Uniting the World, One Map at a Time

The 2024 Esri User Conference (Esri UC) was a gathering of some of the most capable minds in geospatial science from around the world. Attendees came together to learn about new technology, network with peers, and share and exchange ideas about how to use GIS to make the world a better place.

Held in San Diego, California, July 15–19, the conference was attended by 21,500 registrants, with 14,500 tuning in online. Throughout the week, there were hundreds of user presentations, showcases, and technical demonstrations that spoke to the theme of the conference: Uniting Our World.

"Geography organizes everything we know," said Esri president Jack Dangermond to kick off the Plenary Session, a highlight of the Esri UC. "This magical word 'where' is an extraordinary word because it connects all of humanity to all the science. The *where* is a powerful thing. It's your bridge to everyone else on the planet."

The Plenary Session also featured many GIS analysts and engineers who showcased the transformative work they have been doing in their communities. These presentations were followed by National Geographic Explorer Jeff Kerby and other keynote speakers, such as Minnesota governor Tim Walz—now the Democratic nominee for vice president of the United States—who described what it meant to be a "servant leader" that uses data and GIS to drive success.

Each user presentation emphasized how trailblazing organizations are using GIS to not only serve their communities but also unite their worlds.

More than Just Mapping
Located in southeast Florida, Miami-Dade County is nearly as large as the state of Delaware. It is also home to more than 2.7 million people.

County staff developed GIS parcel layers starting in 1990, introduced the county's first web-based GIS app for residents in 1997, and created a GIS-based wastewater data management system in 1998.

Many of Miami-Dade County's GIS successes are related to making long-term investments in Esri's low-code and no-code products, enabling staff to produce nearly 500 business-centric apps for 25 county departments and residents. For example, county staff used ArcGIS Urban to plan locations for 216 new housing units, and a web page created with the AI assistant for ArcGIS Hub enables residents to find cooling centers during heat waves.

GIS also plays a key role in the county's No Wrong Door initiative, which helps ensure that

↑ The 2024 Esri User Conference (Esri UC) boasted 21,500 in-person attendees, plus 14,500 digital participants.

← Esri senior solutions engineer Jess Altamira showed how ArcGIS Business Analyst enhances spatial analysis.

To Manage a Hepatitis A Outbreak, County Health Department Turns to GIS

By Lauren Carson, Erie County Department of Health

When a food worker at a popular restaurant in Erie, Pennsylvania, tested positive for hepatitis A in February 2024, the Erie County Department of Health quickly mobilized to minimize the impact on potentially infected restaurant patrons and members of the broader community. The health department swiftly organized a mass vaccination clinic and rapidly developed an ArcGIS Survey123 form along with two dashboards built with ArcGIS Dashboards to register patients and monitor operations.

"These tools greatly helped in our preparations and in streamlining our efforts at the vaccination clinic," said Erin Mrenak, director of the Erie County Department of Health. "They allowed the health department to vaccinate more than 400 residents against the foodborne virus in just two days."
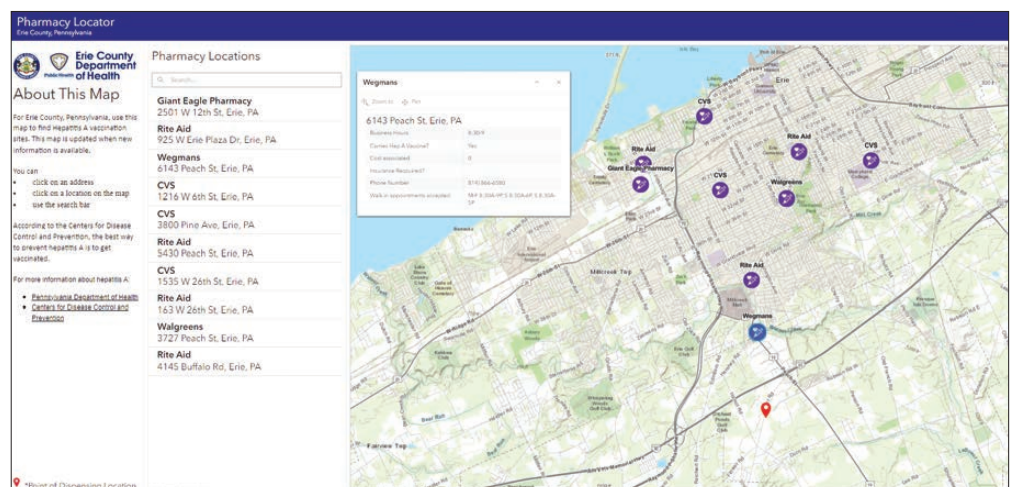
↑ In addition to showing where the Erie County Department of Health was dispensing vaccines (the red locator), this map made by the department displayed where people could get hepatitis A vaccines at local pharmacies (the purple locators).

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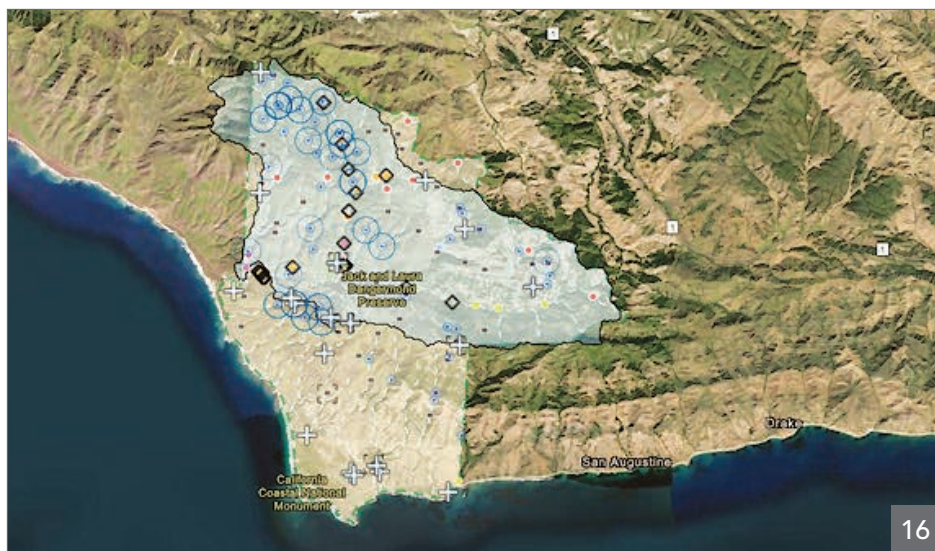
At the Jack and Laura Dangermond Preserve—a nearly 25,000-acre property at Point Conception in Santa Barbara County, California—The Nature Conservancy is leading more than 40 institutions in over 90 research projects that, together with a vast network of sensors, are making the area a smart preserve: a place where ecosystems begin to speak for themselves.

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Ensuring Robust Security for ArcGIS Online Organizations Across Industries

Esri has achieved a significant milestone by securing the Federal Risk and Authorization Management Program (FedRAMP) Moderate authorization for its cornerstone software as a service (SaaS) product, ArcGIS Online.

In today's digital age, as cyber threats continually evolve, organizations across various sectors require dependable solutions to protect their data. FedRAMP Moderate authorization ensures that SaaS providers like Esri meet stringent security standards that are essential for safeguarding sensitive data.

This higher compliance level makes a wider range of data eligible for use in ArcGIS Online, which is vital for high-risk sectors, such as finance and health care, that handle sensitive information and are susceptible to data breaches. Additionally, small businesses benefit from these robust security measures, since they gain high-level protection without needing to invest in their own security infrastructure. FedRAMP's standardized security assessments and ongoing monitoring also improve cybersecurity overall, creating a safer digital environment for everyone.

The authorization reflects Esri's ongoing commitment to software security and compliance. To achieve FedRAMP Moderate authorization, ArcGIS Online security infrastructure and processes underwent rigorous evaluation and received approval from an independent third party. By meeting FedRAMP Moderate standards, ArcGIS Online provides a secure and reliable environment for the storage, processing, and management of moderate-risk data, including financial, health, and personally identifiable information.

With growing cybersecurity risks and tightening data privacy regulations, organizations across all sectors can enhance their mapping and spatial analysis workflows by adopting and expanding their use of ArcGIS Online.

Key Benefits for Organizations
The FedRAMP Moderate authorization for ArcGIS Online presents a range of advantages for organizations that use the SaaS technology, from expanding the types of data that can be stored and processed to strengthening opportunities to collaborate. Read on to find out more.

A Reliably Secure SaaS Infrastructure
ArcGIS Online is the first SaaS-based GIS to achieve FedRAMP Moderate authorization based on the US Department of Commerce's National Institute of Standards and Technology's (NIST) SP 800-53 Revision 5 security controls. As a cloud-based solution, ArcGIS Online enhances organizational efficiency by reducing the time and costs required to set up the system, since it eliminates the need to invest in infrastructure, engineering, and system administration. Not only did Esri seamlessly increase the security assurance level of ArcGIS Online, but the company also migrated to NIST's latest security control revision with no impact to customers.

Confidently Store and Process Moderate-Impact Data
Organizations that use ArcGIS Online can confidently collect, maintain, process, disseminate, and dispose of low- or moderate-impact data. This enables users to perform a wide range of geospatial workflows while adhering to the highest standards of security and compliance.

Enhanced Collaboration and Sharing
Organizations can expand their collaboration with external stakeholders to include those that need to ensure a higher degree of security compliance. With more data in the system and more people able to work with that data, processes such as sharing data, conducting analysis, and expanding situational awareness become more powerful.

A Seamless Integration with ArcGIS Enterprise
Organizations can seamlessly integrate ArcGIS Online with their existing ArcGIS Enterprise deployments to scale beyond the reach of on-premises capacity, facilitating data sharing, collaboration, and comprehensive geospatial workflows.

Using Advanced Geospatial Capabilities for Critical Operations
For organizations that engage in emergency response, disaster management, infrastructure planning, and environmental monitoring, they can expand their use of ArcGIS Online to incorporate a wider variety of geospatial data in support of critical operations.

Value and Relevance for International Users
For international users that need to align with standards such as the International Organization for Standardization's ISO/IEC 27001, the ArcGIS Trust Center provides information on mapping FedRAMP compliance to ISO 27001 security controls. The web page shows how FedRAMP meets international security and compliance requirements, aiding users from around the world in understanding the authorization's relevance to their needs.

More Administrator and User Control
New AI capabilities—including Business Analyst Assistant (Beta) in ArcGIS Business Analyst and the ability to create smart assistants in ArcGIS Survey123—are available to ArcGIS Online users on an opt-in basis. This means that ArcGIS Online administrators can choose if and when their organizations make use of AI.

Depend on Continually Monitored Infrastructure
Maintaining FedRAMP Moderate authorization requires Esri to continuously monitor ArcGIS Online services, perform annual penetration testing, and get approval by an independent third party. Additionally, ArcGIS Online is segmented from corporate systems to ensure system isolation and independence, which foster higher resilience.

The Unique Advantages of Enhanced Security
Since every organization has its own data classifications, IT resources, and specific requirements, each will experience unique benefits from the enhanced security posture of ArcGIS Online.

For example, Organization A, which has stringent security requirements and limited IT resources, can use ArcGIS Online FedRAMP Moderate authorization to meet its compliance obligations and integrate ArcGIS Online into its existing systems. This will allow staff members to access and analyze geospatial data without investing in additional hardware or software. Leaders can be confident that the organization's data is protected at the highest level, building trust with stakeholders and strengthening the organization's reputation.

Organization B, which analyzes utility networks, can now efficiently integrate more workflows into ArcGIS Online while maintaining custom database configurations in its ArcGIS Enterprise deployment. This organization has various options for hybrid deployments with ArcGIS Online and ArcGIS Enterprise, allowing users to incorporate moderate-risk data in workflows that extend beyond the reach of on-premises capacities.

Organization C is a federal agency known for its stringent security measures and vast amounts of sensitive data. It offers public information through a scalable external platform. By adopting ArcGIS Online, this agency can now share previously inaccessible data with external stakeholders, improving situational awareness and communication among teams, emergency centers, and local emergency response leaders. This integration streamlines workflows, boosts collaboration, and supports better-informed decision-making.

In each of these scenarios, the ArcGIS Online FedRAMP Moderate authorization helps organizations meet their unique security needs. This enables them to leverage the power of GIS technology to collaborate, share data, and develop innovative location-based solutions in new ways, ultimately allowing them to achieve their missions.

Understanding Your Organization's Responsibility
Organizations that align their workflows with the FedRAMP Moderate authorization are responsible for implementing and maintaining certain security controls and practices.

These organizations should review the Customer Responsibility Matrix (CRM)—available on the Documents tab of the ArcGIS Trust Center once signed in—and determine how best to implement any required changes. The CRM describes elements of user engagement outside Esri's scope, such as the requirement that end users employ multifactor authentication and categorize datasets to align with Zero Trust Architecture (ZTA) stipulations and privacy regulations, whether at the state or international level.

Visit the ArcGIS Trust Center at trust.arcgis.com to learn more about what the ArcGIS Online FedRAMP Moderate authorization means for your organization.

Uniting the World, One Map at a Time

every person's first point of contact with the county is met with the seamless, comprehensive, and compassionate delivery of government services.

Jose R. Rodriguez, the division director for the county's IT department, described a new GIS app that supports county departments, municipalities, and state agencies in their work on infrastructure projects for road management.

↑ Jose L. Lopez (left) and Jose R. Rodriguez (right) from Miami-Dade County, Florida, detailed many of the ways the county uses GIS.

"This application aims to reduce disruption and save money by identifying collaboration opportunities," Rodriguez said, noting how the county employed ArcGIS Indoors, Urban, and Esri's new Road Closures solution. "With our efforts, we're going to be helping drivers ride to a destination more efficiently."

In addition, staff can assign appropriate county employees to hurricane evacuation shelters based on the employees' areas of expertise.

"We're seamlessly opening virtual doors, physical doors, to our employees and to our community, and that's because of the partnership that we have with Esri," said Jose L. Lopez, the assistant director for the county's IT department.

Ahead of the Flow

Central San, a wastewater treatment agency in Contra Costa County, California, provides wastewater collection, treatment, and disposal services; recycled water production and distribution; and household hazardous waste collection to nearly half a million residents and more than 15,000 businesses.

Although Central San's GIS team is small, it has been able to streamline its everyday work and significantly improve the impact of its community's environmental stewardship, largely through its use of ArcGIS Utility Network for wastewater asset management.

Khae Bohan, asset management program administrator for Central San, and her colleague, GIS analyst Carl Von Stetten, laid out their use of Utility Network. They demonstrated how it is employed to model complex assets, such as maintenance holes, and enable staff to operate more efficiently both in the office and in the field.

"*[Utility Network]* has become the foundation for our enterprise network management system," said Von Stetten, who emphasized that the software allows for more precise communication with mobile workers. For instance, these workers can respond to customer requests by using an app created with ArcGIS Instant Apps that performs a network trace with Utility Network data.

Inside treatment plants, Central San is exploring connecting its GIS workflows with engineering designs and building information modeling (BIM) data in Autodesk Construction Cloud using ArcGIS GeoBIM. This will provide staff with a 3D view of assets alongside computer-aided design (CAD) drawings and BIM documents.

"Having a 3D model allows staff to visualize and interact with each system as a whole in a way not possible with 2D drawings alone," said Bohan. "This will improve communication and collaboration between consultants, engineering staff, and our operations staff."

Managing the Seabed with ArcGIS

The Crown Estate, a national landowner in the United Kingdom, is using GIS to help ensure shared and long-term prosperity for England, Wales, and Northern Ireland. Created in 1760, The Crown Estate helps manage land across the countryside, communities, coastal areas, and the ocean floor.

Presenters described how The Crown Estate considers shipping, fishing, environmental protection, costs, and more in making decisions about where to locate offshore wind farms capable of powering millions of homes.

"We have a responsibility to unlock value for the land and nature through the sustainable management of a diverse portfolio of assets, both on land and across the entire seabed," said technical and spatial planning director Michelle Moore.

GIS helps The Crown Estate identify, optimize, and balance how marine resources are managed while considering

← Khae Bohan (left) and Carl Von Stetten (right) from Central San demonstrated how ArcGIS Utility Network models complex assets.

↑ GIS helps The Crown Estate identify, optimize, and balance how marine resources are managed when planning offshore wind farms.

net-zero greenhouse gas emissions goals, how to boost nature recovery, and how to maintain a thriving marine-based economy. The Crown Estate does this by using its Resource Information and Optimization (RIO) resource management tool. RIO provides scenario-based geodesigns augmented by community input that is collected using interactive crowdsourcing apps built with Hub.

"We need to engage and work with others to consider the whole of the sea and all of its users," Moore said. "It's an act of balance, integrating competing and complementary interests."

To achieve this, RIO shows existing infrastructure, such as oil and gas platforms; legislative data, such as protected marine areas; health and safety considerations; and technical exclusions, including areas that are too shallow for development. This helps The Crown Estate determine where to locate offshore wind farms. Different scenarios focus on issues such as space, costs, and environmental impact.

"It allows us to understand the consequences of those scenarios, both positive and negative," said Marine Delivery Routemap initiative director Jamie Moore.

Empowering Kuwait by Capturing Reality

Established in 1982, the Public Authority for Civil Information (PACI) in Kuwait has spent years building a geospatial repository for the country's government and its people. It is a one-stop shop for authoritative data, apps, and services that supports a population of over 4 million people.

"The data is stored in…various formats, like papers, scanned documents, CAD drawings, and custom apps," said Maher Abdel Karim, GIS consultant and program manager for PACI. "We linked them all together and created a comprehensive basemap for the country."

Karim and his colleagues presented PACI's efforts to centralize Kuwait's location data. In 2013, PACI introduced Kuwait Finder, a mobile app that allows its over 2.5 million users to search for addresses and businesses across the country using an identifier known as a PACI number. This number contains additional information about each location.

As part of its efforts to act as a geospatial data authority in Kuwait, PACI has also used geospatial artificial intelligence (GeoAI) to map and verify speed bump locations across the country and

created a detailed 3D digital twin of many of the country's urban and agricultural areas. To construct this model, PACI collected more than 650,000 drone images and generated an orthomosaic using ArcGIS Reality for ArcGIS Pro.

"By leveraging all these outputs, we used ArcGIS Pro and the ArcGIS Reality extension to generate a fused photo-realistic 3D model," said PACI's reality capture data production team leader, Dr. Bedoor Mohammad, as she demonstrated how to navigate the detailed model onscreen. "Isn't it beautiful?"

↑ Representatives from Kuwait's Public Authority for Civil Information (PACI) used geospatial artificial intelligence (GeoAI) to map and verify speed bump locations across the country.

Innovative Security and Climate Solutions

With almost 9,000 properties in more than 141 countries, Marriott International is the world's largest travel and hospitality company, according to Marriott global vice president of engineering and facilities Robert Bahl. But the company's focus extends beyond hospitality, said Bahl, who described Marriott's innovative, GIS-powered solutions for managing corporate security and mitigating risk.

By leveraging the Instant Apps Atlas template and ArcGIS Dashboards, Marriott global intelligence employees have immediate access to real-time tactical information on a variety of hazards related to civil unrest, terrorism, and climate change. At the same time, Marriott seeks to reduce its carbon footprint and improve sustainability.

Each Marriott property is assessed and monitored for natural and human-related risks, which helps Marriott implement mitigation measures to ensure the safety of its guests and employees.

"Our story begins with the Global Safety and Security Risk Atlas," said Marriott senior manager of global intelligence Richard Barta, who noted that this app was built with Instant Apps. "Our team can quickly compare relative strategic risk scores from threats like terrorism, civil unrest, and crime, under our threat condition program. We can easily illustrate our security risk analyses, countermeasures, and program compliance into a clean, single-pane window."

Preloaded layers from ArcGIS Living Atlas of the World also enable the app to help with operations during potential and actual risk events.

Marriott director of operations support and training Agila Kumar described how the company's engineering and facilities team uses Dashboards to evaluate present and future risks due to extreme weather and climate change impacts such as heat waves and coastal flooding.

In addition, Kumar said, dashboards show carbon footprints for each Marriott property, helping Marriott with its goal of reducing its carbon footprint by 50 percent by 2030 and achieving net-zero carbon emissions by 2050.

A City in Nature

Finally, representatives from the Urban Redevelopment Authority (URA) and National Parks Board of Singapore (NParks) highlighted how the two organizations work together to make Singapore greener and more sustainable.

Due in part to its equatorial climate, Singapore is uniquely vulnerable to climate change. Enter Singapore's Green Plan, an initiative designed to support the United Nations' Sustainable Development Goals by turning Singapore into what the plan calls a "city in nature."

"To achieve this vision, we are preserving our natural capital and creating greenery at different scales within the city," said NParks director Ow Siew Ngim. "We have already set aside more than 20 percent of Singapore's land to preserve our tropical rainforest and mangroves."

As part of this goal, URA has developed a 3D system of record with ePlanner, an app integrated with ArcGIS Enterprise that serves over 1,600 users across more than 40 government agencies. With ePlanner, users can access data on buildings in addition to more than 200 data layers, including those of mainland Singapore's walking and cycling networks and plans for the city.

"Singapore takes a long-term approach to urban planning," said URA systems analyst Tan Chun Xiao, highlighting study areas that planners are currently working on.

But Singapore has a tremendous amount of greenery to manage, and with its ArcGIS Enterprise environment, NParks has bolstered these efforts to create a city in nature by developing a GIS ecosystem to handle everything from tree inspections to landscape operations.

"We have more trees than humans," noted Ngim, showcasing the realistic 3D models of many of the 6 million managed trees in the city. This is one of multiple measures the city has taken to prioritize its natural spaces and features.

The NParks public tree map, for instance, allows residents to learn about the city's foliage and streamlines tree planting and maintenance.

Efforts like this ensure that Singapore's greenery remains a vital part of a healthy and sustainable community. They also conjure up Dangermond's remarks from earlier in the Plenary Session—that overcoming existential challenges such as climate change will require significant collaboration.

"It's going to require uniting around this powerful science that we have—geography," he said. "And we need to do this urgently."

↑ Robert Bahl (left), Richard Barta (center), and Agila Kumar (right) described Marriott International's GIS-enabled solutions for managing corporate security and addressing risk.

Watch all Plenary Session presentations, including the keynote speeches, at **links.esri.com/plenary24**.

The Emergence of 3D Basemaps

Basemaps are more than technical tools. They are hidden infrastructure that support and advance development around the world. Basemaps are foundational data that governments, businesses, and communities need to make informed decisions, create strategic plans, and respond effectively to challenges.

Esri provides a large collection of 2D and 3D basemaps built with data from both Esri and OpenStreetMap (OSM)—and soon, users will be able to access basemaps built with additional data from the Overture Maps Foundation, a collaboration that Esri joined last year. All these basemaps, which cover the globe, employ open data from many sources. They are comprehensive and highly detailed, thanks to the cutting-edge technology and many human hands that contribute to and edit them.

"What's nice about this kind of open data is you can have incredible detail for some types of features," said Deane Kensok, Esri's chief technology officer for ArcGIS content. "And the maps get better and better over time as the open data community improves the data."

Basemaps are better in some areas of the world than others, however. So as Esri continually works to improve the open data-based basemaps available in ArcGIS, staff are also coming up with new ways to help national mapping agencies in underrepresented parts of the world build up their basemaps.

"National basemaps are indispensable for a country's development," said Sohail Elabd, Esri's director of international strategies. "Investing in building basemaps would be transformative for many countries."

Developing Comprehensive 3D Basemaps with Overture

For the past few years, Esri has been using OSM's Daylight Map Distribution (daylightmap.org) to support the basemaps it develops and hosts. At the end of 2024, however, Daylight Map Distribution is moving into mature support. So Esri is transitioning to Overture Maps (overturemaps.org) and releasing a new version of the Open Basemap with that data.

Overture Maps includes a curated and integrated collection of open data from OSM and many other sources. Esri's new Open Basemap will be designed and delivered as a vector tile basemap available in multiple map styles, which can be easily customized into many other styles. Overture data will also be used to update parts of Esri vector basemaps.

Esri has been working with other Overture Maps members to include more buildings with 3D attributes—such as building heights from lidar and data from contributors to Esri's

↓ Basemaps and 3D buildings are better in some areas of the world—such as (from left to right) London, England; Dubai, the United Arab Emirates; and Paris, France—than in others.

Community Maps Program—in Overture data. Expanding on the new 3D basemaps that Esri released last year, Esri will offer new 3D scene layers for buildings, trees, and place labels that are created with Overture Maps data.

In addition, Esri will use Overture data to update large parts of the new Esri 3D Buildings scene layer, which is currently in beta. The 3D Buildings layer is produced with data from commercial, community, and open data sources. Esri will use Overture buildings data to add coverage where commercial or community data is not available.

"Overture Maps provides the most comprehensive buildings layer that exists," said Kensok. "It has over 2.3 billion buildings in it already and combines data from multiple sources, including OSM, Esri, Microsoft, and Google."

In some areas of the world, the buildings data is so detailed that it includes columns, patio coverings, and solar panels. Just like with Esri's basemap data, these details are largely generated by humans, rather than machines, who hand-draw or edit the data.

"The Esri Community Maps datasets are coming from GIS professionals, cities, counties, and national mapping agencies, so they tend to be high quality," said Kensok. "They nicely complement the great work of the OSM community to build and maintain open data around the world."

Other Overture Maps members are also enhancing the 3D buildings data that is available. Meta, for example, has taken elevation values from US Geological Survey lidar data and appended estimated heights to buildings. This can be used to extrude the buildings from the footprints and show them in 3D.

"Overture members and OSM mappers have added heights to millions of buildings in the past couple years, so we have an emerging 3D landscape that didn't exist before and that we can continue to scale internationally," said Kensok.

Just like it did with OSM's Daylight Map Distribution, Esri will update its maps and layers with Overture data monthly, ensuring that any data added by Overture members and the OSM community is quickly reflected in Esri's basemaps.

Making Basemaps More Widely Available Around the World

Having a reliable and detailed map-based view of a country's landscape—from mountains and rivers to roads, buildings, and farmland—is pivotal for stimulating economic growth, attracting investment, and enhancing public services. That's why, in addition to contributing to OSM and Overture and including authoritative data from Esri users in its basemaps, Esri is committed to ensuring that comprehensive geospatial data and detailed basemaps are available for every region in the world.

In 2019, Esri launched the Africa GeoPortal, which brings together geospatial data, tools, and learning for free for anyone working in Africa or on geospatial projects based in Africa. It is also a place for user communities to share their geospatial data and open it up for use by others.

