city parks to analyze the data. Community members are also able to view a variety of GIS apps—such as the GIS Viewer (with confidential information removed) and narratives built with ArcGIS StoryMaps—to increase awareness and understanding of city initiatives. For example, if people want to find out more about the $1.25 million Hobart has invested in green infrastructure, they can check out the *Stormwater Management and Green Infrastructure Projects* story at arcg.is/0muKCS to see how the city is working to reduce runoff pollution and improve local water quality.



↑ A public-facing GIS Viewer allows people to easily access map-based data about Hobart, including information that comes directly from the County Assessor's website.

Hobart's Continued Commitment to Evolving Its Enterprise GIS

With all these tools in place and a still-growing enterprise GIS infrastructure, the City of Hobart is well on its way to becoming a smart community.

The city has a ratified GIS governance and management model that is guiding its geospatial growth, and all its geospatial systems are becoming interoperable via a phased integration. Its software and IT infrastructure is moving to a modern, cloud-based framework. Staff members are gaining a better understanding of what location intelligence is and how it works. Various departments have their own geospatial apps that are helping them streamline and share their work. More people throughout the community are making better use of accurate, reliable, and well-maintained digital data. And the whole system promotes economic, environmental, and social development.

Largest US Municipal Utility Improves Operations, Safety with Enterprise GIS

By Emil Abdelshehid, Los Angeles Department of Water and Power

As the largest municipal water and power utility in the United States, the Los Angeles Department of Water and Power (LADWP) in California faces unique challenges. Several years ago, aging mainframe applications and information silos were making it difficult for the organization to maintain accurate and timely data for assets in its electric distribution system.

To solve this problem, the IT team at the LADWP Power System configured and implemented a new enterprise-wide GIS platform, based on ArcGIS Enterprise, along with several key apps aimed at uniting operations and workflows. This new, modern GIS implementation is now gaining traction within the organization, and the department is beginning to see big returns on its investment. Ensuring that more employees have access to timely and consistent data is driving positive process changes, increasing efficiency, and improving safety throughout LADWP.

Enterprise GIS Shortens the Data Life Cycle

The traditional GIS data workflow in most utilities is complex. During long construction projects and complicated operations, it takes time to receive and process data updates. In some cases, mobile crews and operations staff reference and maintain paper records. GIS can become one of the last systems to be updated with new and time-sensitive data from the field.

To condense how long it took to get data from the field into LADWP's GIS, the IT team at the LADWP Power System set out to develop an ArcGIS technology-centric GIS architecture and replace the organization's existing field inspection apps with a new mobile system. Esri partner POWER Engineers, a global engineering and environmental consulting firm, was brought in to help with change management, data conversion, system architecture and administration, and the development of custom GIS apps and interfaces.

The team incorporated solutions from a range of Esri partners. Along with ArcGIS Enterprise, Schneider Electric's ArcFM forms the basis of LADWP's enterprise GIS. SSP Innovations' Mobile Information Management System (MIMS) was customized to meet the organization's field inspection requirements. Cityworks AMS (asset management system) was implemented to manage in-office task flows for inspection, maintenance, and engineering design activities. Additionally, ArcGIS web services and web maps further expanded what kinds of data are available to users through a web browser.

LADWP ultimately ended up with an enterprise geodatabase that could serve as the single source of truth for distributed electrical assets and integrated enterprise systems.

Quicker Access to Data Makes Processes More Efficient

One of the major advantages of LADWP's enterprise GIS is how timely and widely available its data is.

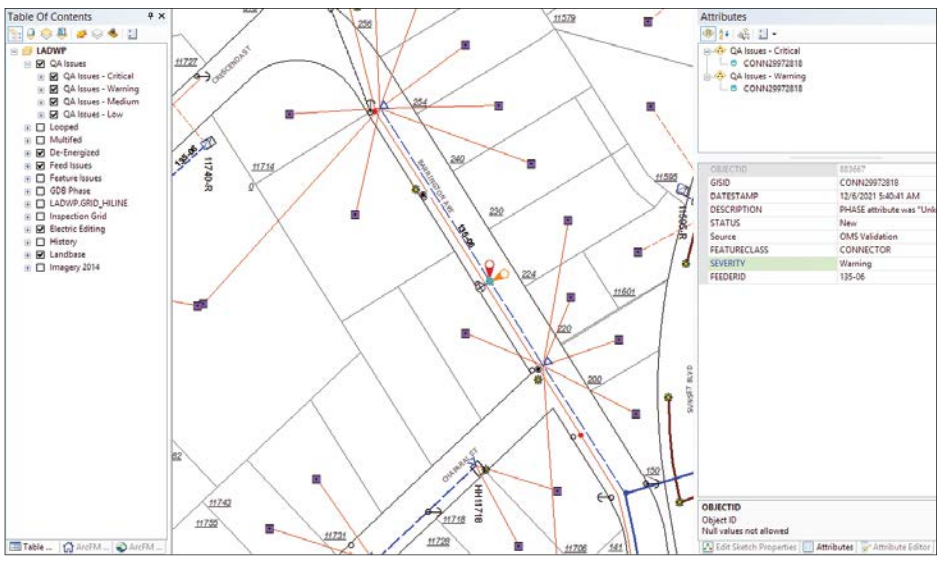
By leveraging new data synchronization technologies along with ArcGIS web services, the department's more modern GIS data life cycle makes inspection information available immediately to users both in the office and out in the field. For example, outage management system dispatchers can search and browse GIS data via the published maps in LADWP's ArcGIS Enterprise portal, giving them immediate access to any changes made by records management staff.

