ArcNews

Esri | Fall 2019 | Vol. 41, No. 4

Briefly Noted

Esri Joins GEO as Associate Member
The Group on Earth Observations (GEO), an intergovernmental organization that works toward advancing open data and promoting sustainability via Earth observations, has invited Esri to join as one of its first Associate members. Esri has been involved with GEO for six years, developing interoperability between the Global Earth Observation System of Systems (GEOSS) and ArcGIS Online and opening up access to data between GEO members and Esri users.

HD Map Data Goes Beyond the Automotive Market
A new collaboration with Mobileye, a leading provider of advanced driver-assistance systems software, is bringing the Intel company's data collection capabilities into Esri technology as native services. Under the agreement, information gathered from vehicles equipped with Mobileye's vision system will serve as a basis for several new data services in the ArcGIS platform, enabling Esri users to visualize and analyze this real-time, high-definition (HD) map and location data.

New Esri R&D Center Opens in Spain
Esri recently launched its 16th research and development (R&D) facility in Barcelona, Spain. It is geared toward pioneering applications in 3D design, game engines, and computer graphics.

GIS Day Is Almost Here!
November 13, 2019, marks the 20th annual GIS Day, an international celebration in which members of the GIS community show colleagues, students, and the public how to use geospatial technology and why. Find or register an event at gisday.com.

The Intelligence of GIS

At the 39th Annual Esri User Conference, held in San Diego, California, July 8–12, more than 18,000 attendees learned about new geospatial technology, networked with colleagues from around the world, and shared how they use GIS to foster data-driven change.

The theme of this year's conference was GIS: The Intelligent Nervous System, a metaphor built around the human nervous system, as Esri president Jack Dangermond explained.

"The human nervous system…is intelligent," he said. "It integrates data from many sources *[and]* couples that data with logic and reasoning; ethics; values; and in some cases, emotions. And then it carries out coordinated responses."

Sound familiar?

Likening the earth to a living organism, Dangermond said that we need something like the human nervous system to create a more sustainable future. We fundamentally need more understanding and collaboration, which GIS is very good at enabling.

"It starts with geography, the science of our world," he said. "Geography helps us see complexities and relationships and patterns. It helps us see holistically and respond more intelligently."

Renowned biologist and Harvard University professor emeritus Edward O. Wilson pointed out that GIS is helping us see environmental problems clearly and work together to solve them. Jane Goodall, DBE, added that GIS helps us see hope in the face of enormous challenges, as she discussed during the keynote conversation she had with Wilson and Dangermond.

See What Others Can't

At the conference, Esri introduced a new phrase—*See What Others Can't.* Many user presentations were woven together in the Plenary Session.

Hearing from local governments, including the City of Pasadena; nonprofit organizations, such as the

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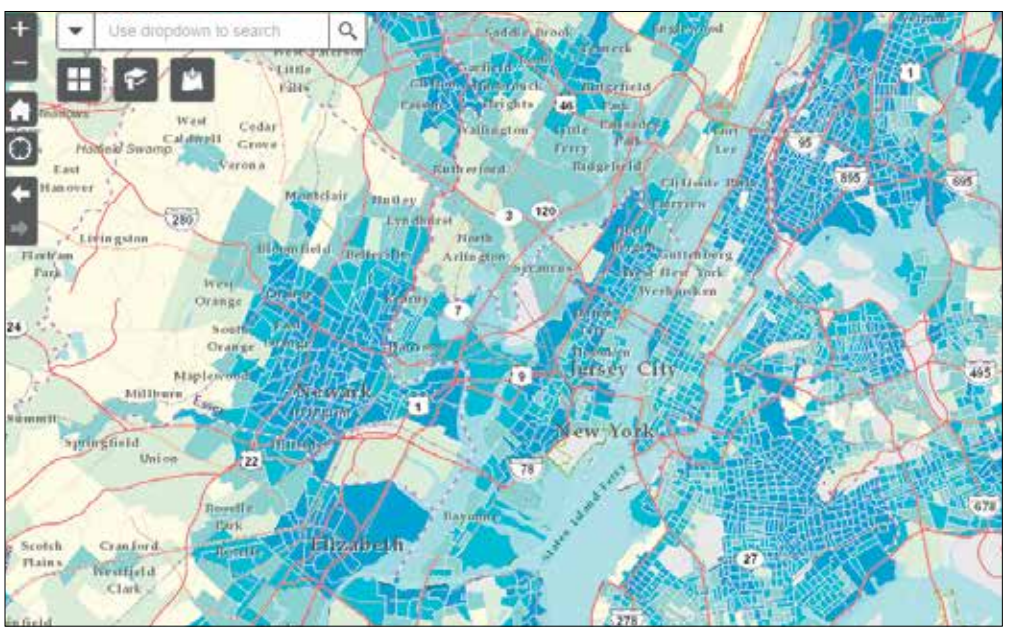
↑ GIS is like the human nervous system. It is intelligent and integrates data from many sources. It helps us understand complexities and then carry out coordinated responses.

Geospatial Technology Underpins Every Aspect of the 2020 Census

And Esri's Tapestry Segmentation Data Helped Enhance the US Census Bureau's New Outreach Model



↑ With the Response Outreach Area Mapper (ROAM), the Census Bureau can better tailor its messaging to people living in the darker blue areas, which are predicted to self-respond to the census at lower rates.

Each decade, the US Census Bureau evaluates and modernizes its enumeration methods. For the 2020 Census, this has resulted in GIS being used in more ways than ever to get the count right.

"We've incorporated the use of geospatial technology into every aspect of the design for the 2020 Census," the Census Bureau's geography division chief, Deirdre Dalpiaz Bishop, said in an interview.

"We've deployed several key innovations that are going to make it easier and more secure for folks to respond and participate in the census," said Census Bureau deputy director Ron S. Jarmin at the 2019 Esri User Conference (Esri UC), where key staff members from the geography division presented at the Plenary Session. "We have a team of dedicated, smart geographers who have been working hard over the last several years to develop, deploy, and *[test]* these *[innovations]*."