The Africa GeoPortal, which is powered by Esri technology, comes with content from ArcGIS Living Atlas of the World that's specially curated so that it relates directly to Africa. Users also get access to ArcGIS Online, apps and analytical tools, and a large selection of Esri's e-Learning materials. But the unparalleled value of the Africa GeoPortal comes in the form of community-contributed data.

"People bring in data they might collect at a local or national or continental level, especially if they need a place to store it," said Matthew Pennells, Esri's director for global community engagement. "We also have governments adding data, *[along with]* broader partners in the geospatial industry, such as *[…]* Digital Earth Africa."

The Africa GeoPortal is intended to be a model for other areas of the world that lack extensive geospatial data, including the Caribbean and Latin America, which have their own geoportals as well.

Many national mapping agencies, though, still lack the capacity to build the authoritative basemaps their countries need to plan urban development and infrastructure projects, prepare for natural hazards, augment climate resilience, optimize agricultural practices, ensure food security, protect the environment, and manage natural resources. So Esri is continuing to expand its efforts to contribute to open data, whether by ensuring that its geospatial data can be downloaded or used as a service and is interoperable with other systems, or by helping users in emerging markets gain the technological capacity to conduct advanced GIS work.

"The evolution of basemaps—particularly the advancement into 3D representations—is revolutionizing how people perceive and interact with geospatial data," noted Elabd. "We hope the solutions we develop can be a model that many national governments, regional organizations, businesses, and aid organizations can repeat going forward."

As Esri continues to champion open data initiatives, contribute to collaborative projects like Overture Maps, and empower national mapping agencies, the future of basemaps looks promising. The accessibility and comprehensiveness of these foundational datasets will play a pivotal role in driving sustainable development, making informed decisions, and responding effectively to global challenges.

"The call to action is clear," said Elabd. "The geospatial community needs to invest in national basemaps, embrace the power of 3D geospatial technology, and collaborate to build a more connected and informed world."
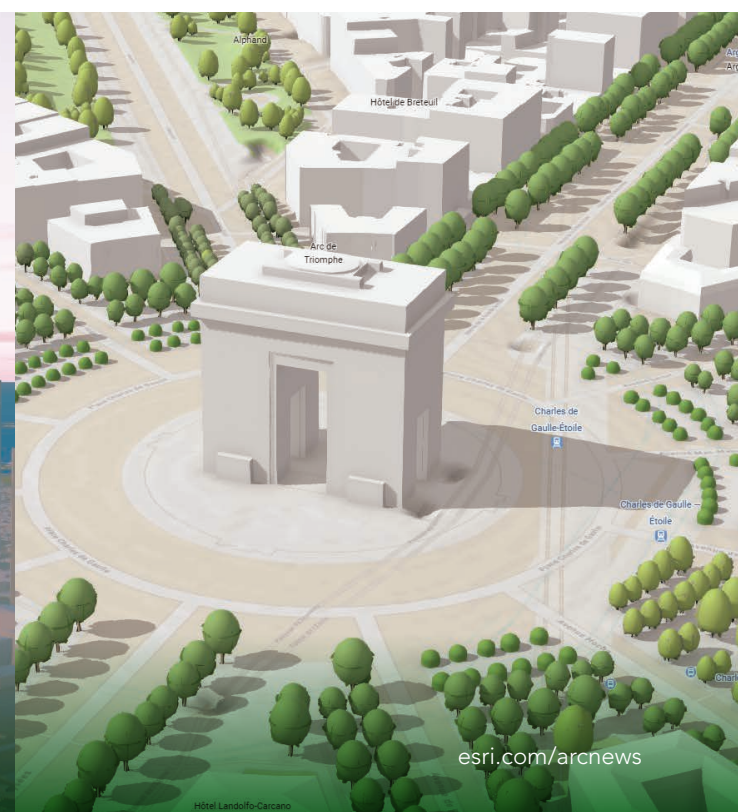
To Manage a Hepatitis A Outbreak, County Health Department Turns to GIS

Activating a Quick Response

Hepatitis A is a highly contagious virus that targets the liver and can cause nausea, fatigue, fever, and even liver failure.

The Erie County Department of Health was alerted about the hepatitis A case on a Thursday. To prevent a widespread outbreak, the health department immediately started working on getting a mass vaccination clinic going near the restaurant.

But the clock was ticking. While vaccinations are effective at preventing hepatitis A, they must be administered to previously unvaccinated individuals within two weeks of coming in contact with the virus.

Department staff members used the weekend to create an ArcGIS technology-based workflow that relied on Survey123 to help patients with registration and check-in, and two dashboards to track vaccination operations in real time. The following Monday, the department used local news outlets and social media to encourage people who had eaten at the restaurant in the previous two weeks to get vaccinated. Department staff administered vaccines that Tuesday and Thursday.

Dashboards Streamline Operations

As patients arrived at the vaccination clinics, staff members helped them register using tablets and laptops equipped with the new registration and consent form created with Survey123. This replaced the department's previous, time-consuming registration process, which involved using paper forms.

The survey employed conditional questions to allow staff and patients to skip certain fields and speed up the registration process. For example, if a patient said they were 18 years old or younger, the survey alerted the patient that they would need to contact their doctor to get vaccinated, since the department was not permitted to administer vaccines to them. The form also provided direction when the vaccination registration process couldn't proceed because of allergies or other circumstances.

The survey results populated a dashboard that helped staff monitor vaccination center operations in real time. The dashboard allowed them to see how long it took patients to get vaccinated after registering, how much of the vaccine supply had been administered, and how many doses were left. This helped health department staff make critical decisions during the clinic, such as when to release a statement informing the public that no more walk-ins could be accepted.

Another dashboard that was populated using the Survey123 form was a patient queue dashboard that enabled health department staff to monitor who had checked in but not yet received a vaccine. The list in this dashboard was filtered for patients who had filled out the survey but had not received a signature from the medical professionals distributing vaccines, meaning the patients hadn't been seen. The idea was to ensure that the first people in were the first people out—without making everyone stand in a line. Since the most at-risk population for hepatitis A is people who are 65 years and older—an age group that also frequents the restaurant where the outbreak occurred—mobility issues were a factor. Allowing patients to be seated and called in the order in which they arrived, rather than wait in line, was a great asset to the department and patients.

This dashboard also had a survey embedded in it that was in edit mode. When a patient was selected from the queue list, their registration and consent form was loaded into this survey so it could be reviewed by the staff members dispensing the vaccine. Additional fields that were conditioned to only be visible in edit mode were then displayed. These included the medical staff signature line, a box to record the vaccine lot number, and a check box to indicate which arm the patient received the vaccine in. Later, this data, plus each patient's immunization information, was exported to the state's confidential immunization records system.

"This saved health department staff hours of manual data entry," said Mrenak.

GIS Improves Efficiency

Foodborne illnesses like hepatitis A can seriously impact the health of a community. It's the responsibility of local health departments to track and evaluate health hazards that originate in places that serve food by managing inspections, enforcing regulations, and educating food workers and the public. When an outbreak occurs, it is up to the local health department to investigate the source of the illness and control its spread.

With this recent hepatitis A case in Erie, a GIS-based workflow helped the health department respond to the outbreak quickly and efficiently. And department staff actually had limited experience with GIS, having only begun a multiyear Esri Advantage Program subscription in 2023. Yet in a matter of days, the department was able to vaccinate 415 patients against hepatitis A, sparing community members the potential effects of a serious foodborne illness.

↑ A dashboard populated by an ArcGIS Survey123 form helped staff monitor operations in real time.

↑ Health department staff and Medical Reserve Corps volunteers learned how to use the vaccine clinic survey and dashboards at a training event.

← A form built with Survey123 helped patients check in at the vaccination clinics.

About the Author

Lauren Carson is an epidemiology research associate at the Erie County Department of Health in Pennsylvania. She is a supervisor who oversees epidemiology and public health preparedness. Carson is also an adjunct professor at Mercyhurst University, where she teaches a course on the foundations of epidemiology.

Executive Briefing for UAE Delegation at Esri Spurs Ideas and Brings Answers

Professionals from United Arab Emirates Visited Esri's Redlands Campus for Five Days of Learning and Collaborating

As historic flooding drenched the United Arab Emirates (UAE) cities of Dubai and Sharjah on April 16, 2024, software engineer Mohammad Al Tayer was among those supporting response efforts by using GIS to gather critical information for the Dubai Municipality.

"It's a matter of making sure that the correct data is presented at the right time, and easily presented to the right people," he said.

Less than a week later, Al Tayer was among a high-level delegation of UAE professionals sitting inside Esri's Redlands headquarters in Southern California. The group was gathered for an Esri Executive Briefing (which was arranged well before any flooding happened) to share and exchange information with one another and Esri developers and leaders.

The Esri Executive Briefing Program, which aims to foster and grow the company's relationships with its users, began several years ago and was revived following the pandemic under the direction of Linda Peters, Esri's executive program and Geo Experience Center (GeoXC) director. A team within Esri's GeoXC coordinates the visits, which can last anywhere from a few hours to several days.

Since 2023, Esri has hosted more than 100 briefings across industries, including for national, state, and local government agencies; utilities; and education organizations. The rate of briefings is steadily increasing as well. Less than a week after the briefing for UAE professionals, for example, the team hosted a contingent from Indonesia focused on the development of the country's new capital city, Nusantara.

Listening to Customers' Needs and Wants

Before any briefing, Peters and her team work to understand the client's mission and the goals of the meeting. They then coordinate with the customer's account team to prepare tailored content to present. They also seek out subject matter experts who can educate participants, discuss application areas such as site suitability or supply chain location analysis, and help answer questions.

The priorities that each client brings to a briefing are unique. They can revolve around overcoming specific business challenges, modernizing GIS implementations, leveraging technology to come up with innovative solutions, saving time, or increasing efficiencies.

"They want to know more about our issues, our problems, how they can solve [them]," Al Tayer noted of the subject matter experts who presented during the visit. "You feel that we're working together to make this product beneficial for both sides," he said of Esri's technology.

When Esri's experts did a presentation about ArcGIS Hub, for example, Al Tayer said he was interested in how the collaborative cloud platform would be compatible with his organization's technology.

"Is it easy to deploy? Are the any prerequisites that I need to keep in mind? And we got the answers like that here," he said, snapping his fingers. "Now it's just a business decision if we're going to go ahead, if we're going to implement it, and how we're going to implement it."

Hearing Directly from Experts

For five days, the 21 GIS professionals, software engineers, urban planners, and utility managers from the UAE were afforded a unique view into the technology that provides them with vital location intelligence. Participants were able to meet with Esri leadership, each other, and other Esri users to learn from their experiences.

Several participants noted how pleased they were to see Esri's advancements in AI during a session led by Ismael Chivite, Esri's senior principal product manager for AI assistants in ArcGIS. The small size of the groups hosted on campus allow for "a level of interaction and discussion that is not possible through a webinar or conference," Chivite said. "It is obviously an investment of time for the customer and Esri, but it's a great opportunity for both to collaborate."

The delegation included participants from several UAE municipalities; utilities; governing agencies, including the country's space agency; and the UAE's largest telecommunications company. Two representatives from gistec—Esri's official distributor in the UAE—who spent several months organizing the briefing's logistics alongside the GeoXC team, also attended.

Meeting in person made it easier to ask questions and get answers, said Khawla Al Fahim, director of the geospatial data management department for the UAE's Department of Government Enablement.

"You meet the people who are involved in either developing the [GIS] tool or are experts in using [it]," she said.

Al Fahim's department uses GIS primarily as a communication tool to support solution-oriented decision-making among UAE agency leaders. She said she was pleased to see the development of Esri's AI-enabled assistant tools, given that her agency has been experimenting with new AI communication technology.

"Coming here, I saw the different solutions that Esri has been coming up with, and I have a very, very long shopping list that I'll be discussing with the team," she said.

Seeing—and Being Part of—the Road Map

Dubai Electricity and Water Authority (DEWA) has used GIS to more clearly see the distribution of its network, which includes 4.5 million assets, as well as the areas that were impacted by the April flooding. Visualized in topographic layers, DEWA has been able to identify locations that may be prone to collecting water in the future.

Adel Al Tamimi, director of digital products and solution management for DEWA, noted that he and his team have regular interactions with other UAE municipalities and agencies amid day-to-day business. Yet the visit to Esri's campus offered a valuable opportunity for them all to socialize and share knowledge in person.

In talking with Esri's leaders, he said, he was also able to "freely communicate our ambitions and our wishes to improve the products further in the future." He added, "We had the privilege to see the road map and what's under development currently in the pipeline and what will see light in the future. That also made us feel that we're part of this community of development and we are becoming part of the road map."

In addition to hearing from Esri developers and leaders, participants visited Orange County Public Works and the City of San Diego. They also met with officials from Riverside County and Southern California Gas to learn about how they're applying GIS in their organizations.

Adnan Sharaf, who's with the Al Ain Municipality, appreciated the real-world examples of GIS technology in action. "Here you can see the case study," he said.

Mohamed Abuziad, CEO of gistec, started organizing international GIS executive visits for UAE-based organizations in 2009 with a trip to Esri Canada in Toronto. April's trip was gistec's first organized Executive Briefing Program visit to Redlands.

"There is discovery," he said of this event that exposes participants to new and additional ways to use GIS. He's witnessed how the participants start to share knowledge, and how friendships form. "It has a different flavor," he said of the visit.

As Abuziad talked, Esri president Jack Dangermond, who had spoken to the group earlier in the week, visited the Esri Café, where attendees were finishing lunch, and chatted with some members of the group.

The site visit was Al Tayer's first time meeting Dangermond, and he said he was surprised and reassured by how much the Esri founder understood each of the attendees' circumstances and needs.

"To add to that, he's very knowledgeable in terms of what he wants, what is Esri's strategy, and where they want to go," he said. "It really aligns with what we're looking for."

To learn more about the Esri Executive Briefing Program, email experiences@esri.com or go to links.esri.com/ExecutiveBriefing.

← Juhan Yoon, a senior solutions engineer for Esri, demonstrated Esri's technology to the delegation from the United Arab Emirates (UAE) inside the Geo Experience Center (GeoXC).

↑ A group of professionals from the UAE visited Esri's headquarters in Redlands, California, for five days in April to get a unique view of ArcGIS technology, how Esri operates, and how other organizations use GIS.

Transforming Fiber Network Planning with Reality Capture and ArcGIS

By John Schroeder, Geosolv

A recent influx of funding to deploy broadband more equitably throughout the United States—including more than $42 billion in investment from the National Telecommunications and Information Administration—has accelerated demand for high-speed internet infrastructure across the country. This funding surge has also increased demand from telecommunications companies to implement efficient and accurate solutions that can help manage increased workloads and meet project timelines.

Sioux Falls, South Dakota-based telecommunications engineering company Geosolv serves a diverse clientele, including urban developers and rural broadband providers. To assist its clients in tackling the current rush of new infrastructure projects, Geosolv starting using an advanced reality capture platform from Esri partner GeoCam, along with ArcGIS products such as ArcGIS Pro and ArcGIS Online, to optimize the planning, design, and deployment of fiber-optic networks.

Data Collection Presents a Host of Challenges

Until recently, Geosolv faced significant challenges in its fiber network planning processes—particularly in capturing accurate field information, given the company's limited field resources and the costs associated with mobilizing them. Traditional data collection methods were time-consuming and resource intensive, often requiring mobile staff to conduct extensive field-based surveys and perform manual data entry. This delayed project timelines and raised operational costs.

Because the company relied on manual data collection methods, it was difficult to capture accurate information in the field, raising the risk of inputting errors and having incomplete information. Geosolv's small team of field surveyors collects data in various urban, suburban, rural, and indoor environments, which often requires the team to use specialized equipment and approaches, further straining the company's resources. Factors such as transportation and having to conduct repeat visits also puts a strain on the company, especially when it comes to surveying remote or difficult-to-access locations.

Upgrading Fiber Network Planning Workflows

To address these challenges, Geosolv turned to GeoCam's advanced reality capture platform. This integrated system—which is customized for utility and telecommunications users—includes a 360-degree camera that can be deployed on vehicles, drones, and backpacks to capture high-resolution imagery across diverse terrain. The platform's visual positioning system and AI models automate feature identification and creation, expediting highly accurate infrastructure data collection and system distribution mapping.

GeoCam integrates with ArcGIS Online and ArcGIS Pro—two core components of Geosolv's toolkit—via GeoCam Manager and GeoCam Editor. GeoCam Manager helps administrators set up reality capture projects, establish users, and configure the cameras. Once captured data is added to ArcGIS Online and ArcGIS Pro via GeoCam Manager, GeoCam Editor streamlines map creation, enabling users to auto-assign feature types—such as poles, pedestals, homes, and fiber infrastructure connections—using single-click mode and smart symbol detectors. Users can also triangulate feature locations by comparing two image views, which increases accuracy.

Geosolv implemented GeoCam QAQC as well, a robust quality assurance and quality control process that helps ensure data integrity. It allows users to review, flag, and correct data inaccuracies in ArcGIS Online and ArcGIS Pro. Additionally, the company implemented GeoCam Viewer to simplify users' interactions with imagery and GIS data. The app allows stakeholders to easily navigate maps, search for features, and collaborate on web maps via shareable URLs.

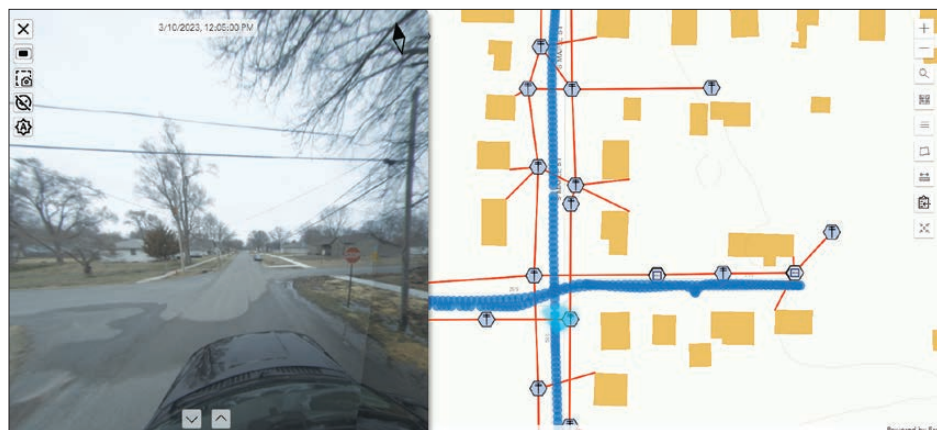## Experiencing Operational Efficiency and Cost Improvements

Implementing GeoCam's advanced reality capture platform and ArcGIS technology has improved data collection, processing, and mapping operations at Geosolv, boosting field data collection efficiency by 60 percent. This enables the company to cover more ground in less time while cutting down on errors. Not only has this enhanced data accuracy, but it has also allowed Geosolv to design more networks with higher data quality. The automated processes that are part of the GeoCam experience have also expedited project timelines, enabling Geosolv to meet tight client deadlines. Fewer revisions are needed, and operational costs have been slashed, giving Geosolv a competitive edge in the fast-paced telecommunications industry.

Geosolv's adoption of GeoCam's reality capture platform alongside Esri technology has significantly enhanced the firm's capabilities in fiber network planning. The implementation not only addresses current industry challenges but also lays the foundation for future growth and innovation.

"The integration of GeoCam and Esri technology has totally transformed Geosolv's approach to fiber network planning," said GeoCam CEO Myles Sutherland. "They can now deliver more precise, cost-effective, and efficient solutions to Geosolv's clients, setting a new standard in the telecommunications engineering industry."

↑ GeoCam Viewer allows users to see imagery that correlates with a map of extracted features.
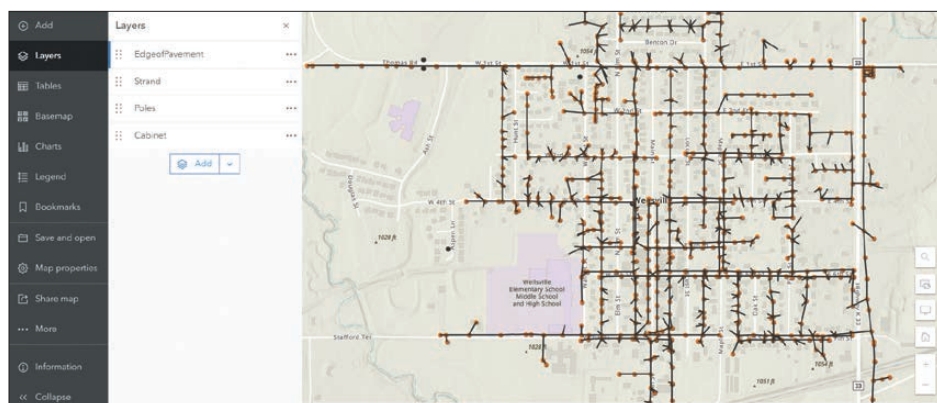
↑ For a project like fiber-to-the-home construction, GeoCam Editor enables users to auto-assign feature types such as poles and homes.

About the Author

John Schroeder is the managing director at Geosolv, where he leads a team of problem-solvers who provide cutting-edge solutions for telecommunications companies, infrastructure development organizations, government agencies, and more. For more information, email Schroeder at john@geosolv.io.

How to Get Fresh ArcGIS Living Atlas Content in ArcGIS Enterprise

ArcGIS Living Atlas of the World provides an extensive collection of ready-to-use authoritative maps, layers, scenes, and apps for ArcGIS Enterprise organizations. Enabling ArcGIS Living Atlas allows an organization's members to use these items in analyses, maps, apps, and more.

In ArcGIS Enterprise 11.3, Esri made substantial changes to ArcGIS Living Atlas. In the past, ArcGIS Living Atlas content was tied to the ArcGIS Enterprise version that an organization was using. This means that organizations didn't have access to updated ArcGIS Living Atlas items until they upgraded ArcGIS Enterprise to a newer version. But having access to fresh, relevant data is important to the work that users do, so Esri introduced a new way for organizations to keep their ArcGIS Living Atlas content up-to-date.

↑ The Living Atlas tab in organization settings shows when content updates for ArcGIS Living Atlas of the World are available.

↑ There is no downtime while ArcGIS Living Atlas content gets updated.

Starting with ArcGIS Enterprise 11.3, organizations can refresh their ArcGIS Living Atlas content in ArcGIS Enterprise. When Esri provides an updated package of ArcGIS Living Atlas items, ArcGIS Enterprise administrators can go into their organization's settings and initiate an ArcGIS Living Atlas content update. This allows an organization's members to access the latest ArcGIS Living Atlas maps, layers, scenes, and apps.

Get Ready for New Content

When a new version of ArcGIS Enterprise is released, an ArcGIS Living Atlas package will now be released alongside it. With the release of ArcGIS Enterprise 11.4, a new package of ArcGIS Living Atlas items is being made available to organizations that use ArcGIS Enterprise 11.3 and 11.4.

This set of content will include exciting new items—such as Landsat Level-2 imagery, updated boundary layers from many regions around the world, Sentinel-5P imagery, and data on current wildfires in the United States—as well as updates to existing items. To find out when this content becomes available, users can look for an announcement on *ArcGIS Blog* or follow the steps below to check for and deploy the new items.

How to Deploy New ArcGIS Living Atlas Content

ArcGIS Enterprise administrators have a tab in their organization's Settings section labeled Living Atlas. This tab contains the organization's ArcGIS Living Atlas configuration settings, including a section that shows which version of the content the organization is currently using.

If a new update is available, administrators will see a notification that includes details about the new version of ArcGIS Living Atlas content. Administrators can choose to update the content immediately or schedule an update for later.

Once an ArcGIS Living Atlas content update begins, new items will be added to the organization's ArcGIS Enterprise portal, existing items will be updated if necessary, and any deprecated content will be removed. There is no downtime while the content gets updated, so users can continue working with ArcGIS Enterprise as they normally do.

When the update is complete, members of the organization have immediate access to the newest ArcGIS Living Atlas content available for ArcGIS Enterprise.

Install ArcGIS Living Atlas Content After Upgrading

In ArcGIS Enterprise 11.4, administrators will notice that their organizations no longer come with a set of preinstalled ArcGIS Living Atlas items. To ensure that users have access to the most up-to-date ArcGIS Living Atlas content packages, Esri now requires administrators to update ArcGIS Living Atlas content after installing or upgrading ArcGIS Enterprise.

If you're an administrator, upgrade your organization to ArcGIS Enterprise 11.3 or 11.4, and give your users access to the incredible, updated library of authoritative maps, layers, scenes, and apps available in ArcGIS Living Atlas.

