

Briefly Noted

ArcGIS StoryMaps Goes Mobile First

Users of ArcGIS StoryMaps can now author short-form, mobile-first stories using the new Frames format. Designed to make it easy to share visually compelling stories with on-the-go audiences across social media platforms, Frames stories begin with a cover slide and can include up to 20 additional slides that contain text, images, videos, maps, and embedded ArcGIS apps such as ArcGIS Dashboards and ArcGIS Survey123. Frames supports web maps, web scenes, and express maps created in the Frames builder. To learn more about this new format and see how Frames works, go to arcgis.com/frames.

Tune In to a New Season of the Podcast

The *Esri & The Science of Where* podcast is back with a new season. Hear how location technology—including geospatial AI and living digital twins—is being used to track massive bird migrations, analyze the blue economy, re-envision emergency planning, make streets safer for pedestrians and cyclists, and more. Go to esri.com/podcast to find new episodes, or download and subscribe to the podcast on your preferred platform.

Get Prepared for the Esri UC

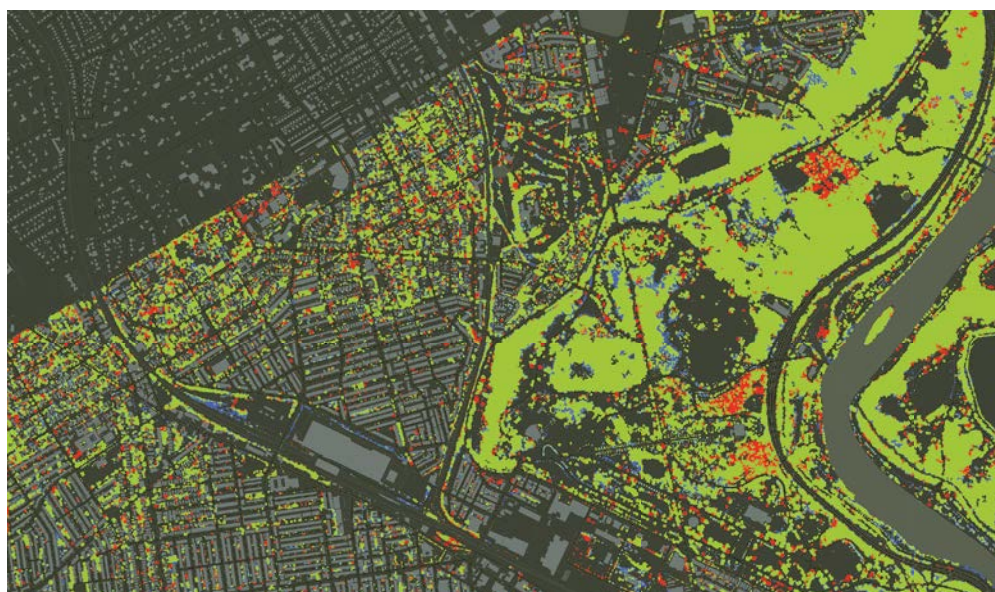
If you're heading to the Esri User Conference (Esri UC) in San Diego, California, July 13–17, 2026—or going to any pre-UC summits the weekend before—prepare early. Visit esri.com/uc to view the agenda, read the Esri UC Q&A, and download the event app. If you're attending for the first time, find out how to make the most of your experience at links.esri.com/first-uc.

AI Needs Geography—and You

By Jack Dangermond, Esri

The geospatial technology field is entering a pivotal moment—one that may prove as consequential as the arrival of digital mapping, satellite imagery, and web GIS. While AI is advancing at extraordinary speed,

its greatest impact will come from fusing it with the work GIS professionals do every day: modeling place, understanding relationships, and translating complex systems into actionable knowledge.



For decades, GIS has been the framework for understanding Earth's physical, ecological, social, and economic systems. Now, as AI is interlaced with geospatial workflows, GIS is being transformed from a system of record and analysis into a system of prediction, simulation, and real-time decision support.

This shift is not abstract. It is already reshaping how organizations manage risk, plan infrastructure, protect ecosystems, and respond to crises.

Geography Gives AI Context

AI can process information at unprecedented scale—but geography gives that information meaning. Spatial context is what turns raw data into understanding.

GIS professionals know this intuitively. They've experienced how location integrates disparate datasets

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← When AI incorporates GIS, it amplifies what GIS professionals can do, such as predicting how a city's tree canopy may change. (Data courtesy of Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community.)

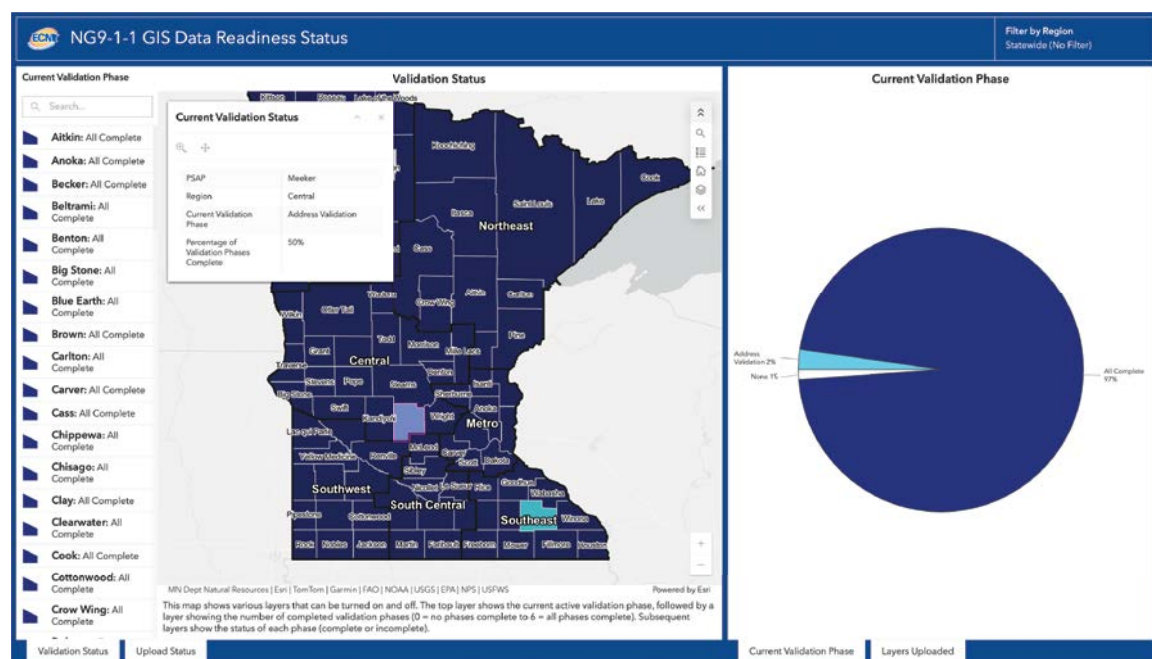
Standardized Addressing Takes Shape with Next Generation 911

An elderly man called 911 several times on behalf of his wife, whose medical condition could turn life-threatening quickly. Each time, the call took over a minute to connect.

The problem, eventually traced by 911 staff, was that the couple's address didn't exist in the system—no address point, not even a road centerline range encompassing their location. Just a gap in the map where their home should have been.

"That story has always stayed with me," said Brooks Shannon, Esri's director of emergency communications solutions. "He wasn't calling about something minor. Every one of those calls mattered. And every one of them was delayed by a data problem that nobody knew existed until someone went looking."

This is the highest-value problem that an accurate address solves. When 911 dispatchers receive a call, everything that follows depends on whether the location of the caller is real, current, and spatially correct.



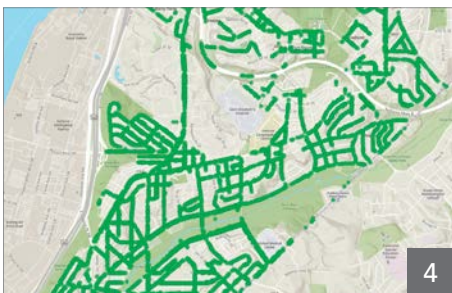
↑ Minnesota's NG911 GIS Hub is a collaborative platform for validating data and resolving address gaps together.

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Türkiye's push to build a digital twin of Istanbul—and, eventually, the entire nation—is redefining how property, risk, and urban growth are understood from the ground up.



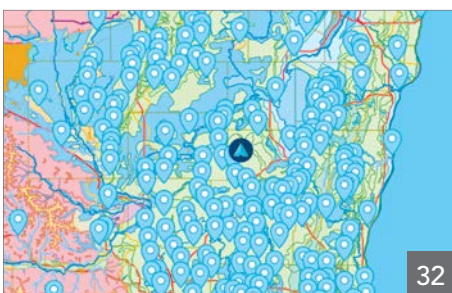
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ArcNews (ISSN 1064-6108) is published quarterly by Esri at 380 New York Street, Redlands, CA 92373-8100 USA. ArcNews is written for the Esri user community as well as others interested in mapping and geographic information system (GIS) technology.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

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AI Needs Geography—and You

into a coherent model. They've seen spatial data unearth interactions that weren't obvious in tabular data. They use maps daily to communicate complexity with clarity and immediacy.

When AI is applied to this geographic foundation, it amplifies what GIS already does well. It helps detect patterns across massive collections of imagery, automate feature extraction, model system behavior, and generate predictions that support more resilient planning.

Without geography, AI produces answers that may be technically correct but contextually wrong. With GIS, AI becomes grounded—aligned with the real world and the communities GIS professionals serve.

From Crisis Response to Resilience Planning

When the Kakhovka Dam in Ukraine collapsed in 2023, 1.4 million acres of farmland lost irrigation overnight, triggering a regional food crisis. The Food and Agriculture Organization of the United Nations

used GIS-based surveys, enhanced with AI, to map inundation, assess irrigation loss, and model downstream food insecurity.

GIS provided the spatial framework. Mapping made the crisis visible. And AI accelerated the analysis, reducing the time required from weeks to hours.

Across industries, GIS teams are integrating AI into spatial workflows to support long-term resilience planning. Retailers and communications providers are mapping their facilities against climate projections—for floods, extreme heat, and wildfire risk—to understand which assets face considerable exposure over the next 5–20 years. Utilities are using AI-enhanced imagery analysis to detect vegetation encroachment and prioritize maintenance. Cities are modeling heat islands, mobility patterns, and infrastructure vulnerabilities to guide equitable investment.

In each case, GIS provides the authoritative spatial model, and AI accelerates the work—automating classification, generating

predictions, and surfacing patterns that inform strategic decisions. This is the emerging pattern: geospatial professionals build systems in which AI augments—but doesn't replace—human judgment. The final decision remains human. AI can process and GIS can illuminate, but only people can decide what to do.

The Skills That Will Define the Next Decade

As AI becomes embedded in geospatial tools, the role of GIS professionals is expanding, not shrinking. The most valuable skills in the coming decade will combine technical fluency with geographic thinking: understanding the spatial structure of problems, designing data models that reflect real-world systems, evaluating AI outputs with scientific rigor, asking good questions to generate useful answers, and communicating insights clearly to decision-makers.

These are all skills that GIS professionals already practice. The growth of AI simply makes them more essential.

A More Intelligent, Responsible Future

The future worth pursuing is one in which AI's processing power and GIS's geographic understanding strengthen human judgment. In this future, geospatial professionals use these complementary tools to build more resilient communities, protect ecosystems, manage infrastructure responsibly, and support decisions that balance efficiency with equity.

This future is attainable. But it requires intention, collaboration, and a commitment to the values that have always guided our field: scientific integrity, clarity, and service to society.

GIS professionals are uniquely positioned to lead this next chapter. Together, we can create a more intelligent and more responsible world.

About the Author

Jack Dangermond is the president of Esri and is recognized as one of the most influential people in the field of GIS technology. Along with his wife, Laura, he founded Esri in 1969 based on the vision that geographic analysis and computer mapping could help design a better future.



↑ GIS professionals design data models that reflect the real world. This is becoming even more important as AI evolves. (Data courtesy of Esri, HERE, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community.)

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The Next Era of AI and ArcGIS

Since its founding in 1969, Esri has focused on empowering customers to use GIS to uncover hidden insights in complex data. ArcGIS has long provided users with a comprehensive platform for conducting spatial analysis, creating visualizations, and making sound decisions. Now, Esri is enhancing ArcGIS by infusing it with AI in a way that's secure, trustworthy, and designed to deliver real value.

Over the past few years, Esri has made strong progress across two core areas of geospatial AI. First, there are AI tools and models that have advanced the science of GIS by automating information extraction, classification, and understanding. Second, there are AI assistants

that have been progressively introduced to modernize everyday GIS work—helping users navigate tools, write code, and move forward with confidence while remaining in control of their workflows.

Esri is now building on this with agentic AI, which lets external agents connect to ArcGIS tools and enables users to build geospatial agents that automate GIS workflows and power apps. These capabilities will extend the reach and impact of GIS beyond traditional users while remaining grounded in geography, transparency, and user control.

But before looking at what's on the horizon, it's helpful to understand how we got here.

AI Tools and Models Advance the Science of GIS

AI tools and models have allowed many organizations to scale up their GIS and save time by automating the extraction, classification, and detection of information from imagery, text, video, point clouds, and more. A small local government team, for example, can use AI to detect, in imagery, where summer tourists go so it can better plan transit to those places. These tools and models enable advanced spatial analysis through pattern recognition, prediction, and forecasting.

Esri's pretrained models have helped many organizations get up and running with AI quickly, since large volumes of training data and

computing resources aren't required. Additionally, for organization-specific workflows—such as detecting invasive species that damage native vegetation—Esri provides tools so users can train their own models when appropriate.

Geospatial foundation models are new to Esri's collection of pretrained AI models. They learn broad patterns from large-scale, multimodal Earth observation data to perform pixel classification, land classification, and object detection. They require minimal training and are adaptable to many workflows, such as inspections or environmental monitoring.

Esri is now developing foundation model capabilities to accelerate analysis across ArcGIS. Two models focus on imagery. One is a remote sensing foundation model that's trained on trusted sources such as Landsat, Sentinel, and the National Agriculture Imagery Program (NAIP), and the other is a vision language model that combines imagery with natural language to support map-based queries and analysis. A third model generates location embeddings from tabular and demographic data—enabling a company, for instance, to pinpoint ideal store locations based on key socioeconomic profiles. Together, these models extend ArcGIS analysis capabilities, helping organizations quickly turn multimodal data into actionable insights.

AI Assistants Accelerate Workflows

In recent years, Esri has progressively introduced AI assistants across ArcGIS. While a few of these assistants are generally available, many are still



← AI tools and models can detect objects, such as cars in parking lots.



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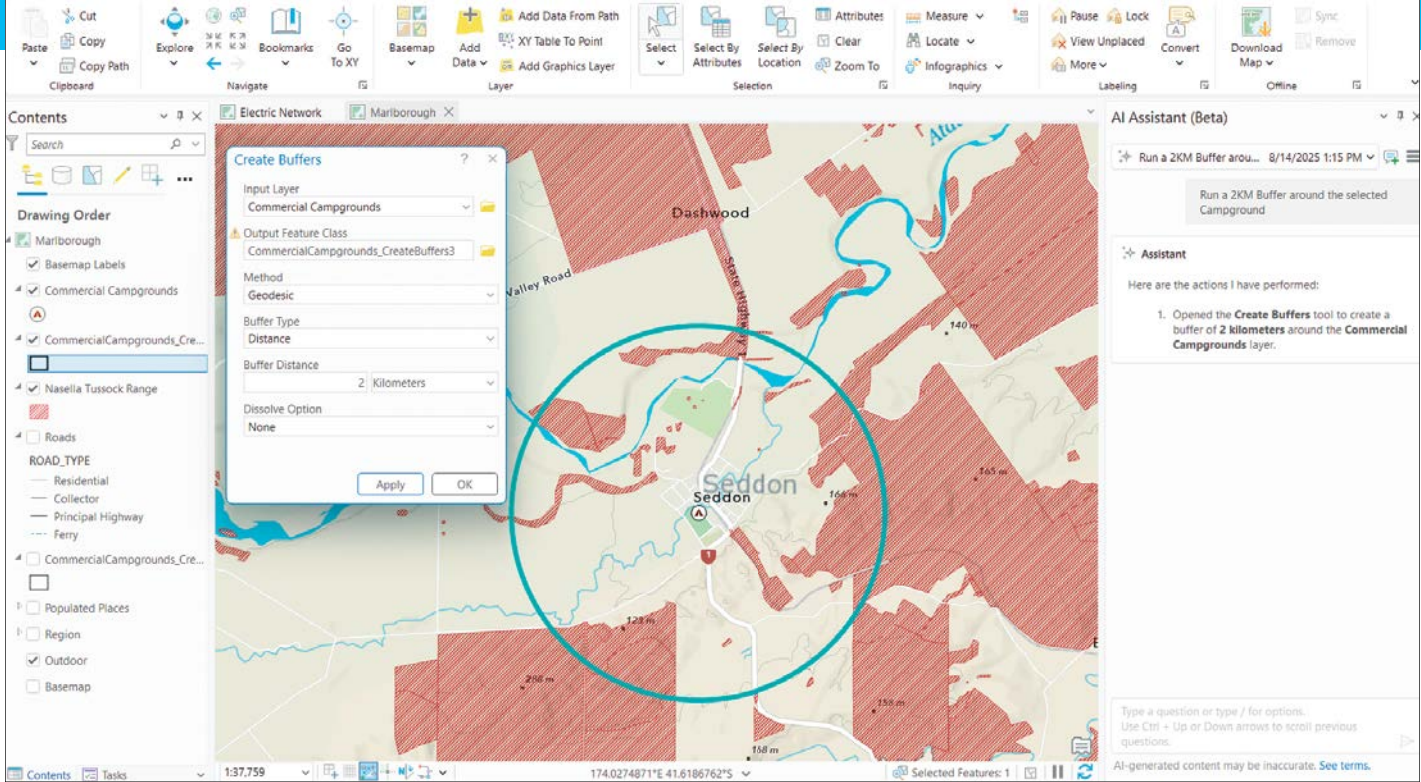


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← The ArcGIS Pro assistant can help users trigger common actions, such as drawing buffers.

in beta or preview. But they already represent a meaningful shift in how people interact with GIS. Now is a valuable time for organizations to enable assistants, try them out, and share feedback with Esri so these experiences can continue to evolve with user needs.

AI assistants in ArcGIS are designed to support users directly within the ArcGIS apps they already use. Users are in full control as assistants provide contextual, natural-language guidance on what tool to use next, how to write code, or how to approach specific workflows. For example, a user working in ArcGIS Pro can ask the assistant which tool to use to create a buffer or get help generating Arcade expressions to perform on-the-fly calculations.

Beyond productivity, AI assistants play an important role in onboarding and skills development. Rather than replacing learning, assistants reinforce it by providing relevant, in-the-moment answers to questions. They help new users progress with their work while gradually building familiarity with GIS concepts, tools, and best practices.

For the latest information on AI assistants in ArcGIS, go to link.esri.com/ai-assistants.

Agentic AI Expands the Impact of GIS

Agentic AI is Esri's next step in making geospatial intelligence accessible across organizations. Esri's approach to agentic AI is headed in two complementary directions: bringing GIS into broader agentic ecosystems and introducing agentic capabilities directly in ArcGIS.

Geoenabling: Putting GIS in Agentic Ecosystems

Across the tech industry, organizations are developing agentic platforms with software that uses large language models (LLMs) to reason, take action, and work toward defined goals. However, these agents are only as effective as the data and tools they can access. Without authoritative geographic context, their spatial understanding is incomplete.

Esri is geoenabling these agentic ecosystems by making authoritative GIS capabilities accessible to external agents. Through support for the Model Context Protocol (MCP), third-party AI agents connect to spatial data and tools in ArcGIS,

allowing them to incorporate geospatial intelligence into their reasoning and outputs.

For instance, an agent configured in a business platform may be asked to analyze pedestrian patterns in a city. Without access to ArcGIS, that agent lacks the spatial data and tools needed to address this query. MCP provides a standardized way for that agent to call ArcGIS capabilities and return spatially grounded results.

By making GIS AI-ready through MCP, Esri expands the reach of geospatial intelligence beyond traditional GIS users, incorporating location awareness into the tools and workflows people already use. Esri is working toward supporting MCP across ArcGIS Enterprise, ArcGIS Online, and ArcGIS Location Platform.

Geocentric: Building Agentic AI in GIS Workflows

In parallel, Esri is introducing agentic capabilities in ArcGIS by building geospatial agents that can interpret and work with maps, layers, and other authoritative, structured spatial data. This geospatial intelligence differentiates geospatial agents from generic ones, which often generate outputs that are disconnected from real-world geographic context.

Geospatial agents operate behind the scenes to strengthen assistant experiences. They also power agentic mapping apps, which allow users to ask questions in plain language and receive results that correspond to the user's intent, the map, and the data. For example, an employee at a public sector organization could use an agentic mapping app to ask, "How many counties produced less wheat in 2022 than in 2017?" The agent interprets the question, runs the appropriate spatial analysis tools, and returns results without the user needing to know how to run the analysis.

To show this vision in action, Esri is introducing AI components in ArcGIS Maps SDK for JavaScript. These components, which are currently in beta and available to try, include out-of-the-box geospatial agents for common map interactions, as well as the ability for developers to create custom agents tailored to their workflows.

Esri is also delivering the Data Explorer template for ArcGIS Instant Apps. Data Explorer, in beta, enables organizations to configure web maps that are powered by Esri-built geospatial

agents. Maps configured with the template let users ask questions to a chatbot that searches, describes, and visualizes data on the map.

Across these experiences, agents operate on authoritative GIS content, follow defined rules, and remain under user oversight.

Designed for People, Built on Trust

As AI agents experience widespread adoption across the tech industry, Esri's development of this new technology remains grounded in user

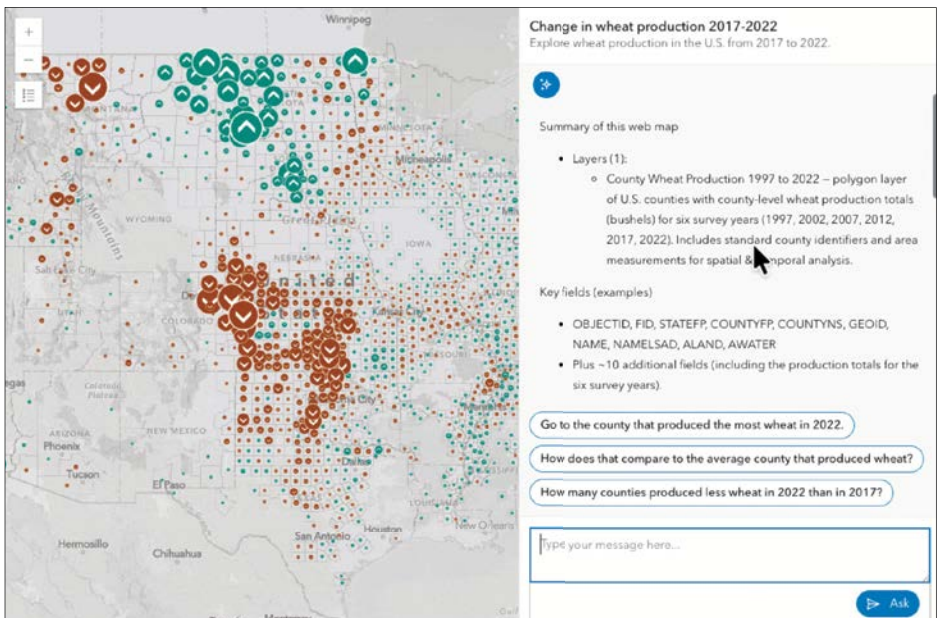
feedback. Staff have been listening closely to customers and recognize both the excitement and concern that accompany conversations about AI.

Agents and agentic workflows certainly introduce greater capabilities and automation to GIS, but AI in ArcGIS remains a tool. From the start, Esri has focused on creating products that support and empower people—and AI agents are no different. They are designed to enhance how users work with geographic data, not wrest control away from them.

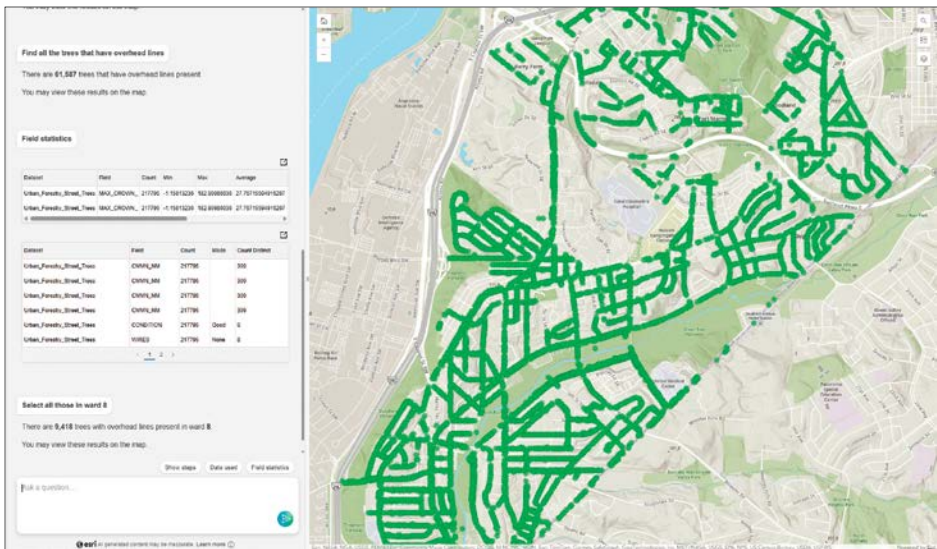
Even as AI takes a more central role in technology, true autonomy and decision-making remain the user's responsibility. By keeping people at the center of technological development, Esri delivers AI capabilities in ArcGIS that are powerful, responsibly developed, and trustworthy. For more information, go to trust.arcgis.com.

Looking Ahead

Geospatial AI is expanding beyond standalone tools and models toward intelligent agents that understand context. And Esri's mission remains the same: advancing spatial science and supporting the vital work of the GIS community. That includes helping users employ AI to improve collaboration and amplify the impact of GIS.



↑ Users can employ out-of-the-box geospatial agents or create custom ones with ArcGIS Maps SDK for JavaScript.



↑ Agentic mapping apps enable natural-language map exploration.

Esri Developer & Technology Summit Maps the Future of ArcGIS

Every year at the Esri Developer & Technology Summit, thousands of GIS developers, administrators, and engineers gather in Palm Springs, California, to attend technical demonstrations, convene with other GIS professionals, and learn what's fresh and upcoming in the world of ArcGIS. Every year, Esri developers and subject matter experts are on hand to offer technical support and guided learning. And every year, conference presenters and attendees encounter technological shifts that are more tectonic than the year before.

The 21st Esri Developer & Technology Summit was held March 10–13, 2026, and whether attending in person or watching videos of the Plenary Sessions, it was clear what was on everyone's mind: enterprise GIS, low-code and no-code app building solutions, developer tools, and geospatial AI.

Nearly 4,000 attendees came together for this year's summit, both in person and online. It isn't difficult to imagine that all of them came away with a clearer understanding of how GIS is growing and changing, incorporating new enterprise workflows and AI models to streamline and enhance the work of GIS professionals.

"The purpose of this meeting is all about you," said Esri founder and president Jack Dangermond to kick off the Plenary Sessions. "It's you and your work, and growing and learning together."

Integration and Configuration

Integration was one of the hottest topics at the two Plenary Sessions. So it was no surprise that Dr. Sud Menon, Esri's corporate director of software

product development, stressed the holistic nature of ArcGIS. It is an enterprise platform that does a lot more than just mapping—it connects data and people, operations and analytics. And web GIS and its architects are at the heart of the endeavor.

"A modern GIS is a web GIS," said Menon. "It allows you to integrate all your sources and make them available anywhere and everywhere that you need them to be."

Recent enhancements to ArcGIS—as well as presentations throughout the Plenary Sessions—demonstrate this kind of web-based systems thinking, with an emphasis on enterprise GIS and low-code/no-code app building solutions.

The new unified metadata editor and redesigned ModelBuilder extension in ArcGIS Pro, for instance, are all about streamlining the user experience. ArcGIS Enterprise, which allows organizations to run web GIS on infrastructure they control, features updates including new cloud storage options and the addition of ArcGIS Data Pipelines, a no-code data integration capability that is now available in ArcGIS Enterprise.



↑ Dr. Sud Menon described ArcGIS as an enterprise platform that connects data and people, and emphasized the power of web GIS.

Jeremy Bartley, Esri's chief technology officer for web mapping and geospatial web app technology, used a web map created with New York City's 311 service request data as an example of how hosted feature layers operate within ArcGIS Online. It was an opportunity to display the most up-to-date versions of data visualization capabilities such as pop-ups and charts, and to demonstrate how feature layers can be shared through low-code/no-code software like ArcGIS Dashboards and ArcGIS Instant Apps.

Presentations from the City of Raleigh and Langan Engineering highlighted the idea that integration and configuration are at the core of modern GIS. In Raleigh, configurable apps, digital twins, and AI-assisted traffic analysis are used in tandem to support municipal operations and growth. The combination of custom apps, created with tools like ArcGIS Maps SDK for JavaScript, that operate within an enterprise GIS and configurable solutions with a low barrier of entry exemplifies the kind of integrated thinking that is becoming more necessary as GIS evolves and expands.