Those "last several years" have been crucial to the upcoming census, according to Bishop. "During

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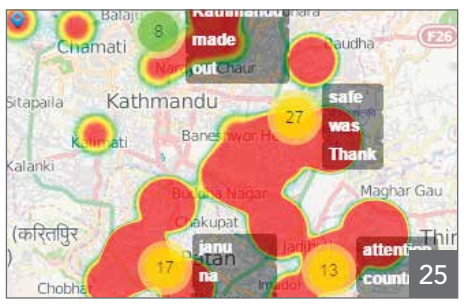
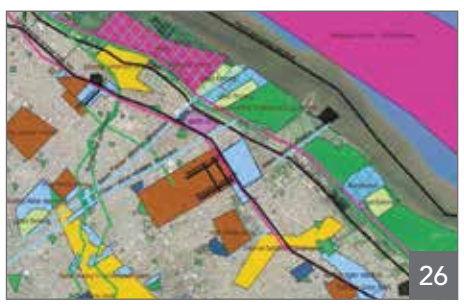
The noxious weed control program in King County, Washington—which aims to reduce the impact of invasive plants—recently implemented ArcGIS QuickCapture. Now, field crews can record and submit real-time information on weed locations and growth with just a few taps on their mobile devices, no matter where they are.





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At Esri, Accessibility Is a User-Focused Endeavor

In the United States, to ensure that people with disabilities can successfully use technology, Section 508 of the Rehabilitation Act of 1973 requires that federal agencies develop, maintain, and use information and communications technology (ICT) that is accessible to people with disabilities. The guidelines encompass both hardware and software, urging the use of closed captioning for videos, for example, and having proper color contrast on web pages to increase readability.

Focusing on providing good product design and user-friendly features, Esri strives to improve accessibility to its software in accordance with Section 508 guidelines.

"At Esri, our goal is to make GIS accessible to everyone," said Dirk Gorter, Esri's director of product management. "To that end, we design and implement our GIS products to be accessible to people regardless of their abilities."

A Comprehensive Accessibility Strategy

In addition to adhering to Section 508 guidelines for US users, Esri complies with Web Content Accessibility Guidelines (WCAG) for international customers with regard to both product development and maintenance. To increase accessibility, Esri supports the accessibility tools provided by standard operating systems, such as Microsoft Windows, and builds special capabilities into GIS functions across its entire product line.

Esri's comprehensive accessibility strategy includes the following:

- Develop products, technologies, and services that are accessible and usable by as many people as possible.
- Leverage accessibility technologies available in operating systems, web servers, and database management systems (DBMSs) when and where appropriate.
- Develop GIS-specific accessibility technologies to enable all people to use and apply GIS.
- Empower customers to make informed choices about the Esri products they use by disclosing the products' accessibility capabilities.

Accessibility Starts with Software Design

At Esri, the inclusion of accessibility-friendly features begins with the software design and redesign processes. A team of user interface and user experience (UI/UX) specialists works with the development group—which includes Esri's product management, product engineering, and software development teams—to ensure that accessibility is built into new products from the start.

Esri staff receive training and resources to guide them during the design process so they can ensure that their products meet compliance standards. For example, ArcGIS Desktop developers have participated in multiple online training sessions aimed at providing tips and informing strategies to identify and address accessibility concerns.

"Accessibility training sessions help our engineers understand compliance and federal standards," said Jim McKinney, Esri's chief technology officer (CTO) for desktop development. "It also enables developers to learn and follow new implementation practices."

For ArcGIS Pro, a design guide shows developers and engineers how to test, design, and implement technology that creates an accessible user experience. The design guide defines important terms, provides detailed instructions for complying with regulations, and has additional resources. It also introduces a variety of assistive technologies, such as screen readers and large-print or tactile keyboards.

Once accessibility features are added to or refined in its technology, Esri reports the current accessibility status of its products to the US government via the Voluntary Product Accessibility Template (VPAT). This helps Esri ensure that it is meeting Section 508 guidelines.

"Industry and government personnel developed the VPAT as an informational tool to assist federal information technology professionals with the market research requirements of Section 508," said John Baleja, Esri's product manager for accessibility. "We are happy to share the results of our work to ensure compliance."

Third-Party Testers Evaluate Products

Esri has a process for testing and qualifying all its software products for compliance with federal regulations. Independent third-party testers evaluate finished products and then create new VPATs or update existing ones. The testing criteria are designed around the established technical standards in Section 508 for software applications and web-based information.

Testers provide feedback to Esri's development teams on any issues they find during their accessibility assessments. The teams then make plans to incorporate any necessary changes into the next release of the product.

In 2018, Esri implemented an additional testing measure for ArcGIS Pro, and it may be employed for other Esri products in the future.

"We began holding accessibility holistic test sessions at each iteration of the ArcGIS Pro development cycle," said Karl Frantz, a member of the UI/UX team at Esri. "This allows testing throughout product development and lets us address any issues that may arise."

Resources for People with Disabilities

Technical support and online resources are available to help persons with disabilities use Esri software. The accessibility documentation for ArcGIS Pro 2.3, available at p.ctx.ly/r/9iu2, offers details on how to use the software with a keyboard, as well as how to enable visual modes of operation, including a high-contrast mode to enhance readability and light and dark themes to improve visibility.

Documentation for ArcMap 10.7, which can be found at p.ctx.ly/r/9iu7, delivers tips on how to navigate the interface and execute commands using a combination of mouse keys and keyboard shortcuts. ArcMap 10.7 also offers a high-contrast mode to boost readability.

Additionally, Esri provides one-on-one tech support in multiple formats, including by phone, via email, and through online messaging. Information on Esri support services can also be found at p.ctx.ly/r/9iu4. The Esri Community GeoNet Accessibility group, at p.ctx.ly/r/9iu3, is another online resource that allows people to interact with other Esri users and get valuable tips and resources on accessibility. Users in the group can join discussions, browse content, and even share files.