↓ ArcGIS Living Atlas has a recently added custom web app for visualizing and analyzing Landsat imagery.
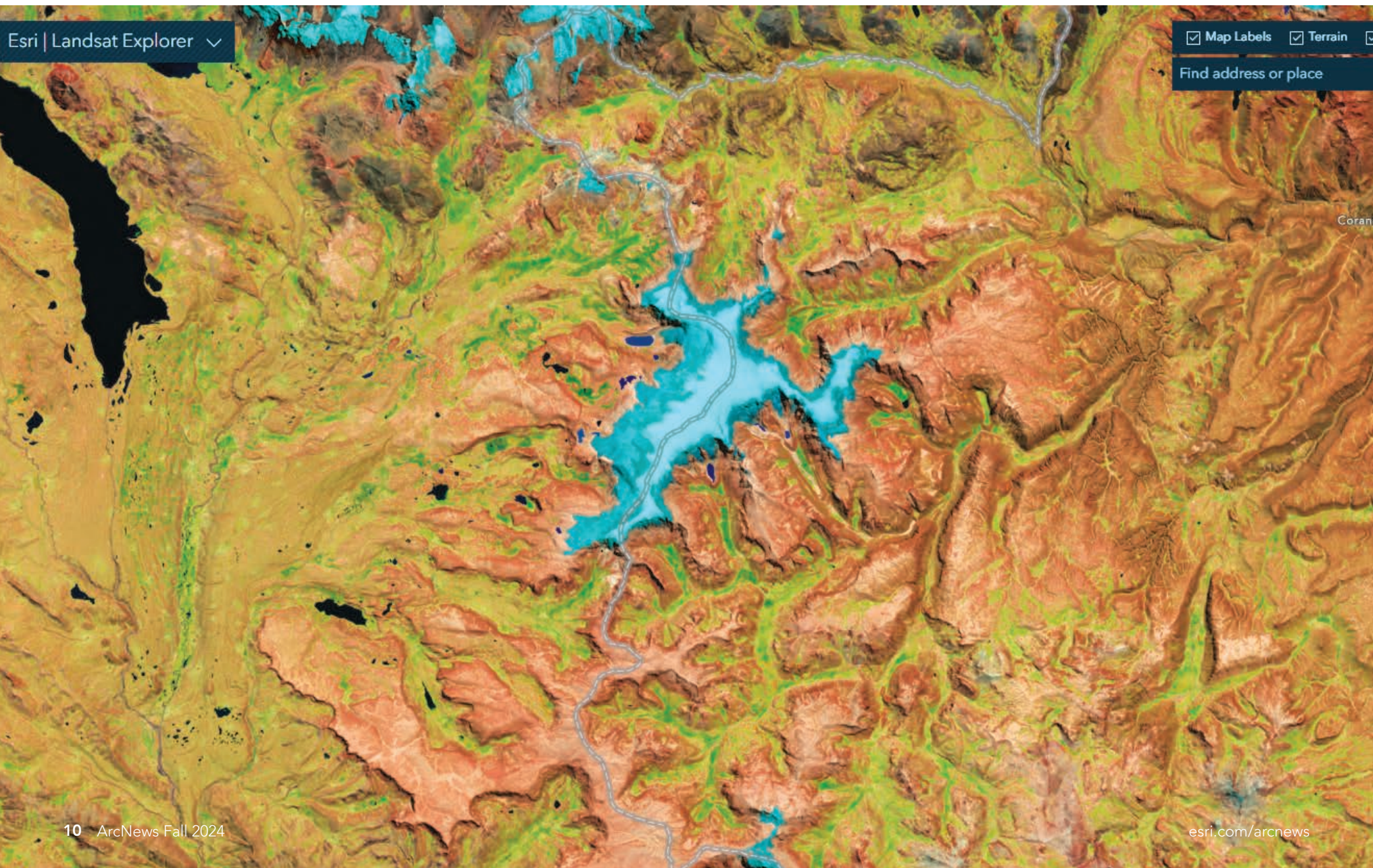
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Seven Ways to Integrate Data with ArcGIS Online

ArcGIS Online allows users to store, manage, and share spatial data as files, web layers, or connections to other data sources. This data, in all its forms, becomes the foundation for visualization, analysis, and editing workflows.

To maximize data's potential in ArcGIS Online, it is essential to integrate data effectively and keep the information current. Here are seven ways to get data into ArcGIS Online.

1 Directly from the Source

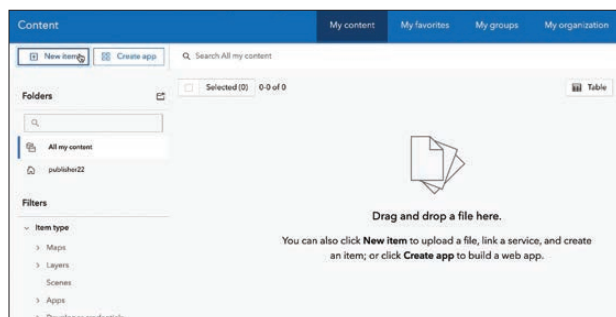For data that doesn't get updated very frequently and is in a ready-to-use state for mapping, analysis, or reporting, it is easy to add this data to ArcGIS Online directly from its source. Users can add data from a local drive or network or by uploading the data from various cloud storage solutions such as Microsoft OneDrive, Google Drive, and Dropbox.

ArcGIS Online supports a long list of file and data formats. Users can add zipped shapefiles, zipped file geodatabases, and CSV files containing location information directly to ArcGIS Online by going to the My content 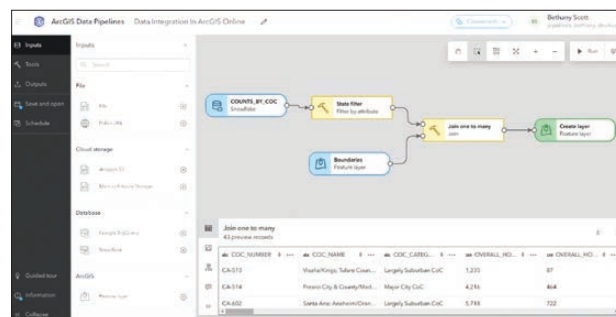tab and either selecting New item or dragging the files into the window. From there, users can create web layers out of their files, transforming the data into a format that is ready to use in web maps, web apps, and analysis tools.

Adding data directly to ArcGIS Online is a great option for when a user's goal is to ingest a static, one-time copy of the data. If the source data changes regularly, is frequently edited, or is growing, then it might be challenging to keep the data current. Users would need to either overwrite relevant items with the latest copy of the data or write a Python script in a notebook to automate the task.

2 ArcGIS Data Pipelines

If the source data is edited outside ArcGIS Online or needs to be cleaned, formatted, and transformed prior to using it in a web map or analysis workflow, it's best to use ArcGIS Data Pipelines. This is a native data integration capability in ArcGIS Online that's available out of the box to all ArcGIS Online organizations.

Data Pipelines offers a low-code, drag-and-drop visual authoring experience that allows users to design data pipelines that ingest, prepare, and engineer data so it is ready to use for mapping, analysis, and reporting. Data Pipelines can establish secure connections to a variety of cloud-based data stores, including Snowflake, Google BigQuery, Amazon S3, and Microsoft Azure Blob Storage. It also supports other data sources such as public URLs and existing feature layers.

Data Pipelines goes beyond merely ingesting data; it can be used to clean, combine, and format datasets. The transformed data is then written out to a feature layer, making it ready to use across ArcGIS. Data Pipelines also includes built-in scheduling functionality that enables users to run their data pipelines on a recurring basis. Thus, as the source datasets change and evolve, Data Pipelines can be used to keep the related layers in ArcGIS Online up-to-date.

3 ArcGIS Velocity

What if the data that needs to be integrated with ArcGIS Online needs to be kept current while also supporting real-time data, such as feeds from Internet of Things (IoT) platforms, message brokers, or third-party APIs? If having real-time situational awareness is the goal, then using ArcGIS Velocity is a good choice.

This real-time and big data analytics extension for ArcGIS Online allows organizations to monitor and gain precise location-based insight on live assets such as cars, trucks, airplanes, boats, and environmental sensors. Velocity does this by ingesting data from IoT platforms and other sensors via the cloud.

In addition, Velocity includes powerful analytics tools, such as dynamic geofencing and visual analysis models. It also supports alerts that can communicate actionable information when time is of the essence.

↑ For ready-to-use data, users can add it to ArcGIS Online directly.

↑ ArcGIS Data Pipelines connect to cloud-based data stores.

4 **Sharing from ArcGIS Pro**

For organizations that begin their work in Esri's powerful, desktop-based GIS software ArcGIS Pro, rest assured that it is designed to seamlessly integrate with the web-based components of ArcGIS, including ArcGIS Online.

Many users start their workflows in ArcGIS Pro, where data creation, editing, and analysis take center stage. ArcGIS Pro offers the flexibility to connect to many different types of data, including files stored on a computer or network drive and data that resides in enterprise geodatabases, cloud data warehouses, and other locations. Users can connect to various data sources, leverage their data in maps and scenes, and perform advanced analytics and visualizations in 2D and 3D.

Once the data is curated, it can be shared to ArcGIS Online as web layers, web maps, web scenes, and more, depending on the use case. This fosters collaboration both internally and externally, whether in the office or around the world. Once the data is published to an ArcGIS Online organization, it becomes available to edit, query, visualize, analyze, and collaborate with.

If the source data changes and updates need to be made to the data in ArcGIS Online, users can either manually overwrite the web layers or automate the process using ArcGIS Python libraries in a notebook or script.
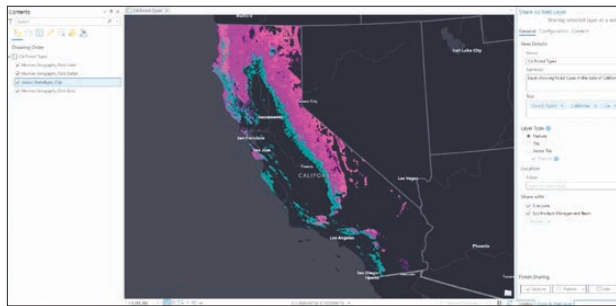
↑ Data curated in ArcGIS Pro can be shared to ArcGIS Online.

5 **The ArcGIS Data Interoperability Extension for ArcGIS Pro**

The ArcGIS Data Interoperability extension for ArcGIS Pro broadens the data integration and transformation capabilities of ArcGIS Pro. Like Data Pipelines and Velocity, Data Interoperability offers an intuitive, no-code visual diagramming interface that can be used to engineer data.

The Data Interoperability extension is an extremely powerful extract, transform, and load (ETL) solution. It provides robust capabilities for connecting to a vast range of supported inputs and file types. It excels at handling complex transformations and allows data to be written back to its source—even beyond ArcGIS.

If changes to source data need to be reflected in ArcGIS Online, organizations do need to have ArcGIS Server licensed with the ArcGIS Data Interoperability extension. This allows users to schedule the ETL jobs to run on a repeated basis via a notebook.

6 **ArcGIS Python Libraries**

When data integration needs are complex or must be automated and no out-of-the-box or commercial off-the-shelf solutions fit the bill, developers and GIS practitioners can use the ArcGIS Python libraries—Python packages that include ArcGIS API for Python and ArcPy. These are powerful, modern Pythonic libraries that provide a consistent experience across ArcGIS for scripting and automating, and they can be used to integrate data.

With ArcGIS Python libraries, users can author Python scripts to connect to an extensive array of data sources and file formats, perform advanced data manipulation and analysis, and write the results to web layers in ArcGIS Online. The Python API has functions and methods for adding and publishing files, packages, and Spatially Enabled DataFrames as web layers in ArcGIS Online. ArcPy can share, overwrite, and replace web layers using a combination of functions and geoprocessing tools.

```
# set the metadata for the CSV file
trailhead_properties = {
    "title": "Trailheads",
    "description": "Trailheads imported from CSV file",
    "tags": "LA Trailheads"
}

# add the CSV file as an item to ArcGIS Online
csv_file = './data/LA_Hub_datasets/LA_Hub_datasets/Trailheads.csv'
csv_item = gis.content.add(trailhead_properties, csv_file)

# publish the CSV item as a web layer
trailhead_service = csv_item.publish()
trailhead_service
```

↑ With ArcGIS Python libraries, users can author powerful Python scripts.

ArcGIS Online includes ArcGIS Notebooks, providing an integrated platform for writing, running, and scheduling automation scripts using the Python API and ArcPy. Python scripts that leverage these libraries can also be written and run externally to ArcGIS Online.

7 **Distributed Collaboration**

Organizations that use ArcGIS Online and ArcGIS Enterprise together should consider employing distributed collaboration to share data from one system with another. This approach requires no scripting expertise and makes it easy to integrate data from ArcGIS Enterprise with ArcGIS Online. Data can be synced in both directions, and once content is shared, updates are sent automatically, keeping the information in sync in both systems.

With distributed collaboration, organizations can seamlessly share maps, apps, web layers, and other content between the two systems. In the case of web feature layers, collaborations can be set up to support the two-way sharing of feature layer edits. This allows a feature layer published to ArcGIS Enterprise to be edited in ArcGIS Online—with the edits then written back to the source, whether that's a hosted feature layer or a feature layer that is referencing data in an enterprise geodatabase.

Distributed Collaboration

ArcGIS Enterprise ⇄ ArcGIS Online

← Distributed collaboration allows content sharing between ArcGIS Enterprise and ArcGIS Online.

Unlock the Full Potential of Data

Once data is integrated in ArcGIS Online, it can be used to perform spatial analyses, create visually stunning maps, and solve problems. The right approach to integrating data depends on each project's unique requirements and each organization's goals.

To learn more and get a list of additional resources related to data integration, see the accompanying Esri Community blog post, "Seven Ways to Integrate Data with ArcGIS Online: Additional Resources," at links.esri.com/7-ways. To ask questions or share additional ideas, visit Esri Community at community.esri.com.

Monitor Credits in ArcGIS Online with Reports

With organizations using ArcGIS Online for everything from managing utility assets to helping communities gain resilience against natural disasters, users can create and follow countless workflows. To ensure that customers only pay for what they use, Esri employs ArcGIS Online credits—a currency that is consumed when users perform specific transactions and utilize certain types of storage.

Not all workflows consume credits, so it is valuable for administrators to know how their organizations are using them. The June 2024 update to ArcGIS Online enhanced credit reports, enabling administrators and other organization members with reporting privileges to view their organization's credit consumption for storage, imagery analysis, and registered app usage.
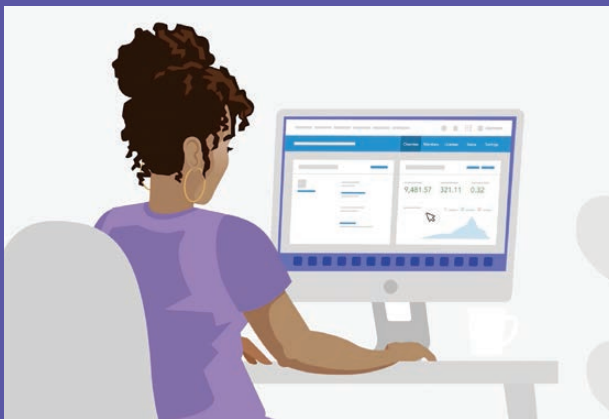
↑ The user types an organization purchases determine how many credits are available.

Understand ArcGIS Online Credits

Organizations purchase ArcGIS Online subscriptions through an annual user type license, which includes a supply of credits at no extra charge. The number of credits available to an organization is determined by the user types the organization purchases for the year. For instance, an organization that purchases both a Creator user type, which includes 500 credits, and a Contributor user type, which includes 250 credits, would have a total of 750 credits. Additional credits can be purchased in blocks of 1,000 from the Esri Store.

Recognize How Credits Are Used

The number of ArcGIS Online credits that an organization uses is determined by its workflows. Yet many of the key ways in which organizations use ArcGIS Online do not consume credits. For example, no credits are consumed when using basemaps and imagery from ArcGIS Living Atlas of the World, creating and sharing maps and apps, managing data, or accessing public services. When an organization does use credits, they are consumed in two ways: through specific transaction-based workflows or by storing files, features, and imagery in ArcGIS Online.

Transactions

When members of an organization employ certain tools to perform spatial analysis, do geocoding, or use premium content from ArcGIS Living Atlas, that organization consumes credits. For example, using Plan Routes in Map Viewer to determine how a fleet of vehicles could visit a set of stops in the least amount of time would cost one credit per vehicle route.

Storage

The number of credits used for storage is determined by the size of the data stored in ArcGIS Online and the number of hours it is stored per month. The most common type of storage is feature storage, meaning data that is stored as a hosted feature layer, including points, lines, polygons, and standalone tables. The other type of storage that consumes credits is file storage, which is charged at a lower rate. This includes imagery layers; attachments; data packages for offline maps; and items that users add, such as PDFs, images, Microsoft Office documents, and service definition files (which contain information about service properties, capabilities, and the service type).

To see a table that lists how many credits are used per capability, visit links.esri.com/credits-table.

↑ Credits get consumed when users perform certain transactions and use specific types of storage.

↑ Credit usage for storage is determined by the size of the data being stored and how long it is stored in ArcGIS Online.

To learn more about ArcGIS Online credits and get detailed instructions on how to create a report, explore the series of resources at links.esri.com/credit-series.

Set Up Your Organization for Success

To help organizations make the most of their credits, several strategies are available to administrators:

• Administrators can enable credit budgeting for transactions to control how many credits members of their organization are able to use.
• With custom member roles, administrators can limit some members' use of tools that consume credits.
• To help organization members understand their credit use, administrators can decide to show each member's available credits on their settings page.
• Before organization members run an analysis tool, administrators can encourage them to use the Estimate credits option to get an approximation of the number of credits they will be charged for the workflow.
• By regularly running reports on items stored in their organization, administrators can assess the size of items and the date that they were last modified to determine whether they should be kept or deleted.
• Administrators can regularly run reports on credits to understand their organization's usage.
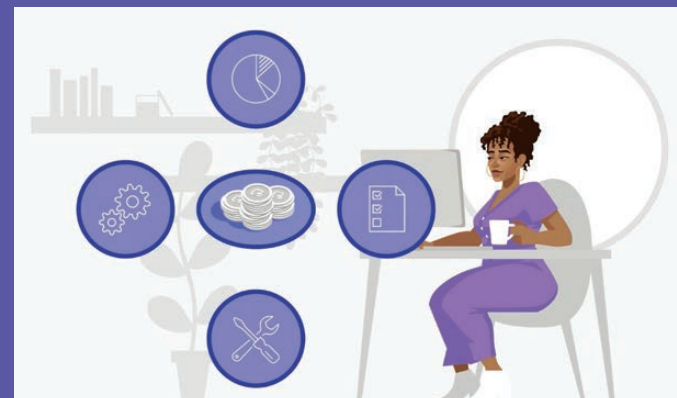
Analyze Credit Use with Reports

It's difficult to know how many credits an organization needs without having detailed information about credit usage. By generating a credit report, administrators and members with reporting privileges can download a CSV file with a comprehensive view of their organization's credit usage by week, month, or quarter. Administrators can also schedule credit reports to help routinely monitor their organization's credits.

Once a credit report is downloaded, administrators can see the number of credits consumed by transaction type for each member of the organization during the specified reporting window. The organization's use of storage credits is also listed and split up by the type of storage, including feature, file, and imagery storage. It is recommended that organizations use a combination of credit reports and item reports to determine whether the items being stored are needed.

To create a report on credits, go to the Organization page in ArcGIS Online and select the Status tab. There, administrators will see options to make and schedule reports and view previously created ones.

Watch a video of how to create a credit report at links.esri.com/credit-report.

↑ Reports give detailed information about an organization's credit use.

Create a Credit Plan

ArcGIS Online credits bring flexibility to organizations, allowing them to scale their usage as needed and pay only for what they use. By running reports on their organization's credit usage, administrators can create a credit plan as unique as their workflows. For many organizations, reports could reveal that the standard number of credits included with their chosen user types is sufficient. For others, they may discover that they need to scale up and add credits to accommodate every user's requirements.
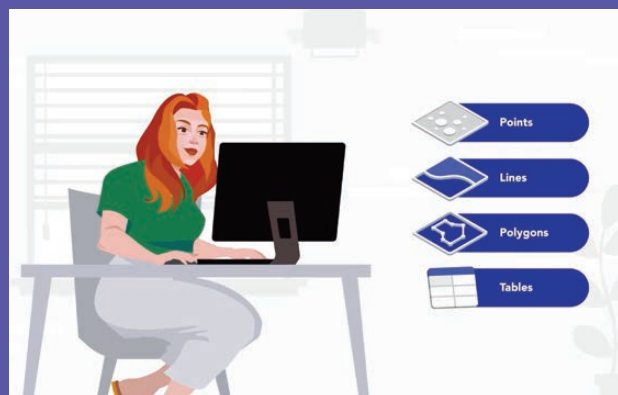
UNIVERSITY OF REDLANDS ANNOUNCES THE INSTITUTE FOR GEOSPATIAL IMPACT

A hub for geographic discovery, innovation, applied research, service, and community, the Institute for Geospatial Impact (IGI) fosters the use of geographic information systems (GIS) to empower people to positively impact society through thoughtful and intentional analysis of the world around them.

In continued partnership with geospatial industry leader Esri, IGI is driven through cutting-edge application of Esri's contemporary technologies for higher education. Our students are guided by expert faculty in GIS who provide one-on-one mentoring and collaborative hands-on, real-life learning opportunities that prepare them to make meaningful impact in their organizations and communities.

Through interdisciplinary instruction and community-based internship projects, students are equipped for diverse careers that employ geospatial insights to improve organizational strategy, streamline government services, optimize non-profit operations, and more. The IGI at University of Redlands is eager to continue mentoring current and aspiring GIS professionals for this innovative and competitive field.

Graduate Degrees

- Master of Science in GIS (MSGIS)
- Master of GIS (MGIS)
- Executive Master of GIS (EMGIS)
- MBA with Location Analytics Concentration
- Master of Science in Business Analytics (MSBA)

Undergraduate Degrees*

- Bachelor of Arts in GIS (BAGIS)
- Bachelor of Science in GIS (BSGIS)

*Offered in person

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Certificates and graduate degrees are available through in-person, online, and hybrid modalities.

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#3 MOST INNOVATIVE UNIVERSITY IN THE WEST

U.S. News and World Report 2024

Located in Redlands, California—close neighbors and partners with geospatial leader, Esri—we offer academic programs that enable access to Esri technology, training, people, events, and internships, including classes taught by Esri employees.

Meet Dr. Avijit Sarkar, Director of the University of Redlands Institute for Geospatial Impact.

Through education pathways, partnerships, and research, Sarkar sees IGI as a forum for bringing people together through GIS and answering the complex problems our world faces today.

"We are positioning ourselves as an institution where we can authentically say that wherever you are in your geospatial journey, the University of Redlands has opportunities and pathways for you to continue to advance your education and professional development to have a positive impact on society."

—Avijit Sarkar
Director, Institute for Geospatial Impact
Professor, School of Business & Society

A Digital Twin of the Dangermond Preserve Fosters Open Science

By Dr. Kelly Easterday and Dr. Mark Reynolds, The Nature Conservancy

At a time of twin climate and biodiversity crises, protecting land and sea is key for conservation. Protected areas are cornerstones of biodiversity, headwaters to life downstream, and critical linkages for climate resilience and species movement. They are essential for confronting the global climate and extinction emergencies—and are also well-suited to be engines of knowledge generation.

Protected areas are sentinel sites for understanding a world in flux, and they operate as living laboratories to help humans figure out how to shore up nature's resilience and live more sustainably. However, for protected areas to function as effective engines of knowledge generation, they must adapt to rapid changes and be adequately equipped to monitor environmental change both as individual sites and as nodes in a larger knowledge network.

The Jack and Laura Dangermond Preserve—a nearly 25,000-acre property that sits at Point Conception in Santa Barbara County, California, amid more than 125,000 acres of regionally protected land and sea—is one such individual site that also operates as part of a larger network. With a watershed the size of Manhattan in New York and several thousand acres of natural habitat, the Dangermond Preserve is an ideal place to pursue conservation science enabled by technology.

In fact, since The Nature Conservancy (TNC) acquired the Dangermond Preserve in December 2017, more than 40 institutions have developed over 90 research projects that span scientific fields. With all the scientific information coming out of the preserve, plus a vast network of sensors that have been installed across the site, the Dangermond Preserve is becoming something akin to a smart city: a smart preserve, where ecosystems begin to speak for themselves.

A Timely and Valuable Tool for Conservation

Conservation increasingly requires having accurate, near real-time information on natural phenomena to anticipate ecological change and design timely strategies and interventions. Creating digital twins of real-world entities and processes has the potential to revolutionize many fields—including conservation—by enabling scientists to model, predict, and simulate ecosystems with the complexity, nuance, and timeliness needed for modern-day decision-making.

Advancements in technology and data availability, plus the ability to leverage progress from other industries, make this the perfect time to develop digital twins for conservation. They are a valuable tool that supports evidence-based conservation, adaptive management, and sustainable development in protected areas—and they can influence integrated decision-making at a time when the impacts of climate change need to be urgently addressed.

At the Dangermond Preserve, TNC—which has protected more than 1.7 million acres of land and 6,000 square miles of ocean in California alone—is creating a digital twin of the landscape's ecology and biodiversity. Point Conception, where the preserve lies, is a well-known ecological transition zone where species ranges start and end, cold and warm ocean currents collide, and mountain ranges take shape and dissipate. It is a place of incredible biodiversity and spectacularly rapid change. For conservation, this is the arena in which the closely linked biodiversity and climate crises can be seen, felt, and now sensed in a nexus of observation, monitoring, and learning.

The digital twin that TNC is developing is being continually updated by a network of sensors and is supported by a baseline GIS, all of which fosters an open and collaborative research portfolio. This means that researchers—even those working remotely outside the preserve—can study how the area's ecosystems evolve due to climate change and ongoing natural processes such as fire dynamics, fluctuations in groundwater and freshwater supplies, and the movement of wildlife.

→ The Freshwater Digital Twin Watershed Instrumentation Dashboard shows live-streaming data related to the watershed. (Image courtesy of Kelly Easterday and Jinsu Elhance.)

↓ With incredible amounts of scientific data and a vast network of sensors, the Jack and Laura Dangermond Preserve is becoming a smart preserve, where ecosystems can speak for themselves.
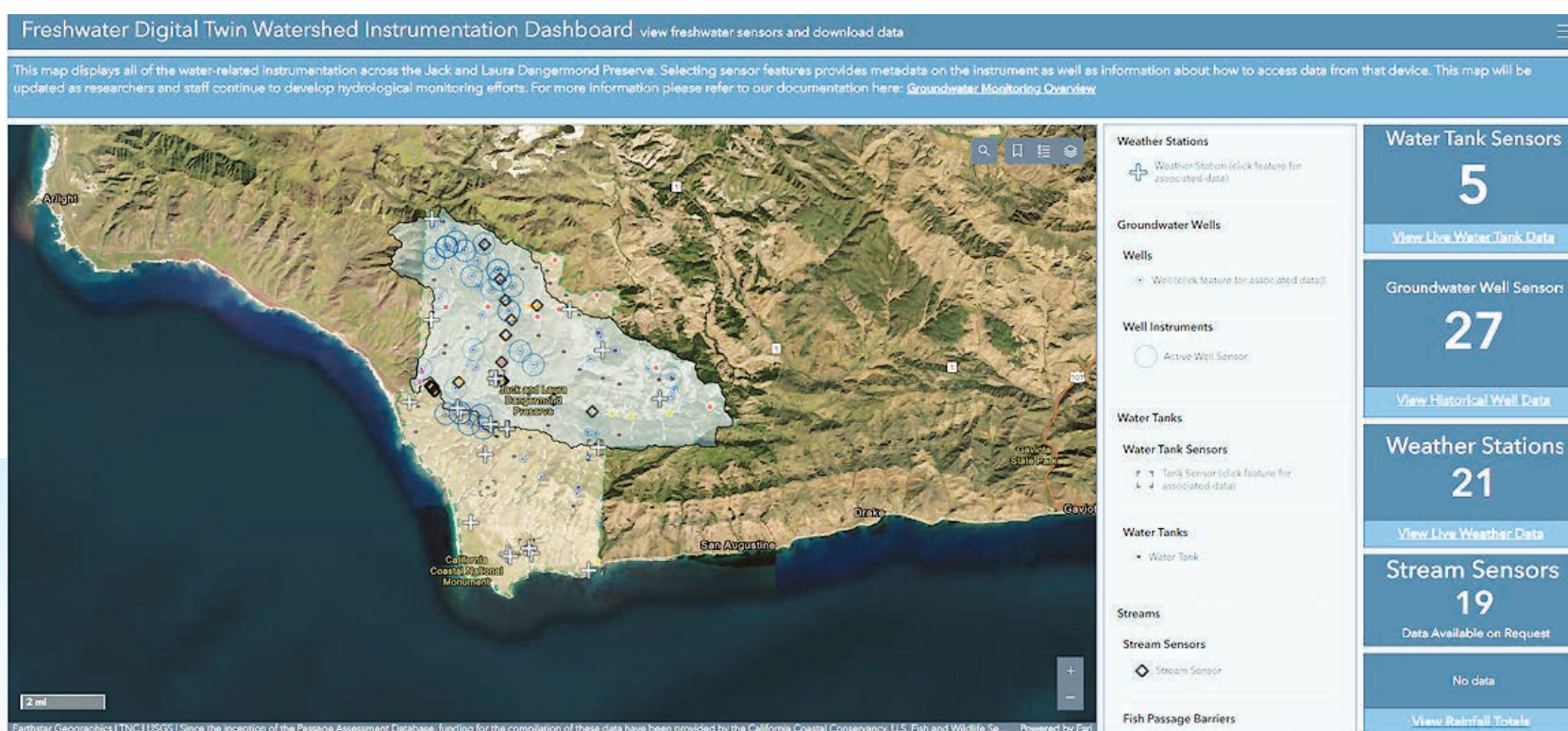
The digital twin is a system of data, models, and tools that work seamlessly together to deliver actionable data. The system includes physical, on-premises network and sensor infrastructure; cloud-based databases and analytical tools; and mobile and web apps that enable visualization and discovery.