Automated nightly updates from the customer care system also keep the GIS synchronized with modifications made to customer information. Because GIS underlies LADWP's fully connected network model, which traces everything from circuit sources to customer service locations, it is now easier for LADWP Power System employees to determine which customers are connected to specific transformers. Additionally, the data relationships and electric distribution network model are widely available at LADWP, so employees on the outage management, distribution automation, planning, and distribution management teams all have access to them.

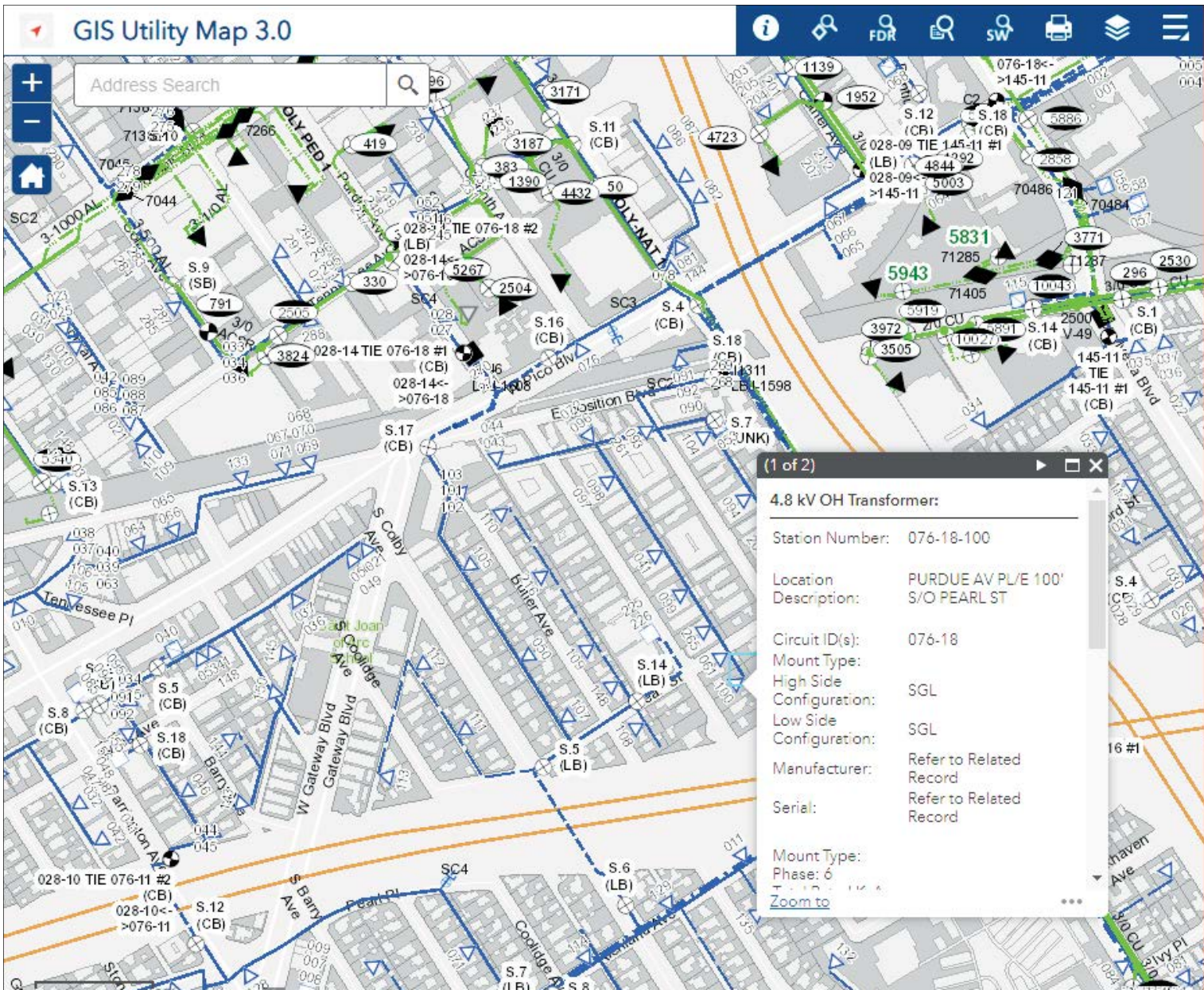
Integrations Save Time and Improve Data Consistency

Approximately 350 users employ LADWP's new mobile inspection capabilities, which make it possible to do mapping and markups on the go. Any data that's recorded in the field is synchronized to LADWP's GIS in near real time.