An Ongoing, User-Focused Process

Integrating accessibility features into ArcGIS technology and ensuring that Esri products are usable by all requires the hard work and dedication of all Esri staff members, including programmers and developers. And Esri's efforts to increase product accessibility will continue long into the future, with a focus on what users need.

"Improving accessibility of our products is an ongoing process at Esri, especially as new products are introduced and accessibility research matures," said Clint Brown, Esri's director of software products. "We strive to find ways to reach more people through our help documentation and as we introduce new accessibility training for developers and end users at our events."

Interested in adding accessibility features to your ArcGIS technology-based apps and web pages? Check out the following videos and tutorials:

Getting Started with Accessibility

- Do-it-yourself accessibility tips and guidelines: p.ctx.ly/r/9iu6
- Web accessibility best practices: p.ctx.ly/r/9iu8

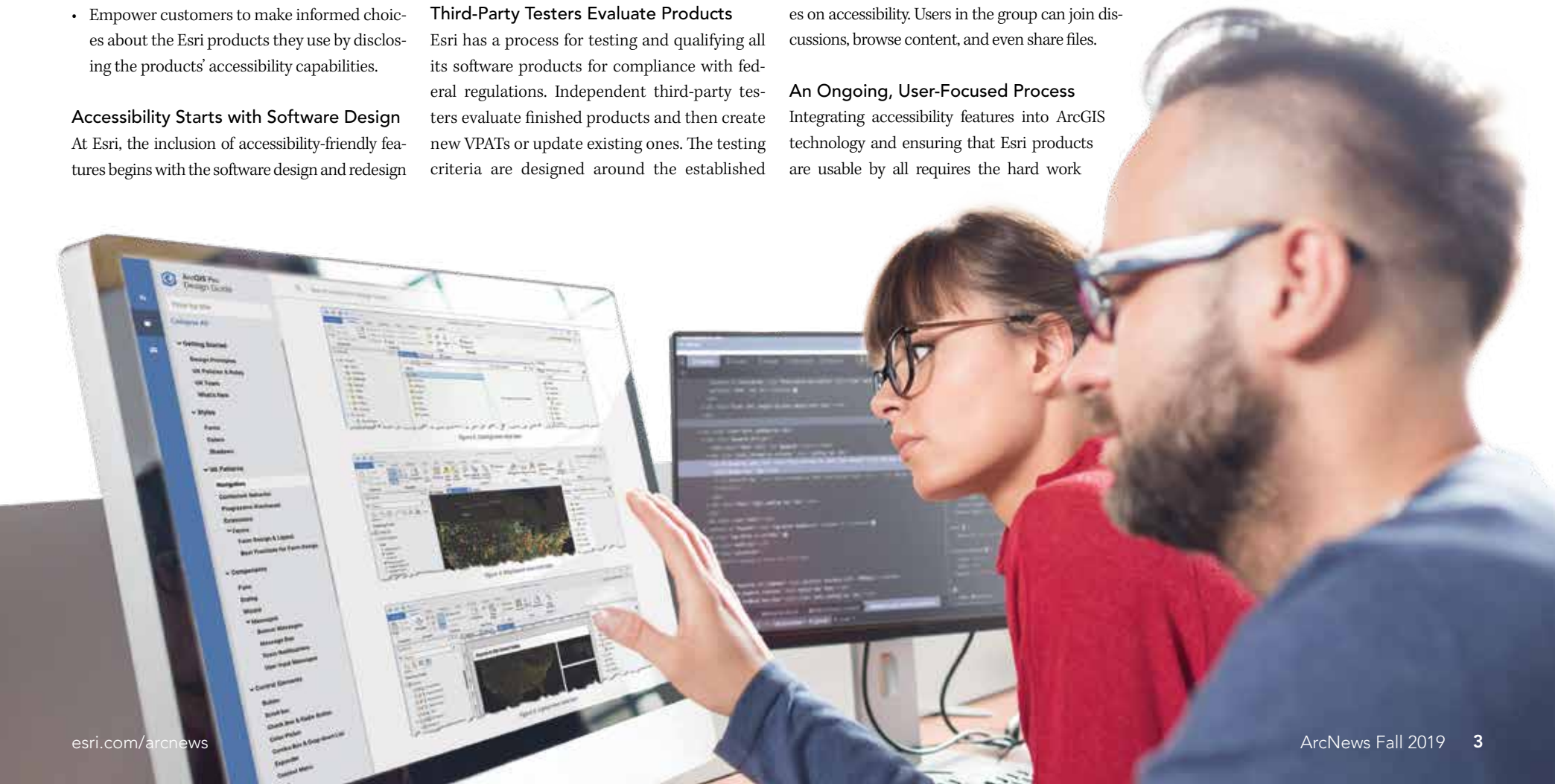
Accessibility for Web Apps

- Improve accessibility in ArcGIS Online hosted web apps without writing code: p.ctx.ly/r/9iu9
- Use ArcGIS API for JavaScript to implement accessibility in web apps: p.ctx.ly/r/9iua

Story Maps

- Add alternative text to story maps: p.ctx.ly/r/9iub
- Incorporate keyboard navigation, semantic structure, and more into story maps: p.ctx.ly/r/9iu5

↓ Esri has a design guide for ArcGIS Pro that shows developers and engineers how to test, design, and implement technology that is accessible to everyone.



New MOOC Invites Users to Gain Skills in Spatial Data Science

This map, which shows the results of an ArcGIS deep learning model that classifies building footprints as damaged (red) and undamaged (green), was part of a damage assessment study that took place after the 2018 Woolsey Fire in Southern California. Participants in the massive open online course (MOOC) will use spatial data science tools to investigate realistic scenarios like this.