Transparency, Open Data, and Open Science

Digital twins are data hungry. They necessitate developing new modes of science that buck traditional data-sharing norms that revolve around having siloed, embargoed, or otherwise inaccessible data. For digital twins to work, science needs to exist in a new social culture—one that favors transparency, open data, and open science.

The Dangermond Preserve has proved to be a beacon for science and learning. It is a living laboratory that connects disparate disciplines that span marine and terrestrial scientific fields. Scientists and educators from a range of disciplines have answered the call to perform research in the Dangermond Preserve that contributes to a growing database of collective understanding.

TNC has partnered with the National Center for Ecological Analysis and Synthesis (NCEAS) and the open Earth observation network DataONE to systematically catalog research contributions from the preserve and make them openly available. This fosters cross-pollination of research across various universities, organizations, regions, and scientific disciplines. It also represents a cultural shift in how science is usually conducted in protected areas.

Incredible Amounts of Data Made Public

At the Dangermond Preserve, this growing catalog of scientific information is coupled with a network of sensors—including weather stations, groundwater monitors, water tank monitors, wildlife cameras, and live-streaming cameras—that record near real-time data about ecosystem properties, from animal photos to measurements of air temperature and precipitation. This

Internet of Things (IOT)-based infrastructure allows for near-ubiquitous sensing at densities, frequencies, and paces never seen before in protected areas or other natural landscapes.

Researchers combine this near real-time data with other baseline information such as remotely sensed data from the National Aeronautics and Space Administration's (NASA's) Airborne Visible/Infrared Imaging Spectrometer-Next Generation (AVIRIS-NG) hyperspectral sensor. In 2022, the AVIRIS-NG sensor aided a campaign known as the Surface Biology and Geology High-Frequency Time Series (SHIFT) in recording several gigabytes of hyperspectral imagery and congruent field-based vegetation measurements of Point Conception. This region now has one of the densest hyperspectral data collections anywhere in the world.

Using GIS, researchers take field-gathered data and baseline information; combine it with topographic maps, vegetation maps, and other data collected nearby on subjects such as mammal counts or sand transport estimates; and analyze everything to reveal patterns and processes. This data can then be abstracted in thousands of ways. For example, researchers can take the data and run statistical models on it to predict patterns in landscape change and determine trends in species populations over time. The datasets can be viewed or displayed in numerous ways in both raw and derived forms such as visualizations, charts, maps, and models.

TNC and other organizations working in the Dangermond Preserve are making the data and its derivative products available to research communities or the public via the Dangermond Preserve's website at dangermondpreserve.org and in a geospatial hub, built with ArcGIS Hub, at links.esri.com/preserve-hub.

The Future of Conservation

At the Dangermond Preserve, TNC's Point Conception Institute (PCI)—a global conservation science center based at the preserve—employs a combination of technologies and approaches to make open and collaborative science possible. But the concept is simple: Get the best available data as quickly as possible;
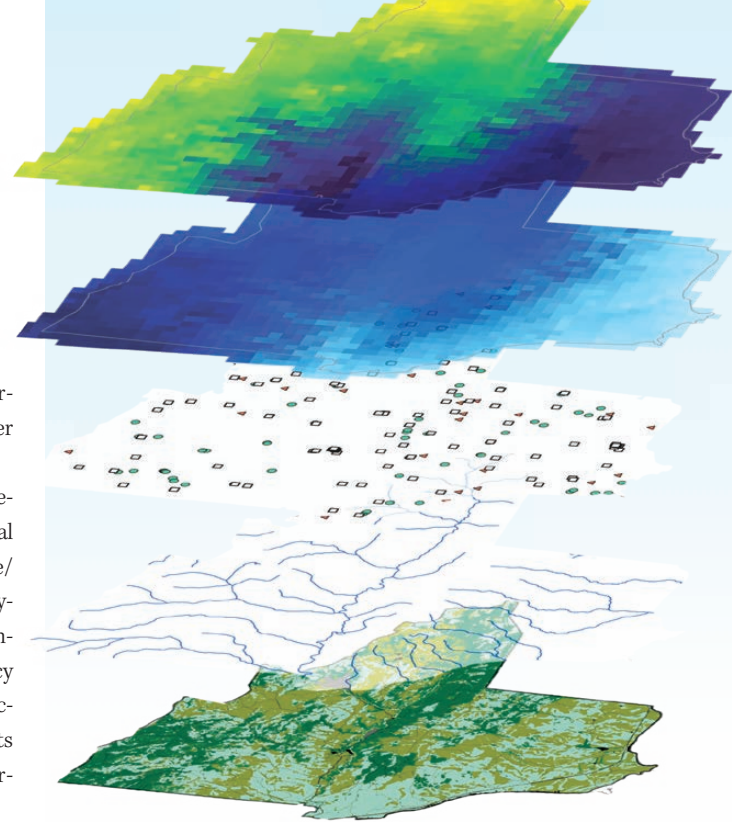
↑ Data layers available in the Dangermond Preserve Geospatial Hub include vegetation, stream network, on-site features, precipitation, and temperature. (Image courtesy of Kelly Easterday.)

analyze it, model it, and turn it into information; and then present that information in a way that can be readily used to make decisions about applied conservation problems.

What TNC and its partners at the Dangermond Preserve aim to build is a technical infrastructure with foundations in both GIS and conservation by design that fosters a new, open database social culture in science. Another goal is that this model of science sets an example for the role that protected areas can have in the future of conservation.

Protected areas are where this generation of scientists can prove that their systems are more collaborative and innovative, and that these systems help make smarter decisions faster. Innovations in technology—particularly the transformation of GIS from a technology that makes static maps to one that creates robust digital twins—are meeting a pivotal moment in conservation. Now, digital twins may be essential to ensuring that places like the Dangermond Preserve remain resilient strongholds for biodiversity in a rapidly changing world.

Wildlife Cameras: motion triggered cameras
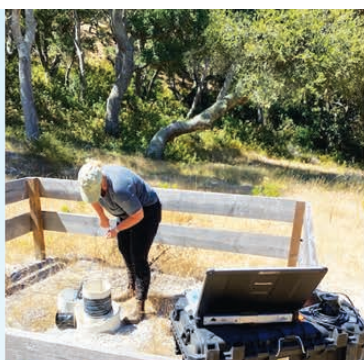
Ground water wells –measuring water level, temperature

Wildfire Monitoring: AlertWildfire Live Streaming Web Camera

Weather Stations: temperature, RH, fPAR, wind, soil moisture

Eddy Covariance Tower- measuring carbon and water flux

Marine Monitor- Radar tracking vessel activity in Cojo Bay

↑ A network of sensors record near real-time data about ecosystems at the preserve.

About the Authors
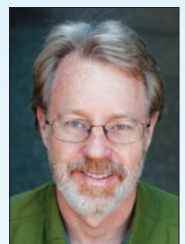
Dr. Kelly Easterday is the director of conservation technology at PCI. She oversees the geospatial infrastructure used to support ongoing operations, management, research, and monitoring at the Jack and Laura Dangermond Preserve. Dr. Mark Reynolds is the director of PCI and the lead scientist for TNC at the Dangermond Preserve. He leads interdisciplinary teams of conservation scientists and data analysts who design, implement, and share conservation strategies based on research at the preserve.

Documenting 100 Years of Alpine Conservation Through a Geographic Lens

For more than a century, Swiss National Park (SNP) has upheld a powerful promise to nature—to mostly leave it alone.

Established as a countermeasure to European industrialism in the early 20th century, SNP lets ecosystems exist and evolve in their purest form. Under the protected area management guidelines of the International Union for Conservation of Nature, Switzerland's sole national park is designated as a "strict nature reserve." This rigidly limits human visitation, use, and impacts by requiring visitors to stay on hiking trails and prohibiting camping, off-trail hiking, and hunting.

Since 1992, staff at SNP have used GIS to manage this pristine protected area. Over the years, SNP's enterprise-wide GIS has advanced and expanded to include a robust implementation of ArcGIS Enterprise and the use of apps such as ArcGIS Field Maps. This technology aids SNP with operational management, infrastructure planning, data collection and sharing, flora and fauna monitoring, mapping, and analysis. It is key to helping the park achieve its goals of protecting natural processes, fostering scientific research, and educating the public.

"GIS supports all of these pillars," said SNP director Dr. Ruedi Haller, who began his career at SNP in 1997 as a GIS specialist. "All park information is spatially related in some way."

A Haven for Research and Data Collection

SNP's wilderness offers ideal research conditions for park researchers and those from outside institutes. The national park serves as an open-air laboratory where scientists can study alpine plants and environments with minimal human interference. Over the past four decades, the SNP GIS team has accumulated more than 1.5 petabytes of data that encompasses thousands of individual datasets.

About 2,000 records are now stored in the public-facing SNP Data Center, including vector and raster GIS layers, satellite imagery, drone-captured orthophotos, analog maps, and other data related to the park. Interested parties can access the metadata of these GIS datasets by browsing categories such as projects and long-term monitoring information or by searching for specific topics including the environment or biota. The data center also offers geographic context and data to assist with spatial planning and park management in Switzerland's 19 regional parks, which make up 14 percent of the country's land area.

The most common way to find information on SNP's geodatabase is to perform a keyword search. For instance, if a user searches for the words "drone" and "Cluozza"—the oldest and wildest valley in SNP—the database yields 10 results: images from drone flights taken over the valley between 2017 and 2023.

Amassing this wealth of information has taken decades, but new geospatial tools have made the process of gathering data more accurate and accessible. SNP rangers and researchers now use Field Maps, for example, to streamline data collection. With preconfigured digital maps and forms, mobile workers can easily locate and capture information on topics such as morphological changes happening in the area and park signs that need to be repaired.

Making Robust Data Available in the Field

Since internet connectivity in the park is sparse and data collection is often done offline, the GIS team used an Esri vector tile package to develop a custom SNP basemap. Field staff can save this robust, dynamic digital map to their smartphones before entering disconnected areas and then use Field Maps to collect and edit information no matter where they are.

Dr. Samuel Wiesmann, head of GIS and information communication technology at SNP, emphasizes the value of visualizing data on a map. "If you can show it on a map," he said, "it brings the data together and makes it much easier to understand."

With Field Maps, users have all the data they need to conduct planning, analysis, and discussions in the field—regardless of their expertise in GIS, geography, or biology. This has greatly enhanced communication and collaboration between office and field staff at SNP, since they all have access to the same, consistently updated data.

For instance, when tracking the growth stages of plants—such as leaf sprouting or flower blooming—it is now clear which plants have been documented and which plants still need to be observed. Additionally, SNP staff have an easier time managing the more than 600 signs posted throughout the park, since each sign's status is visible to all stakeholders at any given moment.

Another notable application of Field Maps at SNP was its use in defining the remediation perimeter of the River Spöl, a Swiss and Italian waterway that's been affected by polychlorinated biphenyl (PCB) contamination. In Field Maps, a blue line showed the maximum height of a hydrologically simulated flood, while a purple-and-white dashed line indicated a possible remediation perimeter based on orthophoto analysis.

The SNP team and the engineers overseeing the remediation project were able to visually compare the two proposed boundaries in Field Maps with conditions on the ground. SNP employees also used the app while on-site to quickly record all the descriptions, explanations, and decisions related to the boundaries. This enabled the SNP employees and engineers to jointly define the river's remediation perimeter, which is represented in Field Maps using a yellow line.

"Before *[using Field Maps]*, rangers brought back paper reports that had to be digitized," Haller said. "You had to make sure there was no error in it…. There was uncertainty. The precision has improved a lot with these modern applications."

Historical Records Enable Keen Observations of Natural Processes

Observation areas were established in the national park as early as 1917, giving researchers and SNP staff access to an astonishing cache of historical records. Manually logged data, such as insight on red deer and ibexes from the 1920s and aerial photographs from the 1940s, assist in current observations of natural phenomena. SNP staff have converted analog historical records into digital spatial datasets for easier visualization and analysis within ArcGIS.

Haller and Wiesmann have prioritized observing and recording the natural processes in SNP to gain a deeper understanding of the origins and effects of these phenomena. The national park is preparing to hold an exhibition at its visitor's center in 2025 to showcase how the landscape has changed since the area became protected.

In preparation, SNP staff members have curated a collection of photographs of the park from the 20th century, focusing on the 1920s and 1930s, and identified their corresponding locations. Wiesmann and his GIS team mapped these locations and created data collection forms to assist field teams as they capture modern-day comparison photos. Equipped with Field Maps,

↓ The flood line for the River Spöl is shown in blue. The dashed line indicates one remediation boundary that was considered, and the yellow line shows the final remediation boundary.

↓ GIS was used to determine which areas of the River Spöl should be marked for restoration.

↑ Tourists visited the Stabelchod Valley via a gorge path for decades. (Photo Credit: Comet Photo AG, ca. 1975, ETH Library Zurich, Image Archive/Com_LC1135-001-005/CC BY-SA 4.0.)

↑ After a 2018 mudflow destroyed the path, it was relocated away from the gorge. For the past six years, the area has undergone a rewilding process. (Photo Credit: Swiss National Park, 2023.)

↑ Rangers use ArcGIS Field Maps to help capture modern-day photos that correspond to older photos taken in the park.

park rangers can locate the area in question and view the original photo and its metadata so that they can accurately position their cameras to take a matching photograph.

"Field Maps has helped us with planning," said Wiesmann. "When we have four or five people involved in this work, it helps to have such a tool on a web map or a dashboard…. We can see where somebody has been and if a photo needs to be redone."

Wiesmann and Haller want these photos to tell stories. Seeing the progression of a tree line, for instance, adds to a larger narrative—one of restoring nature.

"We are on the way to a wilderness area back from a cultural area," said Haller.

A Digital Guide for Visitor Education

SNP is closed to the public for seven months out of the year, but between May and October each year, more than 100,000 visitors explore the park. Hikers and adventurers of all ages can use the Swiss National Park app to enrich their experience.

The app has evolved significantly since the first iteration was released almost 20 years ago.

"We launched the first public-facing version in 2005," Haller said.

His team's forward-thinking, location-based service steadily evolved into the dynamic, mobile app that's available today. The app integrates Esri vector tile basemaps using ArcGIS Runtime SDK for iOS and ArcGIS Runtime SDK for Android. It offers a range of functionalities, such as comprehensive hiking route descriptions and altitude profiles, labeled points of interest, details about wildlife, and panoramic views of the park's most breathtaking regions.

Some features are designed to delight and engage SNP's youngest visitors as well. Along the Champlönch children's trail, for example, hikers can pair the app with a special booklet to receive audio recordings at 10 different points of interest. Animated characters appear in the app to share stories about nature. For instance, a red deer explains in an audio recording what it does to combat the heat in the summer and what conflicts animals have with each other.

SNP also hosts an annual summer camp, offering young students an immersive experience in the park. Camp participants get to experiment with GIS-based apps and tools and learn how maps and analysis assist in managing park projects. Connecting with young audiences helps SNP staff ensure that future generations appreciate the importance of protected areas.

As SNP continues to prioritize conservation, research, and education, GIS will remain a vital component for documenting and preserving the alpine ecosystem for years to come.

"That's one of the good things about GIS," said Haller. "If you store *[and visualize]* your spatially related data, you can have a long-term history of everything."
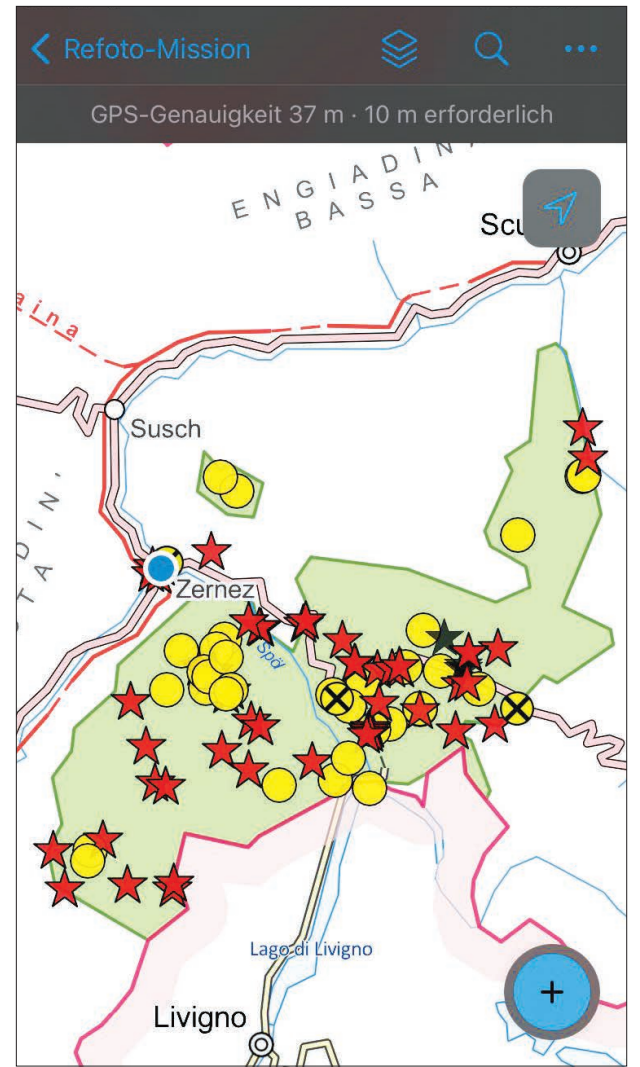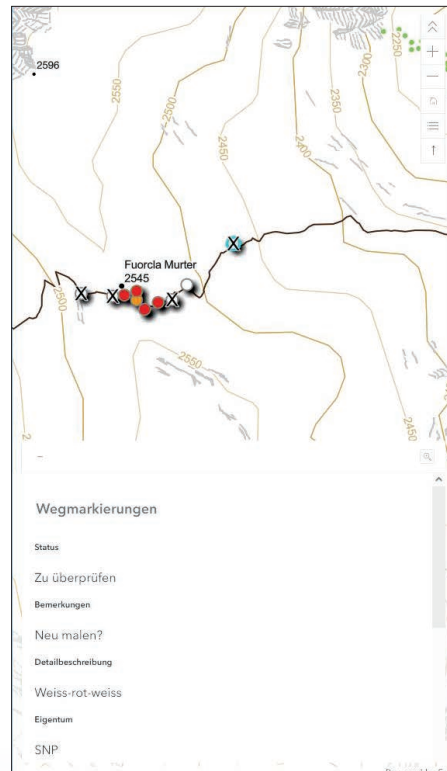
↑ A web map made with ArcGIS Online shows details about this park sign.

Leading Cosmetics Company Manages Complex Supply Chain with GIS

Natura &Co Partners with Traditional Communities to Equitably Access Natural Resources While Preserving Amazon Rainforest's Biological Diversity

Although it covers only about 1 percent of Earth's surface, the Amazon rainforest plays a vital, worldwide role in processing carbon, providing water, and preserving biodiversity. The Amazon helps stabilize the earth's climate by storing hundreds of billions of tons of carbon dioxide; its trees contribute 20 billion tons of water each day to the atmosphere; and it is home to about 10 percent of the world's wildlife species, according to the World Wildlife Fund.

But the Amazon faces a host of challenges related to climate change, including deforestation and infrastructure development. And the human communities that live in and depend on the Amazon are finding it more difficult to harvest rainforest-based resources in ways that are sustainable and equitable.

Natura &Co, a Brazilian cosmetics group that operates around the world and includes the brands Natura and Avon, sources many of its ingredients from the Amazon. The company is known for collaborating with traditional communities—such as Amazonian family farmers, residents of *quilombos* (remote settlements founded by Brazilians of African descent), riverside communities, and Indigenous people—to promote environmental and economic sustainability when harvesting local flora. As a B Corp—a designation that shows that a business has high social and environmental standards, sound corporate governance, and operates with transparency—Natura &Co is helping address the challenges the Amazon faces by focusing on sociobiodiversity: the balance between safeguarding biological diversity and enabling humans to equitably benefit from natural resources.

ArcGIS provides the technological foundation for Natura &Co's sociobiodiversity supply management system. Using ArcGIS Pro, ArcGIS Enterprise, ArcGIS Survey123, and other Esri products, the company has developed what it calls NaturaGIS to trace its supply chain from the raw ingredients to what ends up in cargo shipments, as well as to maintain transparency in its business operations.

"Tracing the source of our raw ingredients—what, when, from where, and from whom we purchase—is a market requirement and a fundamental premise for our fair and ethical trade practices," said Mauro Costa, head of Natura &Co's sociobioeconomy department. "*[ArcGIS]* is a strategic part of our decision-making process."

Tracing Complex Supply Chains with GIS

Natura &Co's founding company, Natura, was the first publicly traded company in the world to receive B Corp certification in 2014, according to the Climate Governance Initiative, a nonprofit organization that helps corporate boards of directors improve their companies' climate resilience. This was the same year that the company incorporated ArcGIS technology into its operations.

Initially, GIS was used as a repository for the company's geographic database—which contained information about local suppliers—as well as for cartographic production and data visualization. Over the last four years, as Natura &Co has set out to achieve its Commitment to Life plan—aimed at tackling the climate crisis, safeguarding the Amazon, and protecting human rights—the company has expanded its use of ArcGIS technology considerably. It now employs NaturaGIS throughout its operations.

Each year, Natura &Co processes hundreds of tons of raw ingredients to make its products—from murumuru nuts, which are good for hair care, to priprioca plants, whose aromatic roots are used to produce essential oils. These ingredients are harvested by dozens of suppliers organized into cooperatives, called sourcing communities, that include thousands of families. One of Natura &Co's goals is to more equitably distribute its raw material sourcing by increasing the number of sourcing communities it relies on in the Amazon. Supply chains like this—that are aiming to be sociobiodiverse—are complicated, requiring careful control and management.

"The complex process to which we adhere allows us certification from the internationally recognized Union for Ethical BioTrade *[UEBT]*," said Costa. "UEBT certifies that ingredients from nature are sourced through systems that respect people and biodiversity. Implementing NaturaGIS has allowed us to double the volume of our raw ingredient inputs while sustaining the strict quality control required for UEBT certification."

Suppliers and field analysts enter data into NaturaGIS using forms built with Survey123. With support from field agents and analysts, members of sourcing communities enter location and socioeconomic information about each supplier family into Survey123. They also use the app to record data related to the ingredients the sourcing communities supply, including what they are (such as raw fruits, nuts, and seeds or processed oils and essential oils) and when and how much will be delivered.

"We input family registration data, cargo manifests, and occasional surveys as requested by our sociobioeconomy processes and control," explained Carlos Talini, former technical manager at Natura &Co. "The data are sent to both ArcGIS Enterprise and our geodatabase, feeding a variety of outputs such as *[maps]* in Map *[Viewer]*, *[ArcGIS]* StoryMaps *[stories]*, and dashboards. These applications serve as the interface for users accessing regional data."

For example, area managers, who work closely with supplier communities to meet Natura &Co's raw materials demand, use dashboards built with ArcGIS Dashboards and ArcGIS Experience Builder to monitor key supply indicators. These include the number of supplier families, the raw materials expected to be provided each year, and the total area impacted by the company's sustainable operations. Area managers also use dashboards to keep tabs on harvest histories and track cargo shipments in near real time. This helps the area management team determine sourcing communities' production capacity and strategize about where to invest Natura &Co's resources.

Other company collaborators use the system to extract information about company operations related to sociobiodiversity. And Natura &Co's geotechnology experts use ArcGIS Pro to edit data; conduct geospatial analysis; and produce maps on a range of topics, from supply estimates to deforestation.

Currently, use of NaturaGIS is limited to internal staff members and approved suppliers.

→ The aromatic roots of the priprioca plant are used to make essential oils.

↓ Sourcing communities in the Amazon rainforest harvest murumuru nuts, which are used to make hair care products.

↓ Traditional community members harvest the *tukumã* fruit, which grows back quickly—even after a fire—and regenerates the Amazon rainforest. (Photo courtesy of Naiara Jinknss de Castro.)

natura GIS

Families Info

Gender
Women 46%
Men 54%

Educational Level
6k
4k
2k
0
Illiterate | Technical School | Middle School | Higher Education | Unfinished Middle School | Unfinished High School | Unfinished Higher Education | High School

Mostrando 1 ✕
FK_FORNECEDOR 115000
Name Maria Elza Ferreira do Carmo
ID 115033
Location

Last Update: 03/03/24

Internet connection
No 74%
Yes 26%

Age
6k
4k
2k
0
Young | Adult | Elderly | Underage

Abaetetuba
COFRUTA

11,713 families

Cell phone
No 60%
Yes 40%

Professions
6k
4k
2k
0
Public Server | Administration Assistant | School Cook | Retired | Others Wage Earners | Housekeeper | No Profession

CAEPIM

Moju

Igarapé-Miri

Earthstar Geographics | Esri, HERE, Garmin

51 communities*
supplier groups**

...anized into associations or ...ratives

...not organized ...peratives

↑ Dashboards provide data about the supplier families that work with Natura &Co.