As these integrations become more customized and elaborate, developers can also extend ArcGIS to accommodate their organizations' needs. This includes the use of ArcGIS Enterprise service interceptors that allow developers to inspect and modify REST-based service requests, as explained by Esri product engineer Pankaj Chaudhari. Service interceptors let organizations synchronize other software ecosystems, such as Salesforce, with ArcGIS. ArcGIS can also be extended through scalable, cloud-based environments like ArcGIS Enterprise on Kubernetes, which increase performance and reduce downtime for crucial apps.



↑ The City of Raleigh demonstrated enterprise thinking through a combination of custom apps and configurable solutions.

← Attendees encountered updates to enterprise GIS, low-code/no-code app building solutions, and geospatial AI.

Low-Code, No-Code . . . More Code

Low-code and no-code solutions have become central to the business of GIS, whether for enterprise workflows, public engagement, or field operations. These tools can expand the reach of ArcGIS and shorten the path from data to outcome.

"Tools like [ArcGIS] Experience Builder and Instant Apps have allowed us to put app creation in the hands of non-developers," said Justin Greco, geospatial developer for the City of Raleigh. "And demand for web apps has never been greater."

Dave Nyenhuis, an Esri senior product engineer, highlighted updates to ArcGIS Dashboards, including improvements to the theme panel and date selector, as well as a new data sources panel that simplifies the process of updating or repairing a dashboard. Instant Apps has also received some major enhancements. Esri product engineer Beth Romero detailed a



↑ Beth Romero's presentation on ArcGIS Instant Apps featured a new beta AI image extraction capability in the reporter template and a new web editor template.

workflow involving the Reporter and Manager templates, showcasing the AI-powered image extraction capability in beta within the Reporter template. This workflow also includes a new Web Editor template, which is designed for precise edits.



↑ Wei Ying demonstrated the power of the new AI assistant for ArcGIS Arcade.



↕ Esri developers offered technical support and guided learning throughout the conference.



Within Experience Builder, updates such as a new login widget and dynamic Arcade expressions provide greater flexibility within a low-code solution. Esri software product engineer Wei Ying demonstrated the power of the new Arcade assistant, which can automatically generate Arcade expressions. Esri developer team lead Gavin Rehkemper showed off some of the capabilities of Experience Builder developer edition, including the ability to create custom widgets using map components within ArcGIS Maps SDK for JavaScript.

JavaScript Maps SDK has also seen many recent improvements over the previous year, according to Bjorn Svensson, group project engineer lead at Esri. For apps that require a greater degree of customizability than low-code/no-code tools provide, developer tools like JavaScript Maps SDK or ArcGIS Maps SDKs for Native Apps are the solution.

“There’s so much that’s been released in the last year,” said Svensson. “Batch editing for maximum productivity, track rendering to visualize real-time data, 3D flow render, 3D basemaps,



↑ ArcGIS Maps SDK for JavaScript has undergone a slew of important enhancements over the previous year, said Bjorn Svensson.

calendar heat charts. With just a few lines of code, using the SDK’s components, you can build compelling and amazing experiences and make your data come alive with dynamic visualizations and client-side analysis.”

Strong support for web components, Esri’s Calcite Design System, and open-source libraries signals that the ArcGIS environment is becoming more component-based, and thus increasingly flexible for developers.

A Geospatial Platform Enhanced with AI

AI has, in many ways, been part of ArcGIS for a long time. But with the rise of generative AI tools, the way AI is incorporated into the platform is changing. The central thrust of this year’s Esri Developer & Technology Summit was this: AI is no longer a technology on the horizon. It now plays a central role in enhancing the ArcGIS ecosystem.

“Our vision in this space is a transformational one,” said Esri chief technology officer Jay Theodore. “Everything that we build is well-architected and well-integrated, because that’s fundamental to how AI gets infused in our GIS workflows.”

Theodore and other presenters at the Esri Developer & Technology Summit explained AI within ArcGIS as falling into three categories: AI tools and models, AI assistants, and agentic AI. Each has the potential to transform how GIS professionals interact with geospatial data.

AI tools and models comprise powerful spatial and predictive analytics capabilities embedded within the software. Rohit Singh, director of Esri’s R&D Center in New Delhi, India, demonstrated new imagery and remote sensing models that can perform accurate damage assessments, road condition classification, and other analyses using multiple kinds of imagery. There are now more than 100 pretrained AI models available in ArcGIS Living Atlas of the World.

ArcGIS also provides tools to create and customize AI models. The Process Text Using AI Model tool within ArcGIS Pro, for instance, can extract data from unstructured text and turn it into spatial layers.

AI assistants, which enhance many of the tools and capabilities within ArcGIS, operate through natural language interactions. These assistants have a major role to play in the future of ArcGIS, a fact that was not lost on attendees. Besides the Plenary Sessions and the Keynote, a technical session on the fundamentals of AI assistants was by far the conference’s most popular offering.

ArcGIS Pro now includes an in-app assistant that uses natural language to help users explore documentation and create expressions and queries. ArcGIS Pro SDK can extend this assistant for custom workflows. ArcGIS Notebooks includes an AI assistant as well. It can explain code, troubleshoot errors, generate Python scripts, and help analysts work more quickly with notebook-based GIS workflows.

Agentic AI in ArcGIS enables systems to carry out tasks using geospatial data and tools, helping automate workflows and bring geospatial intelligence into broader agentic processes. With AI components in ArcGIS Maps SDKs, developers can build agentic mapping apps powered by either custom or out-of-the-box geospatial agents.

“This combination of AI with GIS is very powerful,” said Singh. “Not only can you use it to let AI take care of the drudgery of feature extraction, but [you can] also use it to solve some of the most complex challenges facing the planet.”



↑ The combination of AI and GIS can be used to solve some of the most complex challenges facing the planet, said Rohit Singh.

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Standardized Addressing Takes Shape with Next Generation 911

The dispatcher, the route, and the first responder who drives fast down unfamiliar streets are all downstream of a single data point. Get the address wrong, and the system fails.

And while getting to the right building is one problem, getting to the right door and room is another. The correct address must exist on the map to make all this possible. Yet only now are the adequate tools, standards, and national frameworks converging to tackle this issue.

What makes accurate addressing a stubborn problem to solve is that the United States maintains not one addressing system but many. Each city and county has its own standards, update cycles, and tolerances for error. Actively-used data gets scrutinized, corrected, and kept alive. But data that is consulted by no one outside a single department can harbor gaps for years without anyone knowing.

The address of the man who was trying to get help for his wife had almost certainly been missing from the system for a long time. It took a life-threatening pattern of failed calls to reveal the problem.

Mapping the Path to an Answer

Across the country, local GIS professionals close those gaps. In the United States, addresses are assigned and maintained at the local level—by counties, municipalities, and 911 authorities—then shared with public safety answering points (PSAPs) that dispatch first responders.

When that chain works, a call becomes a coordinate, a coordinate becomes a route, and a route expedites help. When it breaks anywhere, the consequences are immediate and human.

Next Generation 911 (NG911) is the nationwide transition from analog, landline-era systems that have routed emergency calls for decades to fully digital, Internet Protocol (IP) networks. These networks can handle calls from mobile devices, accept texts and video, and use live GIS data to route calls geospatially rather than by address ranges in a table.

The transition to NG911 has forced many states to confront how fragile that chain can be. Moving from a decades-old tabular address guide to fully geospatial call routing means that

every county's road centerlines, address points, and jurisdictional boundaries must be accurate and synchronized with neighboring counties' data. In fast-growing areas, the challenge compounds as new structures go up faster than the map can keep pace, leaving a window where a call from a new home can fail in the same way a call from a missing address does.

The work is painstaking. Rural addressing schemes can be decades out of date, there may be dual-address legacies from past county consolidations, and neighboring jurisdictions can have boundary conflicts. All this must be negotiated one line at a time.

Illinois's statewide effort, led by the Illinois State Police across 102 counties, is among the most documented examples of what that work looks like at scale. Minnesota and Montana have taken a parallel path: investing years in address data cleanup and GIS preparation before NG911 procurement was even underway. Minnesota's NG911 GIS Hub (links.esri.com/MN-NG911) and Montana's corresponding hub (links.esri.com/MT-NG911) reflect that investment. They are collaborative platforms where county contributors, state coordinators, and public safety partners can track readiness, validate data, and resolve gaps together.

States like these have learned that modern GIS tools can streamline the hardest parts of the process. Shared data hubs walk contributors through each step of the address update process. Dashboards make it easier to surface gaps across the state. Collaborative workflows let neighboring jurisdictions see and resolve conflicts without waiting for a scheduled meeting.

The technology is ready. In most states, the limiting factor is sustained investment in modernization.

From the Street to the Room

The work of getting responders to the right address has always been hard. Getting them to the right room is the next frontier. Once inside a large structure, responders receive no guidance from the address given on the call about which hallway to take, which floor to go to, or which room to enter.

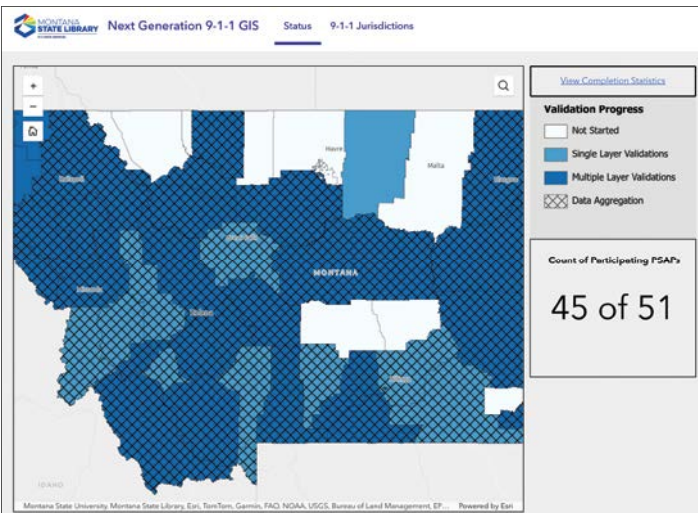
Some jurisdictions are going further, asserting the authority to issue official subaddresses for large buildings—unit numbers

assigned by the jurisdiction rather than the building owner, sequenced so any responder entering knows intuitively which way to go. The goal is to make navigating inside a building as reliable as navigating to it.

Illinois is piloting this at the school level with a statewide indoor mapping initiative. The maps connect to computer-aided dispatch, giving telecommunicators a live floor plan that guides responders directly to the room where help is needed.

When a student began choking at an elementary school, the caller gave a room number, and the map showed it on the far side of the building near a driveway. The responding ambulance and fire truck drove there, entered a back door, walked a few feet, and reached the child. Later, they estimated that the indoor map saved them five minutes.

In Frisco, Texas—one of the fastest-growing cities in America—that same logic has extended citywide. Police, fire, and transportation departments share a single live map—indoor floor plans, personnel locations, traffic cameras, and school camera feeds—so any agency responding to an incident arrives with the same



↑ Montana has spent years cleaning up address data, and that's helping with the transition to Next Generation 911 (NG911).



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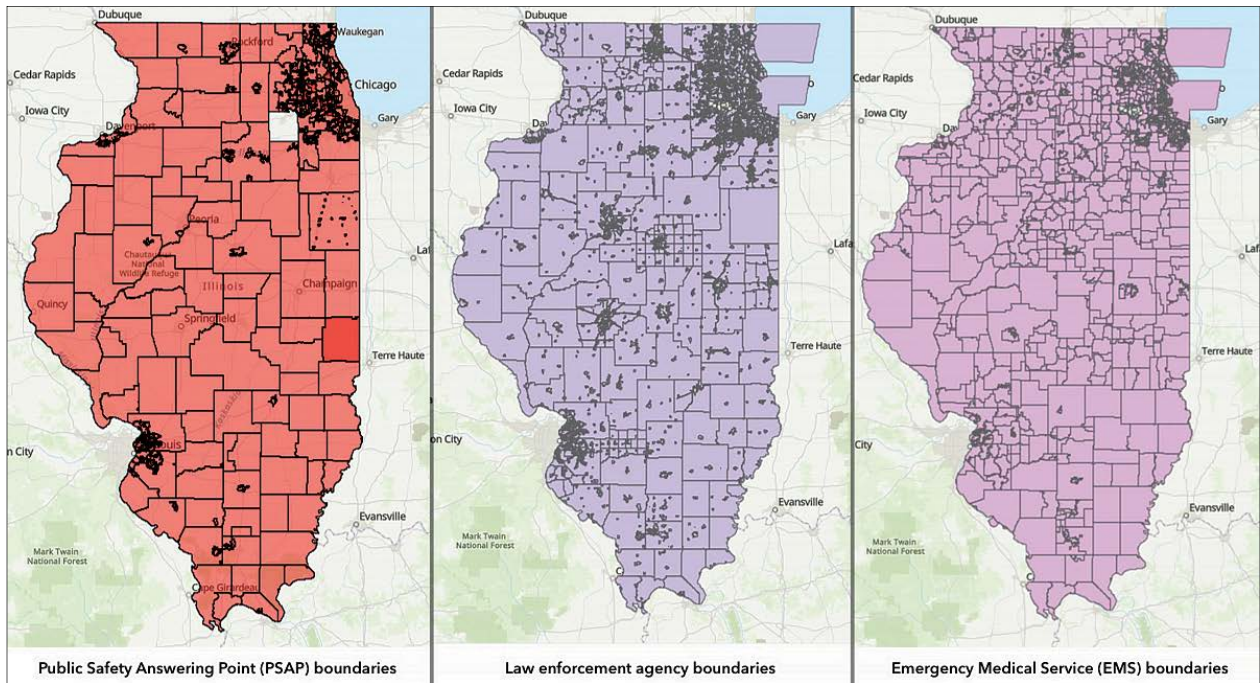
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↑ Indoor school maps integrate with aerial imagery and real-time emergency vehicle locations, giving dispatchers a complete operational picture that reflects reality.



↑ Cleaning and updating address data involves resolving jurisdictional boundary conflicts.

picture. The integration of this information gives dispatchers and first responders seamless access to building features, contact information, and additional details such as chemical inventories directly within the city’s Situational Awareness For Emergency Response (SAFER) platform, which provides a unified operational view for public safety.

“With access to floor plans, SAFER allows Frisco agencies to coordinate resource support for emergencies in real time,” said Jon Bodie, director of emergency management for the Frisco Independent School District.

The address is the key that unlocks all of it.

The Case for Sharing What’s Already Been Built

The address data built and maintained for 911 is precisely what transportation planners, public health agencies, broadband administrators, and federal programs also need. Data kept current through the discipline of emergency response is good data for everyone.

The NG9-1-1 GIS Data Model standard from the National Emergency Number Association gives that work a common structure, making address data built for emergency response consistent and interoperable across agencies and state lines. The National Address Database (NAD), stewarded by the US

Department of Transportation, is designed to carry it to the national scale. As of mid-2025, 36 states were contributing roughly 90 million records—about two-thirds of all US addresses. Completing that coverage, grounded in 911-validated data, is what makes it useful for every program that depends on knowing the location of every address.

That completion is the explicit goal of NAD 2.0, an initiative convened through the National Geospatial Collaborative (NGC) by a coalition of GIS leaders, 911 stakeholders, federal agencies, and national associations. Their plan calls for 100 percent of the nation to be covered, all records to be 911-validated, and a data model that’s flexible enough to make it sustainable for jurisdictions to continue contributing.

Jill Saligoe-Simmel, Esri’s spatial data infrastructure lead and a newly appointed board member of the NGC, sees the convergence of NG911 modernization and NAD 2.0 as a seminal moment.

“A 911-validated address is the highest-quality address there is. It has to be right because lives depend on it,” she said. “Filling in the national map with that standard of data is how we make sure it’s fit for every purpose that follows.”

The framework is there, the standards exist, and the communities of practice are more closely aligned than they have ever been.

CHECKLIST:

Address Data That Works When It Matters

Good address data starts with good habits. Local authorities assign and maintain addresses close to the source, which gives them accuracy no outside entity can replicate.

But that local precision depends on consistency: the same standards, applied in the same way, every time, by everyone touching the record. When data moves up the chain, from county to state to national database, inconsistencies that seemed minor in isolation become compounding errors at scale. Incomplete or inaccurate address data causes 911 calls to be misrouted, slows response times, and leaves gaps in national datasets that governments, nonprofits, companies, and others depend on.

The good news is that standards, best practices, and tools built specifically for this work have matured considerably, giving practitioners a clearer path from local record to authoritative national asset.

- ❑ **Conform to the National Emergency Number Association (NENA) NG9-1-1 GIS Data Model.** NENA’s standard (links.esri.com/NENA-NG911) defines the required fields, formats, and spatial relationships for road centerlines and address points. Conforming from the start means data is interoperable by default.
- ❑ **Audit what you have.** Get a clear picture of gaps before contributing data or doing geospatial routing. ArcGIS Data Reviewer automates this process, surfacing errors that manual reviews would miss.
- ❑ **Establish a recurring update schedule.** Many 911 authorities already provision GIS data updates to their NG911 system on a daily, weekly, or monthly basis. Build NAD submission into that same cadence as an added step. The workflow is already there, and the more frequently data moves, the more useful it becomes to everyone downstream.
- ❑ **Fix iteratively, not all at once.** Address data cleanup is ongoing work. Build correction into routine workflows and revalidate on a schedule.
- ❑ **Share early and often.** A submitted record that needs to be refined is more useful than one that is withheld. The act of sharing exposes gaps faster than internal review alone. ArcGIS Hub provides the collaboration workflows and visibility tools needed to coordinate open data sharing across jurisdictions.
- ❑ **Extend addressing inside the building.** ArcGIS Indoors connects floor plans to computer-aided dispatch so telecommunicators can guide responders to a specific room, not just a structure.
- ❑ **Let AI do more of the heavy lifting.** AI assistants and agents within ArcGIS can flag anomalies, suggest corrections, and identify structures in imagery that lack a corresponding address point.

Navigating the Imagery Landscape

In GIS, imagery and video are foundational data sources that reveal spatial patterns and contextual relationships. They can transform maps into multidimensional tools for exploration and analysis.

Understanding the diverse range of available imagery is crucial for unlocking its full potential in GIS applications.

↓ The City of Miami captured high-resolution (8-centimeter) aerial imagery of Hard Rock Stadium. This level of detail allows viewers to distinguish buildings, vehicles, trees, tents, and even umbrellas.

The Difference Between Imagery Types and Capture Methods

To effectively select and use imagery for GIS projects, it's helpful to understand the differences between imagery types and how they're captured.

Imagery can be categorized based on its characteristics and the technology used to capture it. The type of imagery refers to its inherent properties, such as resolution or spectral characteristics, while the capture method refers to the platform or vehicle used to obtain it. These platforms carry various payloads, or sensors, that capture imagery via remote sensing—the process of collecting geospatial data without direct physical contact.

Types of Imagery

With a vast array of imagery options, two key questions emerge: What's available, and what's the right fit for your project? Here are the main options.

Panchromatic imagery is captured using sensors on satellites, aircraft, and unpiloted aerial vehicles, or drones. This type of imagery is characterized by its resolution, which is influenced by the camera's capabilities and the altitude at which images are taken. For example, high-resolution images can reveal small

details, such as individual bricks or tree branches, while lower-resolution images may only show larger features like road networks or forest boundaries. The level of detail is described by ground sample distance (GSD), with smaller GSD indicating finer detail.

Spectral imagery captures detailed information about how objects on Earth's surface reflect and absorb different wavelengths of light. This is why it's called "spectral"—it analyzes the spectrum of light reflected from these objects.

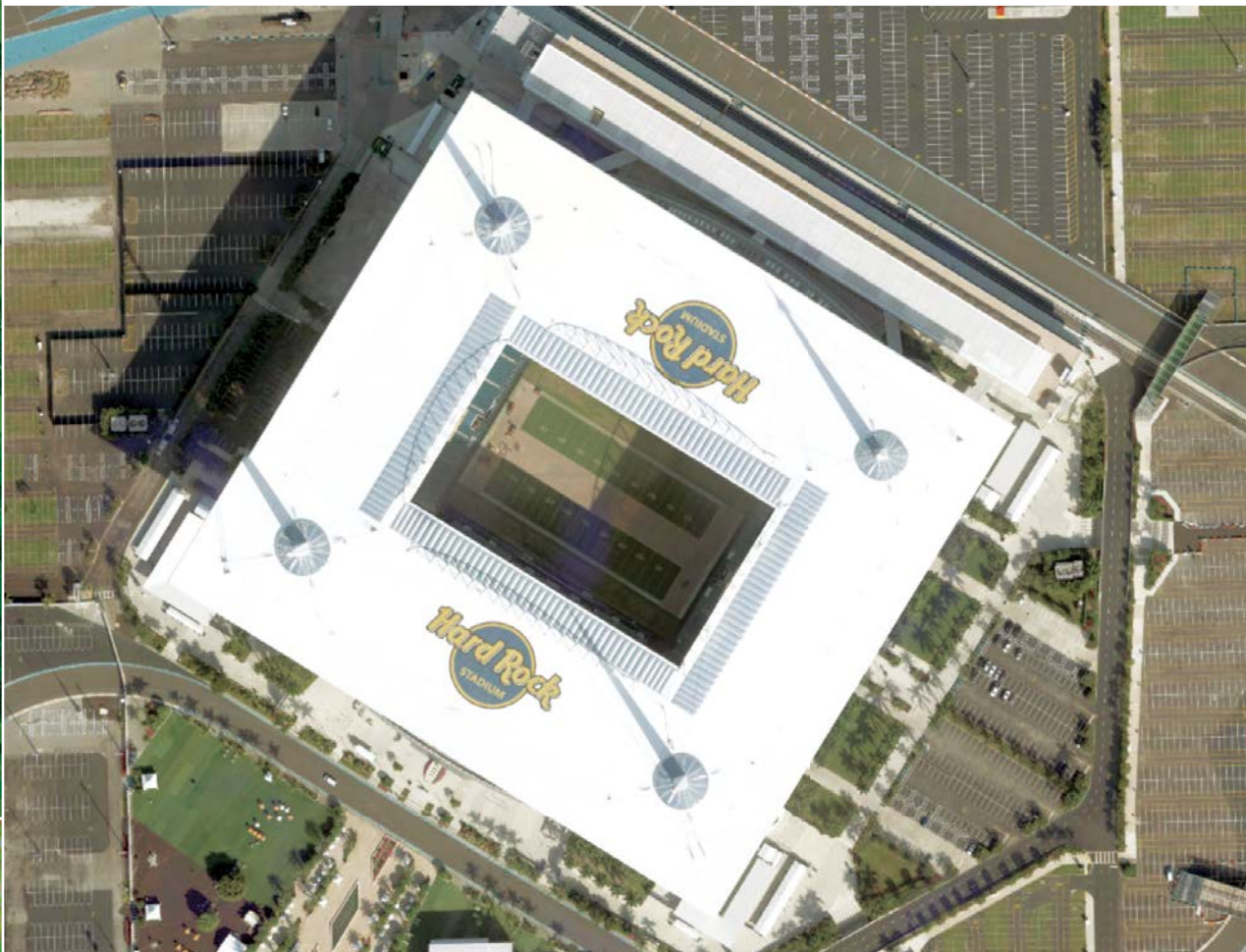
Think of a spectral signature as a unique "fingerprint" of light reflection that allows analysts to distinguish between cornfields, asphalt roads, and healthy forests from miles away. Every material on Earth has a unique spectral signature that can be captured using special sensors carried on satellites, aircraft, and drones. Sensors can be multispectral, capturing 3 to 15 of the bands on the spectrum, while hyperspectral imagery collects hundreds of bands, allowing for more precise identification of materials.

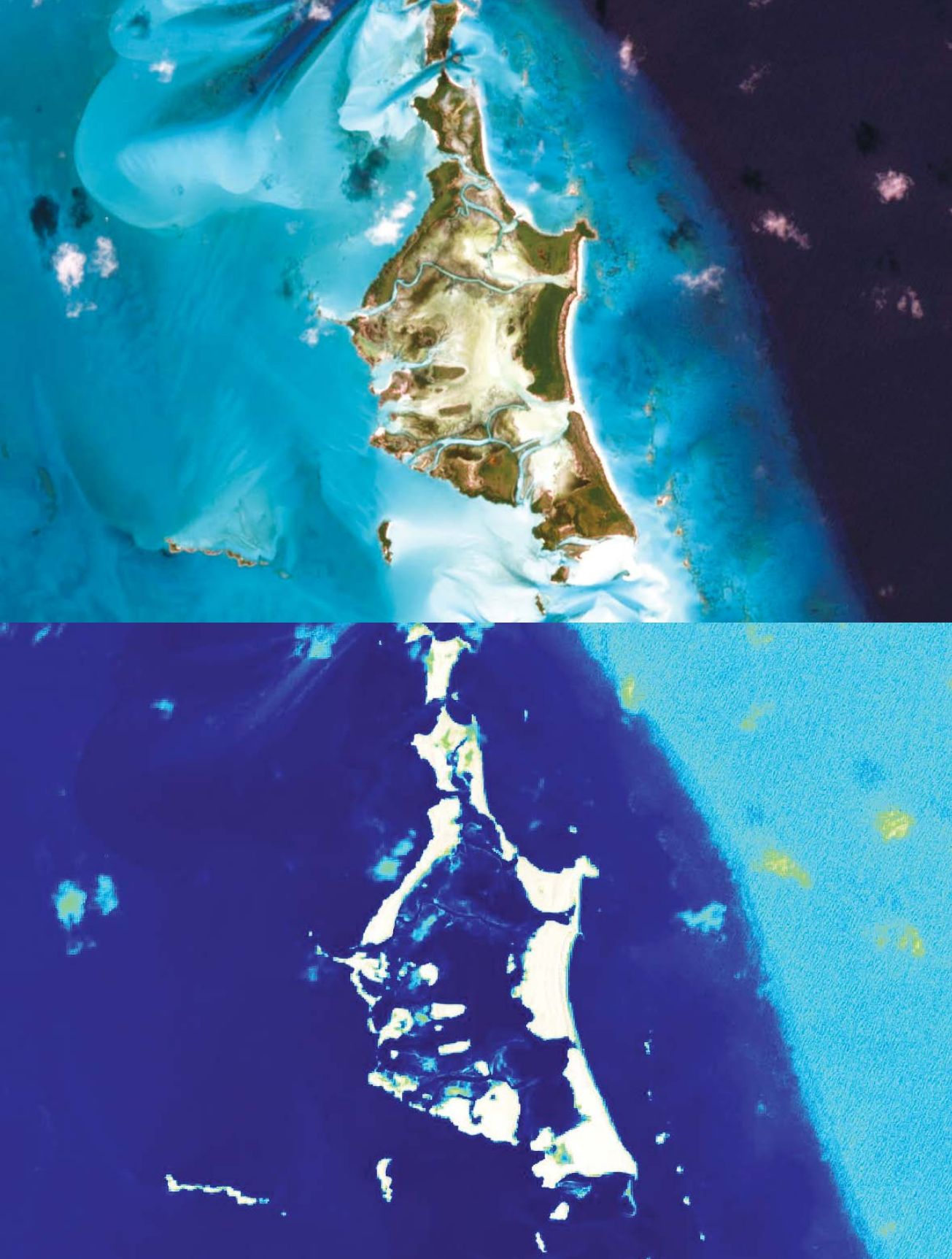
Video data is captured over time using video cameras mounted on aircraft, drones, or stationary platforms like traffic lights or buildings. It provides a more true-to-life representation than static imagery, showing movement and changes from various angles. By examining a sequence of images over time, you can gain a nuanced understanding of how scenes evolve and change, revealing insights that static images cannot provide.

RGB or true-color imagery is captured using standard cameras found in everyday devices, such as smartphones and tablets. These cameras capture images in three bands—red, green, and blue (RGB)—representing the visible spectrum that's similar to how humans experience the world. A specific type of RGB imagery is 360-degree imagery, which captures a complete view of a scene and provides an immersive experience. Both traditional RGB imagery and 360-degree imagery are suitable for a range of projects where visual recognition is important.

Other types of remotely sensed data, such as **synthetic aperture radar (SAR)** and **lidar**, are often included in the imagery category. SAR data is acquired using radar sensors on satellites and aircraft that emit radar pulses to image the Earth's surface. SAR devices can penetrate clouds and see at night. Lidar data is captured using laser scanners, often mounted on aircraft or drones, that emit laser pulses to create highly accurate 3D terrain models. This data is invaluable for elevation and structural analyses.

↓ The multispectral Earth observation satellite Sentinel-2 captured this image of Hard Rock Stadium in Miami, Florida. It uses the shortwave infrared bands, one of Sentinel-2's most powerful spectral channels for environmental analysis. The green tones indicate healthy vegetation.





↑ Sentinel-2 also captured these images of The Bahamas. The top image is a natural-color scene, whereas the bottom image has the Modified Normalized Difference Water Index (MNDWI) applied. MNDWI uses the green and shortwave infrared bands to highlight areas with high water content—displayed here from dark to light blue—while drier surfaces appear in tan to white.

How Imagery Is Captured

Various technologies capture imagery—from cameras that discern visible light to sophisticated sensors that detect beyond the visible spectrum. The choice of camera or sensor, along with the platform it's mounted on, determines the type and quality of the imagery.