Recognizing users' strong interest in the emerging field of spatial data science, Esri is adding a new course—Spatial Data Science: The New Frontier in Analytics—to its popular lineup of massive open online courses (MOOCs). Opening in 2020, the course will explore how incorporating spatial data, tools, and methods enhances analytical and predictive models.

Data scientists, GIS analysts, and others with a strong background in statistics and analytics will find the course beneficial. Attendees should plan to spend three to four hours per week on the course. Esri will award a certificate of completion to everyone who completes the MOOC. And as with all Esri MOOCs, the course is free and includes access to ArcGIS software for the duration of the program.

What Exactly Is Spatial Data Science?

Like data science, spatial data science employs methodologies and tools to extract nonobvious and useful patterns from data, enabling practitioners to make predictions. However, by incorporating geographic data and spatial analysis methods, spatial data science adds place-based context and deeper insight to the practice of data science.

"We're excited to introduce spatial data science concepts and workflows to analysts and data scientists who want to understand how to take their analysis to the next level," said Shannon Kalisky, product manager for analytics and data science at Esri.

In the MOOC, participants will explore how to use spatial data for data science, develop iterative analysis workflows, train and optimize models, perform artificial intelligence (AI) workflows, build compelling and collaborative information products, and share results.

"Esri's application programming interfaces (APIs) and tools make it possible for models to process data from multiple formats, scales, and volumes," Kalisky continued. "In the course, learners will apply many of the spatial data science tools to investigate a variety of realistic scenarios."

Growing Knowledge the MOOC Way

Since Esri launched the MOOC program in 2014, 180,000 learners from around the world have participated in courses on spatial analysis, the value of the geospatial perspective in business, how to build geo apps, and cartography.

Spatial Data Science: The New Frontier in Analytics is planned to open in early 2020. It will be a multiweek course that explores the nature and promise of spatial data science. Videos featuring Esri experts, hands-on software exercises, quizzes, and interactive discussions create a highly engaging environment in which learners are encouraged to explore, seek out answers to their questions, and solve problems together.

For course details and to register, visit go.esri.com/sds-mooc. To receive updates about the course, as well as spatial data science news, join the Spatial Data Science: The New Frontier in Analytics group on LinkedIn at p.ctx.ly/r/9l0i.

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Geospatial Technology Underpins Every Aspect of the 2020 Census

this decade, we've been building our foundation continuously, whereas in the past, we've waited until the end of the decade," she said. "This is a much better approach."

There are four main components to conducting a census in the United States. First, the Census Bureau has to figure out where to count. This involves building and maintaining an address list and a spatial database to make sure the agency has an accurate accounting of every address in the nation. Next, the bureau has to use that address list to invite people to respond—ideally on census day, April 1, 2020. For households that don't respond promptly, the Census Bureau then has to send enumerators door to door to try to encourage those people to fill out their forms. Finally, the bureau has to release the results. Apportionment counts for the US House of Representatives are due to the president of the United States by December 31, 2020, and state governments need to receive their redistricting data no later than March 31, 2021.

All this work depends heavily on the Census Bureau's geographic database, the MAF/TIGER System (which stands for Master Address File/Topologically Integrated Geographic Encoding and Referencing). This is the master address list and spatial database that contains every state, county, city, tract, block, and address in the nation—more than 20 million unique geographic areas—along with the geographically located data for each of them.

"Throughout the decade, we have partnered with tribal, state, and local governments to ensure a complete and accurate database," said census geographer John Pollicino during the agency's plenary presentation. "Our partnerships…have enabled us to validate more than 106 million addresses and millions of miles of roads, *[as well as]* reengineer our address canvassing operation, the method through which we update and validate our address list."

While the Census Bureau used to verify all its address data in the field, this time around, it used satellite imagery and geospatial technology to see what places looked like 10 years ago compared to now. According to Bishop, this allowed the Census Bureau to validate 65 percent of addresses in the office, meaning that only 35 percent of addresses had to be validated in the field.

↑ The Census Bureau used to verify all its address data in the field, but this time, it used satellite imagery and geospatial technology to see what places looked like 10 years ago compared to now.

"What could take over two hours to canvass in the field now takes less than two minutes in the office," Pollicino said in his presentation.

And instead of having to hire 150,000 address listers to walk every block in the United States, as the agency did for the 2010 Census, it only had to hire about 40,000 people to do that work. This also enabled the bureau to reduce the number of address canvassing offices it opened from 151 to 39.

The next part of the census, of course, is getting people to respond. For 2020, the Census Bureau is inviting people to fill out their questionnaires on the internet for the first time.

"People can still respond by phone or using the traditional paper questionnaire if they want to," said Bishop. "We want to generate a full count, so we're giving people options."

The costliest part of the census is knocking on people's doors to get them to respond. That's why the Census Bureau developed the Response Outreach Area Mapper (ROAM) to streamline that process.

"We've used geospatial technologies—a lot of Esri technology—to help map the hardest-to-count areas across the country," said Bishop. "ROAM is used to help direct our outreach efforts to motivate people to self-respond."

One of the ways the app does this is by predicting which populations are most and least likely to self-respond to the census, as well as whether they are more or less likely to fill out their forms online. With this information, the Census Bureau can tailor its outreach messaging to particular populations in specific areas and encourage self-response via the most accessible methods.

ROAM does this by using an audience segmentation model that the Census Bureau developed with its communications contractor, Team Y&R. The model splits census tracts into groups with populations that have similar media consumption habits and comparable census mind-sets. For example, people who live in areas deemed Responsive Suburbia are the most likely to self-respond to the 2020 Census and will probably fill out their forms online, while people located in the Sparse Spaces tracts are expected to self-respond at low rates, and they probably won't do it online.