Expanding Traceability and Participatory Mapping

Natura &Co plans to evolve its use of GIS by continuing to employ the technology to optimize operational processes both internally and for supply partners. For instance, the company is augmenting its use of GIS to document the origins of its raw ingredients.

"We are expanding our traceability forms," said Costa, referring to the Survey123 forms that Natura &Co uses to track its supply chain. "To amplify the information obtained from family farming and extractive areas, detailed family registration and packing list information will be collected. This includes traceability processes that capture information about each step the community takes to transform raw ingredients *[into usable products]*, such as drying, nut cracking, depulping, sorting, and separation. Survey123 will also communicate with printers to produce sturdy labels, specifically selected for the Amazonian environment, that will identify the biodiversity materials."

Supplier communities will also have access to an Experience Builder app that they can use to monitor ingredient processing information in near real time. In addition, the company has plans to extend its participatory mapping efforts, which will allow it to gather more information about remote production areas.

"This data is crucial for gaining a deeper understanding of the areas in which we operate," said Costa. "*[It]* will serve as the foundation for other important data, such as production estimates, harvesting forecasts, and the monitoring of land use and occupancy."

Costa believes that these enhancements to NaturaGIS will boost the company's ability to meet market demands and strengthen its sustainability commitments in the Amazon region.

The company is planning to employ GIS to make its web environment more engaging as well. Using apps such as Experience Builder, the website will eventually combine diverse content—including maps and data from government agencies and nonprofit organizations—to allow employees and partners to better visualize Natura &Co's operations. It will also enable them to customize their views more than they can right now.

"Even though we have effective tools for essential operations, the growing complexity of our work calls for more flexible solutions like those offered through Experience Builder," said Talini. "Enhancing our system with more robust traceability and more efficient operational control will provide greater support for our sociobiodiversity and Amazon conservation efforts."

↓ Members of traditional communities use ArcGIS Survey123 to record information about the raw ingredients they harvest.

↓ Natura &Co is known for collaborating with members of traditional communities, such as in this new essential oils factory.

Scientific Currents

By **Dr. Sue Natali**
Woodwell Climate Research Center

Mapping Permafrost Thaw Is Essential for Understanding Climate Change

The Arctic is warming up to four times faster than the rest of the planet. This polar region is not only a canary in the coal mine, but it is a climate accelerator that won't be stopped until humanity puts the brakes on fossil fuel emissions.

Melting glaciers and ice sheets are contributing to global sea level rise, and temperatures in the north are changing weather patterns across the planet and amplifying droughts, heat waves, and hurricanes. Perhaps less observable to the rest of the world, however, is the thawing of permafrost—permanently frozen ground—that underlies much of the Arctic. Arctic peoples and ecosystems are already grappling with the devastating effects of permafrost thaw, and the consequences extend beyond the northern latitudes.

Yet unlike with sea ice and glaciers, where long-term satellite observations have tracked melt rates for decades, long-term geospatial records of permafrost thaw do not exist. Scientists and Indigenous Knowledge holders have been observing permafrost thaw for decades, but assessing the full scope of these changes—which occur at relatively small spatial scales across a vast and varied region—has been a technical challenge.

Permafrost Pathways (permafrost.woodwell climate.org) is working to map and monitor these important changes. Catalyzed with funding through The Audacious Project, housed at TED, this initiative brings together scientists, Arctic communities, Indigenous Knowledge holders, and experts in environmental justice and climate policy to improve permafrost science. Their goal is to inform and develop adaptation and mitigation strategies to address the hazards caused by permafrost thaw.

Using satellite imagery and AI, the team is mapping permafrost and greenhouse gas emissions across the Arctic for the first time to better inform climate models. To convey what is happening and what to do about it—both with and beyond the scientific community—the initiative has made map-based storytelling a key communication strategy.

The Importance of Permafrost

In the Northern Hemisphere, permafrost underlies more than 5.4 million square miles (14 million square kilometers)—an area that is larger than the United States and the European Union combined. It underlies 15 percent of exposed land surface, including much of Alaska, Canada, and Russia.

This permafrost region is critically important for global climate because it stores a disproportionate amount of carbon that has been frozen for thousands of years. As the climate continues to warm, that once-frozen carbon can be decomposed by microbes and released into the atmosphere as greenhouse gases, carbon dioxide (CO_2) and methane (CH_4). Those emissions contribute to future warming, leading to more thaw. By the end of this century, the amount of permafrost carbon that will be released into the atmosphere is expected to be comparable to that of major greenhouse gas emitting nations—perhaps even as large as current emissions from the United States.

The greenhouse gas emissions caused by permafrost thaw are not fully accounted for in global climate models. Thus, humanity's efforts to curb global warming will be even harder to achieve. Emissions from thawing permafrost could use up to about 25 percent of the remaining carbon budget that would be necessary to cap warming at the internationally agreed-upon 2 degrees Celsius threshold established in the 2016 Paris Agreement.

As permafrost thaws, melting ground ice can cause catastrophic changes to Arctic lands, including sinking and collapsing ground, accelerated coastal and riverine erosion, the draining of lakes and other surface water, and changing distributions in vegetation and wildlife. These cascading effects are already transforming tundra and boreal regions, forcing Indigenous communities in the Arctic to make extremely difficult decisions to protect themselves and their traditional ways of life. The dramatic environmental changes brought about by permafrost thaw impact Arctic infrastructure, access to clean water and other public utilities, subsistence hunting and fishing, food sovereignty, and community health and wellness. In Alaska, more than 144 communities face imminent displacement and other threats from permafrost thaw, flooding, or erosion.

Mapping Thaw and Scaling Its Effects

With so many extreme transformations unfolding across the Arctic, there is an immediate need to better assess current and future rates of permafrost thaw and their impacts, from local to global.

The team at Permafrost Pathways is harnessing high-resolution satellite imagery and AI and using ArcGIS Pro and the Esri World Imagery basemap to identify, digitize, and map places where thawing permafrost causes rapid ground collapse. These "abrupt thaw" features, which have never been mapped across the entire Arctic, are extremely important because the greenhouse gases released from them will cause additional climate warming—possibly double what is currently expected from gradual thaw alone.

Having geospatial data on thaw features is important not only for mapping them but also for scaling site-level observations of the greenhouse gas exchange that happens between permafrost lands and the atmosphere. At some monitoring sites underlain by permafrost, scientists have already begun to observe the net release of CO_2 and CH_4 into the atmosphere. This represents a major shift in the functioning of ecosystems that had historically been carbon sinks—meaning, they had taken carbon from the atmosphere—for thousands of years.
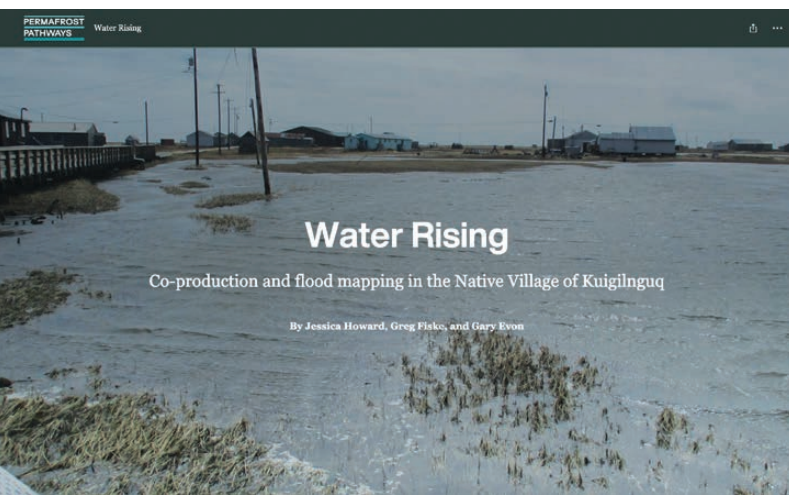
Such site-level observations are essential for gaining a new understanding of processes and changes in system indicators. Yet there are still major scientific uncertainties about how these dynamics function across the entire permafrost region. To fill this gap, Permafrost Pathways is strategically installing new greenhouse gas monitoring sites across the Arctic and using the data that they record to scale greenhouse gas emission estimates for the region.

Sharing Information Through Stories

While advancing Arctic carbon cycling science is crucial for addressing the global effects of permafrost thaw, information needs to be shared beyond the scientific community to inform climate mitigation and adaptation priorities.

At a recent Arctic mapping workshop held at Esri's headquarters in Redlands, California, Western-trained scientists, technical experts, and Indigenous Knowledge holders came together to use ArcGIS technology to tell stories about the impacts that climate change is having in the Arctic, support adaptation decision-making, and track the global effects of permafrost thaw. Staff from Esri and Permafrost Pathways shared how they are integrating AI and geospatial data to map permafrost thaw features across the Arctic and discussed using drone technology to map erosion, flooding, permafrost thaw, and storm impacts. Tribal partners and other participants used ArcGIS StoryMaps to create stories that emphasize the rapid changes occurring in their communities and worked on making new maps with Indigenous place-names on them that will help preserve and share traditional language, knowledge, and culture across generations.

> To learn more about how permafrost thaw is affecting one Indigenous community in Alaska, explore the "Water Rising" ArcGIS StoryMaps story at links. esri.com/water-rising. Also, watch Dr. Sue Natali's TED Talk, "How Ancient Arctic Carbon Threatens Everyone on the Planet," at links.esri.com/natali-ted.

PERMAFROST PATHWAYS — Water Rising

Water Rising

Co-production and flood mapping in the Native Village of Kuigilnguq

By Jessica Howard, Greg Fiske, and Gary Evon

↑ An ArcGIS StoryMaps story created by Permafrost Pathways describes the coproduction of a map that illustrates extreme tidal flooding in the Alaska Native Village of Kuigilnguq.

→ The Peel Plateau in the Northwest Territories, Canada, has experienced abrupt thaw. (Photo by Scott Zolkos, Woodwell Climate Research Center.)

Arctic Indigenous communities have been living with and adapting to climate change for decades. But the rapid escalation of these transformations requires a coordinated effort that brings together multiple knowledge systems to monitor and map the changes and any associated growing risks. Such an effort will help guide adaptation strategies, meet global emission-reduction goals, and support community resilience.

To make this vision a reality, solutions must include an improved understanding of thawing permafrost, take a human rights-based approach, and be designed and implemented with Arctic communities at the helm. The progress we make today and over the next several years can make all the difference in securing a safer Arctic future for all.

→ More than 40,000 abrupt-thaw features have been identified throughout the permafrost region, and they're being used to map abrupt thaw across the entire Arctic. (Map by Greg Fiske and Yili Yang, Woodwell Climate Research Center.)

About the Author

Dr. Sue Natali is an Arctic scientist at the Woodwell Climate Research Center, where she focuses on permafrost thaw. Her team combines field research with remote sensing and modeling to evaluate the current and future impacts of climate change across the Arctic. Natali also leads the Permafrost Pathways initiative.
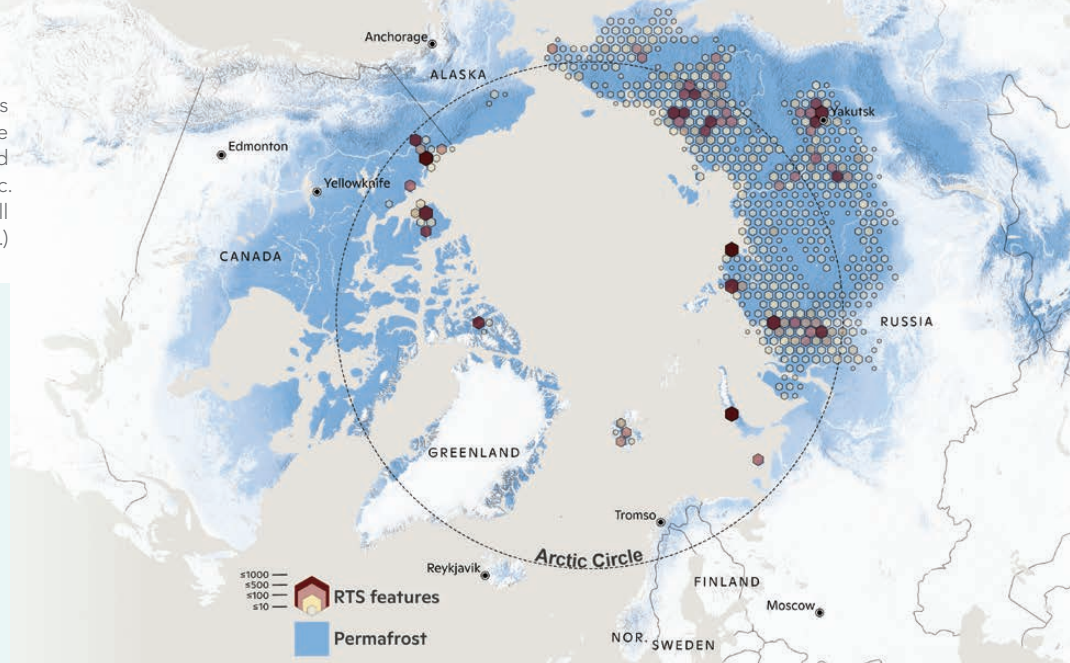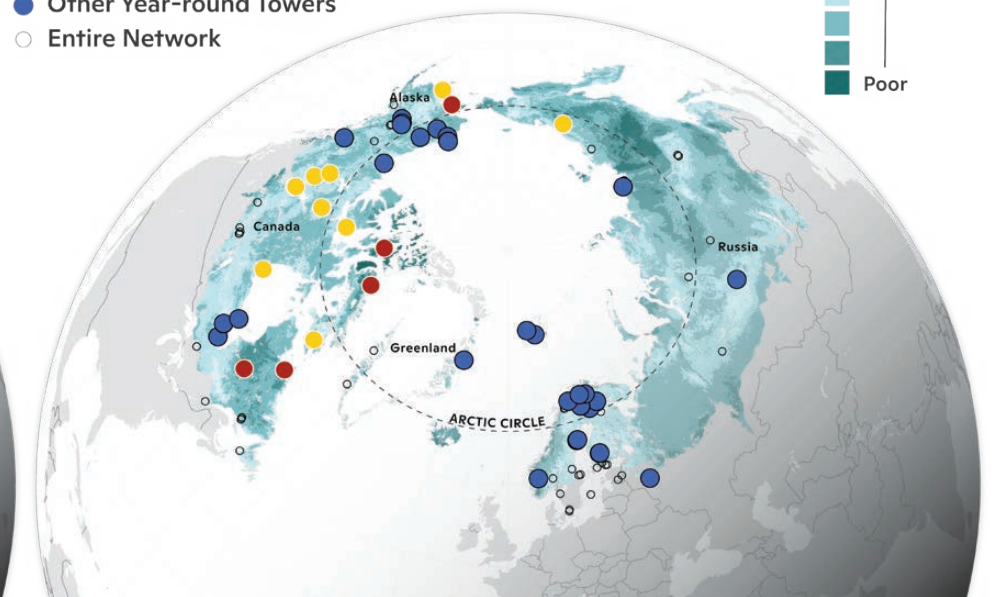
↑ Permafrost underlies 15 percent of exposed land surface in the Northern Hemisphere. (Map by Greg Fiske, Woodwell Climate Research Center. Data from J. Brown et al., *Circum-Arctic Map of Permafrost and Ground-Ice Conditions* [US Geological Survey, 1997].)

↑ Permafrost Pathways is expanding the coverage of year-round carbon dioxide (CO_2) and methane (CH_4) monitoring sites to fill gaps in areas that are not well-represented by the current network. (Map by Greg Fiske and Kyle Arndt, Woodwell Climate Research Center.)

Upgrading to ArcGIS Utility Network Is Key to Utility's Continued Success

Kaukauna Utilities is a community-minded, environmentally responsible electric and water utility that serves 16,000 customers in the Kaukauna, Wisconsin, area. A few years ago, leaders at the utility decided to update its GIS to improve workflows, increase efficiency, aid with capital budget planning, and address the increasing complexity of the electric system. With help from Esri partner POWER Engineers, Kaukauna Utilities implemented ArcGIS Utility Network, which has helped enrich process improvements at the utility ever since.

According to Kaukauna Utilities' engineering and operations director Dave Pahl, the upgrade to Utility Network was a "key requirement to the success of many other systems at Kaukauna Utilities." By leveraging the network topology and integrations, he anticipated "efficiencies in distribution design, system operations, and outage management—all of which provide more reliable service to customers."

From Manual to Automated

Kaukauna Utilities' capital budget planning relies heavily on an engineering analysis of Kaukauna's electric system. The utility uses WindMil software from Esri partner Milsoft Utility Solutions to generate comprehensive visual renderings of its electric grid.

The analysis model was difficult to maintain, however, because it required staff to make updates manually. It was a labor-intensive process and left the data open to errors. As a result, staff only updated the analysis model once a year at budget time, and they weren't very confident in the model's accuracy.

To streamline the process of creating and updating its engineering analysis of the electric grid with WindMil, Kaukauna Utilities needed to migrate from the geometric network it was using for network modeling to ArcGIS Utility Network. POWER Engineers specializes in integrating various technologies for utilities and other industries, so Kaukauna Utilities turned to POWER to get help implementing a solution that would automate feature extraction and keep the data accurate and up-to-date.

Saving Hours of Work

First, Kaukauna Utilities upgraded to ArcGIS Enterprise. It then established a plan to transition from the geometric network to Utility Network.

POWER developed the POWER Network Extractor tool to make it easier for utilities to extract GIS features and their associated network connections and then use this extracted data in third-party apps. The tool enabled Kaukauna Utilities to consume its GIS-based distribution, transmission, and subtransmission networks in the WindMil engineering analysis package.

POWER implemented numerous data quality rules and configured the POWER Network Extractor to run every night to catch all recent updates. The extract in WindMil not only supports the utility's engineering analysis functions, but it also underpins the utility's outage management system, provided by DataVoice.

"The extractor runs nightly to update Milsoft's WindMil, [and] it's coming through without any errors. It's pretty amazing," said Pahl. "POWER's Network Extractor for Milsoft is one tool that has saved us hours of work."

More Accurate, Higher-Quality Data

The built-in attribute rules of ArcGIS Utility Network naturally enforce much higher data quality, so Kaukauna Utilities now has more accurate data about its electric system.

Updating the analysis and outage management system models every day has proved to be a significant process improvement. It has dramatically advanced information currency at the utility, boosting employee morale and confidence in the data. By not having to input all the data manually, engineering staff save many hours of work and avoid preventable errors. The utility has a high-quality system analysis model that's ready for its engineers to use without delay.

The solution also supports Kaukauna Utilities' other operational software, including its customer information system. This new functionality is helping the utility differentiate between types of customers and improve the system's accuracy. Now, customers are more consistently associated with the correct service.

Realizing Efficiencies All Around

Implementing Utility Network laid the groundwork for Kaukauna Utilities to make similar improvements in other areas of its business

↑ The engineering analysis model of Kaukauna Utilities' electric network was difficult to maintain because staff used to make updates manually.
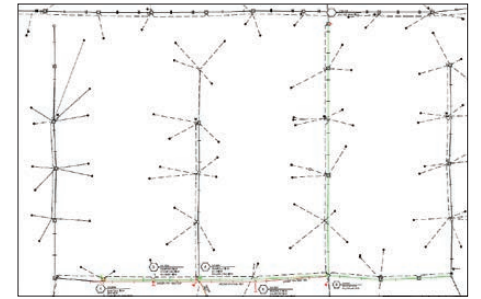
↑ Now, the POWER Network Extractor tool automatically extracts GIS features and network connections and updates the data every day.

as well, including its water and fiber networks. Mobile staff now leverage ArcGIS Field Maps, for example, to view and collect data on the utility's electric and water grid. And designers at the utility employ Utility Network to incorporate their electric network designs into WindMil and DataVoice.

"The choice to upgrade to Esri's ArcGIS Utility Network was based on the realization that future integrations of systems depend on a solid connectivity model, which this network provides," said Pahl. "Kaukauna Utilities is realizing efficiencies not only in mapping but also [in] engineering and operations."

Tucson Builds
Interactive Transportation Plan
Using ArcGIS Experience Builder

The second-most populous city in the state of Arizona, Tucson is a combination of old and new. Archaeologists estimate that Tucson's downtown area has been continuously occupied for at least 4,500 years, and the city is now a busy metropolis that has attracted cutting-edge technology companies.

Tucson is also the hub of a fast-growing region. The government of Pima County, which comprises all of the Tucson metropolitan area and the sparsely populated high-desert expanses around it, expects the county's population to grow from about 1 million in 2020 to approximately 1.3 million by 2035. This projected growth has prompted Tucson officials to develop a new and interactive approach to an old problem: how to get around the city efficiently in a variety of ways.

To tackle this issue, Tucson's Department of Transportation & Mobility, with support from other city departments, developed Move Tucson, a comprehensive plan that aims to modernize the city's transportation network. In collaboration with construction and engineering company Alta Planning + Design, city staff also used ArcGIS Online and ArcGIS Experience Builder to develop a fully digital, interactive version of the plan. Available at movetucson.tucsonaz.gov, the app allows the public to interactively explore how this plan will change their community and understand the investments into community mobility that city staff are seeking to make. This application is part of the transportation department's efforts to make its plans more accessible.

A Plan to Develop Safe and Varied Transportation Options

Published in 2021, Move Tucson describes the current state of the city's transportation system and how it is envisioned to change over time to meet the needs of both residents and visitors.

The plan identifies 234 projects and the potential funding needed to implement them over the next 20 years. Using what city staff call "Complete Streets" design—an approach to transportation planning that emphasizes a safe, connected, and equitable transportation network for everyone—Move Tucson aims to make roadways safe to use for different modes of transportation. It integrates planning for walking, cycling, public transit, and private motor vehicles.

City staff, elected officials, and the public use Move Tucson to gain insight into how the Tucson transportation system will likely develop in the coming years. The plan also explains the factors and considerations that were used to create it.

An Interactive Approach to Engaging with Content

The interactive component of the Move Tucson transportation plan offers an immersive experience that paints a vivid picture of the plan's vision and its projected impact on the city.

With maps, charts, photos, infographics, and other media, users can dynamically explore the plan's content. This includes the project's guiding principles, public engagement activities, recommendations for improvements to make, and implementation strategies.

The Transportation System tab allows site visitors to understand the transportation system in more detail. For example, roadway capacity metrics help depict the local driving experience. Transit is measured by average weekly ridership. Walking and biking are visualized using indexes called the Pedestrian Level of Traffic Stress and the Bicycle Level of Traffic Stress, respectively.

Mode-specific analysis can help a person understand not only that there are a variety of travel conditions for each mode across the city, but also that the experience can vary by mode on a given roadway. For example, a roadway may have good travel conditions for drivers and transit users because the number of motor vehicles is low, meaning the roadway is below capacity and there is ample transit service. The roadway may also have wide sidewalks and street trees, making it a good place to walk, but it might be highly stressful for bicycling because of high automobile speed limits and a lack of bike lanes. If the roadway has excess capacity and is seen as being a priority for bicyclists, bike lane installation may be deemed viable by city staff in order to improve biking conditions without hindering other transportation modes.

This nuanced understanding of the transportation system helps build a picture of how all modes of transportation are interconnected. The app for making this information accessible to the public increases transparency in the planning process while also serving as a tool that can be used for other purposes.

A Robust, Flexible App Boosts Engagement

City staff and the team at Alta Planning + Design selected ArcGIS Online as the foundation for this interactive website so that the city could host and maintain the site from now on. They chose Experience Builder to deliver the content because of its robust capabilities and ability to natively host both spatial data and media such as plan documents, images, tables, and narrative text.

"[Experience Builder] also provides greater transparency in the planning process and allows the public better access to information about the transportation plan," explained Kim Voros, GIS manager at Alta Planning + Design.

Voros and the company's civic analytics team worked with city staff to develop the app when the transportation plan was nearly complete. Tucson staff requested it because they had seen in other projects how interactive web maps and related media made it easier for wide and varied internal and external audiences to understand information.

"Overall, the development of the Move Tucson virtual plan illustrates the city's commitment to continuous improvement and engagement," Voros said. "It reinforces the use of digital planning documents as a valuable tool in shaping the future of Tucson's urban environment."
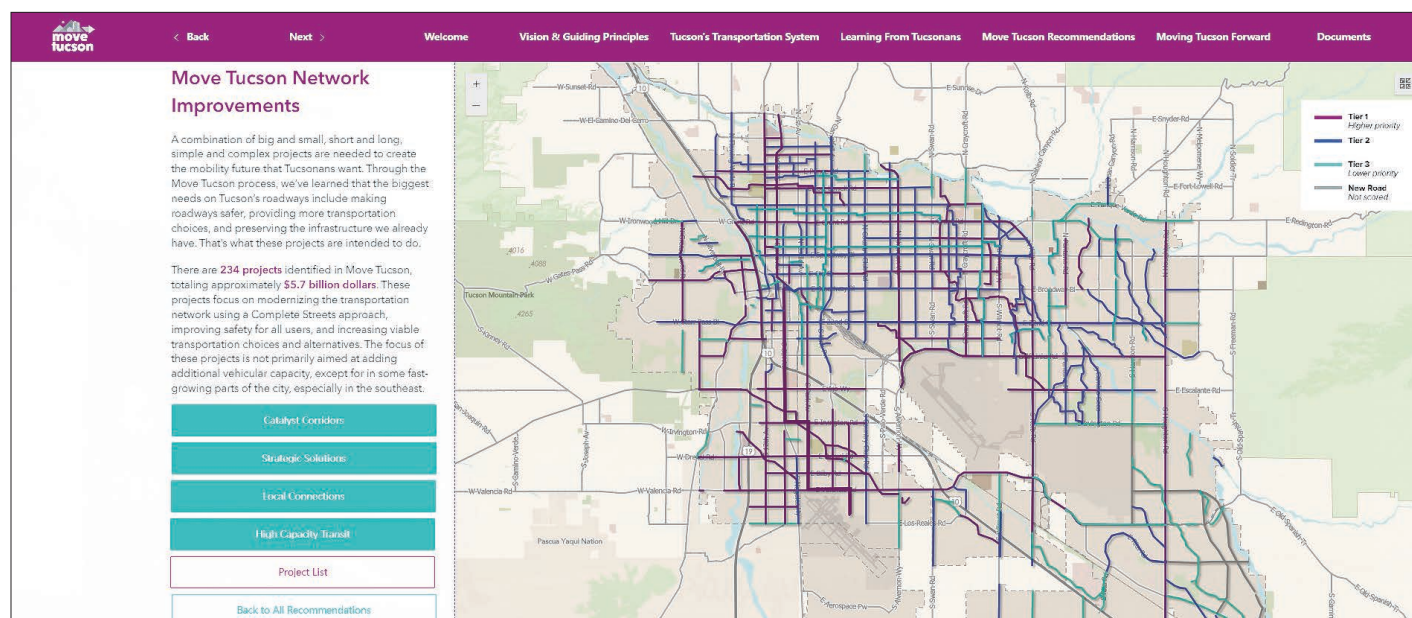
↑ Created using ArcGIS Experience Builder, the Move Tucson app uses maps and informational sidebars to show existing conditions, public engagement findings, improvement recommendations, and more.