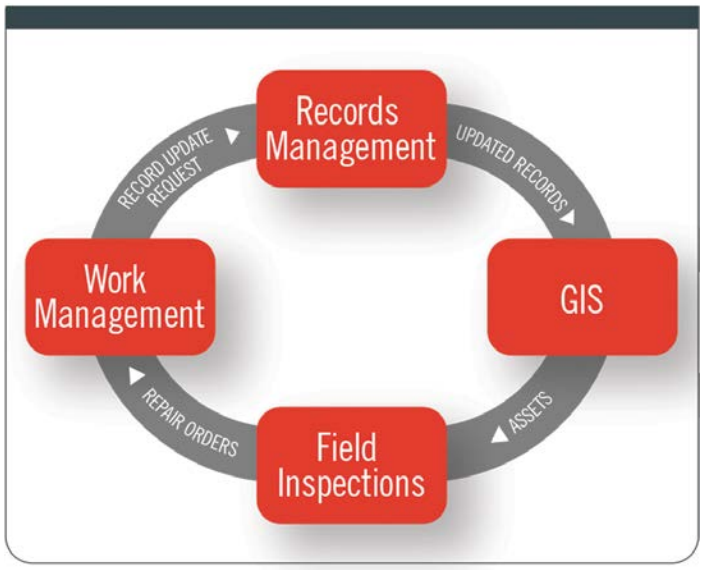
This means, for example, that when a high-severity issue is reported from the field, a work request is automatically—and immediately—sent to the work management system for scheduling. This saves the team at LADWP Power System significant amounts of time when trying to schedule critical inspections. Since this integration was deployed in April 2019, more than



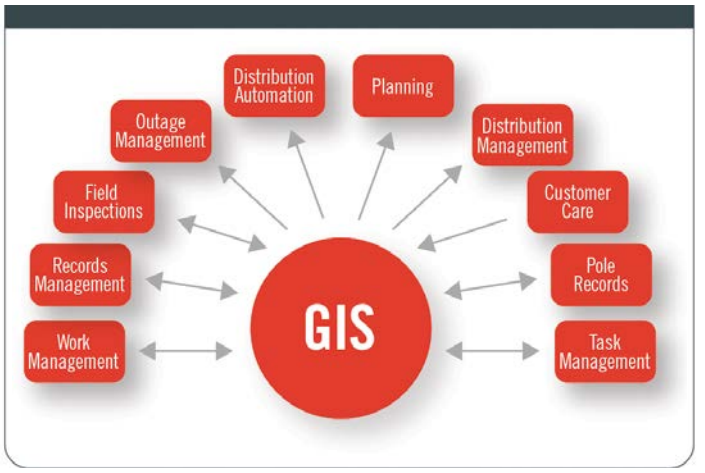
↑ Dispatchers for the outage management system can search and browse GIS data in maps published on the ArcGIS Enterprise portal, giving them immediate access to changes made by records management staff.



→ Users throughout the Los Angeles Department of Water and Power (LADWP) employ the GIS Utility Map to visualize facility information that's housed in the organization's enterprise geodatabase.



→ At LADWP, GIS was often one of the last systems to get updated with new and time-sensitive data from the field.



↑ LADWP's new workflow is GIS-centric, making its enterprise geodatabase the single source of truth for information about distributed electrical assets and integrated enterprise systems.

35,000 work requests have been created automatically, resulting in more than 5,000 hours of time saved in data entry alone.

The integration of LADWP's mobile inspection capabilities with its work management system gives the organization's field data a structure and consistency that it lacked before. This makes it easier for employees to put together reports and identify patterns indicating that process changes or engineering improvements need to take place.

The new system also makes it easier for mobile crews to take photos and mark them up with real-time inspection information. The markups are now more consistent, and this has improved reporting and record keeping. Records management staff members can process hundreds of markups each day and immediately make those edits available for all GIS data users. Since implementing this functionality about four years ago, staff members at LADWP's Power System have processed more than 12,000 markups.

New App for Monitoring Pole Ownership Replaces Spreadsheets

One of the other tasks that employees at LADWP Power System perform is keeping track of who owns which utility poles, in accordance with requirements set out by the Southern California Joint Pole Committee. Before its enterprise GIS system was installed, LADWP was using spreadsheets, paper documents, and its legacy mainframe app to record joint utility pole ownership. This time-consuming approach, however, was producing inaccurate and out-of-date information that wasn't easy to share.

So the team at POWER Engineers developed a pole data app to monitor pole owners, tenants (i.e., communications companies), and attached communication equipment. The app integrates with Cityworks AMS to track office workflow tasks, eliminating the need to do this via spreadsheets. Mobile work is also scheduled automatically through the system.

Since this was put into effect in March 2020, more than 4,000 work management requests have been automatically generated, saving the team at LADWP hundreds of hours of data entry time.

Real-Time Data and Increased Collaboration Promote Safety

LADWP Power System's new enterprise GIS—complete with advanced field apps and integrated workflows—is improving productivity and increasing collaboration across the organization. Leveraging a GIS-based, single source of truth ensures that mobile crews have the real-time information they need to carry out field operations and that office personnel know what's happening on the ground so they can make fast and effective decisions. Not only does this better support outage management and other work activities, but it also promotes safety.

At LADWP, safety comes first for employees, customers, and assets. Being able to identify unsafe conditions before they become problematic allows LADWP to better safeguard its employees, people's property, and residents of Los Angeles.

Now that GIS is infused in all of LADWP Power Systems' operations, it is easier for staff members to get an encompassing view of the utility's electric distribution system. Mobile crews have critical geospatial data available at their fingertips, and staff members across the organization can see how various assets are connected to one another. This helps leaders at LADWP make quick decisions when it comes to safety. For an electric grid that serves more than four million people—especially in hot, dry, and often windy Southern California—that can make all the difference between a problem being a minor inconvenience or escalating into a major public safety event.