Based on Census Bureau research published in 2018, the core variables in this audience segmentation model rely, in part, on Esri's Tapestry Segmentation data, which divides US residential areas into 67 distinctive market segments at the neighborhood level based on residents' socioeconomic and demographic compositions. The study found that the Tapestry segments—which are broken down into 14 LifeMode groups (markets that share a common experience or significant demographic trait) and 6 Urbanization groups (markets in similar locations)—corresponded with the Census Bureau's predicted self-response rates for populations with comparable characteristics.

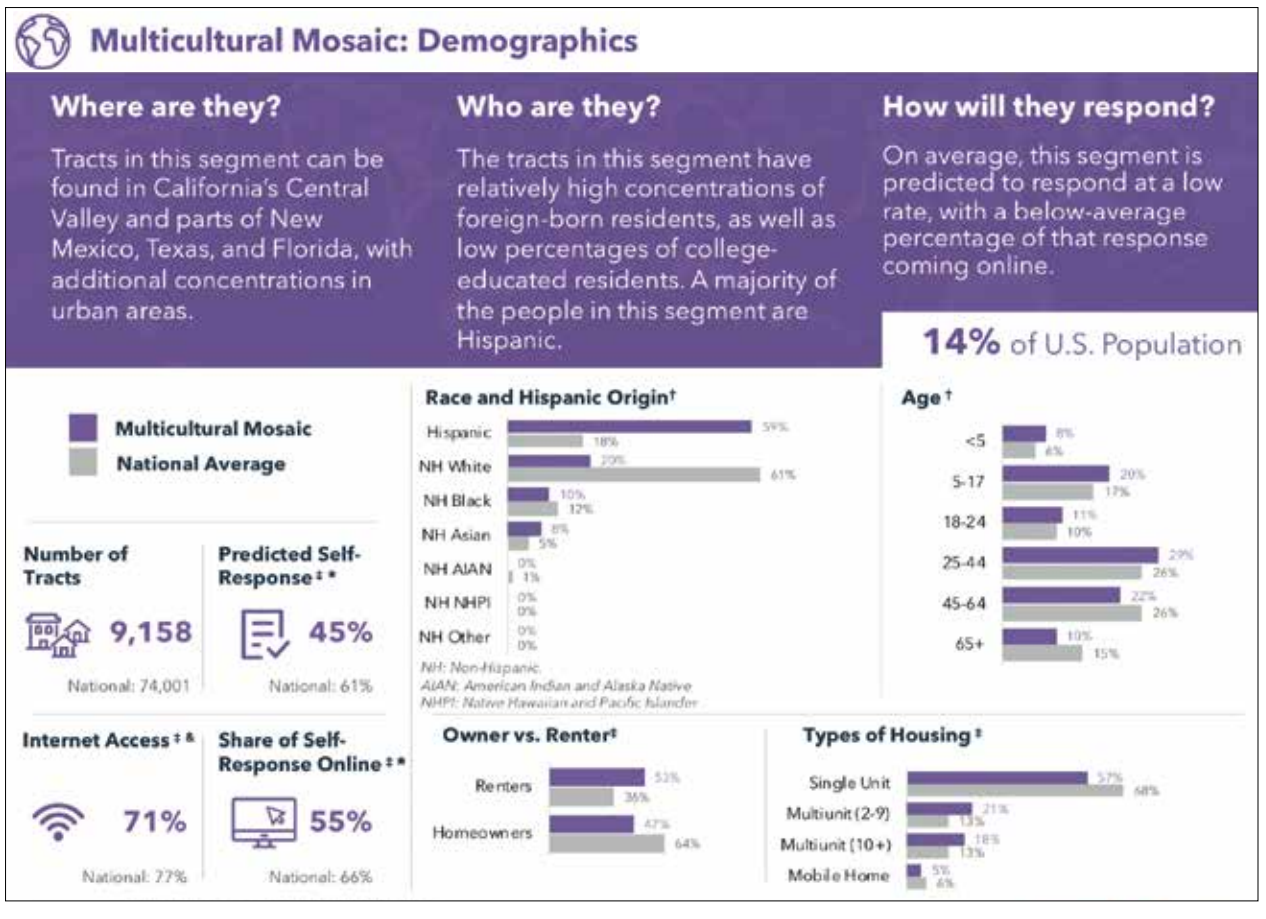
"The Census Bureau will be able to use this research to create tailored messages, craft communications materials, and identify efficiencies when determining where, when, and how to allocate digital advertising about the 2020 Census," said Thomas Gibbs, the commerce account team lead at Esri. "This shows real innovation from the Census Bureau in modernizing some of its approaches."

With the geographic technology in ROAM—plus a new GIS-based app called ECASE that will digitize field-based enumeration work—the Census Bureau expects to hire fewer than 400,000 people to conduct nonresponsive follow-up operations, as opposed to the 600,000 people it needed last time. And it plans to have 248 nonresponse follow-up offices instead of 494.

"By mid-May, we estimate that 60.5 percent of housing units will self-respond to the census," said Bishop. "For the rest, which we expect to be about 50 million households, we'll go knock on doors."

As responses come in, the Census Bureau will tabulate the data and ensure that it's assigned to the correct location. The agency will be ready then to deliver apportionment plans—which allocate US House of Representatives' seats among states—to the president by the last day of the year. And by the end of March, local communities will have the redistricting data they need—complete with shapefiles of the geographies—to start redrawing their legislative and voting boundaries.

As Bishop pointed out, "Geographic work continues throughout the entire cycle of the census."



↑ The Census Bureau's audience segmentation model groups populations with similar media consumption habits and comparable census mind-sets. People who live in Multicultural Mosaic areas, for instance, are predicted to self-respond at lower rates.

For more on the US Census Bureau's plenary presentation at the Esri UC, see page 6.

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The Intelligence of GIS

Geneva International Centre for Humanitarian Demining (GICHD); private companies; federal agencies; transportation authorities; and even young students, attendees discovered all sorts of ways to use GIS to integrate data, find patterns, strengthen collaboration, and turn problems into solutions. Here are a few of those stories.