↑ Experience Builder made it easy to incorporate infographics from the printed plan into the digital version, maintaining consistency between the two.

Planting Seeds of Geocollaboration in Arizona and Beyond

↑ During Leveille's time as deputy state cartographer for Arizona's State Land Department, Arizona's lidar coverage was expanded to include nearly the entire state.

Jenna Leveille, vice president of state and local government for The Sanborn Map Company, describes her career in GIS as a happy accident.

"My degree is in zoology, but my goal was to go into conservation," Leveille said. "I wanted to save the world and at that time, GIS wasn't mainstream—there weren't courses for it. But I got an internship at a place called the Conservation Biology Institute, and all their analysis and research were done using GIS. They were at the forefront of the technology."

The connection between spatial relationships and decision-making has just made sense to Leveille since then.

"I fell in love with the technology and what it could do," she said.

Managing Arizona's Land Trust

Until recently, Leveille worked for the Arizona State Land Department. She spent more than 18 years with the department, first as a GIS analyst and then as deputy state cartographer, providing GIS coordination and support for land-management decisions made by the state in the service of Arizona residents.

After college, Leveille said, "I got a job with Arizona State Land—in part because I could map very accurately…and the department really needed that to manage the state's trust lands."

Because there was so much available land as the United States expanded westward in the 1800s, the federal government granted "trust lands" to Western states—specific tracts of land that were set aside to benefit each state's residents. The Arizona-New Mexico Enabling Act of 1910 authorized Arizona land parcels of about 10.9 million acres (about 44,100 square kilometers) to be held in trust for the benefit of K–12 schools and other public services.

Arizona's State Land Department makes sure that this land resource—on the surface and belowground—is managed for the best use in all cases, while providing funds for Arizona's schools and other purposes.

"That's a pretty delicate balance to achieve," Leveille said. "So in the metro area of Phoenix, the

Jenna Leveille

department strategically sold off lands at the best value it could get, while in parts of rural Arizona the best use is agriculture and grazing leases. In some cases, the land is considered multiuse, so the best uses could include mining or solar farms on ranch land. The department is also concerned with equity around the state, including for things like paved roads, broadband access, and cellular coverage in underserved areas."

Today, the department manages about 9.3 million acres (more than 37,600 square kilometers) of land—which is around 13 percent of Arizona's total surface landownership. To support this effort, the department collects and consolidates GIS data from across the state.

"There were visionary people—lawmakers as well as people that came before me at the department—who were early adopters of GIS. They saw the power early on of where having GIS data will make a difference," Leveille said, noting how reliable GIS data helps manage land for issues related to water, roads, addresses, parcels, wildfires, landslides, and more.

Coordinating Statewide Collaboration

During her time as deputy state cartographer, Leveille also led the Arizona Geographic Information Council (AGIC), a group of federal, state, local, tribal, and private organization representatives who advise the Arizona State Land Department on how best to coordinate GIS data and make it widely accessible.

Filling these two roles helped Leveille guide the development of what she considers the greatest legacy of her time with the department and AGIC: the department-hosted and AGIC-sponsored AZGeo Data Hub (links.esri.com/azgeo), which provides Arizona GIS data online. Built with ArcGIS Hub, the AZGeo Data Hub gives visitors access to online map services, metadata, geospatial data, and apps that are used by municipal, regional, state, and tribal governments; private companies; and the public.

"We revamped our state GIS data clearinghouse and made it more accessible to the public," Leveille said. "This allows our lawmakers and our leaders—whether they have knowledge of GIS specifically or not—to make good, data-driven decisions to support our communities."

Leveille is also proud of the mentorship program developed by AGIC during her time at the organization. "The program, which supports professional development for Arizona geospatial *[technology]* professionals, is now in its third year, and all of the graduates are invested in AGIC and are part of Arizona's GIS community," she said.
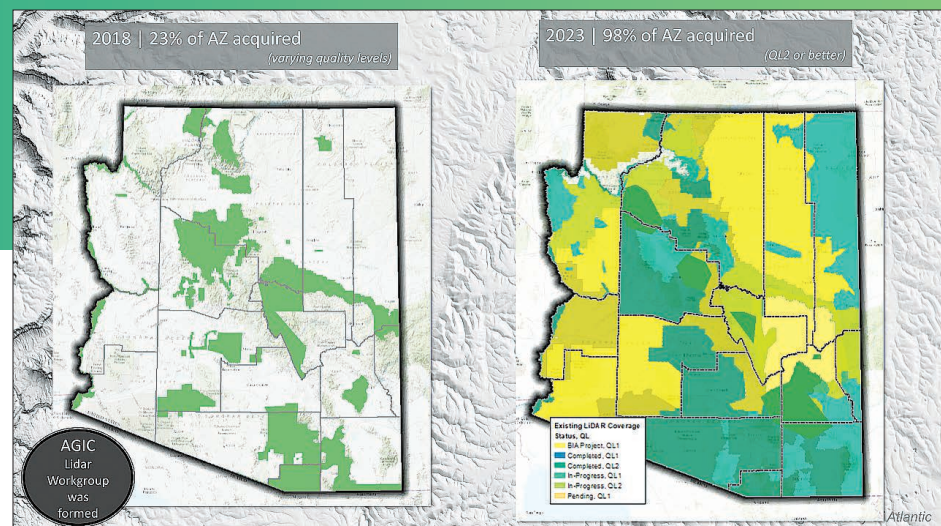
Influencing GIS Decisions Around the Country

Leveille's work with AGIC led to her participating in a national organization called the National States Geographic Information Council (NSGIC). Leveille represented Arizona at the organization and also served as its president from 2021 to 2022.

A national network for geospatial leaders, NSGIC provides a platform for cross-state GIS collaboration. The council also develops and promotes sound policies for geospatial activities at the state level. For example, every other year NSGIC conducts a maturity assessment of states' geospatial technology initiatives, capabilities, and issues, providing each state with a report card to identify areas of strength and opportunities for improvement.

"After I started representing Arizona at NSGIC, I wanted to be part of the board and the organization," Leveille said. "That led to me being elected president. NSGIC helped me to build up the AGIC program in Arizona. My time as NSGIC president was the most meaningful time of my career so far."

While Leveille was NSGIC president, the organization developed a nonprofit called the National Geospatial Collaborative, or NGC (links.esri.com/ngc). Launched in 2023, NGC advances the understanding, use, and integration of GIS and associated emerging technologies by supporting geospatial professionals, organizations, and initiatives via collaborative research, education, knowledge-sharing, and strategic partnerships. Leveille serves on the organization's board.

"Our vision statement is to boldly pursue a more effective geospatial ecosystem," she said.

A New Chapter at Sanborn

In May 2024, Leveille began working for Sanborn, an Esri partner, as vice president of state and local government. The position builds on her past work with the Arizona State Land Department, AGIC, and NSGIC.

Founded as a fire insurance mapping company in 1866, Sanborn has evolved into a

modern, full-suite geospatial technology services provider. Its fleet of planes, equipped with lidar, imagery, and geophysical sensor systems, collects data across the United States and beyond. Sanborn also provides strategic planning, GIS and IT consulting, data processing, spatial analysis, custom app development, and managed services.

With this vast expertise, Sanborn helps clients build robust geospatial solutions and programs in sectors such as transportation, resource management, broadband, public works, mineral exploration, assessment and planning, and disaster response. Through its long-standing relationship with Esri, Sanborn helps clients benefit from the full Esri product suite.

"It's no longer enough for a company to simply deliver data and products," Leveille said. "The company needs to understand how geospatial assets are used and contribute to more effective and efficient government through better decision-making."

Regarding her new role, Leveille said, "I'm in a unique position to help Sanborn deepen state and local governments' understanding of why GIS is important. I'm excited to leverage the company's resources to serve the state and local market in a really meaningful way."

The company also aligns with Leveille's personal values.

"Sanborn believes in relationships, transparency, working together, giving time for learning, and supporting government entities' growth," Leveille said. "That's why the company is investing in me to support state and local governments' GIS efforts."

For Leveille, the success of these GIS efforts often comes down to collaboration.

"In Arizona and in AGIC, we talked about 'Arizona and the GIS world' as a geospatial ecosystem," Leveille said. "I love that concept because it really implies all the pieces that are dependent on each other. We're only successful because we're a community of collaborators with diversity of ideas. We all count, and it all makes a difference."

GIS Hero

Spatial Foundations

By Dr. Amy Frazier and Dr. Trisalyn Nelson,
University of California, Santa Barbara

GIS Has Evolved, and So Must GIS Curricula

In the 1990s, when the first GIS classes were being developed, GIS was taught using command-line interface software, and entire lectures were dedicated to explaining how spatial data has coordinates that are linked to places on Earth. Things have certainly changed! Now, decades later, graphical user interfaces have replaced command-line operations, and high-performance computing and AI are extending the analytical capabilities of GIS, making it possible to perform spatial queries and feature extraction with just a few clicks.

The world is also now awash in spatial data. The proliferation of GPS technology in smartphones and other mobile devices means that massive volumes of spatial data are being collected every day on everything from people's daily commuting patterns to weather and air pollution. This location data, coupled with imagery from Earth observation satellites and other aircraft, are creating rich opportunities for spatial analysis that could not be imagined when GIS was first being taught. For example, ArcGIS Living Atlas of the World makes it possible to easily access thousands of curated data layers, while a growing number of spatial apps provide spatial data over broad scales.

Additionally, there are more ways to apply GIS than ever before, which means that larger numbers of more diverse people need to be trained in the technology and science of GIS. Given the level of change that has occurred in this world with respect to technology and data, it is also time to rethink how GIS is being taught.

Faculty members in the Center for Spatial Studies and Data Science at the University of California, Santa Barbara (UCSB), are partnering with Esri to convene a conversation on how geographic information science (GIScience) curricula should evolve. Supported by a diverse advisory council, the team will generate updated learning outcomes and publicly available materials that can be used in GIS courses. While this project is just beginning, here is some initial guidance on foundations to consider incorporating into GIS teaching.

What Is Being Taught in GIS— and to Whom—Is Changing

For the purpose of curriculum development, it can be helpful to differentiate between GIS "users" and GIS "makers." Much like in statistics, which offers different levels of theoretical training to students who simply want to use statistics in their projects and those who want to develop new statistical algorithms, GIS training should also consider learners along similar tracks.

Applied users of GIS need the skills to be able to evaluate the quality of existing spatial data, ask and answer spatial questions, work in web- and cloud-based computing platforms, and interpret spatial analytical results. Meanwhile, GIScientists, or the makers and developers of the science of GIS, need deep conceptual knowledge of underlying algorithms, spatial data creation, data research basics, projections, and high-performance computing. Taking these two types of learners into consideration, educators can begin to rethink which critical skills and competencies are necessary to include in introductory and topical courses and what content might be better suited to more specialized and advanced courses.

GIS learners need to be diverse as well in terms of their backgrounds, histories, and lived experiences. While diversifying science, technology, engineering, and math (STEM) fields is a job for all the sciences, GIScience is in a particularly powerful position to attract diverse participants because of the nature of the questions that can be addressed and the creativity that can be nurtured through visualization and cartography.

The goal of GIS as a field of study should be that anyone can learn the technology, regardless of their demographics or circumstances. Everyone should have access to the power of GIS, which means that GIS curricula and teaching should be inclusive and support people from a wide range of backgrounds and situations. Partnering with organizations that are led by people who are underrepresented in GIS is a good start. For example, NorthStar of GIS (northstarofgis.org)—an organization with Black leadership—is working toward developing a racially just world through racially just geography. The organization offers a broad array of resources that GIS teachers can leverage.

The Heightened Importance of Spatial Thinking for Decision-Making

It might seem obvious, but all GIS courses, learning materials, and curricula should emphasize spatial thinking, which leverages the properties of space to structure problems, question why objects are located where they are, find answers, and express solutions.

Given the proliferation of both spatial data and data science, GIS training should focus on spatially explicit approaches that nurture students' spatial thinking skills. These approaches include teaching students about neighborhood effects, spatial autocorrelation, and the modifiable area unit problem (MAUP), among other concepts.

Understanding how to work with the geographic elements of spatial data should be a key learning objective, as it differentiates GIS training from more general training in data science.

Embedded in geography, GIS has long benefited from geographic systems thinking and interdisciplinary perspectives. Within this context, GIS has developed as a foundational tool for decision-making. Given the range of challenges that society and the planet face, GIS curricula should center on project- and problem-based learning that teaches students how to solve complex problems through spatial thinking. Since GIS is a fundamental tool for creating a desirable world, students should be exposed to this type of learning from the start.

To be sure, much of what is being taught in GIS courses will not change. Students still need to learn how to integrate and query spatial datasets. They still need to learn how to build buffers, define spatial neighborhoods, and consider issues of scale. However, educators must recognize that not every user needs the same level of GIS knowledge. As some of the fundamentals have moved to the back end of GIS software, there is now space to focus on problem-based learning, and it is up to educators to capitalize on this opportunity.

Cultivating Excitement for GIS and Spatial Thinking

Since the 1990s, when the original GIS core curriculum was developed, GIS technology has changed, as has the world. GIS curricula must also now adapt and evolve.

There is a massive opportunity to engage more people—and more diverse groups of people—in spatial thinking, GIS, and geographic systems thinking. The more that educators can cultivate excitement for GIS and spatial thinking skills, the more prepared the world will be to handle the challenges ahead.

We at UCSB's Center for Spatial Studies and Data Science look forward to leading more conversations about how to evolve GIS curricula and hope that many of you will join the discussion. Watch for events at upcoming conferences, including at the American Association of Geographers' annual meeting in March and at the Esri User Conference in July, or email spatial-admin@ucsb.edu for more information.
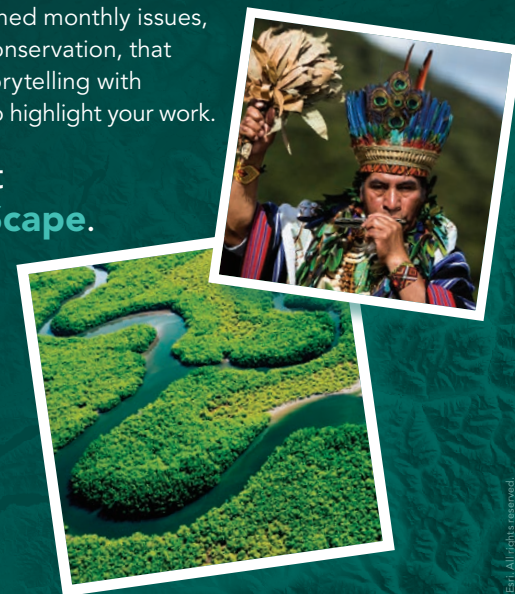
About the Authors

Dr. Amy Frazier is a professor and holder of the Jack and Laura Dangermond Endowed Chair of Conservation Science at UCSB. Dr. Trisalyn Nelson is a professor and holder of the Jack and Laura Dangermond Chair of Geography at UCSB. She is also a Public Voices fellow of the OpEd Project, which seeks to elevate underrepresented expert voices.

From the Meridian

By Dr. Atsushi Nara and Matthew Velasco
San Diego State University

Today's GIS Jobs Call for Geocomputational Skills

Changes in the practice of GIS and the growth of the geospatial services industry are driving demand for job candidates who have geocomputational skills—expertise that exists at the intersection of geography and computing.

For the GIS jobs that are available today, being able to think critically in the fields of geography and computing is essential. Members of the GIS workforce must be able to understand and interpret spatial relationships, patterns, and processes, as well as break problems down into simple steps that can be used to instruct a computer. When employed together, these crucial skills allow for the efficient analysis and interpretation of complex geospatial data.

But there currently aren't enough professionals who have both skill sets. Increasing the supply of people with geocomputational expertise calls for gaining a deeper understanding of the educational and training opportunities available to current and future members of the GIS workforce that allow them to acquire knowledge and skills in both geography and computing.

The Encoding Geography Research Practice Partnership (RPP) is working on this issue. It is a collaborative effort among Southern California middle and high schools, community colleges, and universities—including San Diego State University; the University of California, Riverside; San Diego Mesa College; and Sweetwater Union High School District—and supporting stakeholder organizations such as the American Association of Geographers (AAG), the National Center for Research in Geography Education, Texas State University, and the California Geographic Alliance. The RPP is a National Science Foundation-funded research project (under grants 2031407, 2031418, and 2031380) that seeks to encourage and prepare students to enter geocomputational fields.

In 2022, the RPP conducted a survey of 140 professionals working in the geospatial technology industry to articulate existing pathways to geocomputational professions. The survey also sought to identify gaps in knowledge, skills, and training

needs and uncover opportunities among professionals of different backgrounds.

The survey categorized respondents into four educational pathways based on their university degree backgrounds: geography only; computing only; a combination of geography and computing; and disciplines that are not directly related to geography or computing, such as engineering and earth sciences. The results showed that, while having a geography degree only was the most common pathway to a career in the geospatial technology industry, many people enter the field through various other disciplines.

Unsurprisingly, respondents with an education in computing—whether it is computing alone or the combination of geography and computing—demonstrated greater familiarity and more frequent use of computational and geocomputational thinking than those without a computing background. In contrast, geographic and spatial thinking skills appeared to be more prevalent across all educational pathways. Given that all respondents are employed in the geospatial technology industry, this result makes sense and confirms the prevalence of GIS in education. Additionally, respondents with degrees in something other than geography or computer science tend to be less familiar with geographic or computational thinking and use these skills less frequently.

Most respondents believed that they would benefit from additional training in computational thinking, geographic thinking, and the integration of both. One respondent who studied geography described a geocomputational task that they had recently completed and noted, "I had no background in coding whatsoever, and

I would have had a very difficult time completing the task without the training of my knowledgeable supervisor." Another respondent, who had a background in geocomputational studies, said they believed that many students arrive in the GIS ecosystem via other disciplines such as biology, health, and environmental science. "GIS is just an enabler for some other problem they are trying to solve—but making yet another jump to [computer science] is where the real power is," they said.

Although many respondents indicated that they have some access to training or professional development opportunities related to these critical-thinking skills, a considerable number reported a lack of access to these kinds of opportunities. In particular, respondents with an educational pathway that included both geography and computing were more likely to indicate having no access to training in geographic or spatial critical-thinking skills, even though they use tools and knowledge related to geospatial topics in their professional work.

This implies that professionals with backgrounds in geocomputation recognize the value of geographic and spatial critical thinking and want to participate in additional training to deepen their understanding. However, such opportunities remain limited after graduation. This also underscores a broader issue: the need to incorporate these critical-thinking skills earlier in educational pathways, ensuring that people develop foundational skills well before they enter the workforce.

This result further indicates that professionals appreciate the benefits of using geospatial tools and are eager to learn how to employ them, even without formal training. That said, using geospatial data and tools without adequate training in geographic and spatial critical thinking raises concerns that should be addressed by expanding access to this type of geographic education. Similarly, the use of computational tools—including emerging AI techniques—without knowledge of and training in these topics is another concern, given the complexities and sensitivities associated with geospatial data.

Lastly, findings from the study also reflected reported gender and racial biases in the technology industry and criticisms

about a dearth of diversity in the geography discipline. For instance, respondents who only studied computing were more likely to note a lack of racial and ethnic diversity among their coworkers. Male respondents reported using computational and geocomputational thinking at work more frequently than female respondents. Additionally, white respondents reported using geographic and spatial thinking more often and were more familiar with the term compared to other respondents.

The Encoding Geography RPP study re-emphasizes the need to establish inclusive and diverse geocomputational training and degree programs to ensure that members of tomorrow's workforce gain robust instruction in geographic and spatial critical thinking within the geography and computing disciplines. To achieve these goals, it will be essential to develop targeted initiatives and engage in collaborative efforts.

As part of its endeavor to improve geocomputational employment and preparation, in 2023 the RPP provided professional development workshops in which educators from community colleges and K–12 schools met with university professors and geocomputation professionals to get help with incorporating more geographic or computing content into their curriculum. In addition to encouraging the collaborative creation of geocomputational curriculum, the RPP promoted the enhancement of geocomputational thinking by providing K–12 students the opportunity to participate in research projects, academic conferences, and hackathon events that revolved around using big data. Educators are now implementing the curricula in their classrooms, and the collaboration is ongoing.

Among all levels of educational and work experiences, more integrated geospatial and computational training is needed, whether through collaboratively developed formal education, online courses, or other means. With ever-increasing innovations in technology and interoperability, only a GIS workforce with strong geocomputational skills can face the challenges ahead.

About the Authors

Dr. Atsushi Nara is an associate professor in the department of geography and the associate director of the Center for Human Dynamics in the Mobile Age at San Diego State University. His research interests include spatial data science, spatiotemporal data analysis and modeling, human dynamics and movement behaviors, complex adaptive systems, and geocomputational education. Matthew Velasco is a graduate student at San Diego State University and was a research intern for the Encoding Geography RPP. He recently graduated from San Diego Mesa College with an associate's degree in GIS and sustainability.

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GIS Adoption in the Rocky Mountains: Spurring an Enterprise Mindset

Several years ago, the GIS team for the City of Aspen was stretched thin. Other municipal departments in the famed Colorado ski resort community heavily relied on the team for maps and geospatial information, and city leaders weren't fully aware of the role GIS could play in city operations or all the services that the team was providing.

To help transition city employees to a self-service GIS model while elevating city leadership's GIS awareness, Aspen GIS manager Bridgette Kelly and her team partnered with Esri Training Services. Aspen has a small-government enterprise agreement with Esri and is a member of the Esri Advantage Program. Kelly used Advantage Program credits to purchase custom training and deploy a tailored technology adoption strategy, which her team named the GIS User Expansion Initiative.

In the initiative's first phase, Kelly commissioned a custom web course that prepares employees to leverage the capabilities of a Viewer user type license. The course, which she calls the "viewer course," shows how to access Aspen's GIS portal, navigate the portal's rich collection of GIS content, and find the information needed to answer questions and support work projects.

Kelly also consulted with an adoption strategy expert to engage city leaders. Together, they crafted a communications strategy and a presentation that Kelly delivered to department managers showing how her team directly supported their projects while aligning with city priorities.

This two-pronged approach was well-received. Since the web course was launched and widely promoted, the portal has attracted almost 300 users. Leaders have gained a deeper understanding of how GIS benefits their department and the community as a whole.

Expanding the Expansion Initiative

Having achieved their initial goals, Kelly and her team began the next phase. Their new objectives were to embed GIS into the city's onboarding process and support employees interested in exploring more advanced GIS capabilities. Kelly worked with the city's human resources department to connect with new employees during their first month on the job.

"Even if they never create their own map or use GIS analysis tools, most city employees are going to need to look up information—where is a certain address, who owns this property, and so on," Kelly said. "We want to make sure everyone knows the portal is there, has access to it, and can leverage the content in there."

The GIS portal is one of a suite of enterprise-wide apps that new employees can access starting on their first day.

"Employees use a single sign-on application to access their time sheet and other essential city applications," Kelly said. "New employees see our GIS portal right there, bundled with those essential applications, and they click on it and are curious."

When a new employee accesses the portal for the first time via the single sign-on app, they are automatically assigned a Viewer user type license.

"Meeting with employees early in their onboarding process to explain exactly what it is they've been clicking on has been very useful," Kelly said.

Each month, she introduces new employees to GIS using an ArcGIS StoryMaps story. During the meeting, Kelly invites them to take the viewer course, shows them how to create an ArcGIS public account so that they can access the course via Esri Academy, and connects them to Aspen's My Esri organization.

Because the viewer web course is housed in an Esri Academy private catalog that Kelly administers, she has tools to track employee enrollments, progress, and completions.

Kelly includes summer interns in her GIS onboarding process because they often perform mobile work using ArcGIS Field Maps or ArcGIS Survey123.

"On day one, we get them set up with the portal and into the training because we want them to hit the ground running," she said.

Growing Viewers into Creators

While all Aspen city employees now have a baseline awareness of GIS and the city's GIS portal, some want to create their own content. To support these employees, Kelly commissioned a second custom web course, which she calls the "creator course."

"We met with the Esri team and put together an outline of all the portal items that we wanted to be available within the course, and then we chose certain feature layers for use within the exercises," Kelly explained.

The two-hour course contains conceptual information and exercises to teach learners to access the portal and its feature layers, as well has how to create and edit features, make and share web maps, and annotate a web map using a sketch layer. Exercise screenshots match what learners see in the GIS portal.

Similar to the viewer course, the creator course is hosted in a private catalog on Esri Academy, which means it is accessible only to Aspen city employees. To promote the creator course and the benefits of expanded portal capabilities, Kelly reached out to employees who had taken the viewer course.

And, as she did during the initial phase, Kelly infused fun into employee outreach activities to increase engagement. The first five people to send her their course certificate of completion received a voucher for free cookies.

Whether motivated by a thirst for knowledge or a hunger for sweet treats, by mid-2024, 93 city employees had completed the creator web course.

Enabling Innovation Through Education

Kelly is pleased by city staff's increased engagement with GIS, as well as higher GIS awareness among city leaders.

"We're promoting that GIS is a tool that should be available to everyone in the organization in order to increase their efficiency and improve their workflows and just gain more information quickly," she said.

City leaders have also been influenced by the GIS User Expansion Initiative.

"The public works director and city manager presented a new GIS permitting application to the city council on their own. They told me they didn't need me there," Kelly said with a laugh. "There's a lot of construction activity and a lot of permits being submitted, [and] this application allows city staff and the public to visualize where all the permitting activity is. This is a very big topic in the community."

Kelly has been delighted by the transition to broad engagement with GIS at the City of Aspen.