About the Author

Emil Abdelshehid manages the LADWP's Information and Advanced Technology section of the Power System. For the last 15 years, he has overseen the organization's GIS overhaul, the modernization of its distribution grid, and the deployment of smart meters. He is also responsible for mission-critical systems used by LADWP's operations teams, such as its distribution outage management system. Abdelshehid, who has a background in electrical station design, received his bachelor's degree in electrical engineering from the University of California, Irvine, and a master of business administration from the University of Southern California. He is a certified Project Management Professional (PMP) and a Professional Engineer (PE) licensed by the State of California.

The Relevance of Cartography

A Cartographer's Perspective

By Tim Trainor
President, International Cartographic Association

Cartography in the 20th Century

A New Academic Discipline Confronts Vast Technological Advancements

Throughout the 20th century, the field of cartography experienced many shifts that molded the art, science, and practice of mapmaking into a concrete academic discipline, complete with its own rationale, methodologies, and research. The back half of the century also introduced robust new technology to the process, including computer-assisted cartography and GIS. While some innovations in mapping initially overshadowed the principles of cartography that took decades and even centuries to form (see my last *ArcNews* column, "The Early Evolution of Cartography," at ow.ly/6QMu50GH73U), cartography has benefited from the increased availability of data and the expanded capacity to map just about anything.

The primary source of information for this article is *The History of Cartography*, Volume 6, from the University of Chicago Press, available at press.uchicago.edu/books/HOC.

Cartography Becomes a Bona Fide Academic Discipline

In the United States and Canada, formal training in cartography began in earnest in the 1940s. Academic programs were set up at just a few universities at first, and they were centered on individual cartographers who largely taught mapmaking techniques. But after World War II (WWII), universities began establishing more recognizable courses of study in cartography with dedicated faculty and postgraduate programs.

As the formalized study of cartography expanded at the postsecondary level, other developments in the field took hold. The growing number of professors, students, and practitioners started forming their own national cartographic societies, which convened meetings and conferences and even published their own professional journals, newsletters, and other publications.

While many people contributed to the expansion of cartography as an academic discipline, two cartographers stood out: Eduard Imhof from Switzerland and Arthur Robinson from the United States. They both wrote extensively about cartography, established early national cartographic societies, and presided over the International Cartographic Association (ICA) at different times.

Imhof, a renowned mountain cartographer, founded Switzerland's first academic center for cartography at the Federal Institute of Technology in 1925. Early emphasis at the institute was on representing the earth's surface using design concepts—that is, applying an artistic approach to relief mapping that maintained positional accuracy. Robinson, who taught at the University of Wisconsin-Madison from 1945 to 1980, was instrumental in developing cartography as an academic discipline not only in the United States but also around the world. His *Elements of Cartography* textbook has been widely used for decades, and he helped establish *The American Cartographer*, the first American journal of cartography.

Cartography in North America was strongly tied to academic programs in geography, which focused more heavily on thematic cartography than on the mathematical aspects of mapping, apart from map projections. Topics in geography are broad, however, and that discipline tends to use maps to tell the story of various subjects. On the other hand, cartography programs in Europe often focused more directly on the basemap, beginning with the topographic map. Additionally, academic programs at some institutions showed how cartography was related to other, similar fields such as surveying, remote sensing, photogrammetry, and air photo interpretation. These programs typically focused on topographic science within a larger geography department.

Technological Advances Change How Cartographers Make Maps

Accompanying the development of cartography as an academic discipline were big changes to how people made maps.

Prior to WWII, mapmakers produced maps largely on paper, whereas after, they began using a more stable base material: plastic. This made it possible to employ new photomechanical techniques during the production process that allowed cartographers to decrease the scale of a map while still providing sharp image results. Some mapmakers used scribers to produce high-quality map engravings on the new, more durable material. Thus emerged a new labor category: skilled cartographic draftsmen.

This period only lasted a few decades, though, before the art form encountered the computer age. At every turn in the history of cartography, the goal was to make high-quality products that were not only functional but also pleasing to the eye. It was initially unclear if computers could replicate these tenets of cartography—especially since their automated tasks and processes added pressure on cartographers to make more maps in less time.

In the early days of computer-assisted cartography, the objective was to use the machine to perform as many functions as possible. Repetitive actions that were previously done by hand—like engraving—gave way to line-following devices and scanning technologies. This allowed large volumes of data to be processed automatically, which saved time and reduced errors. So cartographers were able to continue focusing on producing highly effective and well-designed maps.

That said, this joint effort between human and machine was not a natural fit. Several assumptions about this new relationship have never been realized. One was that automation would reduce the cost of mapmaking. However, having to invest in new technologies and skilled labor is still costly.

There was also a view in the early days of automation that the machine could never produce the same quality of maps that a professional cartographer could, both in terms of the artistic work that cartographers do and the decision-making processes they go through to choose content and represent it in different ways. This may have been true for a while—programming ones and zeroes into early computer programs rarely produced accurate lines on maps, and early plotters yielded images that were low resolution and off-color. But it was only a matter of time before these technical limitations improved considerably.