With Help from Residents, a City Sees the Effects of Climate Change

Like many places around the world, the Netherlands is threatened by climate change. Much of its land is below sea level, with 65 percent of it vulnerable to flooding. The low-lying city of Zwolle, with its rivers and canals, is exceptionally at risk.

"We need to be resilient to climate change, and GIS is helping us do that," said Marcel Broekhaar, an adviser for the City of Zwolle's Smart Zwolle initiative.

To be more proactive about flooding, the city traded its passive open data strategy for a more collaborative approach. In the neighborhood of Stadshagen, Broekhaar and his team wanted to involve residents in flood monitoring, so they created an ArcGIS Hub initiative called SensHagen. They built and dispatched weather and air quality sensors and then held a meeting for residents to show them how the sensors work and where to access the data on the hub.

"*[Residents]* appreciated that we involved them," said Broekhaar. "They wanted to participate."

And they did. Local university students made more sensors and installed them around Stadshagen. The city put on "hub evenings," where residents learned how to use SensHagen Hub to make maps and analyze data. People downloaded a Survey123 for ArcGIS app to report standing water. A group of engineers even built wet feet sensors that report flooding directly to the hub—and now other residents are constructing and installing their own.

"Soon, we will have a system-built network of these sensors sending data to the hub," said Broekhaar. That will enable the city to do concrete analysis on climate change by identifying heat islands and seeing which areas are prone to flooding.

"What started as a project became an initiative—and is now a movement," added Broekhaar.

Read more about the City of Zwolle's Smart Zwolle Hub on page 16.

The Census Bureau Gets Ready to See an Entire Population

In the United States, the federal government is constitutionally bound to conduct a census every 10 years, and the 2020 Census is just months away.

"Our goal is to count everyone once, only once, and in the right place," said Deirdre Dalpiaz Bishop, chief of the Census Bureau's geography division. "To ensure we get it right, we incorporated the use of GIS throughout our design."

To verify that every state, county, city, tract, block, and address is accounted for, the Census Bureau used imagery. And for census takers who follow up with nonresponding households, they will use an enumeration app, built with ArcGIS Runtime, on iPhones.

"Our route optimizer leverages data from industry leaders, combined with census-specific criteria such as work availability, and calculates *[an]* optimized case assignment," said IT specialist Anika Adams-Reefer. All completed cases will automatically sync to the Census Bureau's servers, saving time, money, and paper.

To help tribal, state, and local governments prioritize census outreach efforts, the bureau is using a configured web app—the Response Outreach Area Mapper, or ROAM. With this, local leaders can see areas where high nonresponse rates are predicted and plan appropriate actions.

"We're able to make quick, well-informed, and responsible data-driven decisions to help motivate people to respond," concluded computer mapping specialist Suzanne McArdle.

Find out more about how the US Census Bureau is using geospatial technology for the 2020 Census on page 1.

GIS Provides New Ways of Seeing Threats to Protected Areas

Across Africa, protected areas face increasing pressures, yet many national parks lack enough resources to engage in sustainable conservation and development. That's where African Parks—a nonprofit organization that partners with governments and local communities to restore and manage protected areas—comes in. But it's a big job that spans 15 parks in 9 countries.

"Working at this scale across Africa's diverse landscape requires holistic and adaptable management," said Geoff Clinning, African Parks' technology development manager.

Using a vast network of sensors along with ArcGIS technology, including a unique configuration of ArcGIS Pro, African Parks combines traditional conservation measures with context-based strategies.

↓ From left to right, African Parks' Garamba National Park director of research and development Naftali Honig, Garamba cyberinfrastructure officer Evan Trotzuk, and technology development manager Geoff Clinning.

↑ GIS is helping Zwolle, a city in the Netherlands, be more resilient to climate change, according to Marcel Broekhaar, an adviser for the City of Zwolle's Smart Zwolle initiative.

→ The US Census Bureau has incorporated GIS into every aspect of design for the 2020 Census, as demonstrated by (from left to right) IT specialist Anika Adams-Reefer, geographer John Pollicino, computer mapping specialist Suzanne McArdle, and geography division chief Deirdre Dalpiaz Bishop.

The Geospatial Revolution Is Just Beginning

The geospatial nervous system that emerges will profoundly transform our world.

It fuses "our understanding of the human and ecological landscapes," explained Naftali Honig, the organization's director of research and development at Garamba National Park.

In Garamba, in the Democratic Republic of the Congo, the organization executes one of the most complex anti-poaching efforts in Africa. By monitoring collared animals, including elephants, the team can tap into their intelligence and see in real time, on a map, when a herd is acting erratic—perhaps to evade poachers.

"Visualizing *[this]* draws our attention to *[that]* area and drives us to understand the context and landscape around *[those]* particular animals," explained Evan Trotzuk, African Parks' cyberinfrastructure officer at Garamba.

African Parks also records other indicators, such as fires or illegal camps, and always knows where its rangers are so they can be dispatched directly to where poachers might be. This has helped reduce elephant poaching in Garamba by more than 90 percent.

The organization also uses GIS to work with surrounding communities. Outside of Rwanda's Akagera National Park, African Parks started a fishing operation that generates revenue for the community while promoting sustainable fishing. And near Liwonde National Park in Malawi, the organization runs a beekeeping program to stimulate local honey production.

Treating these unique landscapes as a nervous system—complete with sensory inputs, related analyses, and intelligent actions—is a good start. However, there is still much to do to ensure that Africa's protected areas thrive for generations.

Seeing At-Risk Biodiversity, and Planning Around It

NatureServe, a nonprofit that provides species-related data, tools, and services for conservation purposes, uses GIS to better see and understand where to find at-risk species in the United States, Canada, and Latin America. To help guide conservation efforts, it created the high-resolution Map of Biodiversity Importance for the United States—the first map of its kind.