"It's really nice to see," she said.
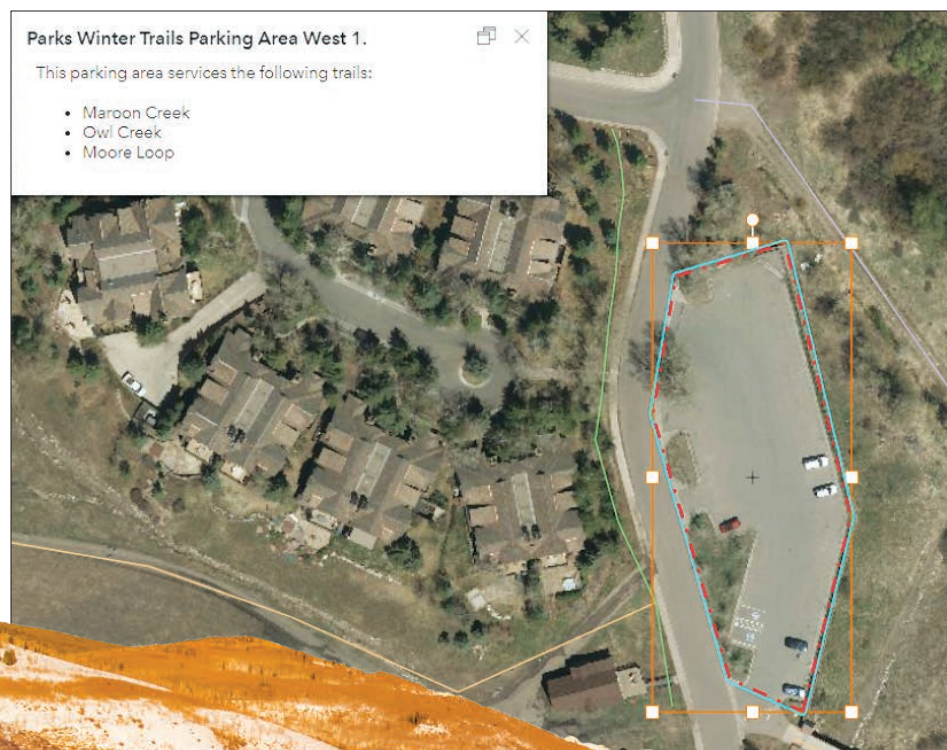
← In Aspen's creator web course, city employees work directly with maps and layers to build their GIS skills.

To find out more about Aspen's GIS program, contact Bridgette Kelly at bridgette.kelly@aspen.gov.

Esri Startup Partner Uses GIS to Transform Wildfire Protection Plans

Lightning strikes play a major role in wildfires, which in the United States cause hundreds of billions of dollars in damages every year. About 53 percent of the average land area burned by US wildfires from 2018 to 2022 was attributable to lightning, according to the National Interagency Coordination Center. As hotter, drier conditions due to climate change raise wildfire risk and the speed at which fires can grow, it's critical to have quick access to information on high-risk lightning strikes.

These are issues that Esri startup partner Fire Neural Network (fireneuralnetwork.com) is addressing with help from ArcGIS Online and ArcGIS Dashboards. The company's High-Risk-Lightning detectors provide location data on strikes that is then combined in ArcGIS Online with other wildfire-related variables. When viewed in dashboards, this data helps firefighting services allocate resources, such as deploying one of Fire Neural Network's high-speed drones to take a closer look at the strike site.

When possible, Fire Neural Network also employs ArcGIS Hub to help communities incorporate lightning strike information into digital, GIS-enabled wildfire protection plans.

Why Lightning Detection Matters
From a wildfire perspective, not all lightning strikes are created equal. Lightning without rain, for example, is more likely to cause a wildfire. And long-continuing-current lightning strikes, which are relatively rare and can last up to 1,000 times longer than normal lightning strikes, are more likely to start a wildfire or damage power transmission lines.

Fire Neural Network's solar-powered lightning detectors pinpoint lightning strike locations and detect the presence of long-continuing-current lightning. The detectors are usually installed as an array of six ground-based units that collectively cover about 1,544 square miles (4,000 square kilometers). Connected to the company's proprietary network, the detectors can identify lightning strike locations within 131 feet (40 meters) of the strike in 40 seconds or less. These are the only sensors on the market that can accurately detect the duration of a lightning strike and its associated heat characteristics.

To evaluate wildfire risk, Fire Neural Network uses ArcGIS Online to pair strike location vector data with more than 30 weather-related raster data layers—for flammability, humidity, vegetation, and rain data, for example—in real time. This data is then converted to a dashboard built with ArcGIS Dashboards and made available to subscribers in wildfire-prone areas such as California, Florida,

↘ Fire Neural Network created an ArcGIS technology-enabled community wildfire protection plan with built-in high-risk lightning detection functionality for San Bernardino County, California.

Australia, and Brazil. From lightning strike to dashboard availability, this data is generally displayed in about 40 seconds.

Improving Wildfire Preparation and Communication
With a dry climate, plenty of flammable vegetation, and strong seasonal winds, the San Bernardino Mountains in Southern California are one of the most wildfire-prone areas in the United States, according to the US Forest Service. In fact, the Forest Service rates homes in San Bernardino County as having higher wildfire risk than 94.5 percent of counties in the nation. This is partly because a lot of areas in the county are part of the wildland urban interface—where developed communities and natural landscapes intersect.

To enhance fire response and preparedness, the San Bernardino County Fire Protection District began working with Fire Neural Network in 2023. The district's goals were to improve stakeholder communication and involvement in wildfire preparedness efforts, including lightning detection and response.

The district already had in place a community wildfire protection plan, or CWPP, that outlines San Bernardino County's wildfire risk-mitigation efforts. In addition to being better prepared for wildfires, communities with CWPPs are prioritized for federal funding to reduce the volume of flammable vegetation in the area.

CWPPs are typically lengthy, highly technical documents that are distributed as PDFs—and they often fall short when it comes to improving community engagement. Considering this, San Bernardino County Fire Protection District fire chief Dan Munsey and deputy fire marshal Adam Panos wanted to transform their static CWPP into a dynamic and interactive online platform that integrates spatial analysis and can be updated in real time. Their goal was to give stakeholders access to up-to-date wildfire risk maps, recent mitigation projects, and resource allocation recommendations.

Fire Neural Network helps communities with this transformation by taking CWPP PDFs and converting them into GIS-enabled solutions. By using these solutions, community members can investigate current mitigation projects on hub sites created using ArcGIS Hub and use ArcGIS Survey123 to fill out mitigation recommendations or feedback forms for local fire departments.

San Bernardino's new CWPP solution, which went live earlier this year, has been a success, according to Panos. "GIS-enabled CWPPs not only improve emergency planning capabilities but also ensure that vulnerable communities receive the support they need before and during wildfire events while enhancing community resilience," he said.

↑ The High-Risk-Lightning detector and the Firebird drone—both from Fire Neural Network—feed data into GIS-enabled community wildfire protection plans.

ArcGIS Enhances Digital CWPPs and Enables Innovative Solutions
This GIS-enabled CWPP was Fire Neural Network's eighth such project, following seven made with communities in Florida. All use Hub to show detailed maps and layers for current fire risks, historical fire and remediation data, and wildfire risk scenarios—along with information on lightning strikes if that information is available for the area covered by the CWPP. In addition to being used to enlighten communities and train fire departments and community leaders, digital CWPPs have aided communities in identifying high-risk areas that are susceptible to wildfire. With this information, community leaders can prioritize resources to mitigate social, economic, and environmental damage.

ArcGIS technology-enabled lightning detection also supports Fire Neural Network's work with GatorX, a Florida-based partnership between the company and the University of Florida, NVIDIA, Satlantis, SwissDrones, Archer Aviation, SWIR Vision Systems, and N5 Sensors. GatorX has developed a solution that reduces risk for wildfire first responders. By using AI with satellite imaging, lightning and smoke sensors, and drones, the GatorX solution can quickly detect and verify hot spot locations before deploying a drone-tethered autonomous fire extinguisher that can put out emergent wildfires before they spread.

Benefiting from the Esri Startup Program
Based in Gainesville, Florida, and launched in 2021, Fire Neural Network joined the Esri Startup program the same year. The Esri Startup program helps early-stage startups incorporate location intelligence and mapping technology in their products.

"The Esri Startup program helped connect us to companies that are at the forefront of GIS analysis," said Caroline Comeau, Fire Neural Network's cofounder and director of marketing and finance. "This helped us further explore the connection between wildfires and GIS. It also exposed us to the many tools that are related to wildfire intelligence, as well as to using ArcGIS [technology] that can help explain this data to less technical individuals."

In communities where GIS-enabled CWPPs have been implemented, local fire departments can deploy resources more strategically, and community members are more informed and prepared for potential wildfire threats.

And as the company continues to advance wildfire management technology, there is potential for further innovation. For example, Fire Neural Network's robust AI and machine learning capabilities could provide precise predictions and alerts for wildfire management when dealing with devastating occurrences such as pyrocumulonimbus cloud events—when thunderstorms emerge in a wildfire's smoke plumes. Both the predictions and alerts could help communities stay safe from major wildfires.

"By digitizing CWPPs and making them Esri enabled, we empower communities to enhance their emergency planning efforts and swiftly understand their risks when reacting to fires in these high-risk areas," said Fire Neural Network CEO Dr. Istvan Kereszy.

For more information on the Esri Startup program, go to **links.esri.com/startup**.

Partners Apply GIS to Gas Pipelines, Real Estate, Water, and Restoration

Esri partners help organizations streamline operations, collect and optimize data, plan land-management strategies, and more. See how four partners aided two utilities and two government agencies in updating their GIS implementations to manage utility assets, empower real estate investors, address public health requirements, and restore a historic district.

Gas Distributor Enhances Services, Field Safety with Mobile GIS

Hope Gas, a gas utility in West Virginia, needed a mobile solution to view and collect data for assessments along more than 6,900 miles (11,104 kilometers) of pipelines. These assessments typically relate to gas leaks, damage due to weather and outside forces, and overgrown rights-of-way.

The solution had to operate on the company's field laptops, which run on Windows 11. It also needed to work in areas with and without cellular connectivity. And it had to be created within three months to properly service the company's approximately 125,000 residential, industrial, and commercial customers.

Initially, Hope staff had planned to use Windows Subsystem for Android to deploy ArcGIS Field Maps. But various complications led Hope to seek a different solution. In late 2023, Hope began working with **RAMTeCH** (ramtech-corp.com).

RAMTeCH's gMobile solution, powered by ArcGIS Maps SDK for .NET, enabled RAMTeCH staff to quickly create a native Windows app with common GIS functions, including the ability to view asset attributes, locate addresses, and search for assets by location or attribute. RAMTeCH added the ability to perform damage assessments and place gas-leak and visual inspection points on a map. The solution also included offline data functions and asset attribute forms.

The gMobile solution uses forms that staff at Hope and RAMTeCH created in Field Maps using ArcGIS Arcade expressions. gMobile is built on a framework called the Prism Library, which allowed Hope's gMobile app to be divided into independent modules for fast and flexible development, testing, and deployment.

Staff members at RAMTeCH and Hope also used gMobile's proprietary data synchronization process—built with the ArcGIS Enterprise feature services sync capability—which scales to allow near real-time data synchronization from hundreds of users. Integration of Esri feature services and SAP software utilizing the Open Data Protocol (OData) enables notifications in SAP that are then managed by internal Hope resources.

Hope deployed gMobile in January 2024, which met the utility's core requirements within its three-month time frame. With Hope's plans to further expand the app to support an SAP-integrated pipeline damage-reporting process, the solution continues to aid the utility company in achieving its business objectives and meeting future needs.
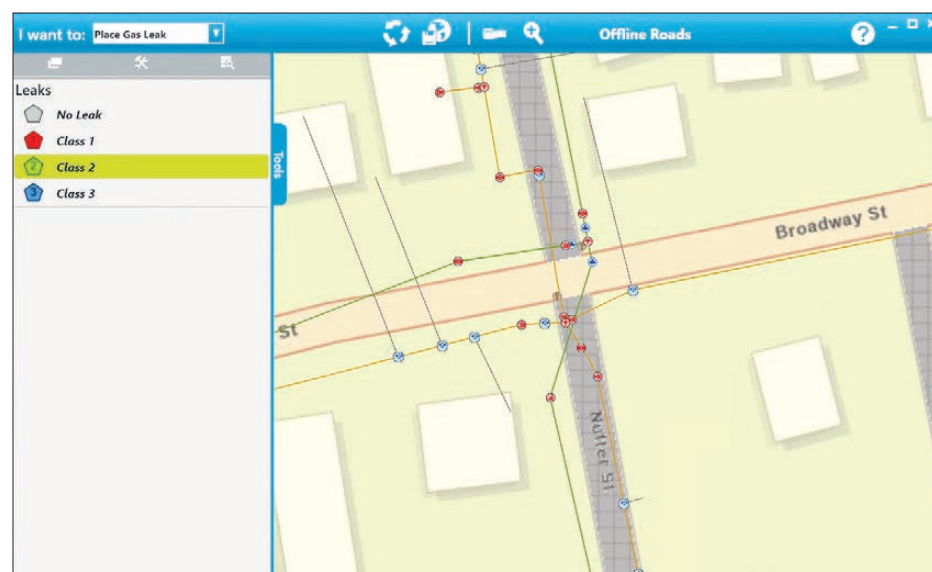
↑ RAMTeCH created an app for Hope Gas that shows gas leak locations.

Transforming Saudi Arabia's Real Estate Sector with GIS

Established in 2016, Saudia Arabia's National Housing Company (NHC) is the investment arm of the country's Ministry of Municipal and Rural Affairs and Housing, which manages urban planning and housing development. In May 2020, the NHC began a new chapter under state ownership. When this happened, the government directed the company to better empower the country's private sector. Digitizing NHC operations and services was a priority, but this was complicated by the fact that the company had fragmented databases across various platforms.

To help with this project, NHC enlisted **Khatib & Alami** (khatibalami.com). Using GIS technology such as ArcGIS Pro, ArcGIS Enterprise, and ArcGIS Dashboards, along with Esri's geospatial artificial intelligence (GeoAI) and geocoding services, Khatib & Alami and NHC created a comprehensive geospatial database that integrates several of NHC's real estate management platforms. The database also incorporates numerous new, innovative functions and drives real estate planning, use, and investment.

As part of this effort, the team developed API services for NHC's rent index app. Employing geocoding and map services in ArcGIS Enterprise together with spatial analysis, this solution provides a detailed overview of property rent prices.

This helps local real estate service providers make more informed and strategic decisions by allowing them to select and evaluate locations.

Incorporating GeoAI models developed using ArcGIS Pro deep learning tools was key in helping NHC distinguish between vacant and developed properties. This supports Saudi Arabia's efforts to foster the development of unused land by encouraging private sector participation and creating investment opportunities. Real estate investors can now evaluate land, determine annual fees, and assess property ages using archived satellite imagery from World Imagery Wayback in ArcGIS Living Atlas of the World.

The team also employed Esri's ArcGIS Geocoding service and the spatial extract, transform, and load (ETL) tool to allow users to find addresses from locations or vice versa.

These technological advances have provided NHC's customers and stakeholders with valuable map-based real estate information. Visualizing the results on dashboards built with ArcGIS Dashboards has empowered more informed decision-making in real estate investments and development projects. These enhancements have led to significant cost savings and improved operational efficiency, driving smarter strategies and better outcomes overall.
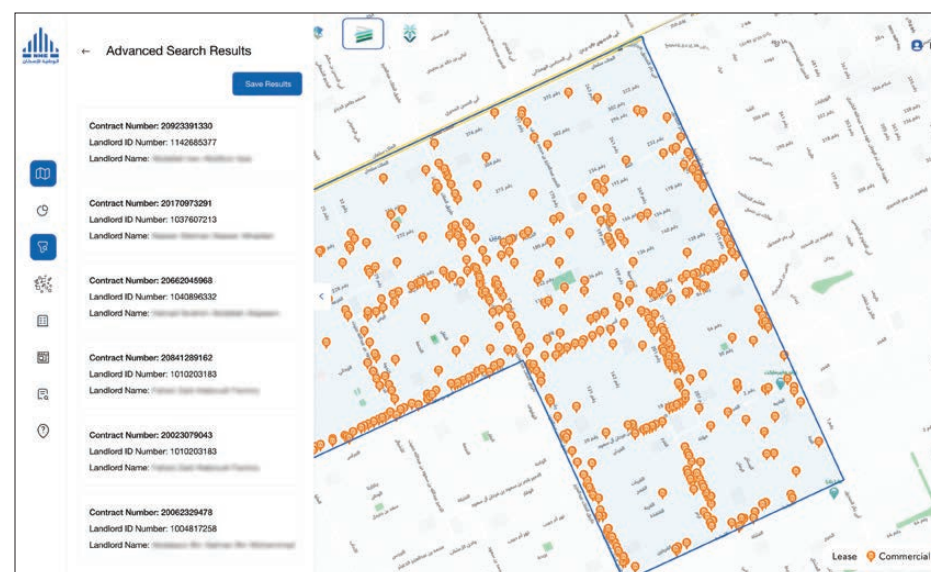
↑ Real estate investors and other dashboard users can search for property data such as location, price ranges, building types, ownership, and land classification.

Esri partners represent the rich ecosystem of organizations around the world that work together to extend the ArcGIS system and implement it in distinct ways to solve specific problems. Find partners that meet your needs at **esri.com/partners**.

Using GeoAI to Make Drinking Water Safer

When lead and copper get into drinking water, the health effects can be serious, ranging from nausea to brain damage. To help prevent these risks, the US Environmental Protection Agency recently revised its Lead and Copper Rule and mandated that all US water utility companies identify and inventory their lead service lines by October 16, 2024.

As with many other water utility providers around the United States, the City of St. Petersburg, Florida, had a lot of work to do. It has about 96,000 service lines in its water system, and when the rule revisions were announced in 2021, only about 1 percent of these lines had a known, documented material type.

While the city had a rich database of work activities that had been performed on its assets and there was plenty of valuable information in the database, much of it was in free-form text fields. With about 500,000 records, an analyst team would have spent countless hours reviewing and classifying text-based data—a process that also would have had a high potential to introduce errors.

With help from HDR (hdrinc.com) and the GeoAI toolbox in ArcGIS Pro, city staff used geospatial artificial intelligence to train a text classification model to read through the database. Via this process, staff were able to pull a variety of location-specific data from the records, including:

- If and when a service line had been replaced
- Known material types for original or replaced service lines
- Whether a service line had been replaced on the city side, the homeowner side, or both

Staff used the toolbox to incorporate known material types from the database with other key variables such as building construction and mainline pipe installation dates. From there, a citywide presence prediction model generated a probability distribution for each material type at each service line location to help staff create a service line inventory and prioritize field investigations.

By using the GeoAI toolbox, the team increased the efficiency and accuracy of text classifications. It also created a repeatable model that the city can quickly use when records need to be assessed—helping St. Petersburg not only comply with federal regulations but also reduce risk from lead and copper contamination.

Automatic Change Detection Helps Restore a Jewel from Saudi Arabia's Past

Located on the outskirts of Saudi Arabia's capital of Riyadh, the city of Diriyah was once a center of education, commerce, and culture, and is the original home of the Saudi royal family. Following the Siege of Diriyah in 1818, this historically rich area was largely deserted until 2000. But in 2010, Diriyah's At-Turaif district was declared a UNESCO World Heritage Site, and in 2017, the Saudi Arabian government established the Diriyah Gate Development Authority (DGDA) to restore and transform Diriyah into an international tourist destination and an even greater source of pride for Saudis.
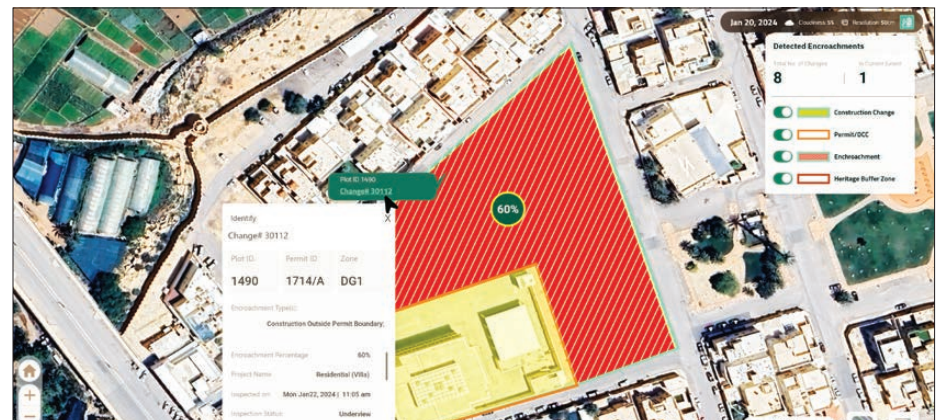
As the geospatial technology partner in fulfilling this mission, Quality Standards for Information Technology (QSIT) worked with DGDA to create a geospatial strategy and road map, with the goal of building a digital twin in the next two years to help empower DGDA's decision-making.

Using ArcGIS Online and ArcGIS Workflow Manager, staff from QSIT (qsitint.com) developed one platform to support seamless collaboration with DGDA and another to manage and automate the validation, conversion, and updating of urban planning data. QSIT staff used FME Flow from Safe Software (another Esri partner) to automate the input and transmission of DGDA's data. QSIT made this consistent by adhering to computer-aided design (CAD) and building information modeling (BIM) standards. ArcGIS Urban helped DGDA staff visualize urban planning data and compare different scenarios.

Using Esri's deep-learning models and high-resolution 50-centimeter multispectral optical satellite imagery, QSIT and DGDA staff also developed a way to automatically detect property changes such as construction violations and encroachments in DGDA's 2.7-square-mile (7-square-kilometer) jurisdiction. QSIT staff then integrated these results with DGDA's Field Works Inspection Platform, developed with ArcGIS Runtime SDK for iOS and ArcGIS Runtime SDK for Android, to help manage year-round inspection missions, field-based inspection activities, and ad hoc requests.

Today, midway through the road map schedule, DGDA has already seen the value of geo-enabled solutions. The visibility of its workflows has improved; it has better control over the area it supervises; and staff are saving money, time, and effort. With QSIT developing more functionality, including real-time capabilities and additional apps and analytics, DGDA is poised to further benefit from GIS technology.

↑ Using the GeoAI toolbox in ArcGIS Pro enabled city staff to inventory drinking water assets.

↑ A platform built on ArcGIS technology tracks construction encroachments.

Come to Vancouver to Help Map the Future

The biennial International Cartographic Conference (ICC) brings together map lovers from around the world to share experiences and the latest research in cartography and geographic information science (GIScience), as well as to enjoy the beauty and power of maps. The ICC—which attracts up to 1,000 delegates from various countries—offers an opportunity to network and connect with like-minded map enthusiasts and to inspire and be inspired by maps and the potential of geospatial data.

The Canadian Institute of Geomatics (CIG) will host the next ICC August 16–22, 2025, in Vancouver, British Columbia, Canada. It will be the third time that an ICC is hosted in Canada, following ICC 1972 and ICC 1999, both of which took place in Ottawa. Vancouver is the largest city in Western Canada, where the fusion of urban sophistication, cultural richness, and natural beauty provides the perfect backdrop for a conference that inspires attendees to shape novel ideas for a future that leaves no one behind.

The 32nd ICC, which is centered on the theme Mapping the Future: Innovation, Inclusion, and Sustainability, will challenge attendees to envision a future in which maps and geospatial data are inclusive and can be trusted, even if some are generated by AI tools.

Paper submissions are due December 2, 2024, and abstracts are due December 9, 2024. Papers should cover topics related to the International Cartographic Association's (ICA) commissions and working groups, which take on the art, science, and technology of cartography via topics such as map design, geospatial artificial intelligence (GeoAI), ethics, inclusive cartography, and the next generation of cartographers. The ICA also invites submissions on themes specific to the Canadian context, including decolonial maps, Indigenous mapmaking, and mapping the Arctic. The papers presented at the ICC are sure to elicit lively discussions in the sessions.

Maps and cartographic products from around the world will be showcased in the ICC's International Cartographic Exhibition, along with finalists in the popular Barbara Petchenik Children's World Map Drawing Competition. Technical tours will allow delegates to experience firsthand how local organizations in Vancouver practice cartography and GIScience.

The ICA's numerous commissions—which each focus on a specific topic in modern cartography, including art, geovisualizations, and marine and mountain cartography—arrange preconference seminars and meet during the ICC to discuss their plans for research, workshops, and other collaborative initiatives. Some commissions organize fun activities related to maps, while some have more serious research presentations and discussions and others engage with local communities. Commission events are generally a great way to meet people and make friends in the cartographic community.

As a special ICC feature, anyone who accompanies a registrant for the conference, such as a friend, partner, or family member, receives complimentary entry to a technical session of their choice. That means that this friend or family member could go to your presentation and support you and your work.

For more information about the 32nd ICC, visit the conference's website at icc2025.com. To receive updates about the conference via email, subscribe to the LISTSERV at icc2025.com/subscribe.

About the Author

Dr. Serena Coetzee recently joined the United Nations University Institute for Integrated Management of Material Fluxes and of Resources (UNU-FLORES) in Dresden, Germany. She still holds an extraordinary professorship at her former employer, the University of Pretoria in South Africa. Coetzee is currently serving as vice president of the ICA.

Award-Winning Government Agencies Deliver Results for Residents

By Wendy Nelson, the Urban and Regional Information Systems Association

The Urban and Regional Information Systems Association (URISA) has recognized government agencies' outstanding achievements in the use of geospatial information technology since 1981, when it first presented the Exemplary Systems in Government (ESIG) Awards. Award winners are effective at applying geospatial technology and data to improve the delivery of government services and increase benefits for residents. The competition is international and open to all public agencies at the local, regional, state and provincial, and federal levels.

Government agencies can compete for the ESIG Awards in one of two categories: enterprise systems, which are used by multiple agencies, and single-process systems, which are used by one agency. Submissions are evaluated on system design and implementation, the impact the system has on the organization, and the resources used to create the system.

The enterprise systems winner for 2024 was the City of Frisco, Texas, which developed a digital twin to give emergency responders rapid access to building information. The single-process systems winner this year was the City of Rockwall, Texas, which developed a dashboard that made it easy to share restaurant health inspection scores with the public.

An Enterprise-Level View of Emergencies

The enterprise system that the City of Frisco developed is called Situational Awareness for Emergency Response, or SAFER. The map-based system—which features aerial maps, floor plans, hazards, and contact information for schools—enables first responders to start planning their operations before they arrive on-site at an emergency.