Satellites capture a wide range of imagery types, from high-resolution panchromatic and multispectral imagery to hyperspectral, lidar, and radar imagery—and in some cases, even video. The choice of satellite depends on the required resolution, spectral bands, and revisit frequency (how often imagery of a particular site needs to be recaptured). Satellites are particularly useful for large-scale projects such as monitoring environmental changes over vast areas or tracking global phenomena.

Crewed aircraft, such as **helicopters** or **airplanes**, can capture high-resolution photography with GSDs ranging from a few centimeters to several meters. Aerial imagery is often used

for detailed mapping, infrastructure inspections, and monitoring environmental changes. The flexibility of aerial platforms makes them ideal for projects requiring high-resolution imagery over small- to medium-sized areas.

Drones offer an adaptable and cost-effective means of capturing high-resolution imagery and video. They can be equipped with various sensors, including RGB cameras, multispectral or hyperspectral cameras, and lidar. Drones are particularly useful for small-scale projects, monitoring hard-to-reach areas, or capturing imagery at very high resolutions (GSDs of a few centimeters or less).

Street-level cameras are often used to capture images and videos at ground level, providing a distinct perspective on the environment. The widespread availability and ease of use of these devices make them ideal for capturing imagery in a variety of contexts, from documenting work to inspecting assets.

Choosing the Right Imagery for Your Project

The next step is to determine which type of imagery is best suited for your GIS project. Here's a list of questions to see what you'd need for various endeavors.

How much do you need to see?

For projects that require identifying small objects or features—such as counting individual cars in a parking lot or analyzing road conditions—panchromatic imagery with high resolution is essential. If your project involves analyzing larger features or broader patterns, lower-resolution imagery may be sufficient. You can obtain imagery from satellites, aircraft, or drones, depending on factors such as area coverage, revisit frequency, and cost.

What information are you trying to extract?

If you need to identify specific materials or objects, consider spectral imagery—multispectral or hyperspectral, depending on what you need to identify. When visual recognition is key, RGB or true-color imagery might be suitable. If you're analyzing dynamic processes or changes over time, or creating detailed 3D models, consider using video imagery or lidar data.

How often do you need to observe changes?

If you're tracking changes or movements over time, consider using video imagery or repeated captures of the same area. This can be useful for monitoring traffic flow, natural disasters, or seasonal changes in vegetation. The frequency of information you need will help you decide whether to use satellite, aerial, or drone imagery. You can also use collections of street-level imagery to monitor changes at close range.

What's the scale of your project?

For large-scale projects, such as monitoring regional environmental changes or analyzing deforestation patterns, satellite imagery is often most efficient. In contrast, smaller, more detailed projects like infrastructure inspections are better suited to aerial or drone imagery.

How accurate does your imagery need to be?

Accuracy refers to how well the imagery aligns with real-world coordinates and features. While resolution determines the level of detail visible, accuracy ensures that those details are correctly positioned. Aerial and drone imagery, especially when paired with ground control points, can provide higher geospatial accuracy, making them ideal for projects requiring precise measurements or feature alignment.

Unlocking the Full Potential of Imagery in GIS

ArcGIS provides a comprehensive set of tools to manage, visualize, and analyze imagery, as well as create reality mapping products such as 3D meshes. By combining different types of imagery, you can gain a more comprehensive understanding of your area of interest. You can also access imagery data from ArcGIS Living Atlas of the World and Content Store for ArcGIS, allowing you to make informed decisions without leaving your GIS workflow.

NASA Makes It Easier to Use Earth Observation Data in GIS

Hundreds of miles above the Earth's surface, satellites collect petabytes of data. Open to the public, these datasets support precision agriculture, energy efficiency, emergency response, and a host of other use cases.

GIS practitioners are well positioned to turn this data into actionable intelligence. But two persistent problems get in the way: Many GIS users are unaware that these resources exist, and those who are aware find them too complex to integrate into daily operations.

To break down these barriers, the National Aeronautics and Space Administration (NASA) is leading the Earth Science to Action (ES2A) strategy. The goal is to maximize the potential societal and economic impacts of Earth science by ensuring it can inform real-world decisions at scale.

Scientists recognize the challenge of what they call “bridging the last mile”—translating complex scientific outputs into the tools that industry professionals already use. This requires a concerted effort, so NASA and Esri are collaborating to connect Earth science and operational GIS.

To build that bridge, NASA needed to meet GIS teams where they work. For many state, local, and federal government organizations, as well as commercial entities, that environment is ArcGIS. To widen its reach, NASA delivers data in GIS-friendly formats such as custom rasters, provides image services, and adds datasets to ArcGIS Living Atlas of the World. NASA also engages with Esri technology users through instructional blog posts, newsletters, and even live events.

NASA's Earth observation data can point miners to surface deposits of rare earth minerals, help water treatment facilities monitor water quality, or guide government agencies in air quality forecasting. The imagery captures insight across land, water, and the atmosphere, making it valuable for nearly every industry.

Breaking Down Barriers to Data

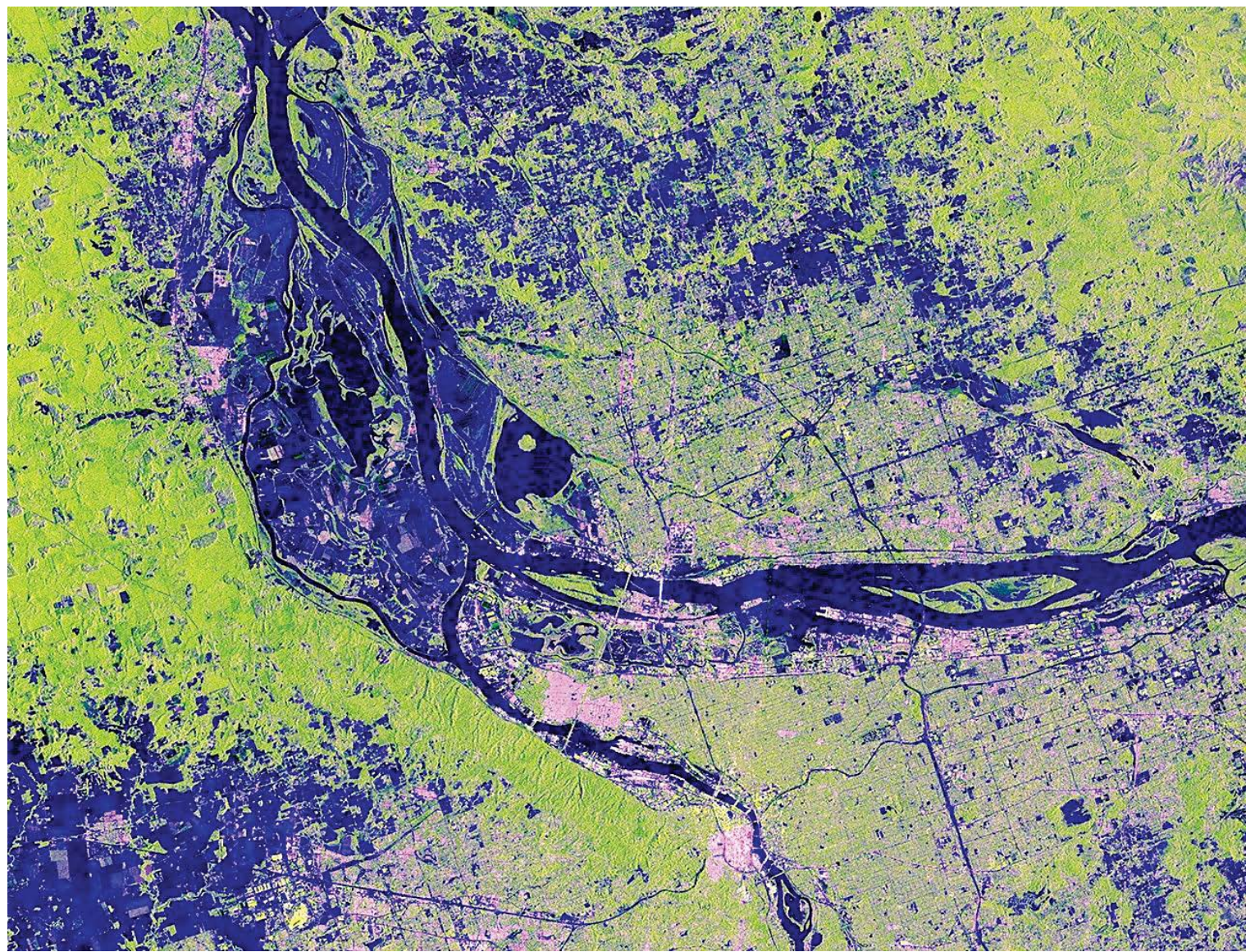
Supporting ES2A are NASA scientists and mission application leads Dr. Dana Chadwick, Dr. Morgaine McKibben, and Dr. Elodie Macorps. They ensure that data from cutting-edge missions is accessible and actionable for leaders.

“Our role is to figure out how best to provide datasets to users who are going to make decisions with them,” explained Chadwick. “We’re helping to communicate what the data [is], how [it] can be used, and what the access points are.”

Start working with NASA datasets now in ArcGIS Living Atlas of the World at livingatlas.arcgis.com, and access resources for the following NASA missions:

- NISAR: links.esri.com/NISAR-data
- PACE: links.esri.com/PACE-data
- EMIT: links.esri.com/EMIT-data

To learn about upcoming workshops and other events geared toward using NASA data, visit earthdata.nasa.gov/events.

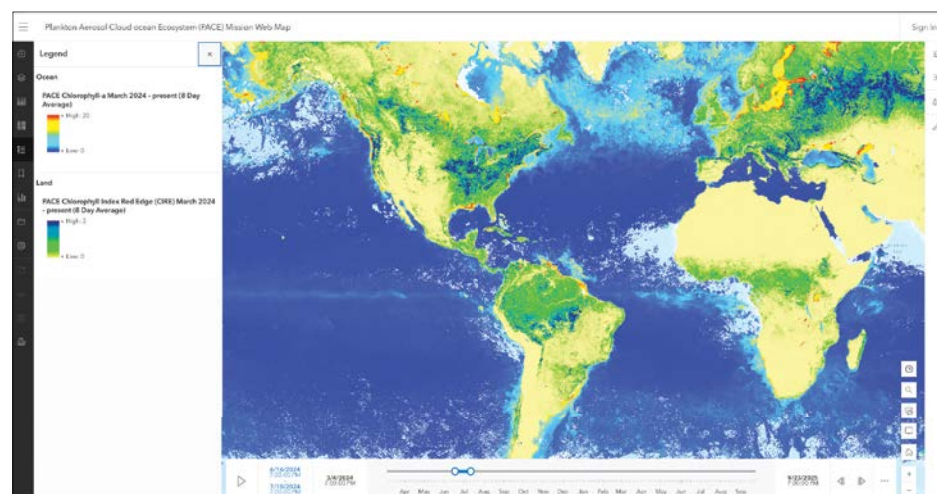


↑ This image of Portland, Oregon, and the Columbia River (to its north) was captured through clouds by NISAR on November 10, 2025. (Image courtesy of NASA/JPL-Caltech.)

→ NASA's Earthdata GIS (EGIS) platform provides image services, like the ones used in this map, for PACE data. (Image courtesy of NASA GSFC.)

Three key missions these scientists support highlight the breadth of NASA's data capabilities:

- NISAR (NASA-ISRO Synthetic Aperture Radar): Designed to measure physical change and motion, this mission—in partnership with the Indian Space Research Organization (ISRO)—tracks land deformation, monitors ice sheets, and measures vegetation structure regardless of cloud cover or darkness.
- PACE (Plankton, Aerosol, Cloud, ocean Ecosystem): PACE provides daily global monitoring of the health and diversity of aquatic and terrestrial life, including algae and plants; types and quantities of aerosols, such as smoke and dust; trace gases; and more.
- EMIT (Earth surface Mineral dust source Investigation): Mounted on the International Space Station, the EMIT instrument identifies specific surface materials and gases, maps mineral composition, and detects large methane emission events.



All these missions generate insight into how Earth functions and changes. But the data they produce is often massive and highly technical.

“All of our data is generally available at one access point in one format,” said McKibben. “We learned this can create barriers for some in the GIS user community, which is exactly the sort of broad and solution-forward user community we’d like to support.”

So the team set out to learn directly from GIS users how NASA can better integrate data into their existing technology and workflows.

“We’re hosting regular user group meetings, workshops, and early adopter programs to

gather feedback,” said Macorps. “We learn how the GIS community needs the data delivered and then codevelop tools with both experienced and new users.”

This collaborative approach helps ensure that data products solve real-world challenges and are accessible to a diverse user base.

Making NASA Data Easier to Find

As NASA creates analysis-ready data for GIS users, Esri integrates that data directly into its technology.

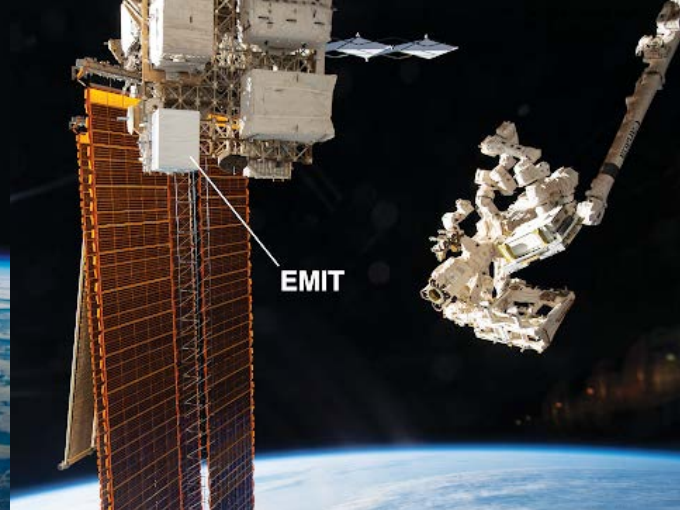
A major step in this process is the development of image services and cloud-enabled data access. Hosting data as image services



↑ NISAR measures physical change and motion on Earth.



↑ The PACE mission helps monitor the health and diversity of the planet's aquatic and terrestrial life.



↑ The EMIT instrument is mounted on the International Space Station.

lets users stream massive datasets directly into ArcGIS Pro and ArcGIS Online without having to download them locally.

NASA's Earthdata GIS (EGIS) platform provides image services for NASA datasets. Services are already available for PACE data and are in development for NISAR.

"We're connecting GIS practitioners directly to the most current data sitting in NASA's Earthdata Cloud," McKibben noted.

In the meantime, users can access specialized raster types in ArcGIS that make it easier to work with files from NASA missions.

This integration is further highlighted by ArcGIS Living Atlas. Stephanie Dockstader, Esri's director of imagery and remote sensing solutions, is raising awareness among ArcGIS technology users that these datasets are available.

"More than 120 NASA data layers are available now in ArcGIS Living Atlas," Dockstader said.

NASA publishes these from the Earthdata GIS repository into ArcGIS Living Atlas.

"That's where GIS practitioners go to find new, authoritative data sources, so the team has made it easy to find," explained Dockstader.

Resources for Learning How to Use This Data

Enabling GIS users to discover analysis-ready NASA data helps, but that isn't always the full solution for complex scientific data. This is especially true for synthetic aperture radar (SAR) information or full hyperspectral satellite data cubes from PACE and EMIT, which currently cannot be streamed directly into ArcGIS.

For NISAR, that's where experts like Heidi Kristenson—a GIS specialist at the Alaska Satellite Facility (ASF)—come in. ASF supports NASA as a Distributed Active Archive Center (DAAC) in NASA's Earthdata Program.

"NASA scientists create the datasets, and DAACs such as ASF distribute [them] to the world," Kristenson said.

For her, this means making complex SAR data more GIS friendly. ASF provides on-demand services that generate analysis-ready datasets. It also publishes EGIS image services to support access to SAR data.

However, there is still a learning curve to understanding the characteristics of SAR imagery. Unlike conventional optical imaging, SAR uses longer

wavelengths to image the Earth. Radar backscatter characterizes different surface properties than optical data, and SAR images include speckle—granular, salt-and-pepper features that mask fine details. Kristenson publishes ArcGIS StoryMaps tutorials, such as *NISAR in GIS* (links.esri.com/NISAR-GIS), *RTC On Demand!* (links.esri.com/RTConDemand), and *OPERA Sentinel-1 RTC* (links.esri.com/OPERA-Sent1), to help GIS practitioners access, understand, and use SAR data.

The spectral resolution provided by the PACE and EMIT missions also yields large and complex files that are challenging to import and use. To serve the GIS community, these missions have teamed up with Esri to create instructional content on importing and working with hyperspectral data in ArcGIS. Two resources—an ArcGIS StoryMaps story (links.esri.com/PACE-ArcGIS) and an *ArcGIS Blog* article (links.esri.com/Explore-PACE)—detail the powerful hyperspectral-data support features being added to ArcGIS.

The Impact of GIS-Ready Satellite Data

Bringing NASA data into the ArcGIS environment enables organizations across sectors to

use it. And they don't need special processing software, extensive computing power, or manual file conversions to get there.

"This hosting model allows organizations to connect directly to these trusted data sources without incurring additional storage or transfer costs," Dockstader emphasized.

For commercial users, the ability to easily integrate NASA data with their proprietary workflows is a game changer. For example, an insurance company could use NISAR data to assess flood damage. An agricultural firm could use EMIT's hyperspectral imagery to monitor crop health and forecast yields. A regional fishery could employ PACE data to observe potentially harmful algal blooms and engage in proactive, risk-based management.

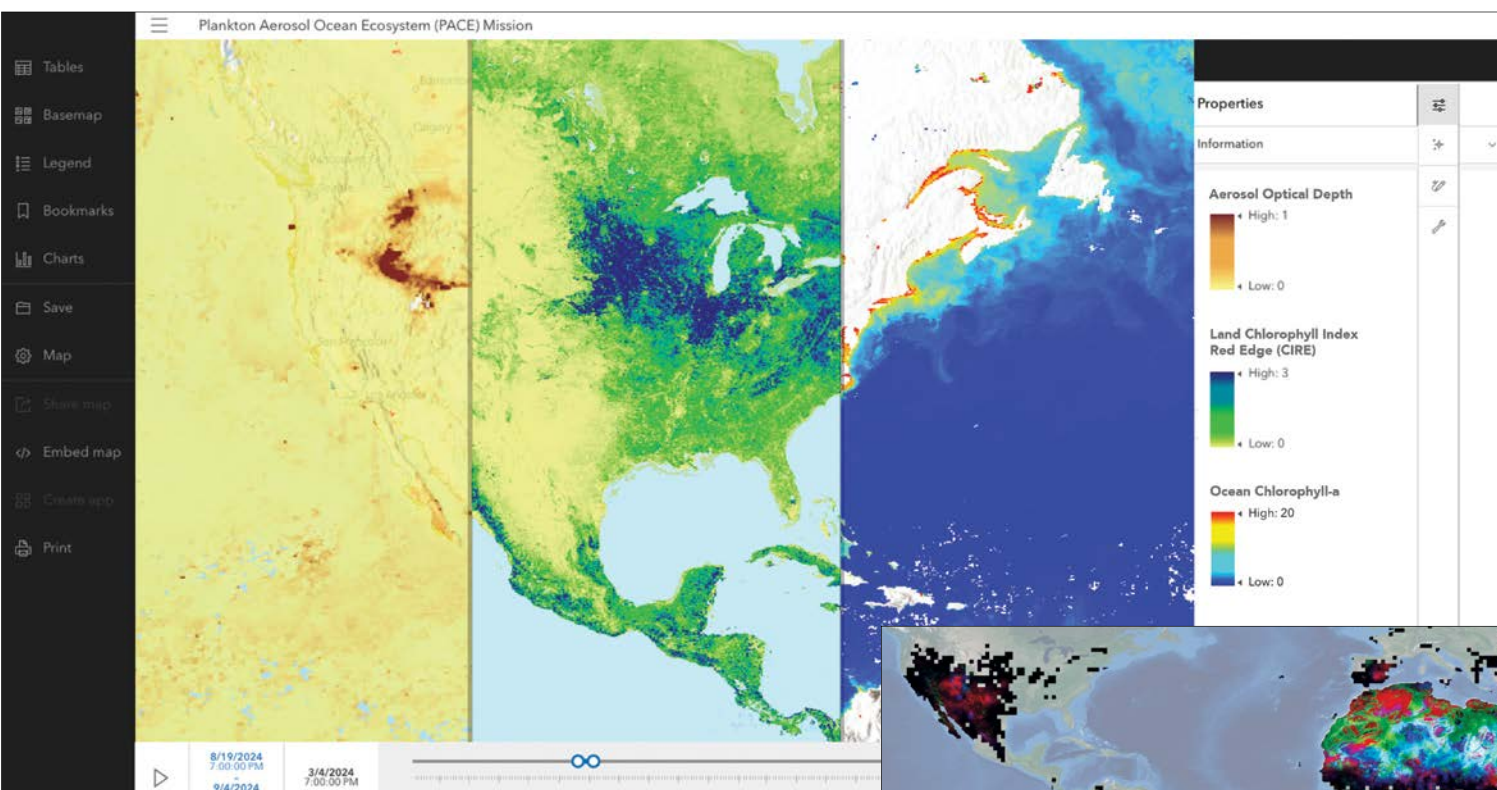
The accessibility of these datasets enables precise, scalable decision-making. Plus, NASA's long-term, high-quality, and consistent data archives offer the kind of reliable foundation for advanced predictive analytics and AI applications.

A New Era of Problem-Solving

By transforming complex scientific data into analysis-ready products—hosted in ArcGIS and the cloud—NASA and Esri are giving decision-makers powerful intelligence to address ongoing challenges.

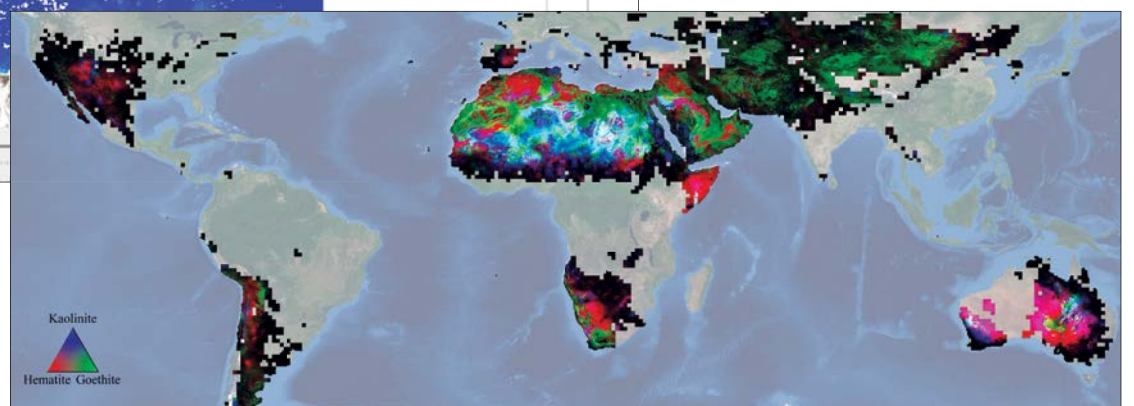
"This is a really exciting time," Chadwick reflected. "These sensors provide new and different data than what we've had in the past. If we can help people work with [this] data, it can support a lot of different applications."

While these datasets are useful for government agencies, commercial organizations can also benefit from them. By making it more accessible to GIS users, NASA ensures that insights gathered from space can have a tangible impact here on Earth.



↑ A simulated image of NASA's EGIS web-based Map Viewer tool shows three different PACE imagery services. (Image courtesy of NASA GSFC.)

→ A global mosaicked map of surface mineralogy from the EMIT mission displays a false color image where red, green, and blue represent hematite, goethite, and kaolinite, respectively. (Image courtesy of NASA/JPL-Caltech.)



Good Parcel Data Builds Strong Communities

Land parcels are the foundational decision-making layer for governments and private companies alike. Not only do they serve as the basis for property taxation, determining who can build what where, and identifying infrastructure needs, but they are also crucial pieces of information when disaster strikes.

Maui County, Hawaii, has prioritized careful stewardship of parcel data for years. When a devastating wildfire ripped through the area in 2023, it underscored the value of land records and parcel data in ways no one could have imagined.

“When the wildfires hit, the critical nature of parcel data immediately became clear: Recovery would be impossible without it,” said Ellen Deleissegues, a GIS analyst in Maui County’s Real Property Assessment Division.

Many organizations struggle to keep their land information current, accessible, and accurate. Parcel maps fall out of date, discrepancies go unresolved, and staff across departments may lack consistent access to the records they need. Tracing a parcel’s history or verifying legal transactions often requires time-consuming manual research.

As Maui County learned, employees across an organization must be able to map, maintain, and access land records from a shared platform to prepare for the unexpected. ArcGIS Parcel Fabric—Esri’s GIS-enabled parcel management software for ArcGIS Pro, ArcGIS Enterprise, and now ArcGIS Online—is designed to do just that. Built-in tools support data quality checks, help resolve discrepancies, and establish consistent, repeatable workflows.

Capturing the Full, Accurate History of Land Records

Land ownership and administration are complex. Every land transaction begins with a legal record, such as a development plan, a plat, a deed, an easement, or a record of survey. And land records are cumulative. Each new transaction on a piece of land is added to its existing file to create a chain of title that catalogs the property’s entire history.

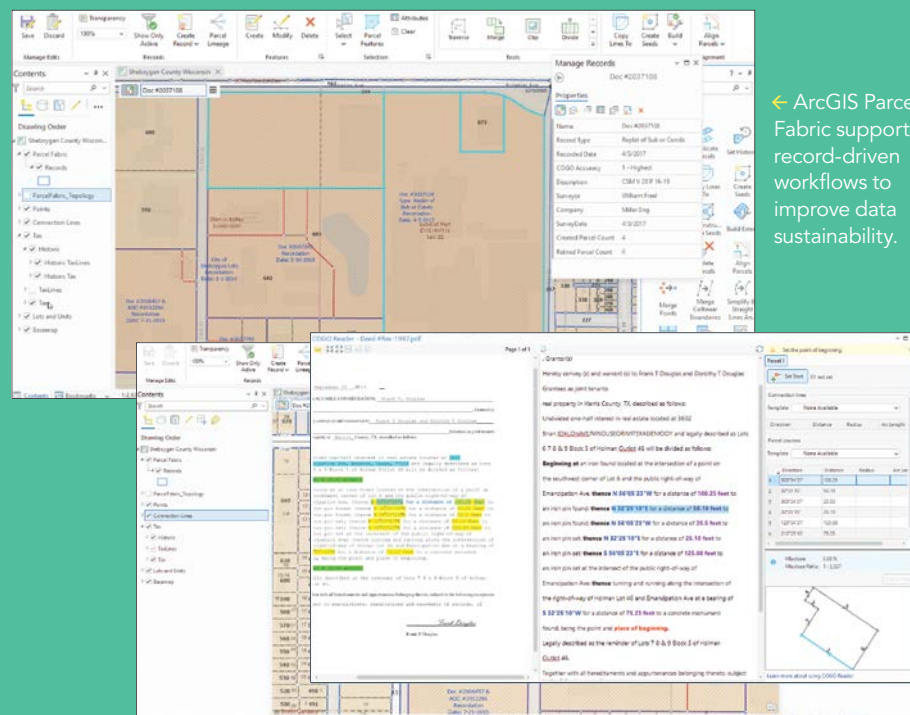
In Parcel Fabric, users create and edit land parcels in response to changes in the legal record, and all legal references get stored in the software. Unlike most traditional parcel management methods, which represent a snapshot in time—meaning all previous work and history are lost—Parcel Fabric is designed for users to enter a land record once and keep it indefinitely. This makes it easier to understand a parcel’s evolution over time and see its legal underpinnings. It also minimizes rework.

The flexible data model in Parcel Fabric comprises separate parcel types such as plat boundaries, lots, subdivisions, easements, rights-of-way, and tax parcels. Users can customize each parcel type. They can even manage parcels in 3D—both aboveground and belowground—and in 4D over time.

When data is redundant, inconsistent, or noisy, parcel managers perform least-squares adjustments—using statistical analysis to estimate the most likely coordinates where points in a network connect. Users can do this directly in Parcel Fabric, without importing or exporting additional data. This type of analysis helps improve the spatial accuracy of—and confidence in—land records data.

Parcel Fabric accommodates attribute rules and constraints, which streamline workflows and minimize data errors. Users can also automate the labor-intensive process of creating parcel geometry from deeds. Usually, this requires typing all the bearing and distance measurements from a deed—including straight lines and curves—into a computer program. But Parcel Fabric has the COGO Reader tool, which can extract text from a scanned image of a deed, find the courses, and plot them on a map to create parcel geometry.

“As someone who has spent many hours throughout my career manually entering courses from deeds and other land records, I see COGO Reader as a game changer—exponentially reducing input times and minimizing human errors,” said Linda Foster, Esri’s director of land records and cadastre solutions.



← ArcGIS Parcel Fabric supports record-driven workflows to improve data sustainability.

↑ COGO Reader, included in Parcel Fabric, automates data entry from scanned land records.

Scaling Parcel Management Across Organizations

Parcel Fabric works for organizations of varying sizes, from those that manage tens of millions of parcels to those with a few hundred. It can also accommodate different organizational arrangements—whether they need a single editor or concurrent editors, whether everyone works in the same system, and whether they access their parcel data on desktop or the web.