GIS Brings New Users to Mapmaking but Not Without Drawbacks

While automated cartography was advancing, the use of a parallel technology—GIS—was expanding as well.

In the 1990s, GIS started to overshadow the field of cartography as the focus of making maps shifted from following traditional cartographic concepts to producing geographic visualizations of data. There are drawbacks to that, though. Someone without a background in cartography only has to try to make a map once to realize how difficult it is to produce a well-designed cartographic representation that successfully communicates the intended message. For example, while there is a GIS tool that lets users choose different types of cartographic symbols for a map, picking the best symbol to portray data in a compelling visual and narrative style isn't a straightforward or simple task. This is also true for selecting what content should appear in a map and how the map visualization should work.

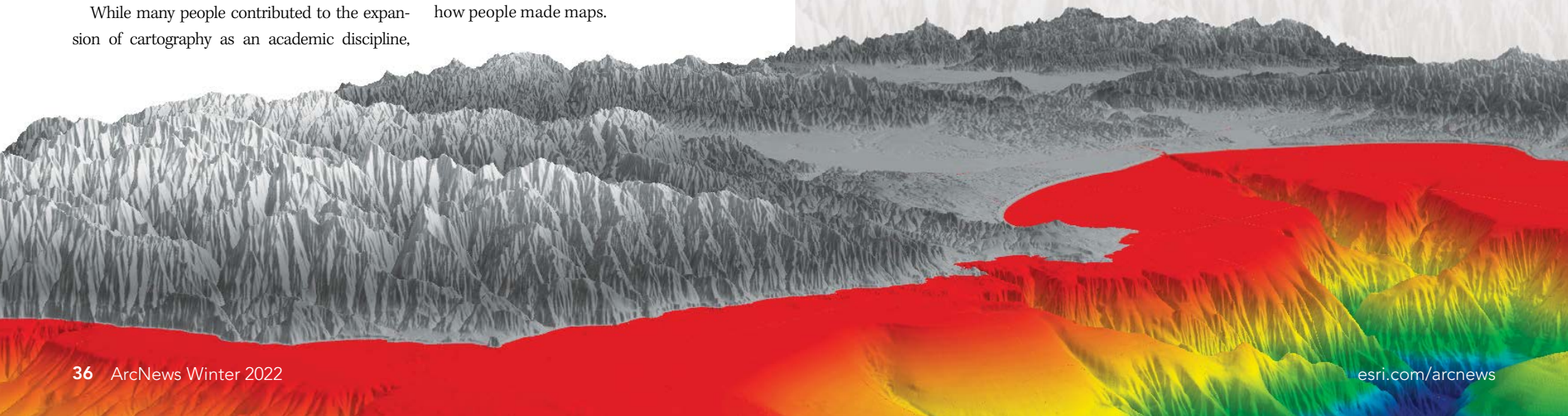
The automation that GIS provides was developed to meet users' expectations as well, which was a shift in the prior practice of offering standard map products. These were not easy requirements to meet, however, especially because the GIS user base was continually expanding into new disciplines, including business, health, education, and urban planning. For cartography, though, the technology's growth in other disciplines ended up providing fresh mapmaking opportunities.

Substantial Developments Alter Cartography Forever

Over the course of the 20th century, and especially in the latter decades, the field of cartography changed dramatically. It came into its own as an academic discipline and was pushed to new extents thanks to the emergence of several cartographic societies. As mapping technology developed, the job of a cartographer moved into new realms, and the principles of cartography took on greater importance, even if sometimes they were eclipsed by new mapping tools. Ultimately, being able to bring together data on any topic—and map it—elicited many cartographic innovations, and that has benefited countless disciplines, including cartography.

About the Author

Tim Trainor is a part-time consultant to the United Nations (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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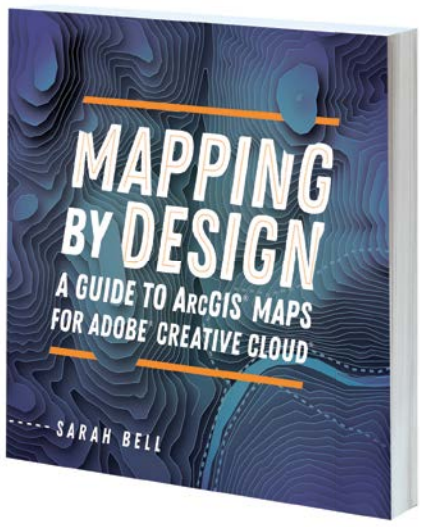
Mapping By Design: A Guide to ArcGIS Maps for Adobe Creative Cloud

By Sarah Bell

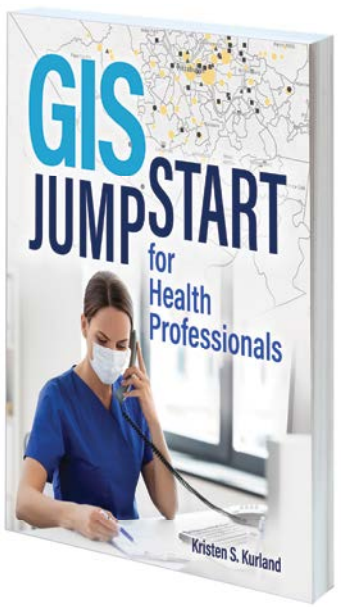
Mapping by Design: A Guide to ArcGIS Maps for Adobe Creative Cloud teaches anyone who wants to make visual and geospatial stories how to use ArcGIS Maps for Adobe Creative Cloud. By following comprehensive tutorials that navigate common mapmaking workflows, readers learn how to blend map science and map design. The book is intended for creatives who seek to make beautiful maps using familiar graphic design apps and for GIS professionals who want to learn the integrated workflows of ArcGIS technology and Adobe Illustrator. September 2021/January 2022, 225 pp. Ebook ISBN: 9781589486058 and paperback ISBN: 9781589486041.