"Using Microsoft cloud computing and Esri's modern *[GIS]* tools, we are able to generate, analyze, and share biodiversity data at a pace and scale never before possible," said Healy Hamilton, NatureServe's chief scientist. "We've produced detailed maps of the geographic distribution of over 2,000 species at risk—plants and animals, vertebrates and invertebrates, both aquatic and terrestrial. We've stacked these maps to see what we've never seen before. We can identify the places that matter for sustaining our nation's biodiversity."

Florida, for example, has undergone rapid development, but it's still rich in biodiversity, according to Hamilton. With NatureServe's data models and new interactive mapping capabilities, governments, businesses, and organizations there can find out which species—and how many of them—are at risk. They can see, for instance, whether there are butterflies, crayfish, or salamanders near a proposed development and how imperiled they are.

"This map provides conservation intelligence for better, smarter decisions," said Hamilton.

The data for the Map of Biodiversity Importance was collected over the last few decades by a network of 1,000 botanists and zoologists in NatureServe's network. Regan Smyth, director of spatial analysis for NatureServe, explained that for areas on the map where little or no data has been collected, data science can fill in the gaps.

"With Esri technology and support from Microsoft's AI for Earth program, we've built a spatial modeling infrastructure in the cloud that allows our scientists—from New York to Arizona—to work together to fill in these blank places on the map," Smyth said. "We are doing it by building predictive information models for thousands of species."

With GIS, Students See How to Overcome Religious Divides

For 30 years in Northern Ireland, Protestant unionists and Catholic nationalists clashed violently over whether to remain part of the United Kingdom or become a united Ireland. Although a peace agreement was reached in 1998, a small town called Lurgan is still divided along religious lines.

But there is hope. This year, students from two Protestant schools and one Catholic school participated in a citizen science project together in Lurgan. They visited 15 sites to "map how people felt at a variety of Protestant and Catholic areas in our town, both during the day and at 10 p.m. on a Saturday night," explained Catholic school student Aiesha Mouhsine.

At each site, students used Survey123 for ArcGIS to record how comfortable or uncomfortable they felt. Back in class, they visualized their data on a map. They saw, for example, that Protestant students felt on edge while visiting a Catholic/nationalist monument but fine in a Catholic place of worship, and that all students felt comfortable at their schools.

"It was really quite exciting to see the patterns that started to emerge," said Protestant school student Leon Van Der Westhuizen, who used ArcGIS Insights to analyze the data.

Local police and the town council are employing the students' findings for further research, but data collection and exploration were only part of the project.

"It's about breaking down barriers and building friendships," said Hannah Trew, a Protestant school student. "We recognize that, yes, we are all different…but overall…there's more that unites us than divides us."

↑ To help find at-risk species, NatureServe created the high-resolution Map of Biodiversity Importance for the United States. The organization's chief scientist, Healy Hamilton (left), and director of spatial analysis, Regan Smyth (right), demonstrated it.

→ Northern Ireland students (from left to right) Leon Van Der Westhuizen, Aiesha Mouhsine, and Hannah Trew charmed the audience with their heartwarming presentation.

The Geospatial Industry Keeps Evolving

Digital transformation is happening around the world at unprecedented rates, and geospatial data is now foundational for most businesses and governments. But until just over a year ago, there was no central body for the geospatial industry—no one association that organizations could turn to for geospatial expertise and guidance and no formal way for leaders in the industry to come together and collaborate.

That is why Sanjay Kumar, founder and CEO of Geospatial Media and Communications, conceived the World Geospatial Industry Council (WGIC). Launched by Esri president Jack Dangermond at the eighth session of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) in August 2018, WGIC brings together the most highly respected leaders in the geospatial industry under one umbrella. Initially, there were 21 founding members, including Esri, Autodesk, TomTom, Hexagon, Trimble, Oracle, and Bentley Systems, encompassing the fields of GIS, surveying, building information modeling (BIM), and navigation on one hand and hardware, software, solutions, and services on the other. Since then, 21 other organizations across the world have joined, taking the total number of members to 42.

"The goals of *[WGIC]* are to advance the role of geospatial technologies, strengthen our ability to contribute, and participate with the public sector…and then, at the same time, impact…the world economy, the environment, and ultimately society itself," announced Dangermond during the WGIC's launch at United Nations (UN) headquarters in New York, New York.

"This was a unique effort to, for the first time, bring the geospatial leaders representing the entire gamut of the business onto one platform," said Kumar, noting that the founding members hail from five continents. "The geospatial industry is one of the fastest-growing industries. It is also transforming from being product driven to solutions driven and is finding itself highly embedded in mainstream IT and engineering technologies. Therefore, we need to have better collaboration and convergence of technologies."

As Alain De Taeye, member of the management board at TomTom and vice chair of WGIC, explained, "The geospatial industry is foundational to so many of the changes that will happen in the next couple of years. If we want to change the world, we need to cooperate. And if we can work together and connect better to policy makers and authorities and have an influence on those policies, that will pay off."

"WGIC is the first dedicated body that really is promoting not just geospatial but also the convergence of various spatial technologies and other industries," added Theo Agelopoulos, senior director of infrastructure strategy and marketing at Autodesk and the marketing director for WGIC. "It's about broadening the awareness of geospatial information and how it touches various industries and communities because geospatial is going to become a lot more intertwined in everything we do and a lot of the decisions that both governments and communities make."

The Geospatial Industry Gets Its Own Space

Over the past year, WGIC has focused primarily on engagement—getting the leaders of the top geospatial companies in the same room so they can collaborate and then, together, foster meaningful connections between the geospatial industry and businesses and governments around the world. So far, that has been a success.

"I have been hearing that it has been a highly useful platform for leaders to cocreate and expand their business networks," said Kumar. Several members echoed that viewpoint.

"At the WGIC, we talk amongst colleagues in the geospatial industry; but not only that, we also connect to authorities in a more efficient way than we did before," said De Taeye.