The Land Title and Survey Authority of British Columbia (LTSA) in Canada—which manages 2.4 million parcels—migrated its land management system, ParcelMap BC, to Parcel Fabric in ArcGIS Pro. It moved from an on-premises ArcGIS Enterprise deployment to cloud infrastructure while maintaining data continuity. Parcel Fabric’s scalability enabled the organization to minimize user impact while increasing efficiency.

Tooele County, Utah, is at the other end of the spectrum, managing about 35,500 parcels. Because Parcel Fabric can accommodate small organizations as well, the county used it to bring two departments into the same system, improving both accuracy and efficiency.

“We have confidence in our data because we’ve been able to clean up errors, perform maintenance, and publish updated data much more efficiently,” noted Emily Jones, director of operations for the county’s Recorder/Surveyor’s office.

If an organization manages parcels using both CAD and GIS, Parcel Fabric can accommodate that as well. Users can leverage web and feature services and the ArcGIS for AutoCAD integration to work on the same dataset in the environment that’s most efficient for them.

Esri also recently released a new way to work with Parcel Fabric—in ArcGIS Online. Available now, this option allows users to manage parcels directly from a software as a service (SaaS) environment, minimizing on-site IT infrastructure and database administration tasks. Working with Parcel Fabric in ArcGIS Online supports the same record- and quality-driven workflows, administrative parcels, and multiple editors as Parcel Fabric in ArcGIS Enterprise. However, advanced geodatabase capabilities, such as branch versioning, attribute rules, and full geodatabase topology, are available only in ArcGIS Enterprise.

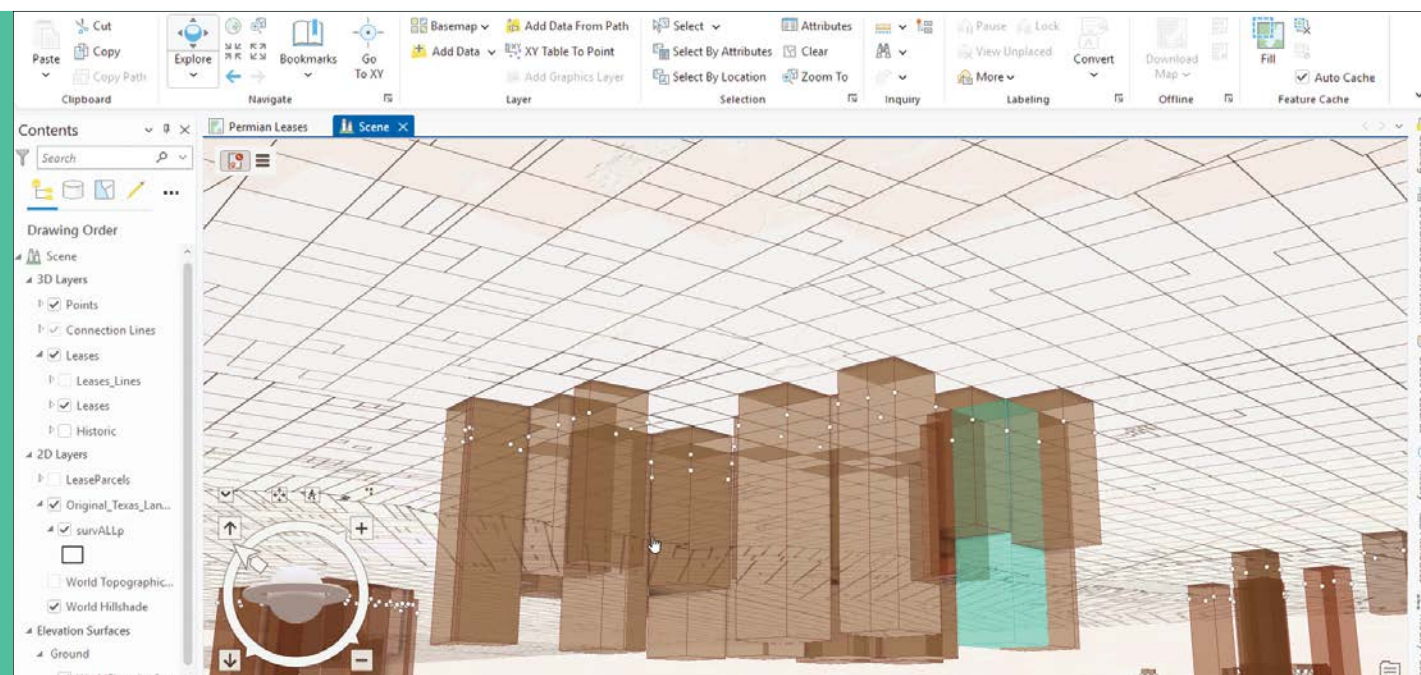
“Being able to leverage Parcel Fabric in ArcGIS Online makes modern parcel management accessible for many more organizations managing and maintaining land records,” Foster noted.

Better Land Administration for a Better World

Land is a finite and life-sustaining resource that everyone depends on. In a world of increasing demands and decreasing resources, it is imperative that organizations modernize how they manage parcels so they can improve sustainability and resilience in their communities and beyond.

To learn more about ArcGIS Parcel Fabric and how to implement it, go to links.esri.com/parcel-fabric.

← Parcels can be managed and tracked both aboveground and belowground over time.



Celebrating Esri Partners Innovating with GIS

At the 2026 Esri Partner Conference, Esri honored several partner organizations for their outstanding achievements in GIS that help customers succeed with ArcGIS technology.

Congratulations to

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for integrating ArcGIS with
another IT system

geonamic
integrity matters

for gaining a customer win via
partner-to-partner collaboration

ASPLUNDH

for using the Mobile Worker user type to deploy
a new field asset management system

Trimble

for using Esri technology to impact
current issues around the world

LOGIC
SOLUTIONS
group

for its large-scale system implementation
of multiple ArcGIS products

UDC

for its use of emerging
technologies

CADMAP

for successfully modernizing a customer's
GIS with the new ArcGIS user types

XR
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for leveraging ArcGIS in new
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TeachMeGIS

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Wind Environmental Services, LLC

Learn more about these and other Esri Partners at partners.esri.com



When Lived Experience Can Help Others

Pat Dolan ran almost every morning. A high school cross-country state champion and scholarship track athlete, he was the guy at the local fun run who could really fly. When he won, he would give his coworker's name, and they'd share a joke when the announcer called the winner.

Dolan, then a solutions engineer at Esri, gave technical demonstrations for visiting customers at the Redlands headquarters in California. He scripted the demos and practiced them until they were polished. He had props—a gas meter, a clock he'd dial in to unfolding events—that he stashed around a small stage in the corner of the executive conference room.

When Esri president Jack Dangermond or another executive brought a group into the building, Dolan was ready with a scenario:

"It's 3:00 a.m. There has been a train derailment," he'd begin.

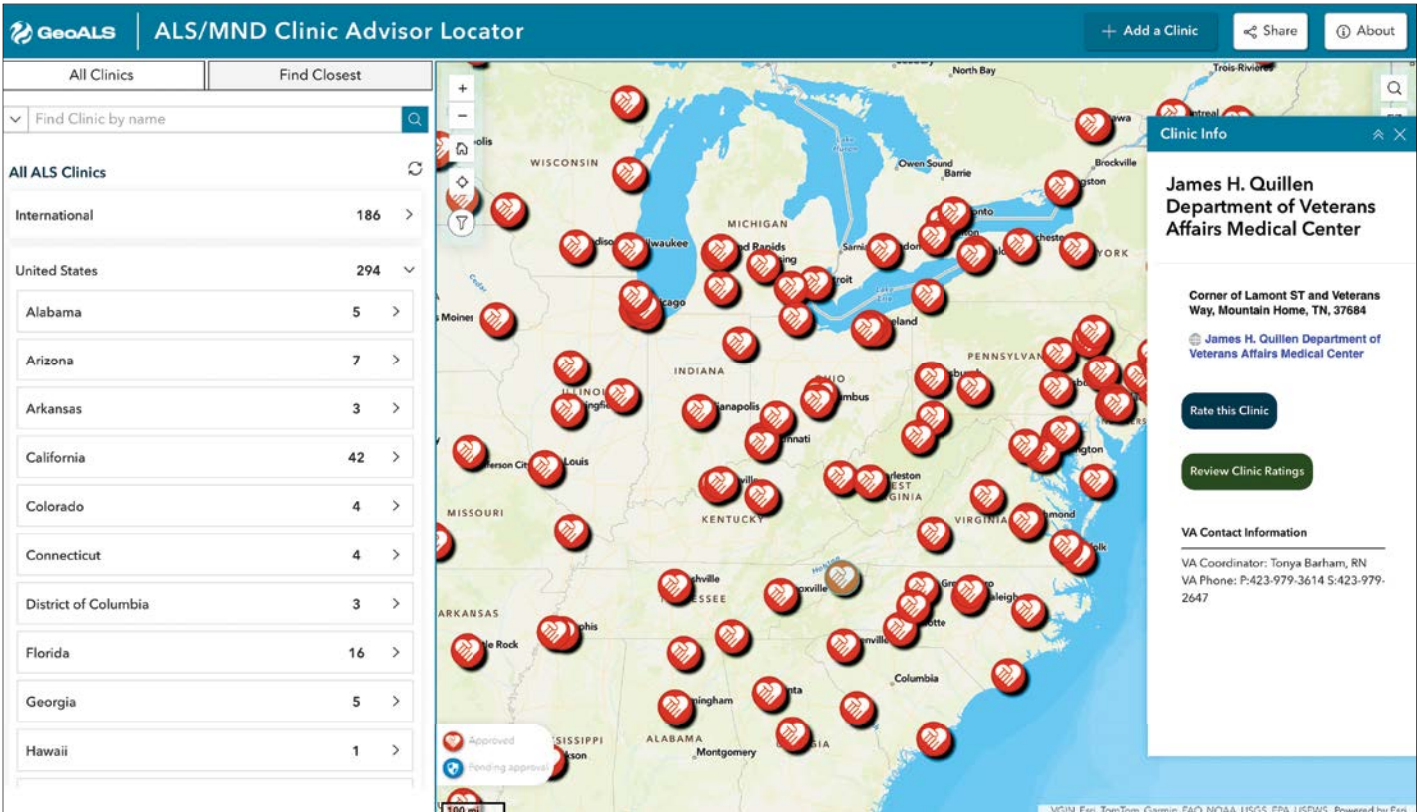
Visitors clicked through the software as his narrative progressed. Five computers delivered five experiences for five different roles within an organization. This was enterprise GIS.

"Pat brought the idea of structured demos to Esri," said Chris Thomas, Esri's director of government markets. From there, he explained, Dolan's ideas evolved into what are today mature departmental programs, including the Executive Briefing Program and the Geo Experience Center.

Dolan was recruited to Esri by Tim Rankin, Esri's technical marketing manager. Previously, the two had collaborated when Dolan worked at Telvent Miner & Miner (which Esri partner Schneider Electric later acquired), an engineering firm in the utilities space.

The duo helped usher enterprise GIS into mainstream data management. In the early 1990s, very few utility companies were using GIS. Today, it's a must-have technology.

↓ Dolan uses an eye-gaze device to do his GIS work.



↑ The ALS Clinic Advisor shows the location, name, neurologist, and rating of ALS clinics.

Dolan and Rankin had a complementary dynamic. "I am an outside thinker and have to talk my way to a conclusion," Rankin said. In contrast, Dolan listened, studied the room, and spoke last.

"Pat would end the meeting saying something profound—it was brilliant," Rankin reflected.

A Call to Advocacy

On one of his usual morning runs, Dolan suddenly fell. A couple mornings later, he fell again, and within a week, lost his balance while walking. Doctors eventually diagnosed him with amyotrophic lateral sclerosis (ALS), also known as Lou Gehrig's disease—a fatal, degenerative illness with no treatments that stop the disease, or cure.

Devastated, Pat and his wife, Mara, had a million urgent questions and few answers.

"After I accepted my diagnosis, I knew I wanted to apply my GIS skills to the fight," Dolan said. "At one of my first clinic visits, I saw how I could do it."

The United States has around 300 ALS clinics. These clinics bring a coordinated care team together in one visit: neurology, respiratory care, nutrition, speech and swallowing, physical and occupational therapies, social work, and mental health support. Every three months, patients report to a clinic where the care team monitors disease progression, manages symptoms, and plans care as the patient's needs change.

The Dolans found an ALS clinic practically in their backyard—at Loma Linda University Medical Center, a 15-minute drive from their home. But they had nearly missed it. For Dolan's initial visits, they drove 70 miles to the Cedars-Sinai clinic in Los Angeles.

At the time, Loma Linda was a new clinic, so it didn't show up in Dolan's search results. An ALS Association care manager pointed him in the right direction.

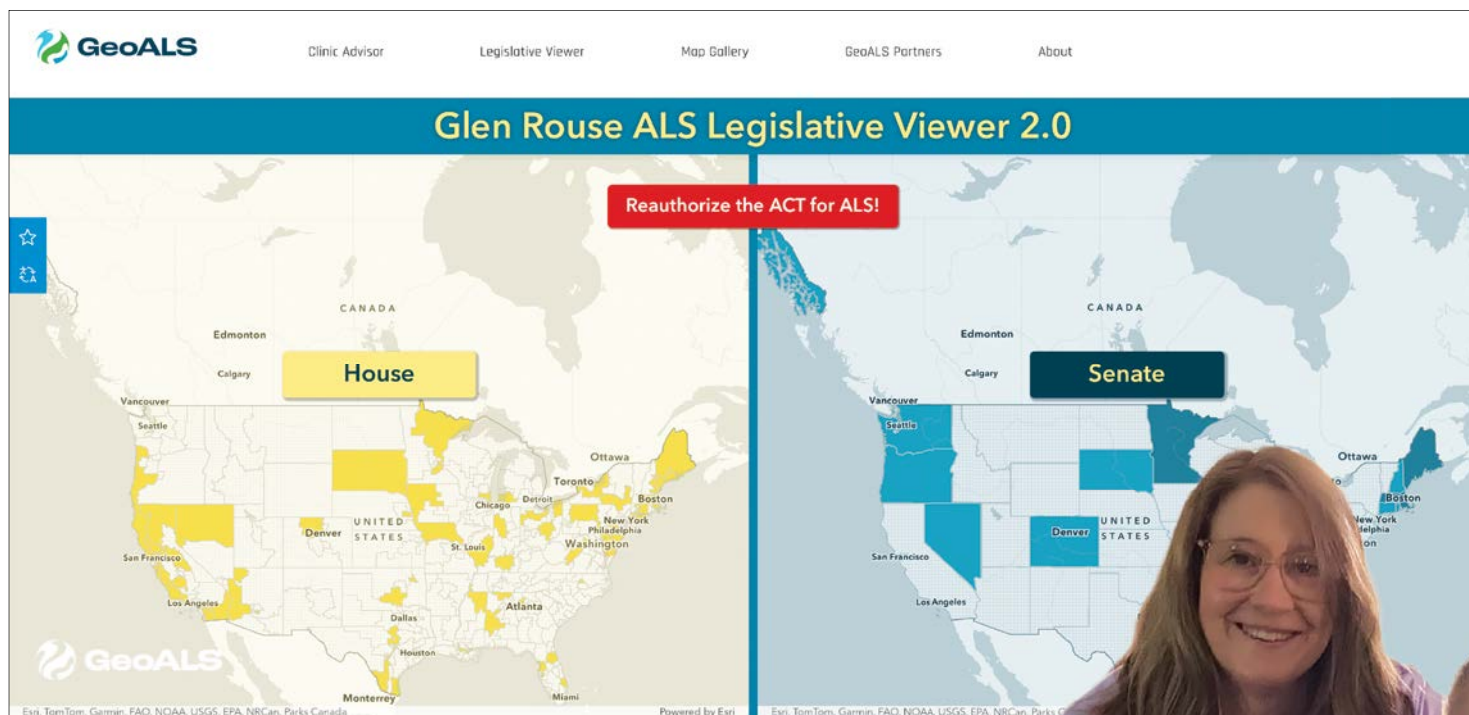
At Dolan's first visit in Loma Linda, he met a man who had traveled 170 miles from Bakersfield, California. Each clinic session meant two nights in a hotel.

Clinic days leave patients exhausted. Even on the short drive home from Loma Linda, Dolan would often fall asleep in the passenger's seat. Many patients must drive themselves or risk missing their sessions.

"That's when I needed to understand access to care for people living with ALS," Dolan said.

Patient Access Data in One Place

ALS Clinic Advisor was the first of several resources Dolan conceived in what would become



← The Glen Rouse ALS Legislative Viewer shows which members of the US House of Representatives and US Senate support the Accelerating Access to Critical Therapies (ACT) for ALS Reauthorization Act of 2026.

↓ Mara and Pat Dolan founded the nonprofit GeoALS.

the GeoALS Hub (home-geoals.hub.arcgis.com), a platform that organizes data by geography to improve care, accelerate research, and support advocacy for the ALS community.

Using ALS Clinic Advisor, patients can search clinics by location, clinic name, and neurologist; filter by rating; and browse services. The app compiles reviews of clinics and clinicians from across the country. Clinicians can see best practices emerging in ALS care and identify areas for improvement. ALS Clinic Advisor is a living survey—people’s review responses appear almost immediately in the dashboard.

The hardest thing was creating the data. “There wasn’t a central database of ALS clinics,” Dolan explained. “I had to visit multiple websites just to find them and identify the care deserts.”

Launching with 100 tracked clinic locations, ALS Clinic Advisor now includes nearly 300 clinics in the United States and 186 more internationally. Validating and updating the dataset are handled by what Dolan calls the Mappers, a volunteer collective of about 20 GIS professionals, ALS advocates, caregivers, and researchers. All this work—plus the volunteers, data, and maps—now make up GeoALS, the nonprofit that the Dolans founded.

The ALS clinic database is one of the most important datasets in the GeoALS Hub. It puts authoritative data from federal agencies and research institutions into geographic context—and it’s open to anyone who wants to build on or analyze it.

No-Hands Mapping

A person with ALS who can no longer move their hands or body often uses their eyes and facial expressions to communicate. Eye-gaze devices include a tiny infrared camera that detects corneal reflection and tracks pupil movement to determine

where the user is looking on a screen, functioning like a cursor for typing or commanding an application. It takes time to get used to this technology.

“It took about a month, plus another month to become proficient using ArcGIS Online and ArcGIS Pro,” Dolan said. “You forget that you normally use both hands, your voice, and your eyes to work.”

“Pat can type faster than anything,” Thomas exclaimed. “He’s flying.”

GIS for Political Action

Dolan discovered that other ALS advocates were also working with eye-gaze GIS. Glen Rouse had spent 31 years as a forester for Sierra Pacific Industries. As he lost control of his hands and speech, he directed his energy toward advocacy, gathering data for ALS legislative maps that showed lawmakers exactly how ALS affected their districts and states.

Mara arranged a virtual meeting. Dolan and Rouse collaborated as much as they could before Rouse’s death in 2022. The Dolans continue taking that GIS-based approach to political action.

The Glen Rouse ALS Legislative Viewer (links.esri.com/als-viewer) filters GIS data into district-level evidence that policymakers can easily understand. Maps back the narrative with data: where people with ALS live, where clinics and services exist, and how those patterns align with congressional representation and ALS policy support. The app shifts advocacy conversations from national averages to local impact.

It was the tool of the moment leading up to the Accelerating Access to Critical Therapies (ACT) for ALS Act. Passed in 2021, the bill invested in and expanded access to investigational therapies for patients who do not qualify for clinical trials. The US Congress passed the ACT for ALS Act by an overwhelming margin, 523–3, and it became law on December 23, 2021.



Esri senior solution engineer Amanda Stanko—whom Dolan has nicknamed “Wing Amanda” for copiloting the ALS work—is his primary mapping partner and copresenter for GeoALS. She steps in wherever needed: making map layers, geocoding tables, coordinating volunteers, and presenting at conferences.

“One of the most amazing things Pat has done is make connections,” Stanko said. “The ALS Association, the Centers for Disease Control and Prevention, Veterans Affairs—all these siloed organizations with ALS data—he got them talking when they weren’t before.”

Outside of rare genetic cases, ALS is considered sporadic. Yet patterns in the data suggest it is not entirely random. Elevated risk among certain groups, including veterans—who are several times more likely to develop ALS—points to possible links with environmental or toxic exposures.

“Amanda and I developed a map showing the number of ALS clinics, veteran populations, and amount of ALS research funding by state and congressional district,” Dolan explained. “This information helped educate Congress on the impact of ALS in their districts.”

For Stanko, the impact was clear during conversations at the Health and Human Services Conference where she and Dolan presented.

“They could go on Capitol Hill with concrete demographic data: These are your constituents. These are the people at risk for ALS. These are the veterans in your district. You need to support this,” Stanko explained.

A Tight Timeline to Act

As Congress considers whether to renew the ACT for ALS Act in 2026, Dolan is doing what helped the law pass in the first place: turning lived experience into evidence that lawmakers can’t ignore. Same message, sharper tools. This is what ALS looks like on the ground—and this is what happens when policy meets, or fails to meet, reality.

Dolan and other ALS advocates are building momentum. A Zoom call in March led to congressional sponsorship and, in April, Representative Mike Quigley of Illinois introduced the ACT for ALS Reauthorization Act of 2026 (H.R. 8205). A simple majority—218 votes—is needed to pass the bill by September 30.

Time is tight in Washington and tighter still for Dolan. His eyes are becoming less responsive. Eventually, paralysis will extinguish his ability to communicate.

The ALS and GIS communities have what they need to continue to support this work: the data, maps, and systems that Dolan has built to last.



The Dolans ask that readers visit the Legislative Viewer (links.esri.com/als-viewer) to see whether their elected officials support the Accelerating Access to Critical Therapies (ACT) for ALS Reauthorization Act of 2026—and to call them if they don’t.

Oklahoma Automates Election Data Maintenance, Improving Accuracy

In a democracy, voting is geography. The street someone lives on determines their congressional district, the school board candidates on their ballot, and the municipal races they vote in. If the geography is wrong, democracy can break down at a fundamental level.

In Oklahoma, this geographic information has been maintained for more than 20 years by a small team at the University of Oklahoma's Center for Spatial Analysis (CSA). But by 2020, the team's system was showing its age. Manual data processing, delayed quality checks, and a cumbersome workflow that took 11–12 hours every month left too much room for human error. And the stakes were about to get higher: Redistricting would redraw boundaries across the entire state.

CSA modernized its GIS by moving from ArcMap to ArcGIS Pro, creating a single database, and automating quality assurance and data processing workflows. Now, Oklahoma's election data is easier to share and use.

A System Under Strain

Established in 1994 as a research unit at the University of Oklahoma, CSA has supported the Oklahoma State Election Board since 1996. The center maintains spatial data for street records tied to voter precincts and jurisdictional boundaries across all 77 counties in Oklahoma.

Until a few years ago, CSA's workflow relied on a database management system for data ingestion and validation, paired with ArcMap for spatial editing.

"It worked for a long time, but there were human error issues with data entry and delayed review and notification," said Jacob Tillotson, senior GIS analyst at CSA.

Every month, CSA received data from Oklahoma's counties and ran dozens of manual

queries to process changes. Quality assurance checks happened at the end of each cycle, after CSA staff completed their edits.

"If there was an error, you'd find out about it about two weeks later," Tillotson explained. "You'd have to go back and try to remember what you did and why you did it."

Under the former process, onboarding was also a challenge because it relied on institutional knowledge and long manual sequences.

"The modernization simplified the monthly run and added redundancy," Tillotson said, adding that now, "someone with a high-level understanding of the project can step in if one of us is out."

The Tipping Point

In 2020, in addition to imminent redistricting, CSA was upgrading from ArcMap to ArcGIS Pro. This transition raised questions about the long-term viability of CSA's aging database system.

"There was growing concern about relying on a legacy platform," Tillotson said. "We didn't want to be put in a position where we were forced to react."

Dr. Todd Fagin, executive associate director at CSA, noted that the center's role in a complex data ecosystem added urgency to the effort. CSA works alongside the State Board of Education, the Oklahoma Tax Commission, 77 county election boards, and other contractors—all maintaining parts of a system that must remain consistent and accurate.

Building a Modern Foundation

From their years as student interns to their current roles at CSA, Tillotson and Zakary Gipson, another senior GIS analyst, had accumulated deep knowledge of the project's challenges and potential solutions. They spearheaded the system upgrade. Before beginning the redesign, they attended conferences; learned from the

GIS community; and accumulated knowledge of PostgreSQL, Python, C#, and ArcGIS Pro SDK for .NET.

The modernized architecture centers on three major components.

First, CSA migrated from its legacy database system to PostgreSQL, with spatial database engine capabilities. This change enabled the team to consolidate 77 separate county file sets into a single statewide database that multiple users could edit simultaneously.

"The workflow is now a clear three-stage pipeline—ingest, report, and submit—not a long chain of manual queries," Tillotson explained.

Second, the team used ArcGIS Pro SDK and C# to develop custom tools. The most significant is the checks button, which runs more than 80 quality assurance tests on the data.

The checks tool transformed quality assurance from an end-of-cycle bottleneck into an immediate safeguard. When analysts finish working on a county, the system prompts them to run the checks. Any problems are immediately flagged with an explanation, allowing analysts to fix errors on the spot rather than weeks later.

"The ArcGIS Pro checks tool validates entries against lookup tables, so mistakes are caught immediately," rather than weeks after they occurred, Tillotson said.

Third, the team automated data processing using Python scripts.

The old report generation process required staff to manually create three PDF reports for every county with data changes, every month. This process took five to six hours. The new automated system generates reports and emails them to county election boards in a single run—all in less than 10 minutes.

"Monthly processing now includes automatic before-and-after snapshots and nightly backups," Tillotson said, "so audits and rollbacks are straightforward without rebuilding anything by hand. Some codes are also autopopulated from lookup tables during processing."

Enterprise Technology and Public Access

The new system leverages ArcGIS Online as its foundation. CSA maintains a 10-server infrastructure that hosts its enterprise systems and the State of Oklahoma GIS Data Warehouse. Powered by ArcGIS Hub, the warehouse

provides free public access to precinct boundaries and other election-related datasets.

"If data can be shared, it should be shared," Gipson said. "The data warehouse is a great way for us to do that, and it makes all this data more transparent and easier to access."

The transition to ArcGIS Hub marked a significant improvement over CSA's previous HTML-based data repository, which primarily served existing GIS users who wanted to download shapefiles.

"It wasn't really designed for the general public," Fagin noted.

The modern platform includes a viewer that allows anyone with a web browser to access and explore election data without specialized GIS software.

The publicly available data serves multiple constituencies. County election boards download updated precinct boundaries for their operations, news organizations use the data for election coverage, and members of the public can verify their own precinct assignments and polling locations.

A Seamless Transition

One of the most remarkable aspects of the modernization is what didn't change—the State Election Board's experience. CSA continued delivering its reports and met all regular deadlines throughout the transition. The only indication that something had changed came from CSA's primary contact at the State Election Board, who noticed fewer errors than in the past.

"They never saw any changes on their end," Tillotson said. "They never actually even knew that this was [happening] on our side."

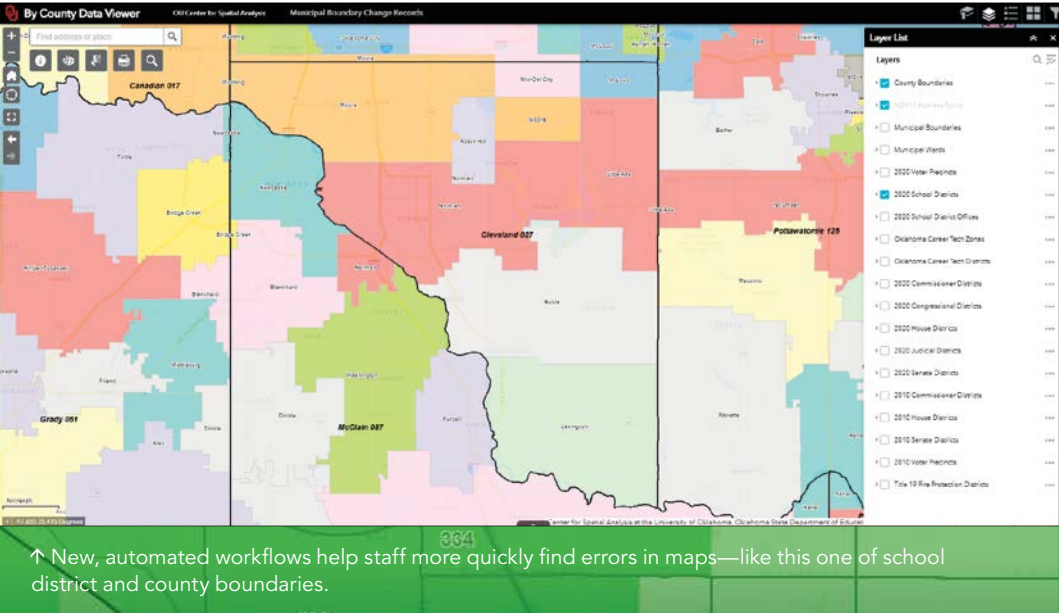
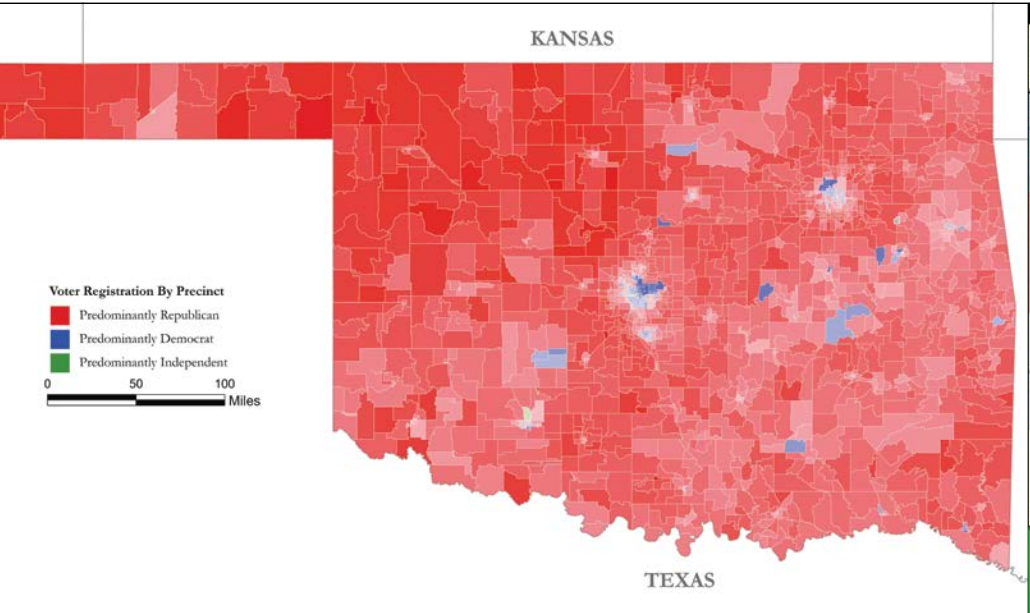
Lessons for Other States

Oklahoma's election GIS modernization can be a model for other states facing similar challenges. The key takeaway, according to Fagin, is recognizing when a legacy system has outlived its usefulness.