GIS Jump Start for Health Professionals

By Kristen S. Kurland

GIS Jump Start for Health Professionals is a concise workbook that introduces location analytics and ArcGIS technology to health professionals; medical students, residents, fellows, and researchers; nursing students; and others interested in health IT and informatics, health-care administration, and health policy. Tutorials demonstrate how to use web-based data and storytelling apps, while short video lectures included with the book improve learning outcomes. September 2021/January 2022, 196 pp. Ebook ISBN: 9781589486546 and paperback ISBN: 9781589486539.



Keeping People Safe: GIS for Public Safety

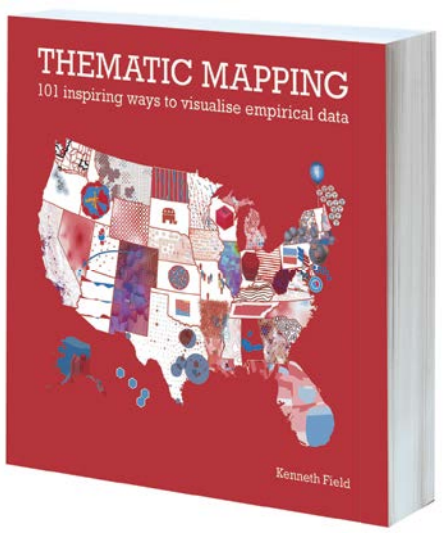
Edited by Ryan Lanclos and Matt Artz

Threats and hazards are more complex and devastating than ever before, so public safety agencies are modernizing how they create safer, less vulnerable communities. *Keeping People Safe: GIS for Public Safety* is a collection of real-life case studies that highlight how emergency management, law enforcement, fire, rescue, emergency medical services, and homeland security organizations employ GIS to deal with threats. Readers can use the book to jump-start their own use of GIS for public safety. October 2021/February 2022, 158 pp. Ebook ISBN: 9781589486874 and paperback ISBN: 9781589486867.

Thematic Mapping: 101 Inspiring Ways to Visualise Empirical Data

By Kenneth Field

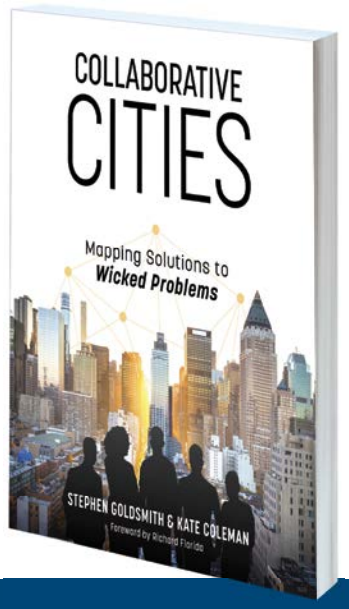
Maps are rarely right or wrong; they are simply different versions of the truth. The meaning people find in a map can reinforce or challenge their understanding, and people are much more likely to trust a map if it presents a version of the truth that they already believe in. Using 101 maps, graphs, charts, and plots of the 2016 presidential election in the United States, *Thematic Mapping: 101 Inspiring Ways to Visualise Empirical Data* explores the rich diversity of thematic mapping and the visual representation of data. Each map illustrates a different approach to the same data, and all lead to different maps and different ways of seeing different shades of truth. August 2021/March 2022, 296 pp. Ebook ISBN: 9781589485587 and paperback ISBN: 9781589485570.



Collaborative Cities: Mapping Solutions to Wicked Problems

By Stephen Goldsmith and Kate Coleman

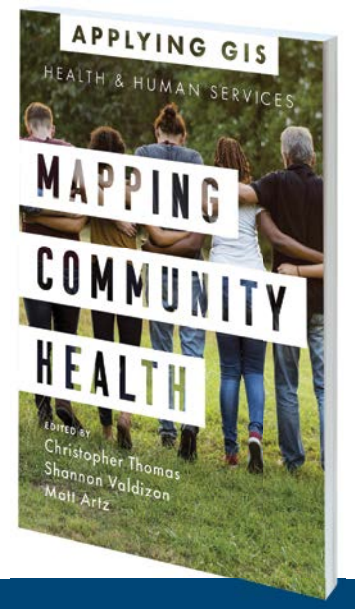
Confronting complicated issues such as climate change, homelessness, and access to health care demands that governments, nonprofits, businesses, and residents work together. While these stakeholders don't always agree on the best approach to take, they can all work from one commonality: place—where problems are happening and where people need assistance. *Collaborative Cities: Mapping Solutions to Wicked Problems* addresses how to form, operate, and adapt cross-sector collaborations that make use of maps, data analytics, visualization, connectivity, and the Internet of Things (IoT). October 2021/January 2022, 250 pp. Ebook ISBN: 9781589485402 and paperback ISBN: 9781589485396.