The project leveraged strong partnerships among fire, dispatch, police, transportation engineering, and IT departments, along with a local school district. In developing an in-house geospatial platform, the City of Frisco realized its vision to enhance situational awareness during emergency response.

Since its implementation, the SAFER platform has gone through a series of transformations, evolving into a public safety digital twin that incorporates more than 30 integrations and 240 GIS data layers. These systems include pre-planning resources such as building floor plans and geospatial details related to a variety of resources, including the following:

- Critical infrastructure
- Fire and computer-aided dispatch records
- 911 (emergency) callers
- Fire suppression system impairments
- RapidSOS (an intelligent safety platform)
- Real-time traffic conditions
- Vehicle and Motorola radio GPS locations
- Waze traffic incident reports
- Road closures
- Live video feeds of schools and traffic
- Weather conditions
- Hazardous materials plumes

The SAFER team also created a custom software solution with several components, all of which were developed with in-house resources. Collaboration among multiple city IT departments yielded an innovative product that the ESIG Award judges described as unparalleled in the commercial market and unprecedented among local governments.

"The dedication of the GIS, fire, police, transportation, and other departments to work collaboratively on this is astounding," one judge observed. "Bravo for ease of user acceptance. The impact is easy to see, given [that] thousands of hours were saved, which is big for efficiency. Resource [and] information sharing is huge, and at the end of the day, if it saves lives and property, it is all worth it."

A Streamlined Way to Share Restaurant Health Inspection Scores

The single-process system that the City of Rockwall built is a dashboard that displays health inspection scores for restaurants throughout town.

The dashboard was initially implemented as a GIS-centric permitting and inspection solution for the city's health services department. It was then automated even further to share restaurant inspection scores with the public, local businesses, and other city departments.

Rockwall's GIS division automated the publication of restaurant health inspection scores in a manner that users can easily understand. Accessing the app through the health services department's website, users can either select a restaurant from a list or find one on the map.

Once a restaurant is selected, a pop-up displays the establishment's recent health inspection scores and allows users to view current and historical inspection reports.

The dashboard has reduced the amount of manual and duplicative work that city employees have to do, improving the efficiency, effectiveness, and timeliness of data sharing.

To build the system, GIS staff leveraged spatial views, custom scripts, and web customization tools to create a sustainable and elegant map and dashboard that also give users access to actual health inspection reports. Personnel who provided expert customizations were pivotal to the dashboard's successful implementation.

"The previous system was not always updated in a timely manner, nor equally, across all restaurants, and [it] required manual data entry," said one judge. However, this new system, the person noted, "provides clear, current, and—most importantly—accurate information related to restaurant [health inspection] scores."
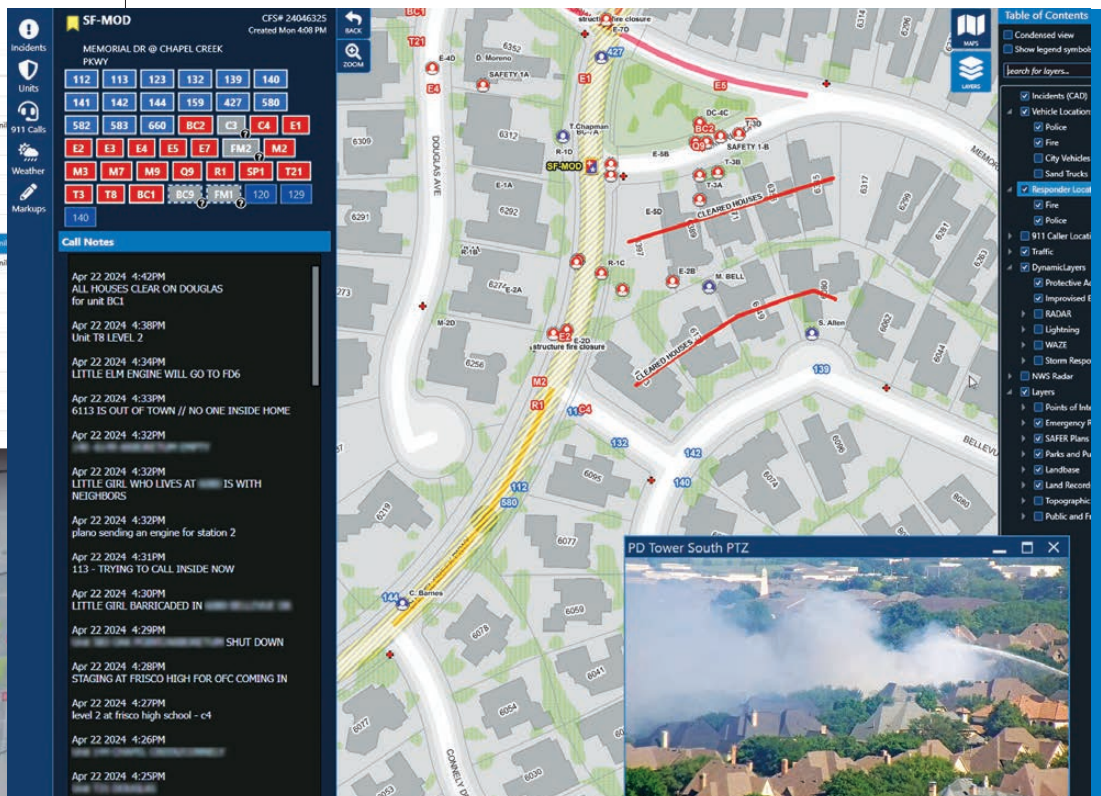
Another judge added, "I want the city I live in to do this, too!"

About the Author

Wendy Nelson is the executive director of URISA, a position she has held since 2005.
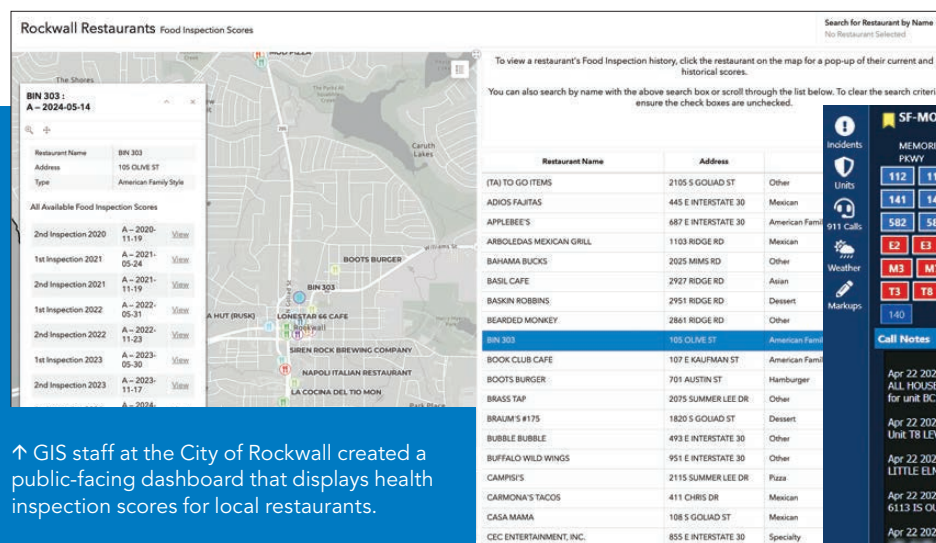

↑ GIS staff at the City of Rockwall created a public-facing dashboard that displays health inspection scores for local restaurants.

City of Frisco SAFER Program

← Emergency responders in Frisco, Texas, use the Situational Awareness for Emergency Response (SAFER) system to quickly plan emergency response operations.

↑ SAFER features aerial maps, floor plans, hazards, relevant contact information, and more.
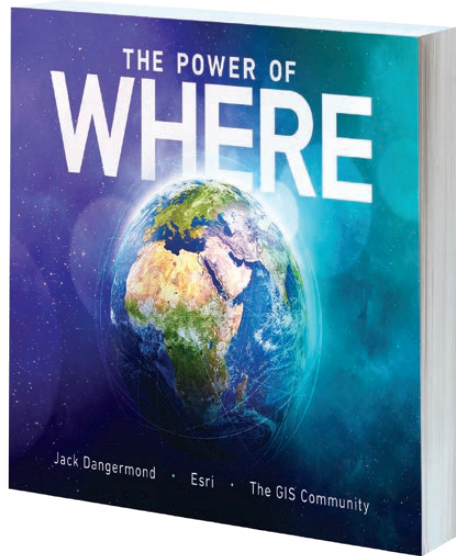
The Power of Where: A Geographic Approach to the World's Greatest Challenges
By Jack Dangermond

Discover the growing potential of modern GIS to address the most considerable problems of our time. With a foreword by James Fallows, bestselling author and writer for *The Atlantic*, *The Power of Where: A Geographic Approach to the World's Greatest Challenges* is filled with the latest web maps, illustrations, and real-life stories from GIS users that demonstrate how the geographic approach can be used to monitor wildlife migration, address rising sea levels, plan urban spaces, streamline food production, and more. Author and Esri president Jack Dangermond draws on his 60 years of research and experience in the industry to argue that GIS and the geographic approach are well-suited to tackle climate change, hunger, water scarcity, inequity, and other issues large and small. August 2024, 300 pp. Ebook ISBN: 9781589486072 and paperback ISBN: 9781589486065.

Mapping the Deep: Innovation, Exploration, and the Dive of a Lifetime
By Dawn J. Wright with Esri Press

Oceanographer and author Dawn J. Wright made history in 2022 when she became the first Black person to visit Challenger Deep, the deepest and least-explored place on Earth. With a foreword by oceanographer and former astronaut Kathryn Sullivan, *Mapping the Deep: Innovation, Exploration, and the Dive of a Lifetime* takes readers on an extraordinary adventure with an extraordinary woman to the depths of the Pacific Ocean. Focusing on Wright's historic dive, her personal journey, and the cutting-edge technology that made the expedition possible, the book highlights the importance of mapping the ocean as well as deep-sea exploration's profound impact on our planet's future. September 2024, 186 pp. Ebook ISBN: 9781589487895 and paperback ISBN: 9781589487888. Audiobook coming this fall.
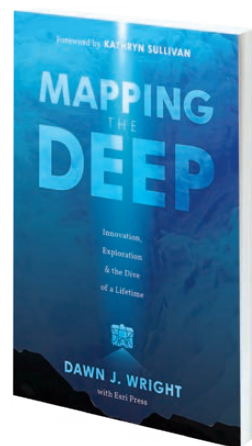
Advanced Python Scripting for ArcGIS Pro, Second Edition
By Paul A. Zandbergen

An easy-to-follow guide to writing specialized Python scripts, *Advanced Python Scripting for ArcGIS Pro*, Second Edition, is updated for ArcGIS Pro 3.2. Intended for users who have a good foundation in Python, the book explores how to turn scripts into tools, develop notebooks to share with others, employ third-party packages, and more. May/September 2024, 286 pp. Ebook ISBN: 9781589488045 and paperback ISBN: 9781589488038.
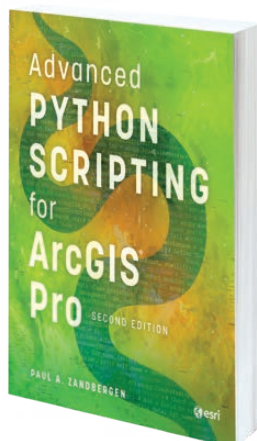
Python Scripting for ArcGIS Pro, Third Edition
By Paul A. Zandbergen

Python Scripting for ArcGIS Pro, Third Edition, teaches readers how to write Python scripts to automate tasks in ArcGIS Pro. The book begins with the fundamentals of Python programming and dives into how to write Python scripts that work with spatial data in ArcGIS Pro. With step-by-step instructions and practical examples, it reveals how to use geoprocessing tools; describe, create, and update data; and execute specialized tasks. May/September 2024, 414 pp. Ebook ISBN: 9781589488021 and paperback ISBN: 9781589488014.
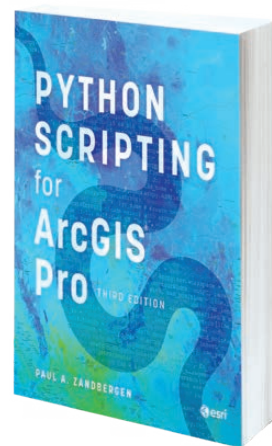
The Locators: Adventure in Oceania
By Kyle Bauer and Colleen Conner, illustrated by Wesley Jones

Lucy, Oliver, and Moe the Parrot are on another mission—this time in Oceania, where they use maps, technology, and spatial thinking to study the Great Barrier Reef, Papua New Guinea, and more. With a mission to offer help to those who need it, the trio finds and grows healthy coral in the Great Barrier Reef and rescues unique species facing a dangerous wildfire in New South Wales, Australia. While completing the illustrated activities in each chapter, readers get to scuba dive in the ocean, check out a wombat's burrow, and even follow a pod of whales! *The Locators: Adventure in Oceania* is perfect for children ages 8–11 who love geography and exploring the world. July 2024, 132 pp. Ebook ISBN: 9781589487574 and paperback ISBN: 9781589487567.

Mapping with Altitude: Designing 3D Maps
By Nathan C Shephard

Representing and reviewing data on maps in 3D lets viewers explore complex relationships in new ways. But creating digital 3D maps that are accurate, intuitive, engaging, and easily navigable can be daunting—even for experienced cartographers. In *Mapping with Altitude: Designing 3D Maps*, author and Esri senior product engineer Nathan C Shephard takes a fun and enthusiastic approach to exploring the concepts, challenges, and opportunities in 3D cartography while focusing on the practical decisions and techniques that mapmakers need to use as they boldly enter the world of 3D map authoring in ArcGIS. July 2024, 280 pp. Ebook ISBN: 9781589485549 and paperback ISBN: 9781589485532.
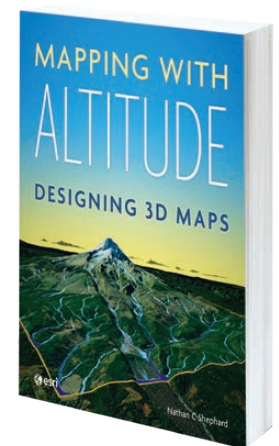
Designing Better Maps: A Guide for GIS Users, Third Edition
By Cynthia A. Brewer

For more than 18 years, *Designing Better Maps: A Guide for GIS Users* has been essential reading for all mapmakers who use GIS. The third edition—updated with new and revamped design practices—continues that legacy. With more than 400 illustrations, this book applies map design best practices to both reference and statistical mapping. Readers learn how to plan maps, use basemaps, employ scale and time, share maps, apply type and labels, understand and use color, and customize symbols. October 2024, 272 pp. Ebook ISBN: 9781589487833 and paperback ISBN: 9781589487826.
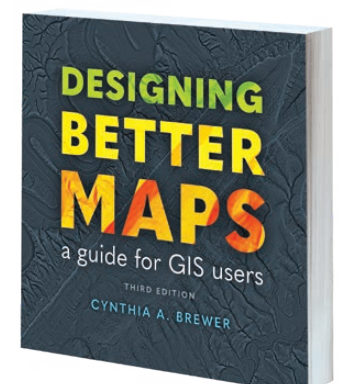
A Book That Explains GIS to People Who Don't Do GIS

By David Yarnold, Author of *The Geography of Hope: Real-Life Stories of Optimists Mapping a Better World*
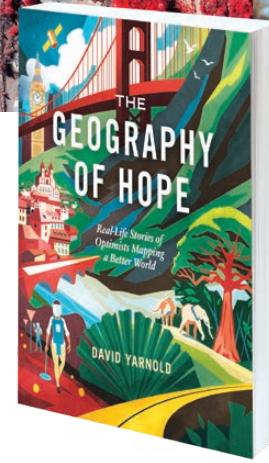
The Geography of Hope: Real-Life Stories of Optimists Mapping a Better World, 252 pages, is available. Ebook ISBN: 9781589487420 and paperback ISBN: 9781589487413. Go to **esri.com/ esripress** for purchasing options.

Get excerpts from the book, and more, by exploring the ArcGIS StoryMaps story at **links.esri.com/geography-hope**.

Editor's note: Former National Audubon Society CEO and award-winning writer and photographer David Yarnold traveled the world to meet people who are effecting change using what he calls "the most important technology you've probably never heard of." *The Geography of Hope: Real-Life Stories of Optimists Mapping a Better World* puts these human faces to GIS in a way that hasn't been done before, revealing the GIS that's all around us all the time.

"I wish my boss got GIS."

"I wish more people got how important GIS really is."

I've heard GIS professionals lament how obscure geospatial technology is since I attended my first Esri User Conference (Esri UC) in 2011. That's why I wrote *The Geography of Hope*. I wanted to write a book for you—one that you could give to the people around you who don't get what you do.

The Geography of Hope describes GIS technology tools but focuses primarily on the extraordinary things people do with it. Although GIS can be "complicated to explain" or, perhaps, "doesn't feel real to people"— thoughts I heard from attendees at the 2024 Esri UC—people around the world accomplish incredible feats with it, whether that's using AI to reshape a national intelligence program or employing maps to give voters their fair shake in local politics.

I hope this book makes you feel appreciated and understood for the work you do. It really does change the world.

VALUES
HIGH: 12
LOW: 0
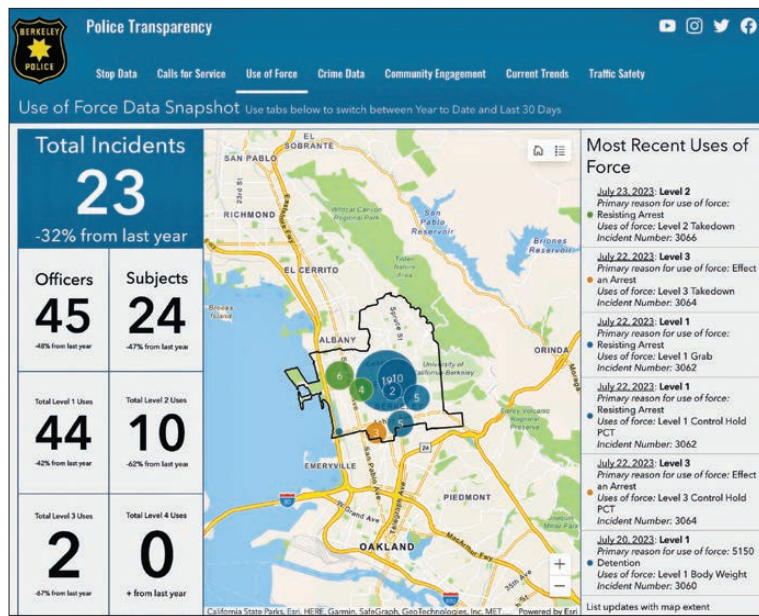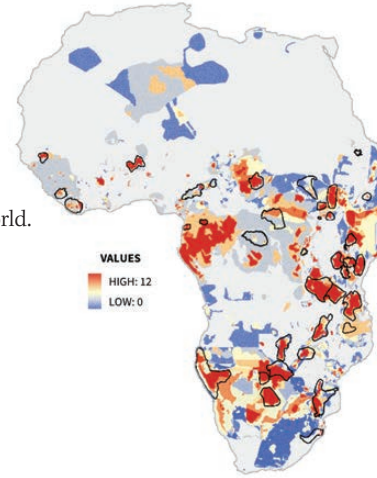
"My friends and family don't understand what GIS is or what I do."

← While police and fire departments have used GIS for decades, Berkeley, California's Police Transparency hub site reflects what may be the United States' most advanced, transparent accounting of what the police do, how they do it, and where it all happens.

↑ Africans have put the world on notice that they will do conservation for Africans, by Africans. They will find ways to protect forests, jungles, savannas, and coastlines while raising the standard of living through city building, agriculture, and efforts to ensure that economic rewards flow to all.

"I wish my students saw the potential impact they could have."

↑ Generations of warriors have dropped bombs, sabotaged farmers' fields, and secured their battle lines with cheap antipersonnel explosives in more than a third of the world's countries. Sophisticated GIS-based maps identify land mine hot spots and help eliminate costly false-positive locations.

New Training and Certification Offerings

Training

Make a Bigger Impact with GIS

Esri's instructor-led courses provide the most efficient way for GIS leaders to help their teams advance their skills and prepare for new technology initiatives. Developed and facilitated by subject matter experts, these courses teach essential concepts while emphasizing practical use. Flexible options are available to meet diverse workforce training needs. Classes are taught in person, online, and as private training events for groups. Optional instructor coaching days can be added onto private training experiences as well.

Esri offers a suite of courses for professionals in the defense and intelligence community who use GIS to anticipate threats and plan operations. Explore all these courses at go.esri.com/di-courses, and check out the following two new ones:

- **Introduction to Geospatial Concepts for Intelligence Using ArcGIS AllSource:** Participants learn foundational geospatial concepts that support the intelligence cycle and operations. Explore course details at go.esri.com/gcon-allsource.
- **Using ArcGIS AllSource for Geospatial Intelligence Analysis:** Attendees acquire skills to support the production of timely, accurate, and actionable intelligence and mission-specific products. Find out more at go.esri.com/uaga-allsource.

Advance Leadership and Change Capabilities

Influencing organizational change and getting teams to adopt new technology requires strong interpersonal communication skills. Esri offers one-day workshops—ideal for GIS project stakeholders, teams, and leaders—that equip participants with strategies to promote collaboration, organizational agility, and geospatial resilience.

- **Communicating and Collaborating for ArcGIS Success:** Participants gain insight into their core behavioral preferences and learn how to understand and work with others. See details at go.esri.com/communicate.
- **Building Organizational Agility and Enabling Change in a Geospatial World:** Attendees learn new ways to think, act, and react when implementing geospatial strategies. Find out more at go.esri.com/agility.
- **Creating Organizational and Geospatial Resiliency:** This workshop helps participants learn how to implement new geospatial capabilities effectively. Explore details at go.esri.com/resilient.

Thursdays Get Lively with Live Training

Live training seminars provide a great way for busy professionals to stay current on popular GIS topics, learn about new ArcGIS capabilities, and pick up expert tips. Hosted by Esri Academy, these no-cost, one-hour events include software demonstrations and question-and-answer segments. Polls and a chat feature add fun to the learning experience.

Each seminar is presented twice—always on a Thursday—at 9:00 a.m. and 11:00 a.m. Pacific time. For those who can't attend live, the recordings are available on demand via Esri Academy. To explore upcoming seminar topics and dates, visit esri.com/lts.

New Year, New MOOCs

Esri's free massive open online courses (MOOCs) offer a budget-friendly way to gain more experience with ArcGIS software while exploring interesting topics. These courses are hosted by experts and include videos, guided exercises, discussion forums, and a certificate for course completion. Esri provides all the ArcGIS software needed to participate. Explore the complete 2025 MOOC calendar at go.esri.com/moocs.

Registration is now open for the following popular courses:

- **Going Places with Spatial Analysis:** Offered January 29–March 12, this course teaches spatial analysis workflows using the latest ArcGIS Online tools. Sign up at go.esri.com/going-places-mooc.
- **GIS for Climate Action:** Taking place February 19–April 2, this MOOC helps participants discover the critical role that GIS plays in understanding climate-related risks and build skills to create more resilient communities, systems, and infrastructure. Sign up at go.esri.com/climatemooc.

Certification

The Esri Technical Certification program supports professionals, educators, and students who want to validate their GIS skills. The following new ArcGIS Pro certification exams are currently in development, with plans to release in January:

- ArcGIS Pro Associate 2025 is recommended for individuals with two or more years of experience applying ArcGIS to manage, analyze, and manipulate geospatial data. Explore exam details at go.esri.com/eapa2025.
- ArcGIS Pro Professional 2025 is for those who have at least four years of experience using a broad range of ArcGIS tools and functionality to apply advanced GIS concepts. Find out more at go.esri.com/eapp2025.

You can also help shape exam content by participating in certification blueprint surveys and beta exams. Learn more at go.esri.com/2025-exams.

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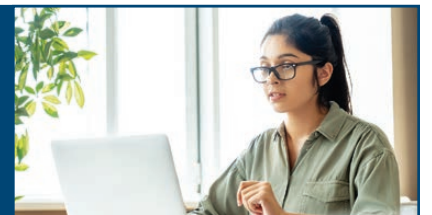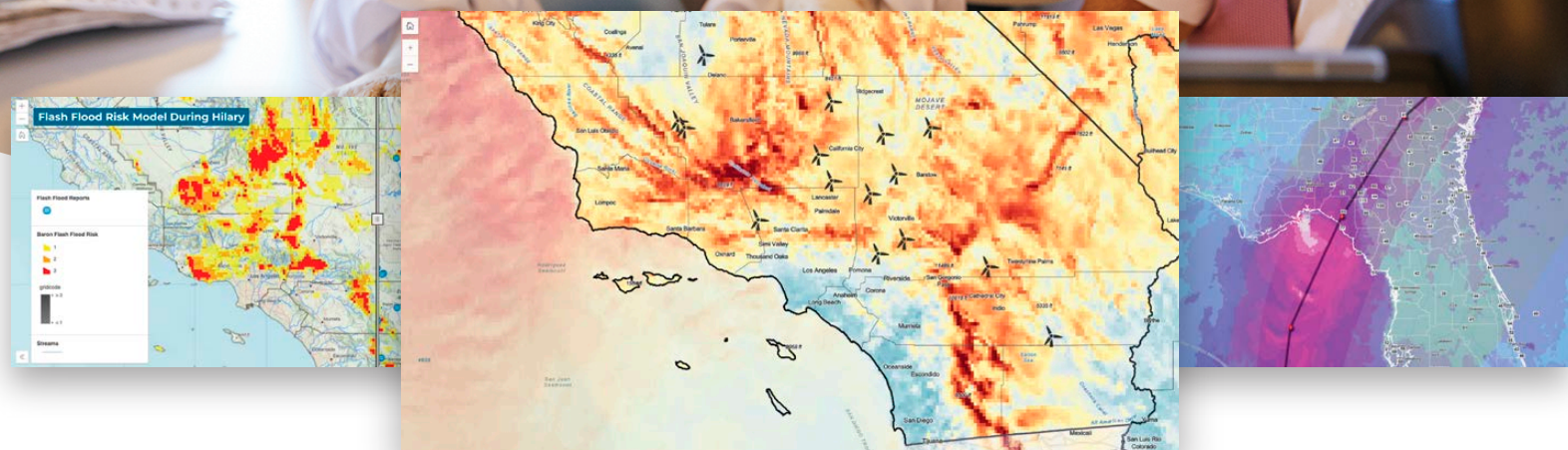
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