"There's good reason that anyone who's still using a single-user database and managing multiple databases may want to go to a multiuser database," he said.

For more information on CSA, visit ou.edu/ags/csa or email Fagin at tfagin@ou.edu or CSA director Dr. Chengbin Deng at cdeng@ou.edu.

↓ A web map shows voter precinct boundaries and other administrative layers in central Oklahoma.



↑ New, automated workflows help staff more quickly find errors in maps—like this one of school district and county boundaries.



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A Digital Twin of Istanbul Now, a 3D Cadastre of Türkiye Next

The foundation of property rights rests on two simple questions: Who owns what, and where is it? For centuries, cadastres—official property registries—answered these questions in 2D. But as cities have evolved, officials in Türkiye realized they needed a third dimension—one that would extend vertically across the entire country.

The result is a national initiative to map every building, parcel, and property boundary in 3D, from Istanbul's historic skyline to the ancient streets of Ankara. By providing a digital foundation for 21st-century cadastres, this effort will transform how Türkiye manages property rights.

Understanding the Foundation of Property Rights

A cadastre is an official register that documents the ownership, boundaries, and value of real property. Historically maintained as paper records and 2D maps, cadastres have since evolved into digital systems. Adding a third dimension—height—unlocks entirely new capabilities.

“The third dimension's importance really kicks in when you consider things like boundaries and volumes,” said Yavuz Eren, CTO of Esri partner MipMap Technologies, which leads the project in Türkiye.

In countries where property taxes are based not just on land area but also on the volume of constructed space—like in Türkiye—these volumetric calculations matter for taxation as well.

A Unique, Integrated Platform

The project integrates Türkiye's disparate property data systems into a single, authoritative platform.

“This project unifies outdoor and indoor 3D city modeling, parcel-building-unit relationships and inventory, cadastral integration, and advanced 3D GIS analysis into a single, end-to-end operational system,” Eren said.

Istanbul serves as the initial testing area, with about 1.3 million buildings mapped in a citywide digital twin. MipMap CEO Cenk Şen said that Türkiye started with Istanbul because of the size of its data repository, as well as its earthquake risk, economic impact, complex building stock, and data challenges.

“If the system can succeed at an Istanbul scale, it can be deployed anywhere in the country,” he remarked.

After Istanbul, the model will expand to cover the rest of Türkiye, enabling a next-generation approach to property management. It will help address—on a country-wide scale—issues such as earthquake risk, rapid urbanization, national digital transformation goals, administrative needs, and economic motivations.

ArcGIS Reality Drives Additional Solutions

Türkiye's cadastre authority evaluated multiple solutions before selecting ArcGIS Reality as the foundation for creating high-fidelity 3D content. The decision came down to geospatial accuracy, visual realism, performance, and the ability to integrate diverse data sources.

The next step was identifying a partner. With more than 25 years of photogrammetric experience, MipMap quickly demonstrated what the technology could achieve.

“ArcGIS Reality generates 3D textured meshes that preserve straight edges and fine details and eliminate distortions,” said Şen, adding that the project uses 10-centimeter-resolution imagery.

The software delivers survey-grade accuracy that's essential for cadastral applications. It also supports distributed processing across multiple machines so it can be implemented at large scales.

Beyond the core Reality mapping with ArcGIS Reality, the broader Esri ecosystem proved essential.

“The real hero of this project is actually ArcGIS Enterprise,” Şen said, noting its high-availability structure, performance monitoring tools, and integration with field apps such as ArcGIS Field Maps and ArcGIS Survey123.

Advanced urban analysis and Internet of Things (IoT) integration will eventually help with projects related to property valuation, urban planning support for earthquake resilience, environmental simulations for flood prevention, and noise and air-quality mapping, according to Eren.

In one district of Istanbul, the system uses 3D building models, structural data, simulation models, and AI to estimate which buildings, floors, or units might experience the most shaking during an earthquake. AI can also simulate added trees, changed bus routes, and redesigned intersections to make targeted areas quieter and healthier.

Overcoming Challenges with Data

Even with more than 200 MipMap employees and subcontractors working on the project, MipMap faces significant technical and logistical challenges.

One involves combining three distinct data formats: a city-scale semantic model (including building types, uses, construction information, and topology), building-scale interior architecture data, and digitized photogrammetric building data. The solution requires sophisticated automation, semantic mapping, geometric cleaning, and a geospatial database that can handle both 3D geometry and building-level semantics.

Another challenge involves keeping the massive dataset current. To detect change, the team compares periodically collected aerial imagery with existing models and combines that with digitized



↑ Türkiye is on a mission to map every property in the country in 3D, from Istanbul's historic buildings like the Sultan Ahmed Mosque, or Blue Mosque (shown here), to the streets of Ankara.



↑ The 3D textured meshes that ArcGIS Reality generates preserve fine details and eliminate distortions.



building permits that trigger updates when approved, ensuring that the model stays current and accurate.

A Blueprint for the Future

Eren sees potential for new applications of landscape-wide, digitized geospatial analysis.

“We have to come up with new approaches in terms of extracting value from urban-scale digital twins,” he said, noting the need for better coordination regarding revenue sharing and service creation.

He envisions companies in fields such as real estate analysis, energy efficiency, and environmental simulation being able to build apps atop a foundational model for sustainable development and data-driven urban planning. This could inform solar energy analyses and citywide building retrofitting projects. Economic benefits include 3–12 percent increases in property tax revenues as unmapped areas become visible, plus operational cost savings via automation, according to Eren.

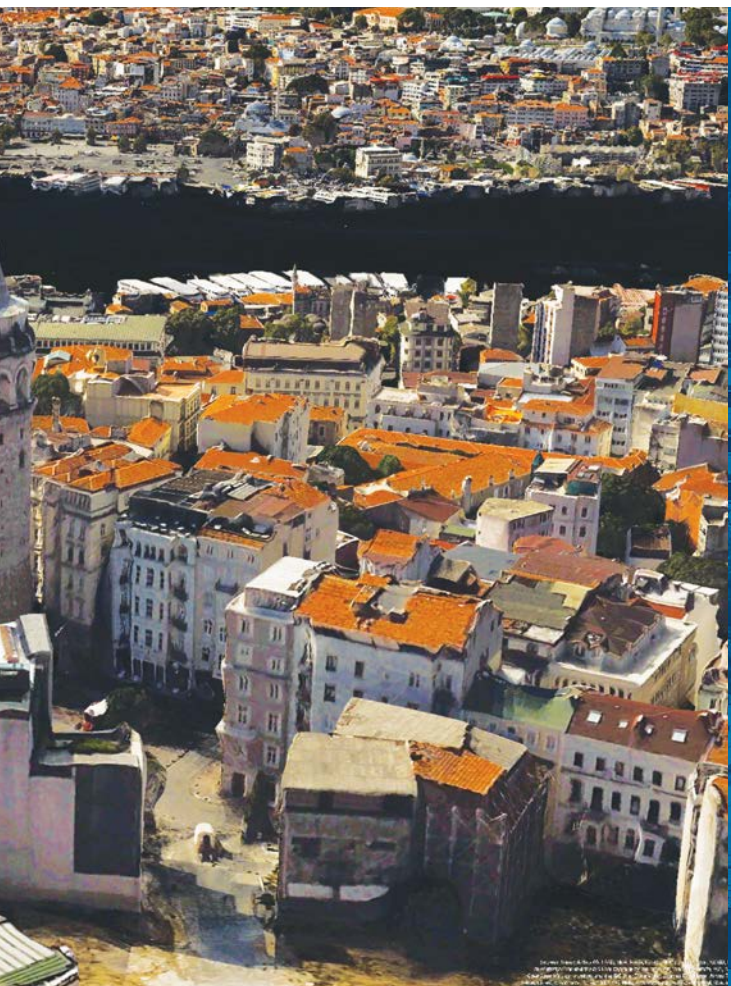
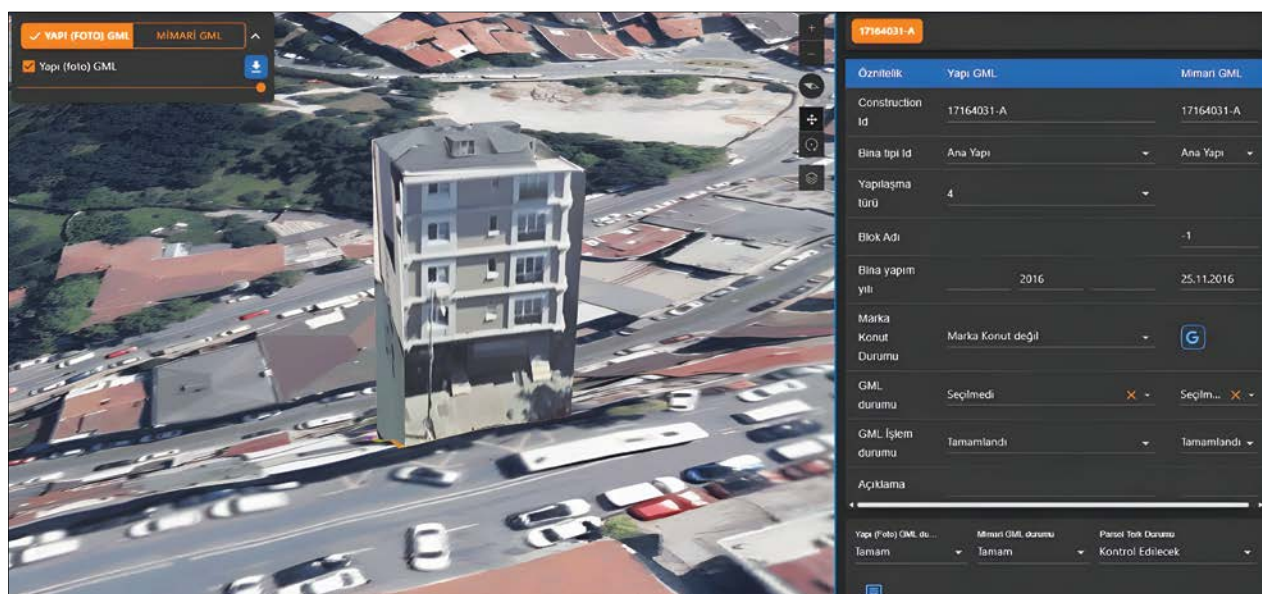
“Organizations can save more than 20 percent on inspections, zoning checks, and valuation processes, as much of this work is automated,” he said. “City planners, emergency teams, and utility providers also benefit from accurate 3D data, avoiding mistakes and making infrastructure investments more efficient.”

Sohail Elabd, Esri’s global director of emerging markets, said the project is noteworthy not only for the scale of its 3D modeling but also the fact that it’s built as an operational system.

“Türkiye’s approach shows how geospatial technology has moved beyond maps to become part of core government workflows,” Elabd said. “A national 3D cadastre creates a digital backbone for modern cities—supporting resilience, efficiency, and transparency, and setting a benchmark for other countries as they modernize their land and property systems.”



↑ The project incorporates building-specific 3D imagery with floor plans, ownership information, construction details, and more.



↑ It is important for officials in Türkiye to build and maintain a 3D cadastre for the entire country.

Technology Transformed

When Clint Brown joined Esri in August 1983, GIS was barely an industry. The software ran on high-end minicomputer systems that cost close to a million dollars to install. Only a small number of organizations could afford to experiment with the technology. Those early users weren't following best practices—they were inventing them.

Today, Brown serves as Esri's director of software products, a role shaped by decades of listening to how people actually use GIS in their work.

From the earliest user meetings to today's Esri User Conference (Esri UC), Brown reflects on how peer-to-peer sharing—of maps and methods, via personal stories and professional workshops—helped grow a community that transformed GIS from a niche field into an enterprise-wide technology that's vital to all industries and sectors.

The following Q&A has been condensed and edited for clarity.

Q When you think back to the first Esri user meetings in the 1980s, before there was an official Esri User Conference, what do you remember?

A What stands out most to me is just how early it all was. At the time, GIS was growing, but there weren't established best practices—a shared language or documentation to look to for how to do the work. Everyone was essentially inventing their own approaches as they went.

That's what made those early user meetings so important. They became a space where people could compare notes: what they were trying, what was breaking, what was working, and what they were learning along the way. It wasn't formal instruction. It was practitioners trying, together, to make sense of a new technology.

My first experience with that was as a user, not as an Esri employee. I attended the third Esri user meeting in May 1983 while I was working at the US Fish and Wildlife Service. For the first few years, the meetings were held on Esri's campus in Redlands, California, during spring break at the local Montessori school, which Esri shared grounds with. There were 18–20 of us in the room, representing roughly 10 organizations, figuring things out in real time.

That act of learning directly from users—that willingness to share with each other—became the foundation for how this community formed. In many ways, those early conversations set the tone for how GIS would evolve: not just as software, but as a practice shaped by the people using it.

Q From the very beginning, listening to users—on support calls, in documentation work, and in meetings—was central to your work. What did that teach you about how people were learning GIS?

A When I began working at Esri in August 1983, one of the first things I was given was a paper on thinking about software as a product. It introduced eight principles: specifications, testing, documentation, release planning, naming, release notes, training, and user support. I had no previous exposure to the ideas and tenets that paper outlined, but it became the framework we implemented to support our software development, and one we still use today.

In my second week, I started answering technical support calls. Those calls quickly became one of the fastest ways to understand how GIS was actually being used. You could start to recognize patterns. Certain problems kept showing up. New approaches were emerging.

A lot of learning came through those conversations. Users were not just looking for help with commands in ARC/INFO's text-based interface; they were also trying to assemble workflows and make decisions about methods. These were things we had to figure out how to address within those tenets.

Answering and responding to those calls became a guide for identifying the topics and workflows we needed to write about. That work shaped our documentation and training and, eventually, the technical workshops at the conference. That combination of listening closely and then capturing what we heard as teachable practices became a durable tradition. It helped the community learn faster, it evolved software development, and it helped us build better support for how GIS was being used.

Q You've often pointed to 1986 as a turning point, when the map gallery and technical workshops were introduced at the Esri UC. What changed once users started bringing their own maps and teaching one another in workshops?

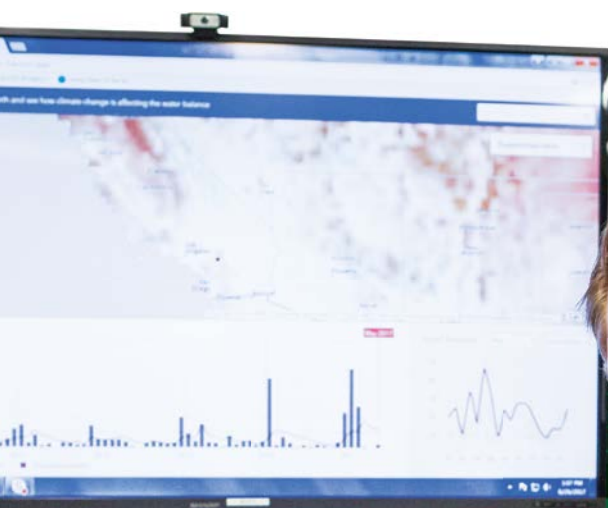
A By 1986, one of the clearer signals coming out of support calls was the need to help a growing GIS user community connect with each other, not just with us at Esri. Learning had been happening for years, but we needed ways to make it more visible and tangible. The map gallery was a result of that shift.

For the first time, users brought maps that represented months or years of work and put them up where others could see them. You could walk around the room, look at the maps, and immediately understand how different organizations were applying GIS. That visibility changes how people learned from each other.

The same need showed up in the technical workshops. We had already recognized that documentation could only go so far in explaining the software. Workshops created space for people who were deeply invested to work through ideas together. What mattered most was the synergy that came out of that participation. The questions people posed—and worked through together—often pushed the community further than any single explanation could.

And we needed that. Making learning visible changed how Esri thought about GIS, how we communicated about it, and how we supported it. It influenced our writing, our documentation, and how we stayed engaged with users on real problems, accelerating GIS development.

The 1986 Esri User Conference became a place where the community could see itself learning, and that spirit is still what makes the week such a critically important and energizing experience today.



→ Clint Brown is Esri's director of software products.





Q How did that early culture of sharing at the Esri UC shape the way Esri built and delivered GIS as it became more widely adopted?

A That culture of sharing changed how we thought about delivering GIS to our users. It made clear that this wasn't software meant to be used in isolation. GIS could be applied at different scales and in different contexts. If we wanted it to scale, we had to design and deliver it in a way that supported that diversity of use.

Over time, that's where ideas like spatial data infrastructures (SDIs)—the technologies, policies, and institutions that, together, make geospatial data usable—started to matter. Early SDIs were an important step because they put more geographic information on the web as shareable resources. But the limitation was that SDIs often stopped at individual datasets. What users actually needed was the ability to bring things together into maps and apps and use them to solve problems. That's where web GIS and shared information systems started to make practical sense.

Q Today, sharing data and collaborating across organizations is essential, especially in moments of crisis. What lessons from that culture of sharing still shape how GIS is practiced now?

A For me, Hurricane Katrina was the moment that really changed GIS. When it hit the Gulf states in August 2005, people suddenly needed the same data at the same time, and they didn't know where to get it. I remember getting calls before the storm from people asking where they could find basic layers. There was a lot of duplication, a lot of overlapping effort, and no clear authoritative source. It was chaotic.

That experience made something very obvious: You can't collaborate under pressure if data only lives in one place or inside one organization. In moments like that, the idea that every system is separate just doesn't hold up. Those lessons pushed the community toward shared services and authoritative information that could be reused and combined. A lot of the early thinking behind ArcGIS Living Atlas of the World came from that reality—not just from the idea that everything would be digital but from the need to have information ready and accessible when it mattered.

COVID showed what that looks like when the scale is global. When people talk about the Johns Hopkins COVID-19 dashboard, what stands out to me isn't just the dashboard; it's the fact that it worked because a community came together around shared information. We had built systems that could scale, and we'd learned—sometimes the hard way—that keeping things simple is what makes them hold up under pressure.

Q As GIS continues to grow and take on more complex challenges, what do you think is most important not to lose from those early, community-driven moments?

A What I think matters most is staying connected and continuing to share with each other. A lot of the most important shifts we've made didn't come from big plans—they came from listening closely and paying attention when something wasn't working.

As things scale, it's easy to assume the technology will carry itself. But GIS has always been strongest when it stays grounded in real problems and real people.



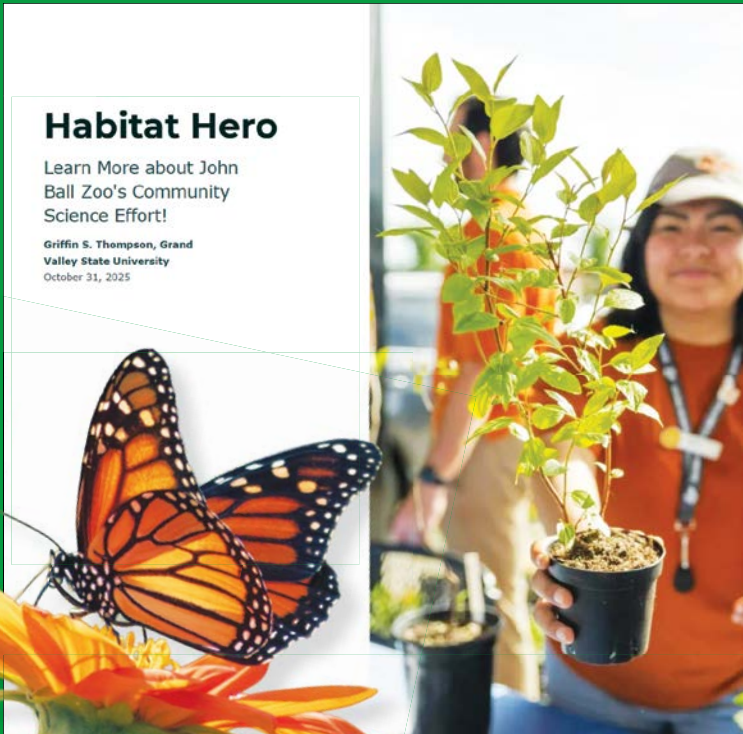
Spatial Data Is the Key to Community Conservation

By Griffin S. Thompson and Alexandra Locher, Grand Valley State University, and Travis Kurtz, John Ball Zoo

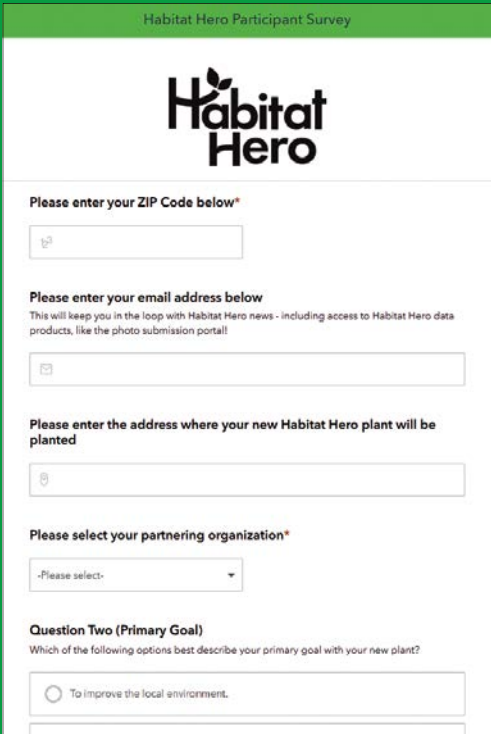
Development, intensive agriculture, and pollution routinely threaten the habitats of native pollinator species across North America. To mitigate these threats, John Ball Zoo in Grand Rapids, Michigan, established Habitat Hero in 2022. This community science and pollinator conservation initiative distributes over 2,000 native plants annually to more than 1,000 residents, augmenting pollinator habitat and engaging participants in active conservation. At dozens of community events, farmers markets, and other forums, Habitat Hero operates booths with a selection of native grasses, wildflowers, milkweeds, shrubs, and trees available for free.

As the program has expanded, so has the need for accurate, comprehensive geospatial data to assess its impact. In 2023, John Ball Zoo began recording plant recipients' ZIP codes to better understand the distribution of planting locations—which also aimed to shed light on pollinator habitat connectivity in western Michigan. However, the initial data collection method left something to be desired. Participants were asked to write their names, email addresses, and ZIP codes on a list, which required manual transcription and didn't provide the precision and resolution needed to identify potential pollinator corridors.

In collaboration with a research team from Grand Valley State University in nearby Allendale, John Ball Zoo reorganized the data process. GIS was already an invaluable mapping tool for Habitat Hero, but the zoo's conservation team realized it could be a means for engaging community science through participatory data collection, analysis, and communication. By January 2026, Habitat Hero expanded to 12 zoos and conservation organizations across the United States, largely drawn by the benefits associated with blending participatory and web GIS with community science. ArcGIS technology—including ArcGIS Online, ArcGIS Pro, ArcGIS Survey123, ArcGIS Dashboards, and ArcGIS StoryMaps—has enabled the team and its partners to collect and communicate a robust dataset and create easy-to-use apps. Now, communities throughout the country can participate in Habitat Hero's conservation efforts.



↑ A Habitat Hero story was created with ArcGIS StoryMaps and links to the Habitat Hero Dashboard.



↑ The 2025 Habitat Hero Participant Survey, built with ArcGIS Survey123, was distributed via QR code prior to participants receiving their plants.

ArcGIS Enhances Community Science

In April 2024, the John Ball Zoo conservation team used Survey123 to create the Habitat Hero Participant Survey. The survey has three sections: background information (such as ZIP code and email address), plant species, and intended planting location. It also includes some questions related to participants' perspectives on and knowledge about pollinator species. Responses to these questions can be aggregated by school district to identify any cold spots, which are used to guide educational efforts in the region. Approximately 85 percent of participants submit plant locations, forming the Habitat Hero Database. The rapid growth of Habitat Hero warranted a transition to Survey123 Connect—an app designed to create, publish, and manage surveys through XLSForm—beginning in spring 2026. This enables cascading selects with the list of native plant species, depending on the regional location of the participant, and streamlines data collection.



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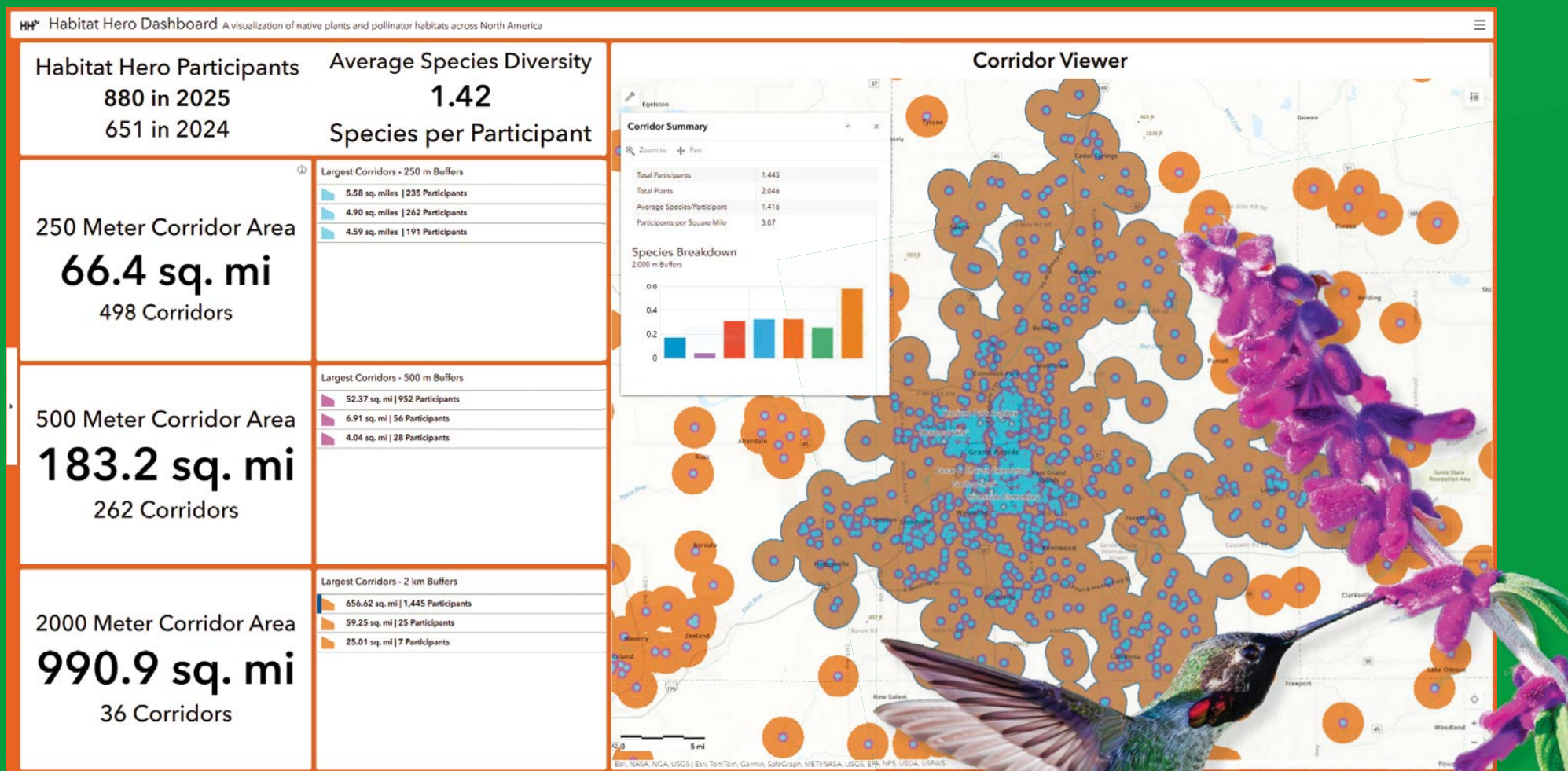


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↑ The Habitat Hero Dashboard is shared with all Habitat Hero participants and partnering organizations.