Mapping Community Health: GIS for Health and Human Services

Edited by Christopher Thomas, Shannon Valdizon, and Matt Artz

For many public health service agencies, the ability to build healthier communities, increase access to health care, and improve people's health outcomes relies, in large part, on using GIS. *Mapping Community Health: GIS for Health and Human Services* showcases health organizations that are employing location technology to address issues such as the opioid epidemic, homelessness, food insecurity, and health and racial inequities. The book suggests strategies to help readers get started with using GIS for health and human services. December 2021/March 2022, 120 pp. Ebook ISBN: 9781589487000 and paperback ISBN: 9781589486997.



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

Training

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Esri's instructor-led courses are developed in-house by subject matter experts who have a deep understanding of ArcGIS best practices and recommended workflows. All instructors have Esri technical certifications and CompTIA CTT+ certification. Courses are currently offered online, in real time (in multiple time zones), and as private training events.

Are you looking to build consensus and encourage action on key GIS and organizational initiatives? Perhaps you need to deliver data-driven insight to colleagues and decision-makers. If either of these scenarios speaks to you, take a look at the following courses:

- **Communicating and Collaborating for ArcGIS Success**—Executives, senior managers, GIS managers, and other change influencers who need to communicate ArcGIS strategies and initiatives to their colleagues will benefit from attending this one-day, workshop-style course. Available as a private training event for teams, the course is full of activities and emphasizes dynamic discussion to help participants understand how people's different behavioral styles affect their productivity and performance and project success. Attendees learn strategies for leading others through change while boosting their own professional capabilities.
- **Location Analytics Using ArcGIS Insights**—This class gives participants a solid grounding in the capabilities and components of ArcGIS Insights. Attendees learn how to structure an analysis and dynamically visualize and analyze nonspatial and spatial data together. They are then taught how to share their work using attractive visual themes and repeatable analysis workflow models.

Take an Esri MOOC

Massive open online courses (MOOCs) are free and convenient and offer a great way to build in-demand skills and stay up-to-date with Esri technology. Participants get access to ArcGIS software, and each course includes video lectures by Esri experts, hands-on software exercises, and interactive forums to engage with learners from around the world. Everyone who completes the course content receives a certificate of completion. View all the MOOCs Esri has available at esri.com/mooc. For a closer look at some upcoming courses, check out the following:

- **Cartography.**, February 16–April 6—Learn the cartographer's craft from experienced professionals. Over six weeks, Esri experts share with participants their best tips for how to create beautiful, effective 2D and 3D information products and publish them online using the map design tools available in ArcGIS Pro. With the hands-on experience offered in this course, attendees discover how to take their basic mapping skills to a whole new level. Find out more and register for the MOOC at go.esri.com/carto-course.
- **Going Places with Spatial Analysis**, April 13–May 25—Esri's first-ever, and always popular, MOOC is ideal for those who are new to GIS and anyone who wants to explore the latest spatial analysis capabilities of ArcGIS Online. Attendees learn the fundamental concepts and real-world applications of spatial analysis and discover why it's a vital tool for decision-making. Learn more about the course and register at go.esri.com/going-places-mooc.
- **Imagery in Action**, April 27–June 8—This course offers a great opportunity for participants to learn about the latest advances in integrating imagery with GIS. Attendees get to explore cutting-edge imagery apps and the ArcGIS capabilities that are used to visualize, process, analyze, and share imagery and other remotely sensed data. Hands-on exercises guide learners through realistic scenarios and common imagery workflows. Find out more and register for the course at go.esri.com/imagery-mooc.

Certification

Esri has released new exams for people who want to validate their ArcGIS Pro knowledge and skills. The Esri technical certification team has additional exams in development as well, so look for other exam release announcements in the coming months.

- **ArcGIS Pro Foundation**—This certification is for people with a strong grasp of basic GIS concepts and experience working with ArcGIS Pro at the entry level to produce maps, manage data, perform spatial analysis, and share GIS resources. The exam also measures candidates' skills in accessing and sharing data in ArcGIS Online. It is intended for individuals who have less than two years of experience using ArcGIS Pro. View detailed exam information at go.esri.com/arcgis-pro-foundation.
- **ArcGIS Pro Associate**—For GIS professionals and others who regularly employ ArcGIS Pro to perform their work, this exam measures the skills and knowledge needed to accurately use the technology to manage, analyze, and manipulate geospatial data. Candidates for this certification should have an intermediate level of applied ArcGIS Pro experience, which is typically acquired over two or more years of use. Find out more about this exam at go.esri.com/arcgis-pro-associate.

If certification is something you're interested in pursuing, get some inspiration for your GIS journey by viewing certification success stories at go.esri.com/certification-success. Also, explore the latest Esri technical certification exams at esri.com/training/certification, and join the Esri Technical Certification groups on LinkedIn and Esri Community.