By creating a precise native pollinator host plant dataset, the conservation team can visualize the initiative's results and assess its effectiveness in reaching target communities. Anonymized survey results are displayed on the Habitat Hero Dashboard, with dynamic indicators showing the area within corridors connecting plant locations. These corridors are formed by dissolving buffers around plant locations that represent the maximum foraging distance—how far they travel between food sources—of pollinator classes. It's a simple and effective way to display contiguous areas formed by participants.

"Investigating corridors using foraging distance data from several pollinator classes will permit more realistic assessments of this program's impact," said Eric McCluskey, assistant professor of biology at Grand Valley State University.

One of the strengths of the Habitat Hero Dashboard is that it's a living document. It is subject to change as new elements are added and existing elements are modified or removed.

But these aren't the only ArcGIS tools Habitat Hero has incorporated successfully. In spring 2025, the team began using ModelBuilder in ArcGIS Online to anonymize survey results and automate dashboard processes.

ArcPy scripting increased the replicability of ArcGIS Pro analyses. These changes streamlined workflows and generated an 80 percent reduction in time spent on data management.

In addition, ArcGIS Business Analyst provides a variety of highly specific data related to other socioeconomic variables that the team uses to analyze the impact of plant giveaways. Stories created with ArcGIS StoryMaps introduce participants to the impact of Habitat Hero and its GIS analyses. Publicly accessible web GIS applications are shared in the Habitat Hero monthly newsletter.

Spatial Data-Driven Conservation

As Habitat Hero has expanded nationwide, it has enabled other organizations that hadn't yet taken advantage of geospatial tools to invest in GIS. Few of Habitat Hero's partnering organizations had done so previously. But these organizations quickly found that GIS enabled them to better understand their efforts in the community and provide a source of data when applying for outside grant funding.

Susan Meyers of Monarchs Across Georgia, for instance, helped expand Habitat Hero into the southern United States in 2025.

"It was amazing to see the impact we had across the metro Atlanta community," she said. "We could zoom in to identify where we created pollinator habitat corridors and to detect where we needed to do more work. The map was remarkably easy to use and share with our audience."

Organizations like Meyers's also discovered that ArcGIS Online, along with tools such as ArcGIS Dashboards and ArcGIS StoryMaps, can facilitate geographic and environmental public education efforts. Simple ArcGIS Online apps not only open the doors of geospatial analysis and meaning to the public but also serve as a form of geographic education for users. This emphasis on educational initiatives further develops a sense of place among participants and increases community investment in native pollinator

habitats and native plants—especially as more regions contribute to the Habitat Hero Database. These apps increase the likelihood that participants provide plant locations and deepen their understanding of the world around them.

When embraced by municipalities, Habitat Hero can contribute to urban natural resource management plans and applications for outside funding. Not only does the distribution of native plants increase natural land cover without taxpayer burdens, but it also amplifies local capacity and support for green infrastructure in these areas. Additionally, as plants mature, carbon sequestration increases—a key resource for climate action plans.

Over the coming years, John Ball Zoo's conservation team will seek new partners for Habitat Hero at zoos and conservation organizations across North America. Already, the number of people within 75 miles of a partnering organization has increased from just under 2 million in 2024 (in the area surrounding John Ball Zoo) to over 45 million in 2026 (around 12 partnering organizations collectively). As momentum continues to build, Habitat Hero combats the risk of extinction of threatened pollinators through active, collaborative community engagement.

For more information about Habitat Hero, email Travis Kurtz at tkurtz@jbzoo.org. For more information about GIS-related aspects of the initiative, email Griffin S. Thompson at thompgri@mail.gvsu.edu or Alexandra Locher at lochera@gvsu.edu.

About the Authors

Griffin S. Thompson is a graduate research assistant at Grand Valley State University who designed the GIS data management process for Habitat Hero. Alexandra Locher is a professor in natural resources and environmental management at Grand Valley State University. She guides the direction and data analyses associated with expanding Habitat Hero. Travis Kurtz is the community science coordinator for John Ball Zoo. He leads the implementation of the Habitat Hero program.

Angling for Interdepartmental Success

By Lewis Bruce, Iowa Department of Natural Resources, and Freddy Segura, Iowa Department of Management

↓ The Iowa Fishing Atlas interface with a focus on trout streams in northeastern Iowa.

The Iowa Department of Natural Resources (Iowa DNR) Fisheries Bureau has developed various public mapping tools designed to improve fishing opportunities for anglers in Iowa. However, lakes, urban ponds, rivers, and trout streams have historically been covered by separate maps and were developed with different platforms. Symbology was inconsistent, not all maps were interactive, and location updates were not automatically pushed from associated databases to apps. Additionally, some of the platforms used to make these maps were outdated.

To address these inconsistencies, Iowa DNR staff sought to combine their mapping tools into a single interactive web mapping app. The solution was the Iowa Fishing Atlas, a one-stop shop for the mapping needs of Iowa anglers.

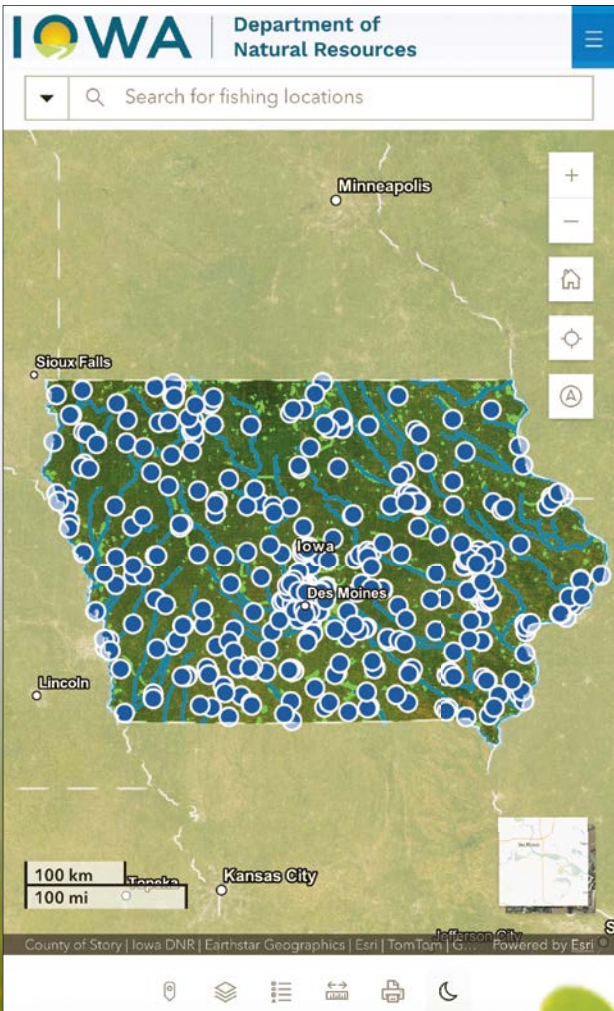
The app, created with ArcGIS tools such as ArcGIS API for JavaScript and ArcGIS Field Maps, facilitates ease of data collection and updates, standardizes map symbology, improves user trip planning, highlights amenity locations, and showcases fishing structures. Anglers of all skill levels can use it.

A Collaborative App

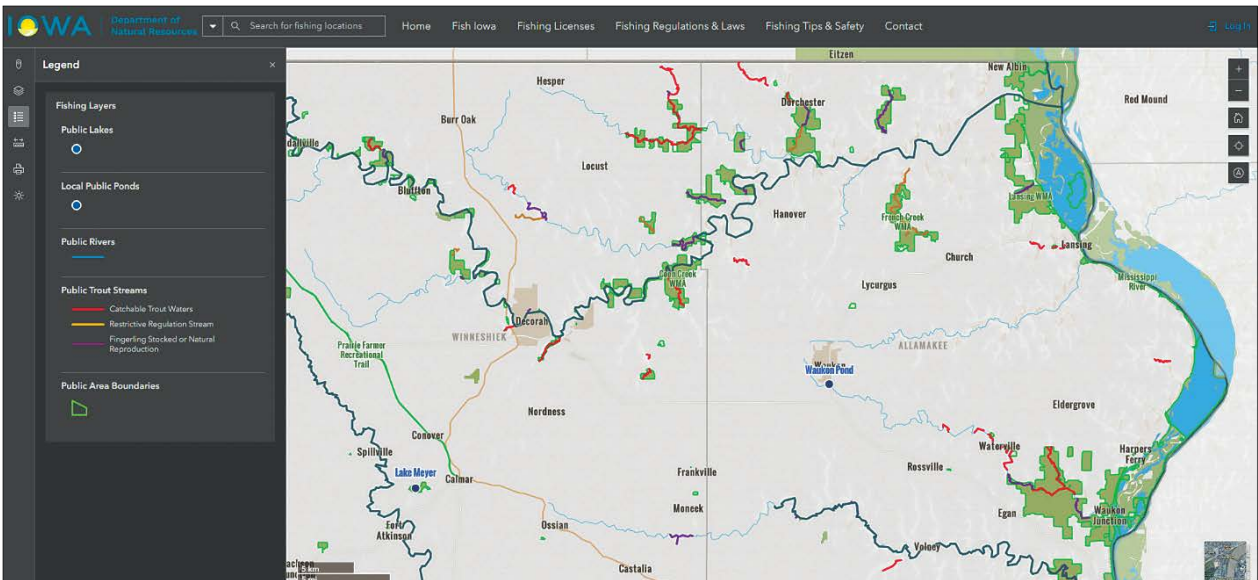
The first step in designing the Iowa Fishing Atlas was fostering collaboration among three disparate departments: the Iowa DNR Fisheries Bureau, the Iowa DNR GIS section, and the Iowa Department of Management (Iowa DOM). The Fisheries Bureau collected the location data and provided important feedback to the GIS section and Iowa DOM, which jointly developed the web app.

Built with HTML5, CSS3, and Bootstrap 5, the app is responsive and mobile friendly. Bootstrap's built-in components, such as the navigation bar and grid system, allow for rapid interface

↓ The Iowa Fishing Atlas is mobile friendly and can help anglers of any skill level find fishing locations across the state.



→ Male bluegill protect their nests during May spawning season.



development and a consistent look across devices. Custom styling ensures the app remains visually aligned with Iowa DNR branding while offering a clean and intuitive user experience.

The core mapping functionality is powered by JavaScript API, which enables dynamic map rendering, feature popups, complex spatial queries, and spatial interactions. Fishing data is presented with a variety of feature layers grouped by type, such as lakes, rivers, and amenities—eliminating the need for separate mapping tools.

A custom basemap and URL-driven map centering also enhance usability, letting users easily share or revisit specific locations. A wide range of interactive map widgets are designed to further enrich the user experience. These include a search bar, layer list, legend, basemap toggle, coordinate display, print tool, and sketch and measurement tools. Widgets are configured dynamically through JSON, allowing for flexibility and scalability. On smaller screens, certain tools are automatically hidden or repositioned to ensure a clean and accessible interface for all users.

One of the unique aspects of the Iowa Fishing Atlas is that it provides support to anglers of all skill levels and types, including shoreline anglers, boat anglers, and ice anglers. A novice angler can plan a trip from the comfort of home on a laptop, then open the Iowa Fishing Atlas on a mobile device after arriving at their destination to find congregations of fish near fishing structures. Avid anglers can view lake bathymetry, reducing the amount of time spent fishing unproductive waters.

Sometimes people prefer a map in hand; this was the impetus for designing the printing widget. Symbols can be turned on or off and spatial scale can be adjusted to create customized PDF maps. And all these features are available using equipment most people already own—cell phones, tablets, and PCs. No need to purchase specialized gadgets.

Internal Capabilities

Internally, the Iowa Fishing Atlas has proved useful as well. Iowa DNR uses the app for project planning, inventorying fishing structures, and maintaining infrastructure. A measuring widget, for instance, was added to facilitate measuring areas for aquatic vegetation treatments and shore lengths for shoreline bank armoring. Accurate and precise project planning can reduce costs, especially with an app all staff can take advantage of.

Given the importance of visual communication with the app's public users and the limited resources available for managing location data, ArcGIS Field Maps is another invaluable tool Iowa DNR has used to collect data and provide instant updates to the app. It's important to be able to communicate the locations of stiles and signs used to navigate trout streams, for example, or sites for Iowa's Community Fishing Program, which are dynamic and thus require constant updating.

For Iowa DNR, collaboration and communication have bridged the gap between fieldwork and the end user, helping to improve its maps and provide easy-to-use navigation. The Iowa Fishing Atlas is a vital tool for both Iowa anglers and the internal staff dedicated to managing the state's fisheries.

For more information, contact Lewis Bruce at lewis.bruce@dnr.iowa.gov or Freddy Segura at freddy.segura@dom.iowa.gov.

About the Authors

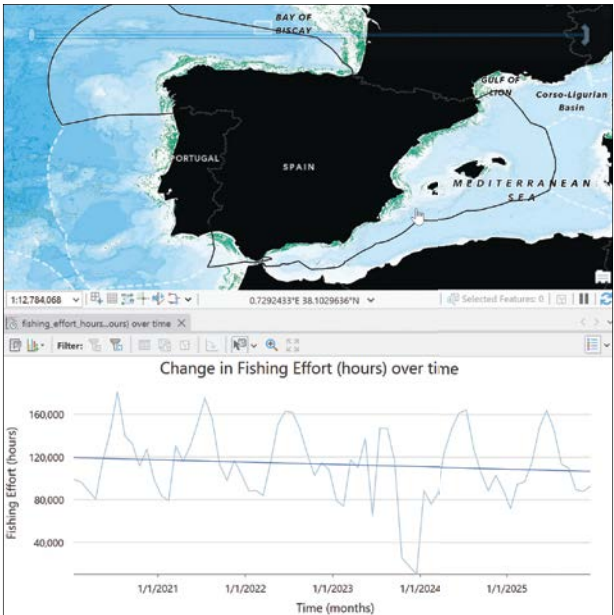
Lewis Bruce is the small impoundment research biologist for the Iowa Department of Natural Resources Fisheries Bureau and serves as the project manager for the statewide lake mapping project. Freddy Segura is a geospatial app developer with the Iowa Department of Management, where he designs, develops, and maintains GIS web applications.

A Clearer View of the Seas: Mapping the Fishing the World Can't See

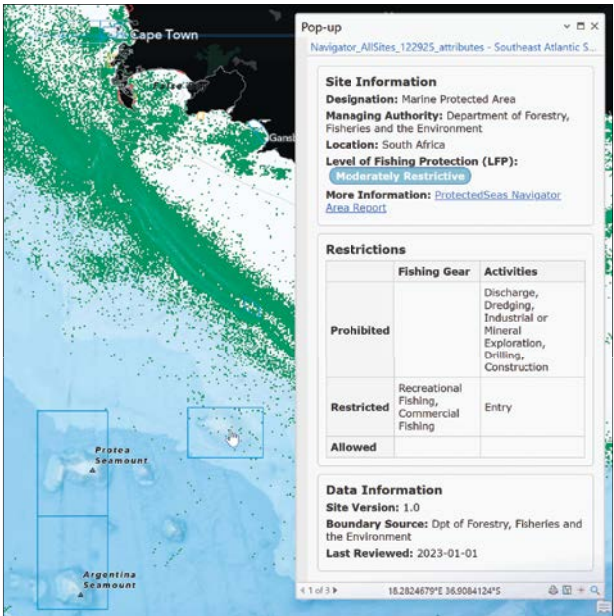
More than 70 percent of Earth's surface is open ocean. A significant share of commercial fishing activity happening across that expanse remains invisible to organizations trying to manage it.

Research published in *Nature* suggests that publicly accessible systems track only about 25 percent of global fishing activity. This leaves the rest essentially unseen. Without this information, regulatory agencies cannot set sustainable catch limits, enforce protected area boundaries, or prosecute illegal fishing.

To help address these issues, new data layers from Global Fishing Watch—an international nonprofit dedicated to ocean transparency—are now available in ArcGIS Online and ArcGIS Living Atlas of the World. These layers give the GIS community its most detailed look yet at vessel movements, fishing patterns, and offshore infrastructure across the world's oceans.



↑ The layers help marine conservationists monitor activity in and around marine protected areas.



↑ Data layers in ArcGIS Living Atlas of the World help ocean conservation groups and regulatory agencies monitor changes in fishing intensity over time.

A Milestone for Marine Data Access

Global Fishing Watch has a straightforward but ambitious mission: to make human activity at sea observable, open, and freely accessible to anyone working to understand or protect the ocean. The organization makes its data available to researchers, policymakers, journalists, and the public—including the growing number of GIS users working on marine conservation, fisheries management, and ocean planning.

While Esri created earlier versions of these layers, Global Fishing Watch has contributed new data. This signals a new level of engagement between the ocean data nonprofit and the Esri community, according to Esri senior principal GIS engineer Keith VanGraafeiland, who helped coordinate the effort to bring the new layers to ArcGIS Living Atlas.

Gaining Deeper Ocean Insight

The new layers bring together four data categories: vessel presence, fishing intensity, and vessel positions that are either known or unreported. Each is designed to illuminate a different dimension of human activity at sea.

Among the new datasets, Vessel Presence shows where commercial fishing vessels have been detected across the ocean, providing a clear picture of maritime traffic across time and space. A companion dataset, Fishing Effort, visualizes areas where fishing activity is likely occurring, enabling users to track patterns and identify hot spots where pressure on marine ecosystems may be greatest.

Two other layer pairs use satellite-based synthetic aperture radar (SAR)—a remote sensing technology capable of detecting objects on the ocean's surface regardless of weather conditions or time of day. The SAR Detection Matched layer identifies radar detections that correspond with known vessel positions reported via the Automatic Identification System, a network of terrestrial receivers that monitors the movements and locations of equipped vessels. An accompanying SAR Detection Unmatched layer highlights what analysts call "dark targets"—vessels that do not appear in public monitoring portals even when satellite radar detects them at sea. These unmatched detections may indicate vessels operating without active transponders, a behavior sometimes associated with illegal, unreported, and unregulated fishing.

Rounding out the new release is a fifth layer: SAR Fixed Infrastructure, which maps offshore structures such as oil platforms and wind farms detected by satellite radar. This layer helps planners and regulators monitor the expansion of the offshore industry over time, supporting marine spatial planning at regional and global scales.

Supporting Conservation and Planning

The dark targets that the SAR Detection Unmatched layer reveals sit at the center of one of the oceans' most persistent governance problems: illegal, unreported, and unregulated fishing.

The Food and Agriculture Organization of the United Nations identifies this as one of the greatest threats to ocean health and coastal livelihoods worldwide. Global fishing demand has grown steadily for decades—averaging 3 percent annually since 1961,

according to the organization—placing increasing strain on stocks and ecosystems already under pressure from activity that monitoring systems cannot detect.

Marine conservation practitioners can use Vessel Presence and Fishing Effort data to identify critical habitats, monitor activity near marine protected areas, and assess the cumulative impacts of fishing on biodiversity. Data gathered in this way can support negotiations for new marine reserves and inform management of existing ones, providing the evidence base policymakers need to make decisions with confidence.

For planners and regulators involved in offshore energy development, the SAR Fixed Infrastructure layer provides a current, authoritative inventory of platforms and installations across major ocean basins. Combined with other ArcGIS Living Atlas layers—such as bathymetry datasets, ocean current models, or habitat classifications—the new data helps ensure that infrastructure planning accounts for the full marine environment rather than just what is visible from shore.

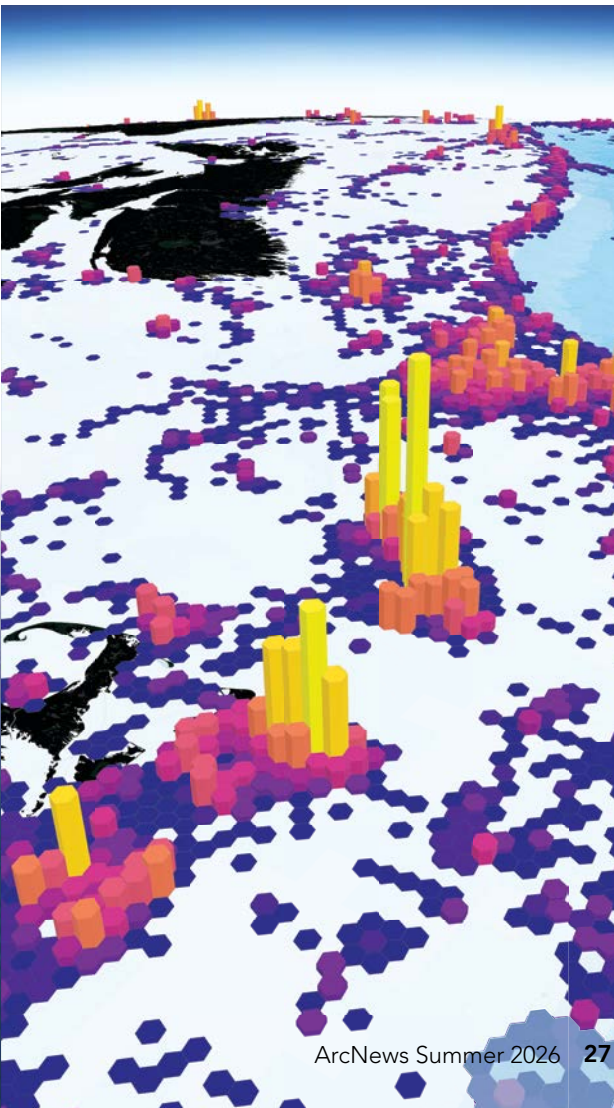
Getting Started with the Layers

The new layers, which users can access in ArcGIS Online and ArcGIS Pro, build on previous ArcGIS Living Atlas fishing layers, with expanded topic coverage, greater spatial and temporal detail, and multiyear time-series coverage.

For fishing vessels that have long operated beyond the reach of public monitoring systems, the SAR layers in particular represent a meaningful shift—satellite radar is indifferent to switched-off transponders, fog, and darkness. The world's oceans remain vast, but the window into what happens across their surface has never been clearer.

For more information on these layers, email Keith VanGraafeiland at kvangraafeiland@esri.com.

↓ A 3D map of coastal New York and New Jersey uses hexagons to show areas of high fishing activity.



In the Arctic, Coproduced Maps Help Find Balance Under Pressure

Scientific Currents

By Greg Fiske,
Woodwell Climate Research Center

Often described as the world's thermostat, the Arctic reflects solar heat and regulates the global jet stream that dictates weather patterns far beyond the North Pole. Climatic conditions in the Arctic have implications for the rest of the planet.

But the Arctic's critical cooling system is under immense strain. The region is warming at a rate nearly four times the global average, sparking the potential for more extreme weather and rising sea levels that threaten communities in every latitude.

For the Indigenous peoples who have stewarded the Arctic for millennia, this crisis is compounded by a dual pressure: the rapid physical collapse of their environment, as permanently frozen ground—called permafrost—thaws, and the encroaching footprint of industrial resource extraction and development.

At Woodwell Climate Research Center, cartographers and geospatial experts with the Permafrost Pathways project recognize that navigating this unprecedented breaking point requires more than just remote monitoring. That's why project participants work alongside Indigenous partners to transform spatial data into a tool for empowerment, ensuring that those most affected by a warming world have the mapping resources necessary to adapt to it and influence decision-makers.

Making Threats Visible

Woodwell's geospatial experts work throughout the Arctic, including in one of the most unique corners of the permafrost zone: the high-altitude taiga of northern Mongolia. The Dukha people have lived in this part of the world for thousands of years and have maintained a delicate symbiosis with their reindeer and the frozen earth beneath them. But today, this balance is under pressure from multiple angles.

In addition to thawing permafrost that's quickly changing the taiga environment, the Mongolian government recently established national parks and unmarked administrative boundaries along the Dukha people's traditional migration routes. Because the herders have lacked access to spatial data, they often find their customary movements inadvertently criminalized by borders that exist only on a distant bureaucrat's desk.

Woodwell's cartographers have partnered with Dukha reindeer herders to create maps and build a geospatial arsenal that makes these threats visible.

→ A herd of reindeer at a camp in northern Mongolia. (Image by Greg Fiske.)

This work allows the herders to put what's important to them on the map. It also establishes GIS as a bottom-up mechanism for land-use advocacy and cultural resilience rather than a top-down surveillance tool.

The foundation of Permafrost Pathways' mapping work on Dukha land—and throughout the Arctic—is the coproduction of maps: an intentional synthesis of Indigenous knowledge and Western geospatial science. Coproducing maps is a collaborative, community-led process in which Indigenous knowledge-holders and external partners work together as equals to create map products that integrate Indigenous knowledge with Western science.

Building trust and long-term friendships is the core of this process and a benchmark for success.



↓ Drone imagery like this helps visualize the Dukha reindeer herders' camps on the taiga of northern Mongolia. (Image by Sugarragchaa Lkhagvajav.)



↑ The Woodwell Climate Research Center has taught GIS workshops in Anchorage, Alaska; Kautokeino, Norway; and Mongolia—all in the permafrost zone of the Arctic. (Map by Greg Fiske and Christina Shintani. Data from Jaroslav Obu et al., *Northern Hemisphere permafrost map based on TTOP modelling for 2000–2016 at 1 km² scale*, 2019.)



↑ After training with cartographers from Woodwell, Lucy Martin created this map of Kuigilnguq, Alaska, showing the infrastructure destroyed by Ex-Typhoon Halong.

Training Events and Workshops

True coproduction begins not with discussions of data and software but with iterative conversations. Rather than arriving with a predetermined suite of solutions, Woodwell cartographers prioritize listening to the community’s needs. Does persistent Arctic cloud cover require the use of drone technology? Is it important for community members to learn ArcGIS Pro to better communicate with government agencies?

“This is a deeply iterative process,” said Jackie Dean, a research assistant and geospatial expert on the Permafrost Pathways project. “We listen, we map, and we adjust based on constant feedback.”

By centering Indigenous community members’ experiences and specific goals, the resultant maps become more than data visualizations—they become a shared language that respects millennia of tradition while benefiting from cutting-edge geospatial technology.



↑ Permafrost Pathways hosted a GIS workshop in Anchorage in 2025. (Image by Amanda Poston.)

The Power of the “Map Share-Out”

Woodwell cartographers have extensive experience facilitating map-based training workshops throughout the Arctic. The process follows a narrative arc that begins and ends with the participants’ unique voices.

The sessions start with a “map share-out,” where each participant stands at the front of the room to introduce their home

and history. Using whatever tools are available—a paper map, an interactive web map, or a digital layer—they define what their land means to them and describe what’s special about their home and way of life.

Custom technical training comes next. Based on the priorities identified in the months leading up to the workshop, Woodwell cartographers develop tutorials that provide the tools needed to solve local problems. This could include how to manage drone data using Site Scan for ArcGIS, an introduction to using ArcGIS Pro for government-level reporting, or an ArcGIS StoryMaps lesson for public advocacy and communication with broad audiences.

Gaining Geospatial Fluency

The true power of this relational approach to mapping was evident during Woodwell’s 2025 workshop in Anchorage, Alaska, held in the wake of Ex-Typhoon Halong. Participants came from the Yukon–Kuskokwim Delta in southwest Alaska—a region devastated by the storm.

The resilience shown by workshop participants was staggering. Three people arrived at the training just two weeks after evacuating from their homes. Two of them were rescued from inside their houses as the structures floated away. One of these people was Lucy Martin of Kuigilnguq, Alaska, who, despite enduring this trauma, felt that gaining geospatial fluency was important enough to continue with the training so she could use maps to tell her story.

At the workshop, Martin developed a comprehensive map of community infrastructure destroyed by the typhoon. Her work has since transcended the classroom, serving as a visceral and effective tool for briefing Alaskan representatives from state and US congressional offices on the urgent need to fund climate adaptation in her community.

Over the years, Woodwell has worked with numerous workshop participants like Martin to build GIS expertise for local advocacy. This collaboration relies on weekly check-ins—both before workshops, to identify specific needs, and afterward, to help participants hone their newly acquired skills.

Building the Digital Infrastructure to Help

Each workshop culminates in a final share-out, where participants retell their stories through the lens of their newly acquired skills. This is often the most transformative part of the experience

and demonstrates what participants have learned. The final map share-outs also serve as catalysts: When one participant shares a breakthrough, it often inspires others.

Whether the challenge is storm resilience in southwestern Alaska or the rapidly changing landscape of the Mongolian taiga, the fundamental mission remains the same: providing Indigenous communities with the tools to tell their stories on their own terms. GIS has proven transformative in this effort, shifting the power of mapmaking from distant agencies to those who have lived in harmony with these landscapes for as long as humans can remember.

By documenting their boundaries, migration routes, and climate impacts, these communities are doing more than just creating data; they are building a digital infrastructure to support their cultures and futures.

A Deep Global Partnership

The Woodwell team is traveling to Mongolia again this summer, where they will sit down with the Dukha herders to listen and learn. This next chapter is not merely a continuation of technical work but is also a deepening of a global partnership that spans the entire permafrost region.

The lessons from across the Arctic are clear: If there’s any chance of stabilizing the Arctic permafrost, we must look to the people who have managed it for millennia. Indigenous-led conservation, fueled by the precision of modern mapping, represents one of the most effective strategies for global climate adaptation.

When we support the traditional stewards of the North in visualizing and defending their lifeways, we aren’t just helping them navigate a changing landscape—we are ensuring a more resilient and equitable future for the entire planet.



About the Author

Greg Fiske is the director of geospatial technology at Woodwell Climate Research Center. A geographer and cartographer with over two decades of experience, he specializes in GIS, remote sensing, and data visualization. Fiske bridges art and science, creating impactful maps to communicate complex climate data, particularly regarding Arctic ecosystems.

Make Maps *with* People, Not Just for Them

From the Meridian

By Dr. Clancy Wilmott,
University of California, Berkeley

Cartographers and geographic information scientists often fall into this field because they enjoy maps. They like sourcing data, conducting geospatial analysis, and communicating visually. Many also enjoy the solitude and relative control they have over the process, which leaves plenty of room to make maps that are accurate, rigorously researched, and aligned with best practices in cartographic and geospatial standards. Meanwhile, the cartographer's client stands on the other side of the desk (or email), asking for their expertise and offering feedback when necessary.

Then, something different happens. The once-left-alone cartographer is asked to work with a community to use maps to better understand their worldview. Perhaps they've been approached by a local organization trying to produce social or environmental data, or they've joined a movement that wants to make a map for certain groups of people. Suddenly, the cartographer's processes, setup, and even fonts are thrown into disarray. Suddenly, the cartographer is making a map *with* people rather than *for* people.

When this happens, it can feel overwhelming. Cartography and GIS are often taught to be methodical, systematic, and orderly. Most cartographers develop their systems and workflows based on these expectations. Working with communities, however, is rarely any of that. Typically, mapping with communities flips the entire process on its head, rearranging the classic pipeline of gathering data first, conducting analysis next, and determining representation last.

Participatory mapping, for instance, is a method of working with people to understand how they see and know their worlds. It is often used to work with Indigenous and other vulnerable communities to bridge the divide between state-based understanding and local knowledge. Here, the map acts as a spatial anchor for information sharing,

Cartographers usually start these projects with a blank piece of paper and colored pencils. Participants identify what they would like to see on the map (for example, where land rights have been abused or people have been displaced) and what to keep off of it (sacred and ceremonial places, locations that are vulnerable to resource extraction, and spaces for people escaping violence

or persecution). These kinds of projects engage with information that's not routinely collected, so recuperating data is the end goal, not the first step.

This way of mapping is challenging. It also offers an opportunity for seasoned cartographers and geographic information scientists to see their professions from the viewpoint of people whose lives and environments are being mapped—people who might want different data, analysis, and representations so they can make their own decisions. This is one of the most valuable aspects of community-based mapping: It asks cartographers and geographic information scientists to rethink their processes, systems, and representations to better fit a new purpose.

Making maps *with* people requires a great deal of humility, care, and flexibility. Cartographers must listen, ask questions that may not seem necessary, and challenge the conventions they may take for granted. It's hard work. But keeping the following principles in mind can help:

Know the Purpose

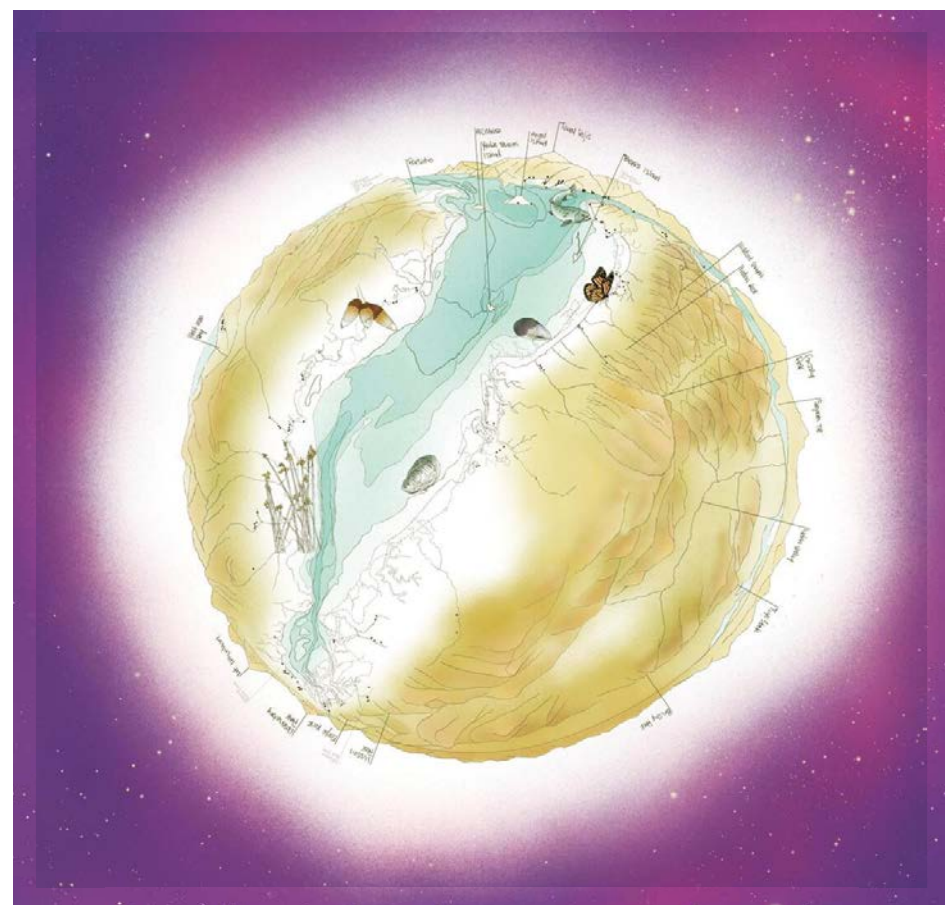
Who is this mapping project designed for, and why are you participating in it? What is the end goal? (To develop a proposal for a government organization? For the community to gather information about themselves or their environment?) Is the process more important than the final product? Is the map's purpose something other than wayfinding or conducting conventional analysis? Will the map challenge or expand the way maps tell stories? Who makes the map? Who reads it?

Set the Standards

Different community projects have different values. The training that cartographers and geographic information scientists receive prioritizes accuracy, quality, and readability. When mapping *with* people, however, participants might have different priorities that reflect their experiences and needs, such as data sovereignty, including where the data comes from and is stored; whether the software is no cost or inexpensive; how flexible the cartographic design is; or whether the politics of the project's technical side match or conflict with their own cultural and political worldviews. Sometimes, urgency is critical; other times, moving slowly and building trust is more important. The cartographer's role is not to decide on the standards but rather to advise on options and explore them as openly as possible.

Make a Community Agreement

Community agreements document the decisions made between mapmakers and the community



↑ This map portrays an Indigenous cartography of the San Francisco Bay Area. It uses an irregularly stereographic projection from three perspectives alongside astrological, environmental, and cultural data depicted as a mix of symbols and icons. (Map courtesy of the Sogorea Te' Land Trust and Clancy Wilmott.)

partners they're working with. Agreements elucidate the project's values, along with how and when intellectual property and cultural knowledge is shared, acknowledged, and credited (including authorship of the data or map). They also outline parties' labor and compensation expectations—and the right to end the partnership without animosity, plus what happens to the data if that occurs. The Guidelines for Ethical Research in Australian Indigenous Studies, from the Australian Institute of Aboriginal and Torres Strait Islander Studies, is a helpful resource for community agreements.

Listen

Community partners won't always know technical lingo, and it might be difficult for cartographers to be open to criticism of their work or the organizations they represent. But surprisingly often, these arguments are similar to the critiques that cartographers and geographic information scientists already have of their own industry. (We know the world is not the map!) Community partners may just use different language and experience unfamiliar consequences. What appears to be a technical issue could reflect generations of attempted erasure or the dispossession of knowledge and cultural property. So it's important to listen—carefully, openly, and slowly—and come to community agreements on how projects should proceed. Sometimes just listening and acknowledging is enough.

Not All Solutions Are Software

When cartographers and geographic information scientists learn to listen, a range of problem-solving options open up—options that don't involve technical or software-based solutions. Maybe there's no way around placing data on the mapping organization's server, but the community agreement can be renegotiated to ensure that control of intellectual property and copyright remains in the hands of the people who created it. Perhaps the modifiable areal unit is an enduring problem for measuring local outcomes, but the map or platform can display a disclaimer that makes viewers aware of the history of the unit and how it skews the data. Maybe adding images, videos, recordings, or other materials to a map would help communicate knowledge that can't be reduced to points, lines, and polygons.

By creating a space of reciprocity based on mutual respect and trust, it is possible for cartographers and geographic information scientists to embrace new opportunities that make a difference for those who need maps most. If you are prepared to listen, be flexible, document agreements, seek out unusual solutions, and let go when necessary, you can do incredible things and make maps *with* people, not just for them.

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

“ Suddenly, the cartographer is making a map with people rather than for people. ”



About the Author

Dr. Clancy Wilmott is an assistant professor in critical cartography, geovisualization, and design at the University of California, Berkeley. She was previously at the University of Manchester, where she received her PhD in human geography with a multisite study on the interaction among mobile phone maps, cartographic discourse, and postcolonial landscapes.



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← The Wisconsin Geological and Natural History Survey (WGNHS) took its statewide map of Quaternary geology, shown here, and made it usable by people who are blind, have low vision, cannot use a mouse, or are illiterate.

“Pressing the Up Arrow”: A Big Step Forward in Accessibility

Accurate geological data is crucial for understanding a region's landscape, managing mineral resources and water supplies, and facilitating research. For the Midwestern United States, the Wisconsin Geological and Natural History Survey (WGNHS)—part of the University of Wisconsin's Division of Extension—is one of the organizations that supplies this data. The interdisciplinary research organization provides free public information, such as maps and reports, based on surveys and analyses of Wisconsin's geology, water, soil, and mineral resources.

WGNHS faces a problem that has plagued cartographers and government agencies for decades: how to make complex digital maps accessible to everyone, including users who are blind, have low vision, cannot use a mouse, or are illiterate. Working with Esri startup partner **XR Navigation** (xrnavigation.io), WGNHS created an accessible digital map that goes beyond alternative text and gives users of varying abilities the chance to truly experience maps of Wisconsin's rich geology.

A Global Accessibility Barrier

Current estimates suggest that 1.6 billion people worldwide cannot access digital maps due to disabilities, literacy barriers, or technology limitations. Globally, 1 billion people are blind or have low vision, about 300 million people are colorblind, tens of millions of people have mobility impairments affecting mouse usage, and hundreds of millions more have print disabilities or low literacy.

For geological surveys, universities, and government agencies, inaccessible maps represent both a legal risk and a missed opportunity to serve the public. Digital accessibility lawsuits

increased by more than 20 percent in the United States last year compared to 2024, according to several sources, with legal fees alone averaging \$350,000 per complaint. What's more, beginning in April 2027, the US Department of Justice will require all digital maps from state and local governments to meet the Web Content Accessibility Guidelines (WCAG), which call for

blind, keyboard-only, and other disabled users to have equal access to digital content.

Beyond compliance, accessible maps open new professional and educational opportunities to people with disabilities. Critical fields of study—including geology, climate science, epidemiology, urban planning, and environmental science—all rely on understanding spatial data.

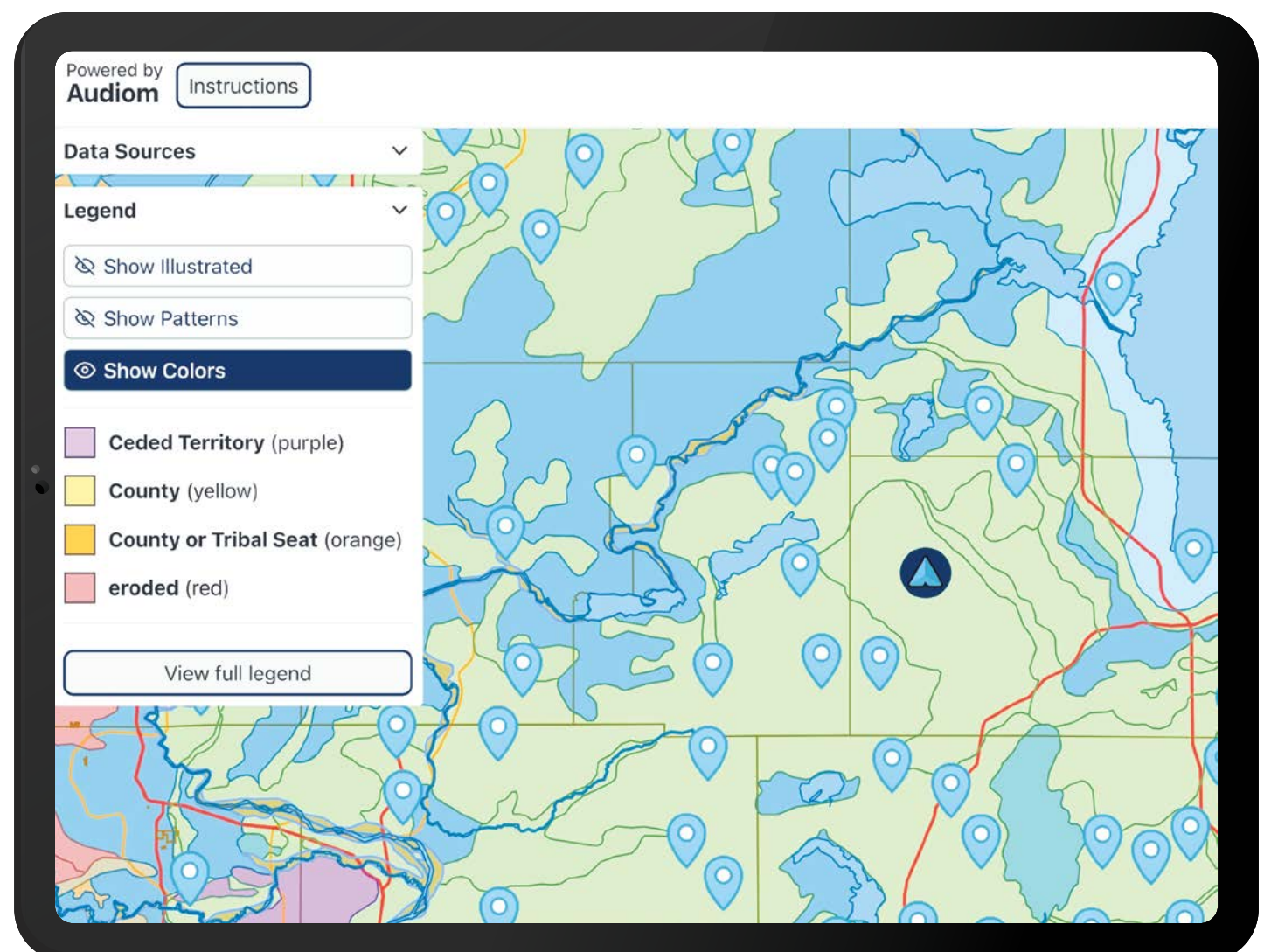
In 2025, WGNHS published a statewide map of the Quaternary geology—the current geological period. This map, available at links.esri.com/WGNHS-map, will serve as a major reference for K–12 schools, researchers, and the public for the coming decades. It shows glacial deposits and other geological features across Wisconsin using 57 color and pattern combinations, along with a variety of point and line symbols.

WGNHS cartographer Caroline Rose knew traditional digital maps exclude many users. When visually impaired people who use screen readers encounter a map, they hear only a placeholder phrase, such as “graphic” or “image.” Low-vision users can't zoom without breaking the interface. Users with color-vision deficiency can't distinguish between features shown only by color. Keyboard-only users can't select map features to learn their names.

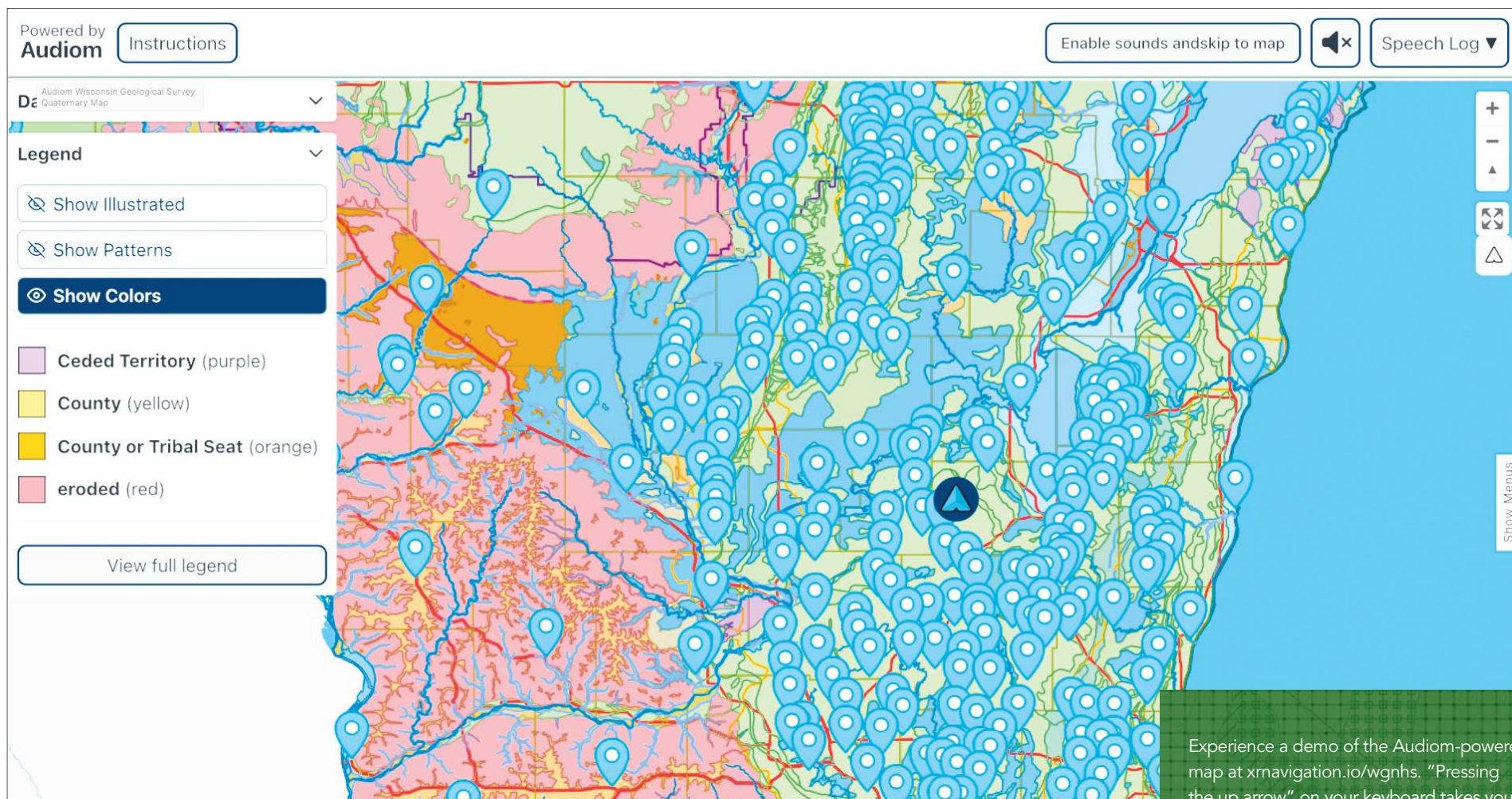
“Most maps are visual only, which is not useful to someone who is totally blind,” Rose said.

Following presentations and advice from accessibility researcher Frank Elavsky of Carnegie Mellon University, Rose was inspired to write a grant application to acquire resources to build more accessible maps.

WGNHS needed a solution that would make complex geological data truly accessible while maintaining the spatial information that makes a map a map—not just a table or text description. XR Navigation had the answer.



→ The colors in the map help users with color-vision deficiency distinguish features.



↑ The map shows Wisconsin's geological features using 57 high-contrast color and pattern combinations, along with a variety of point and line symbols.

Experience a demo of the Audiom-powered map at xrnavigation.io/wgnhs. "Pressing the up arrow" on your keyboard takes you forward in the map—the same direction that accessible cartography is moving.

Making Maps Accessible to All

Founded in 2020 by Brandon Biggs and Chris Toth, XR Navigation's mission is to make every map usable for everyone. Through the company's visionary digital map viewer and editor, Audiom, maps are accessible visually, auditorily, and textually.

Rose worked with the team at XR Navigation to integrate Audiom with WGNHS's existing

ArcGIS infrastructure and data. The collaboration transformed 16 ArcGIS feature layers containing vector data—including more than 3,000 unique polygons, lines, and points—into a fully accessible, interactive map. The map includes:

- Map unit polygons showing different types of geological deposits across Wisconsin.
- Cartographic lines indicating processes such as water flow direction.
- Point features marking geological interpretations.
- Reference layers such as counties, cities, highways, and water bodies.

The integration process required careful attention to how geological information would be conveyed in multiple ways. Typically, cartography only focuses on the visual presentation of geographic features, but with Audiom, the job of the cartographer expands to include audio and text. Rose created custom "rules files" that assigned meaningful names and sounds to each geological feature, translating complex scientific data into a visual-, audio-, and text-based experience.

"We grouped features based on geological relationships," Rose explained. "For instance, glacial deposits are presented together, and the grain size—from fine clay to coarse sand to large boulders—is conveyed through distinct sonic textures."

Seamless ArcGIS Integration and Versatile Functionality

The Audiom system connects directly to WGNHS's published ArcGIS feature layers. Any updates to the source data automatically appear in the accessible map, with no manual conversion required. The map is presented as either a tab in WGNHS's ArcGIS Experience Builder app or as an inline frame that can be embedded in any app or website.

Unlike simple reference maps, this geological map contains multiple overlapping data layers with hierarchical relationships. The Audiom interface allows users to toggle layers on and off, filter by geological properties, and navigate between different zoom levels that reveal appropriate levels of detail.

"The process was very thoughtful," Rose said. "XR Navigation understood both the technical requirements and the cartographic principles that make geologic maps meaningful. First, they focused in on what could make the Audiom map most effective at conveying the map's theme—in this case, geology. Then, they began to consider how to apply the approach broadly, so that implementing future geologic maps will be more seamless. They deeply considered both the textual and auditory cartographic aspects to communicate the map's message."

The team, working with Rose, developed sophisticated mapping that covers both visual cartographic conventions and nonvisual representations. Geological concepts that cartographers traditionally convey through color and visual grouping principles were translated into audio cues and text descriptions while maintaining navigable spatial relationships.

A Milestone in Accessible Cartography

The Quaternary Geology of Wisconsin map represents a breakthrough in map accessibility. It is built on the first known system—Audiom—that, according to Biggs, complies with the Americans with Disabilities Act (ADA) Title II, Section 508 and Section 504; Level AA of the WCAG; and other accessibility standards.

Unlike alternative text or data tables, the map preserves the spatial information—including distance, direction, shape, orientation, size,

and topological relationships—that makes a map valuable. Users can access the map visually, through audio, with a keyboard, via a screen reader, on a braille display, or through any combination of these methods—expanding the map's reach to a broader audience than ever before.

Rose's project has drawn attention from the cartography and accessibility communities. Rose presented the project at the North American Cartographic Information Society (NACIS) conference in October 2025 and other meetings in 2026, receiving enthusiastic feedback.

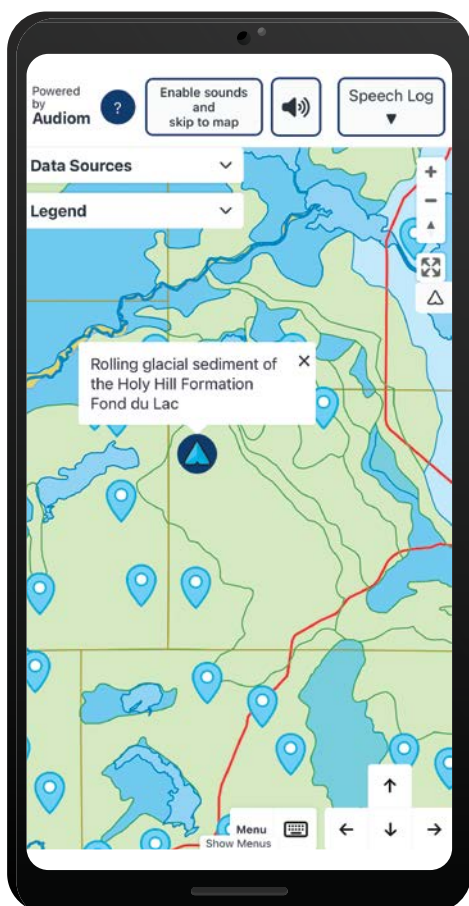
The Quaternary Geology of Wisconsin map has also connected University of Wisconsin science communication staff with researchers from Carnegie Mellon and the Georgia Institute of Technology who are working on map accessibility, opening up broad possibilities for future innovation.

Unfolding Future Potential

The success of the Quaternary Geology of Wisconsin map has revealed new prospects. WGNHS is exploring the use of accessible maps for many of its other publications, and the integration with Experience Builder widgets will allow even faster deployment for future maps and projects.

This project proves that the impossible is possible. For decades, digital map accessibility exceptions in laws like the European Accessibility Act existed because legislators assumed accessible maps couldn't be built. The Wisconsin Geological and Natural History Survey has shown that with the right technology and commitment, government agencies really can make maps usable for everyone.

↓ Geological concepts that are typically conveyed through color and visual grouping principles are presented as audio cues and text.



Cartography Goes Beyond Visual

The Relevance of Cartography

A Cartographer's Perspective

By Dr. Vincent van Altena, Kadaster and Dr. Jakub Wabiński, Military University of Technology

Maps do more than show where things are; they denote the landscapes, weather, environments, and histories that shape society. They make scattered pieces of life click together.