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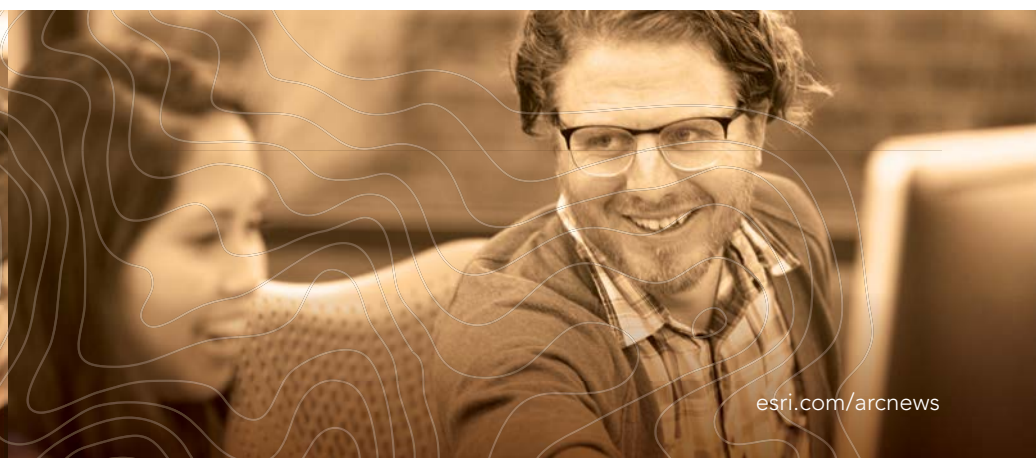

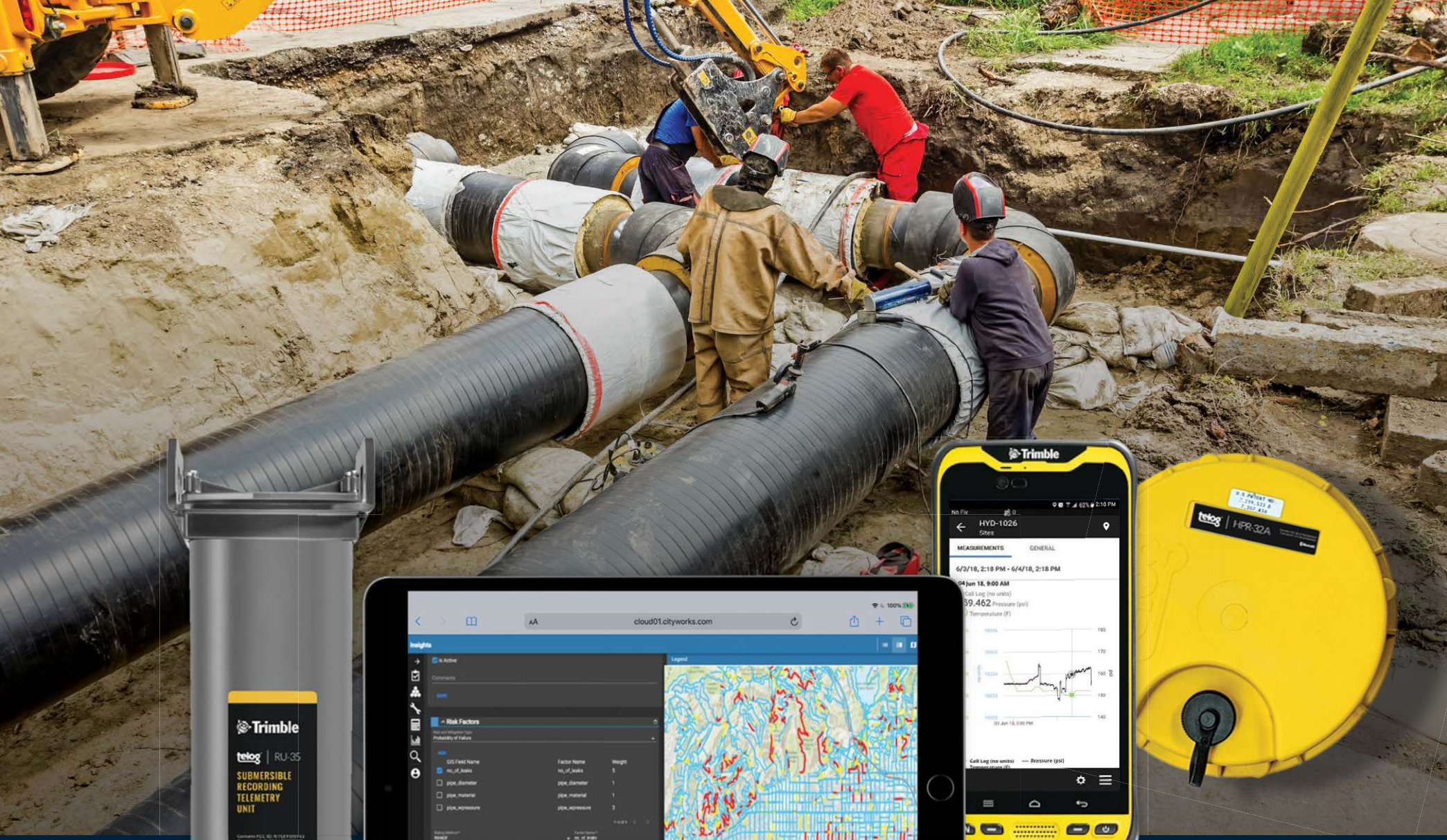

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