Local maps, for instance, help people navigate neighborhoods without getting lost. Public transport maps keep travelers on track, helping them get to the right place at the right time. Globes showing parallels, meridians, the Tropic of Capricorn, and the Tropic of Cancer give students a better understanding of the seasons. In well-designed maps, visual variables such as orientation, shape, size, and

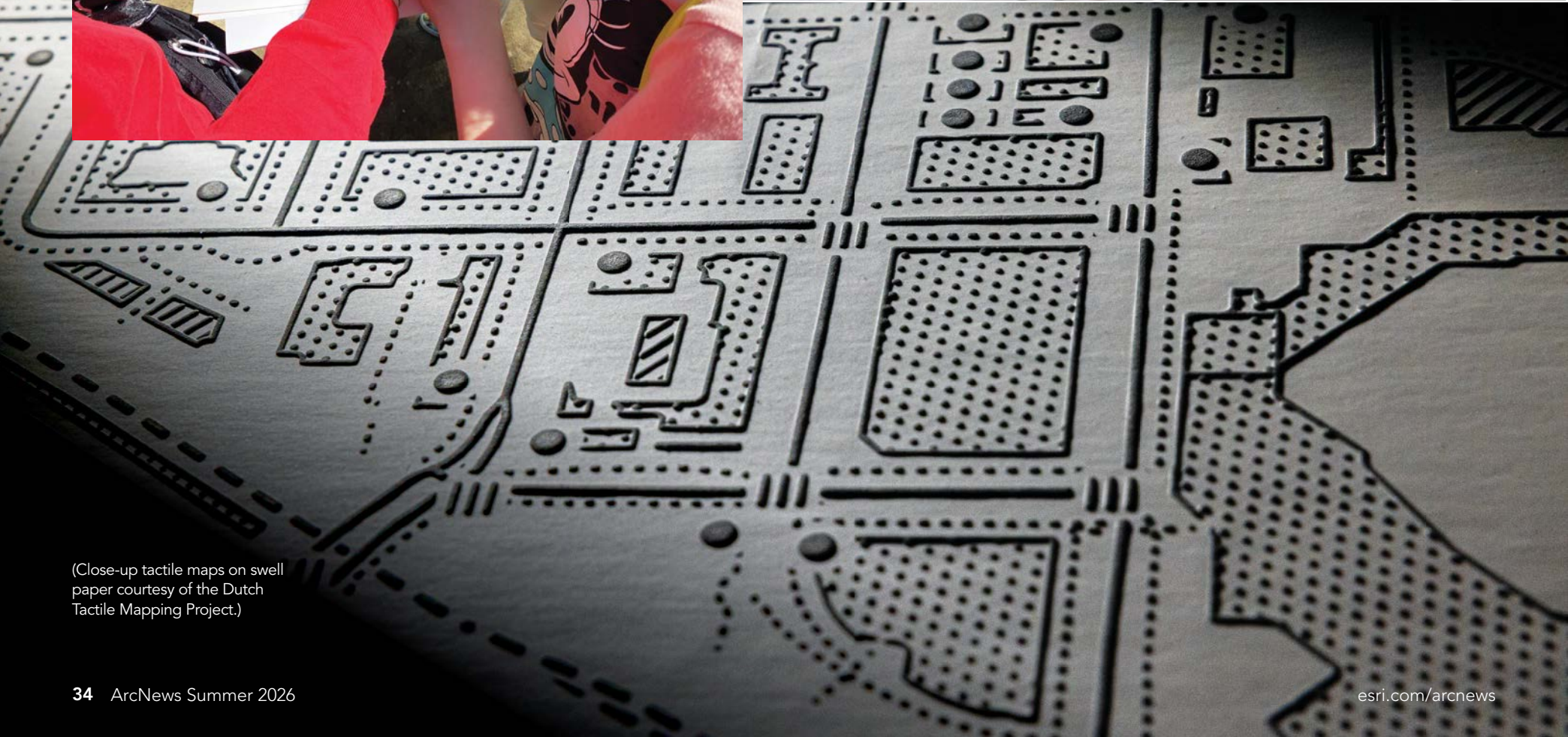
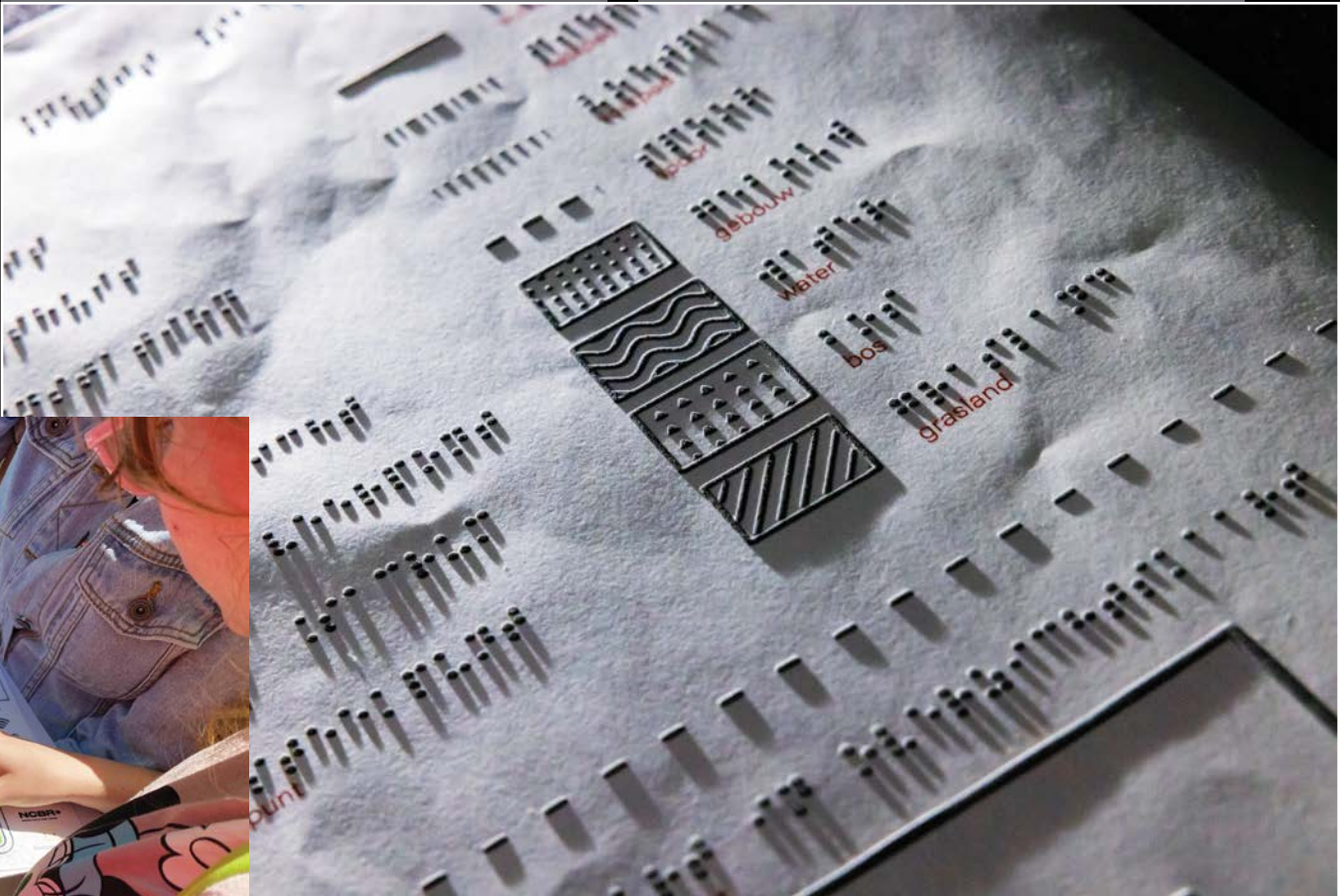
↓ To make useful tactile maps, it's important to work through the entire design and development process with people who have visual impairments. (Image courtesy of the Military University of Technology.)

color work together to relay specific messages. But what if the traditional, image-driven format of a map simply isn't accessible, excluding you from using it? Both of us are intrigued by this question.

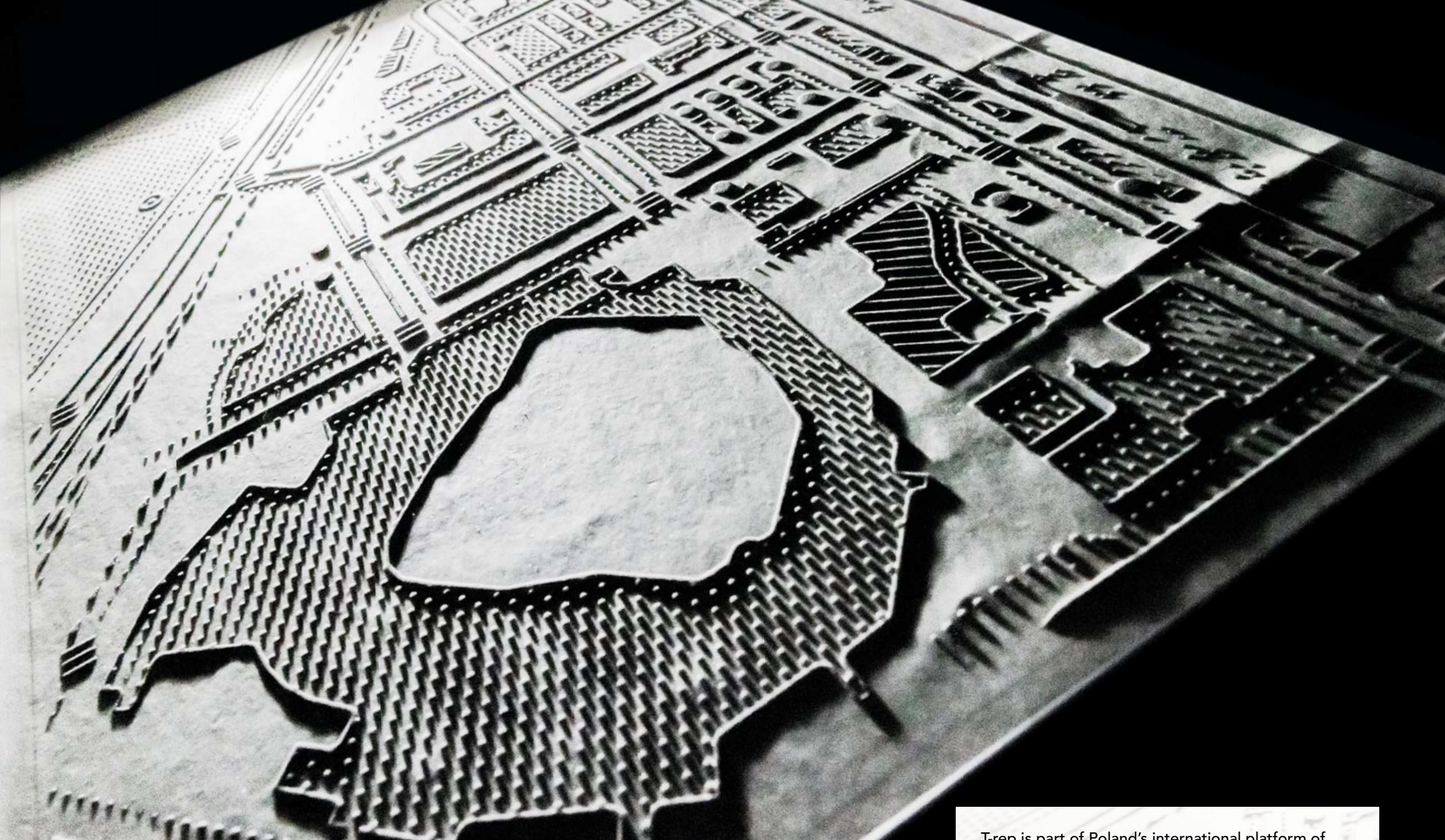
Wabiński remembers being five years old, clutching his first hiking map in the Polish mountains.

I was thrilled by the idea that I could find my own way, even if it meant getting lost now and then. That early love for maps stayed with me, and years later, I stumbled into a second fascination: 3D printing. The two

passions collided when I was at university. I thought, "Why not use 3D printing to create raised maps for people who can't rely on sight?" I have spent the last eight years researching design approaches and production methods for creating legible and informative tactile maps—physical maps with embossed elements that allow people with visual impairments to feel the lines, polygons, and other shapes that symbolize different spaces. My research is based on inclusive participation, where end users are involved in the creative process, from providing feedback to verifying solutions.



(Close-up tactile maps on swell paper courtesy of the Dutch Tactile Mapping Project.)



Van Altena's journey from digital map production to tactile cartography began in Zurich, Switzerland, in 2017. Cartographer Anna Vetter—then an intern at Esri Switzerland—showed him an example of her work during the internship: a black-and-white paper map with raised lines that revealed the shape of Switzerland.

At that moment, something clicked: If Anna could create an entire tactile atlas of her country, why couldn't I do the same for my country, the Netherlands? That question led to a map-development project where people with visual impairments were brought on as experts rather than merely consultants. They shaped everything, from the purpose of the maps to the symbols, textures, and layouts. The maps were iteratively refined to improve symbol clarity and reduce the cognitive load required of users. My greatest takeaway from this project was to design with people, not for them.

Our paths crossed in 2023 when we were both searching for other tactile mapping initiatives. That first online meeting sparked a collaboration, and since 2024, we have cochaired the International Cartographic Association's (ICA) Working Group on Inclusive Cartography. In the mid-1980s, the ICA began pushing cartography beyond purely visual formats. Its former Commission on Maps and Graphics for Blind and Partially Sighted People laid the groundwork for decades of tactile mapping research, while the Working Group on Inclusive Cartography now seeks to close the gaps between theory and practice. Chairing this group for the last two years has allowed us to work with other cartographers around the world to advocate standards, develop course materials, and host workshops about accessible mapmaking.

We also cowrote a book, published by Esri Press in 2025, called *Tactile Mapping: Cartography for People with Vision Impairments*. With case studies and user stories from around the world, it examines the technical side of creating tactile maps—including how symbols, textures, and generalization work together to recreate spaces in ways that people with little to no sight can recognize—alongside real-world accounts of how people with various visual impairments use maps. The chapters cover a wide array of topics, from tips for designing inclusive map symbols to optimizing route planning for blind pedestrians. But one principle unites the entire volume: A tactile map only works when the people who use it say it does.

The amount of information that can be digested through touch is significantly smaller than what can be perceived by sight. Since people read tactile maps using their fingers and hands—and at times, also with limited eyesight—what these maps convey must be distilled to its essence. This makes tactile mapmaking one of the most demanding forms of cartography.

Most guidelines that exist for making tactile maps are tailored to specific contexts, which inherently limit the maps' uses. What's more, creating tactile maps is typically a slow, subjective, and expensive process. In effect, tactile maps aren't widely available—despite rising demand for them, especially in areas with large aging populations.

Another project—the Tactile Graphic Repository, known as T-rep (t-rep.wat.edu.pl)—is an emerging source of knowledge on principles for tactile map design, complete with

T-rep is part of Poland's international platform of tactile graphics knowledge exchange (2024–2027), a project financed by the Ministry of Science and Higher Education as part of the Science for the Society II program.

a library of tactile symbols made with input from experts all over the world. Led by Wabiński, T-rep combines theory with practice in a way that's helpful for designing and producing tactile maps. Anyone interested in making tactile maps can go to the repository to see what kinds of symbols work, as well as share their knowledge of this field.

The best way to get a feel for tactile mapping is to give it a go. That's why Van Altena helped develop a tutorial for ArcGIS Pro that teaches people how to create a tactile map. Over about an hour, participants design a tactile map of Washington, DC, for a friend who is blind. This friend enjoys visiting the city's Edward R. Murrow Park and wants a clearer sense of the neighborhood's layout. While it's a simple exercise, it captures the essence of tactile mapping: translating spaces that most of us see into something that someone else can understand via touch so they can build their own mental map of the world.

We believe that maps should not reinforce barriers but should instead dismantle them. The more mapmakers and cartographers who embrace this ethos, the greater impact we can all have. So please join one of our initiatives, get in touch to collaborate, or start a tactile mapping project of your own. Even if it's just one map for now, that map could make all the difference to the person whose hands it falls into.



About the Authors

Dr. Vincent van Altena is a senior researcher at Kadaster—the Netherlands' Cadastre, Land Registry and Mapping Agency. A geospatial expert with a background in theology and GIS, he led the Dutch initiative on tactile mapping from 2023 to 2025. Dr. Jakub Wabiński is an assistant professor at the Military University of Technology in Warsaw, Poland. He has a background in geospatial engineering and a passion for novel geovisualization methods.

Ethical GIS Starts with Committing to the Locus Charter

Managing GIS

By Greg Babinski, GIS Management Consulting Services, LLC



GIS management is a demanding yet rewarding career. GIS doesn't come ready-to-use, right out of the box. Every GIS is a custom system built with data, hardware, software, apps, and a team of GIS professionals—each with their own role to play. The GIS manager is the glue that holds this system together.

GIS managers must focus on the ethics of their teams' work and the industry as a whole. The GIS Code of Ethics—originally developed by the Urban and Regional Information Systems Association, or URISA (now the Geospatial Professional Network, or GPN)—requires GIS practitioners to be proactively ethical with regard to society, employers and funders, colleagues, the profession, and individuals.

It comes pretty naturally to be ethical toward employers and funders. But how should GIS managers address other ethical obligations?

The Hazards of Data Protection

People generally entrust money and power to government agencies so they can provide benefits and services to society and the individuals who live within it. Many GIS operations support these benefits and essential services. This means that many GIS departments manage large databases that contain lots of data about society, plus people's personal information.

Danger abounds. Have you ever received a letter from a law firm stating that you are a member of a class action lawsuit? Put "largest 2025 data breaches" into a search engine or an AI-powered chatbot and see how many personal records were compromised. This happens to government agencies, too. A data breach can cost a local government millions of dollars. There are now consulting companies whose sole business is to advise agencies and companies on how to respond to data breaches and regain public trust.

A variety of national and intergovernmental regulations apply to GIS. The European Union has the General Data Protection Regulation that strengthens individuals' data rights and unifies data protection laws. Canada has the Personal Information and Electronic Documents Act that regulates how organizations collect, use, and disclose personal information. And the United States has a variety of laws and agencies—including the Health Insurance Portability and Accountability Act (HIPAA) and the Red Flags Rule—that aim to safeguard personal data.

“GIS managers are in a strategic position to be agency leaders in establishing policies and practices for safeguarding data. The Locus Charter can be a great tool for elevating the discussion of data protection.”

GIS managers, especially those who work in government, need to be proactive about protecting data. That's where the Locus Charter comes in.

What the Locus Charter Is—and Why It Matters

The Locus Charter (ethicalgeo.org/locus-charter) is a proposed set of international principles that support ethical, responsible practices when using location data. The charter's 10 guiding principles enable organizations to commit to the ethical use of location data across all their activities.

The Locus Charter evolved from an initiative of the American Geographical Society's EthicalGEO project called the Benchmark Initiative. Benchmark consisted of 10 workshops, held from 2019 to 2020, that brought together thought leaders from around the world to draft the Locus Charter. Launched in March 2021, it states:

The Locus Charter proposes that wider, shared understanding of risks and solutions relating to uses of location data can improve standards of practice, and help protect individuals and the public interest. We hope the Charter can improve understanding of risk, so those can be managed, and the many benefits of geospatial technologies can be realized for individuals and societies. “Locus” is the Latin word for “place.”

The Locus Charter proposes the following guiding principles:

- Realize opportunities
- Understand impacts
- Do no harm
- Protect the vulnerable
- Address bias
- Minimize intrusion
- Minimize data
- Protect privacy
- Prevent identification of individuals
- Provide accountability

These principles, if implemented and acted upon, allow GIS practitioners to meet their GIS Code of Ethics obligations to both society and individuals.

Who Supports the Charter, and Where There Are Gaps

GIS departments usually manage the largest databases and information systems for a typical local agency. GIS managers are in a strategic position to be agency leaders in establishing policies and practices for safeguarding data. The Locus Charter can be a great tool for elevating the discussion of data protection.

The Locus Charter Engagement Letter, available on the website, helps with this. An entity that signs the Locus Charter Engagement Letter commits to joining other Locus Charter supporters to

...promote responsible practice in the use of location data across all sectors including public, private, educational, and not-for-profit contexts. We seek to inform and improve practice across all scales including individual projects and organizational mandates.

Current Locus Charter supporters include the following:

- Professional organizations, such as the GPN, the Association for Geographic Information, EIS-Africa, OSGeo, the Open Geospatial Consortium, the World Geospatial Industry Council, and the Royal Geographical Society
- Industry leaders, including Esri UK, Albedo, and Celantur
- National government agencies such as Mexico's National Institute of Statistics and Geography (INEGI) and the United Kingdom's Ordnance Survey

Even my little GIS consulting company is a Locus Charter supporter. But who is missing? Local and regional government agencies, plus state and provincial government organizations are lacking—even though they maintain large amounts of personal location data.

This is where the benefits of responsible location data management will have the greatest impact on society, including for you; me; and your friends, neighbors, and family members. This is not abstract—it's local and personal.

The Call to Action

All GIS managers—especially those who work for government agencies—must advocate for and implement the Locus Charter across their organizations.

Who should sign the charter? Ideally, your agency's leaders should sign. But if that's not possible, you can sign it and join the Locus Charter community. This is the best way to ensure that you meet your GIS Code of Ethics obligations.

The Locus Charter offers a great way to start a conversation about data privacy with your organization's chief information officer, your city's mayor, the county executive, and your local council. Its guidelines make it easier to explain the potential pitfalls of tracking and holding people's data and should convince organizational leaders that supporting the Locus Charter is good for their constituents and protects their administrations.

Locus Charter supporters meet online periodically to discuss their development of Locus Charter use cases, the wider adoption of the charter, and related activities. If you want to learn more, you can attend a meeting.

For more information about joining the Locus Charter as a supporter, or if your organization is ready to sign the Engagement Letter, email Ivana Mowry-Mora, the initiatives and special projects coordinator at the American Geographical Society, at imowrymora@americangeo.org.

I hope to see you at a future Locus Charter meeting.

About the Author

Greg Babinski, GISP, is a GIS management consultant and founder of GIS Management Consulting Services, LLC. From 1998 to 2021, he served as GIS manager, GIS finance manager, and GIS marketing and business development manager for the King County GIS Center in Seattle, Washington. Previously, he was a GIS mapping supervisor for the East Bay Municipal Utility District in Oakland, California. In 2019, he was awarded an EthicalGEO Fellowship through the American Geographical Society. For more information, email Babinski at greg@gismcs.com.

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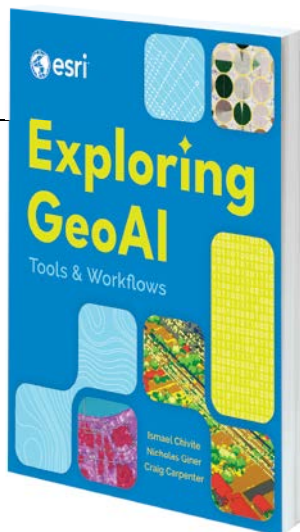
2027 Esri Press Wall Calendar: 16 Months of Beautiful Maps

By Esri

See the “art” in cartography all year long. Showcasing 13 maps by Esri cartographers, the *2027 Esri Press Wall Calendar* celebrates the beauty of geography and maps over 16 months, from September 2026 through December 2027. Each spread features fun facts about maps and history, reflections from the cartographer, and a relevant Esri Press book. July 2026, 24 pp. Print wall calendar ISBN: 9781589489141.



Scan this code to buy the calendar.



Exploring GeoAI: Tools and Workflows

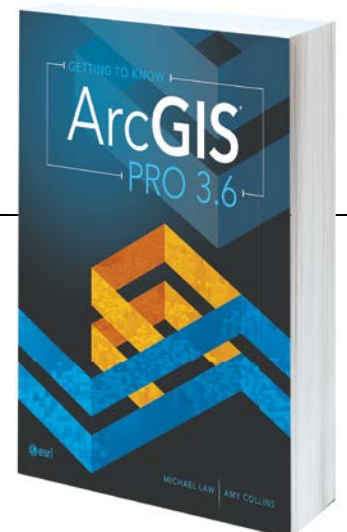
By Ismael Chivite, Dr. Nicholas Giner, and Craig Carpenter

Exploring GeoAI: Tools and Workflows takes readers through the latest geospatial AI models and tools in ArcGIS. Comprehensive, hands-on tutorials move through the basics—installing deep learning frameworks, confirming hardware capabilities, and optimizing system settings for peak performance—before introducing the complete GeoAI workflow: determining project needs, reviewing available data types and formats, assessing and training models, and evaluating performance. The book demonstrates a variety of ready-to-use pretrained deep learning models in ArcGIS Pro and ArcGIS Online, empowering readers with practical skills they can use to automate, predict, and optimize their GIS workflows. August 2026, 168 pp. Ebook ISBN: 9781589489097, paperback ISBN: 9781589489080, and hardcover ISBN: 9781589489127.

Getting to Know ArcGIS Pro 3.6

By Michael Law and Amy Collins

Learn how to use ArcGIS Pro with this best-selling workbook and desk reference. In *Getting to Know ArcGIS Pro 3.6*, readers follow simple, step-by-step instructions to learn core analytic and mapmaking skills. Case studies throughout the book employ real-world datasets and exercises to show how members of the GIS community use ArcGIS Pro to address complex issues. Each chapter builds on the previous one to reinforce skills, and the book includes a glossary of technical terms. June 2026, 340 pp. Ebook ISBN: 9781589488991 and paperback ISBN: 9781589488984.



The Spatial Edge: The Strategic Advantage of GIS Skills Across Higher Education

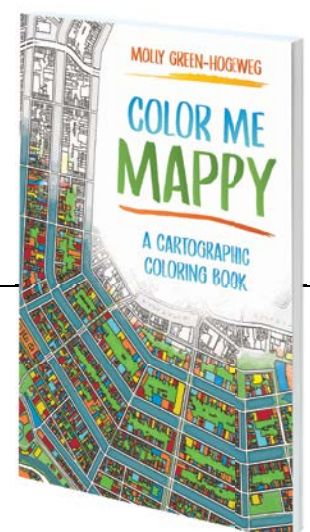
By Thomas Fisher and Len Kne

Although GIS is now widely taught in higher education, it is typically associated with a handful of disciplines: geography, planning, natural resources, and landscape architecture. *The Spatial Edge: The Strategic Advantage of GIS Skills Across Higher Education* presents a series of case studies that show how integrating the geographic approach across academic disciplines and university operations can unite campuses in addressing challenges. The book operates as a guide for administrators and educators, illustrating the many ways in which their colleagues—in virtually every field—use GIS to teach students, conduct research, connect with communities, operate facilities, and produce geospatially skilled graduates who are ready for the workplace. July 2026, 250 pp. Ebook ISBN: 9781589488977, paperback ISBN: 9781589488953, and hardcover ISBN: 9781589488960.

Color Me Mappy: A Cartographic Coloring Book

By Molly Green-Hogeweg

Discover the world one line at a time in *Color Me Mappy: A Cartographic Coloring Book*. Designed for curious minds and creative spirits, this coloring book—with 39 maps of real-world places—transforms iconic destinations into immersive experiences that are both engaging and relaxing. Make your crayon- or colored pencil-based mark on cities such as Amsterdam, Rome, and Kuala Lumpur, as well as natural wonders including Machu Picchu and Yellowstone National Park. Slow down and follow the lines. June 2026, 80 pp. Paperback ISBN: 9781589489011.



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Training and Certification Offerings

Training

Coming Soon: A Streamlined Digital Experience for Learning

Soon, it will be easier to find, start, and complete training via Esri Academy. Later this summer, Esri will unveil a new website design that reflects user feedback and research-based best practices for accessibility and digital experience. Additionally, the catalog, which houses hundreds of learning resources, is being enhanced to provide users with a seamless experience.

After the redesigned site launches, learners will continue to have access to their Esri training history, in-progress learning plans and courses, and scheduled trainings. New certifications, classes, and no-cost live training seminars and massive open online courses (MOOCs) are opening over the next few months, so head to link.esri.com/2026-training to explore what's new from Esri Academy.

Learn How to Automate Workflows

For many organizations, automating workflows to quickly uncover insights from data is critical—especially given how rapidly technology is evolving. Esri provides several instructor-led training courses to help individuals learn and develop the skills they need to maximize automation opportunities in GIS.

- **Spatial Data Science: Advance Your Analytics**—This brand-new instructor-led course helps analysts, data scientists, and researchers learn how to apply spatial statistical techniques and predictive analysis tools in ArcGIS Pro to discover hidden patterns and relationships in data. Sign up at link.esri.com/spatial-statistics-course.
- **Creating Python Scripts for ArcGIS**—This popular three-day course teaches participants how to automate time-consuming or repetitive tasks. Attendees explore the Python environment in ArcGIS Pro and get step-by-step practice with scripting common data management tasks and geoprocessing workflows. Sign up at link.esri.com/python-course.

To make it easy for organizations to access instructor-led classes, coaching, and other tailored GIS learning solutions, they can purchase the Esri Training Pass. Review the details at link.esri.com/trpass2026.

Make Time for Massively Popular Online Courses

Participating in an Esri MOOC is an excellent way to improve GIS skills and keep up with trending topics. Each no-cost course includes access to ArcGIS software, expert videos, and guided exercises. Participants who finish the course receive a certificate of completion.

Four MOOCs will be offered this fall, including two new ones. Registration for the following courses is open now:

- **The ArcGIS Imagery MOOC: Foundations and Frontiers**—Running August 26–October 7, this course takes participants on a journey through the latest ways to use GIS and geospatial AI to combine imagery, remote sensing, and geospatial data. Real-world scenarios provide context for how organizations can get the most out of using GIS with imagery. Register at link.esri.com/imagery-mooc.
- **Spatial Data Science: The New Frontier in Analytics**—Offered September 23–November 4, this MOOC teaches data-engineering workflows—including spatial methods and algorithms, regression analysis, deep learning models, and space-time cubes—that help users gain deeper insight from their data. Register now at link.esri.com/sds-mooc. Stay up to date with the latest MOOC offerings at link.esri.com/2026-moocs.

Certification

Get Ahead with New Esri Technical Certifications

The Esri technical certification team is updating six exams this year, with three new exams ready now. For anyone looking to take the next step in their career and validate their expertise with ArcGIS Online administration or ArcGIS developer techniques, the following exams are available:

- ArcGIS Online Administration Associate 2026: link.esri.com/ea0a2026
- ArcGIS Developer Foundation 2026: link.esri.com/eadf2026
- ArcGIS API for Python Associate 2026: link.esri.com/epya2026

Go to esri.com/training for more information. Find courses at esri.com/coursecatalog. Subscribe to *Esri Training News* (links.esri.com/training-news), read *Esri Training Blog* (links.esri.com/trainingblog), connect with the Esri Training community on Esri Community (links.esri.com/training-community), and follow [@EsriTraining](https://twitter.com/EsriTraining) on X.



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The ArcGIS Imagery MOOC: Foundations and Frontiers

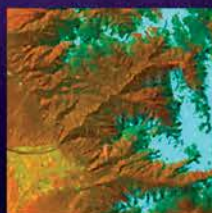
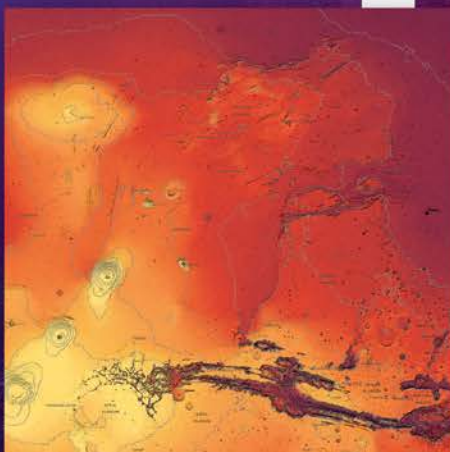


August 26–October 7, 2026

Join Esri's upcoming no-cost massive open online course (MOOC) to unlock the synergy of GIS and imagery. You will discover modern workflows used by organizations worldwide to seamlessly combine imagery, remote sensing, and geospatial data with cutting-edge GIS tools.

“The step-by-step instructions are very detailed and accessible to all levels, and the videos are well planned and highly authentic.”

— Beatriz B., Attendee



link.esri.com/imagery-mooc-2026

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