"Along with gaining valuable insights and sharing the trends we're seeing in the industry, we can also better understand what challenges geospatial professionals around the world are facing," said Ken Mooyman, executive vice president of global marketing for Hexagon's Geosystems division and a WGIC board member. "For example, in Hexagon, we have customers across many industries, but another executive on WGIC may have a deeper knowledge on an industry we're not currently serving. When we come together, we share the unique information from both sectors, allowing us both to develop or adapt technologies with these key insights."

"We're not just discussing issues, we're actually taking actions to solve them," added Juergen Dold, president of Hexagon's Geosystems division and one of the founding members of WGIC.

To that end, the young organization has already forged valuable partnerships outside the geospatial industry.

"Through WGIC, the geospatial industry is engaging formally with a number of multilateral institutions, like the International Telecommunication Union, the European Commission, and the United Nations," said Kumar.

WGIC also has formal memorandums of understanding with the Open Geospatial Consortium, Inc. (OGC), buildingSMART, and the World Federation of Engineering Organizations and is working with the international public transport unions. "We're collaborating with all of them to share the perspectives of the geospatial industry," said Kumar.

"WGIC is also partnering with governmental organizations to set benchmarks for achieving new standards in the industry," said Dold.

And because of his position as secretary general and CEO of WGIC, Kumar is the first international member on the United States' National Geospatial Advisory Committee (NGAC), an authority on geospatial issues.

"The WGIC has been able to make its own space," said Kumar. "Now, the leaders from other industries have recognized this and are expressing their interest in working with us."

How to Make Big Things Happen

Getting the geospatial industry to claim its own space, however, has been a lengthy process.

↑ The World Geospatial Industry Council (WGIC) brings together the most highly respected leaders in the geospatial industry. Here, several patrons and members of the executive board pose for a photo after the organization's launch at the United Nations (UN).

↑ WGIC achieved rare credibility and global acceptability the day it was launched at the UN in front of delegates from 150 countries.

The first inkling of an idea to even do this came in 2011, when the UN established UN-GGIM, an initiative aimed at developing global geospatial information in ways that can help address the challenges the world currently faces.

"They wanted to involve and engage the geospatial industry, but they did not find any global association of geospatial companies," explained Kumar.

Given Kumar's deep involvement and array of top-level contacts in the geospatial industry, UN-GGIM invited him to organize a workshop between geospatial industry leaders and public sector authorities. He assembled a meeting in Seoul, South Korea, in 2011 and then helped the initiative take more formal shape in 2016 when he chaired the new Private Sector Network of geospatial companies set up by the UN.

"That was probably the first time I realized that the world is looking to engage with the geospatial industry," said Kumar. "But we didn't have a collective platform."

By January 2017, he started to think more seriously about forming a new organization. That's when his company, Geospatial Media, hosted a Geospatial Hall of Fame awards ceremony at one of its conferences.

"That was the first time the founders of about 10 global geospatial companies came together on a single stage," said Kumar.

He also remembers it being the first time that Esri founder Dangermond and Trimble founder Charlie Trimble ever met.

"They were both from California, they'd been doing business for 40 years, and they had never met!" Kumar exclaimed.

The two leaders lamented onstage about how long it took them to come together in the same room. "And that was a spark for me," Kumar recalled. "I thought, oh my God, I think these meetings can make big things happen."

Soon after, Kumar shared his idea about starting a global organization for the geospatial industry with a few people and then hired a consulting firm to do an independent study of the proposal. By January 2018, Kumar had assembled the 21 cofounders, who elected Dangermond as the interim chair so he could articulate the group's vision. And on July 4, 2018—heeding the symbolism of the founding of the United States, which Kumar points out was a consortium to begin with—WGIC was officially registered in the Netherlands. A month later, the organization launched at the UN.

"We achieved credibility and global acceptability on the day of the launch when the United Nations gave us a platform and Jack Dangermond gave a speech in front of 150 countries," said Kumar. "That's very rare."

From Seeing Change to Leading Change

The timing of the formation of WGIC was no coincidence, though. As the industry advances and produces more technologies that shape urban, suburban, and rural ecosystems, and as people, businesses, and governments become increasingly connected, the geospatial industry is an essential component for ensuring that all this development and all these advancements are scalable and sustainable.

"The need for collaboration, the demand from multilateral nations to engage with industries, growing deliberations on data polices—all that came on at once," said Kumar.

"Change has been the critical reason we're participating. From Autodesk's perspective, we see disruption in the industry, as well as market dynamics, changing the way our customers use building information modeling and geospatial technology," said Agelopoulos. "The convergence of BIM and GIS was a big driver of Autodesk's partnership with Esri in 2017—to basically provide an accelerator for our mutual customers to use both technologies. And that was a big contributing factor for why we engaged with WGIC: we see WGIC as a similar accelerator."

"The more suppliers of solutions in this industry that collaborate, the more support we can offer the industry and advance the profession," concluded Mooyman.

As WGIC continues making progress toward its interdependent goals of fostering collaboration within the geospatial industry and elevating the use of geospatial technology outside the field, Kumar wants to continue building it up as an organization and seeing it grow.

"What I would like to see going forward is, first, I would like to strengthen the secretariat," he said. "Second, we need to properly position the geospatial industry and its value proposition to the mainstream political, business, and economic leadership. And third, we need to double up quality membership."

This jibes with what other members want to help the organization do as well.

"I see the WGIC continuing to expand its influence and become even more recognizable and credible across the world stage," said Dold.

"We are making WGIC step by step, and I really believe it will make a difference in the longer term," said De Taeye. "It's a fantastic start!"

Michigan Moves Statewide Aerial Imagery to the Cloud

← Imagery is supposed to be collected when deciduous trees don't have leaves and lakes have no ice. This is difficult to do on Michigan's Upper Peninsula, so compromises—like having some ice on a lake—must often be made.

The State of Michigan is a leader in technology use. In the latest Digital States Survey, conducted by the Center for Digital Government, Michigan landed a top-five showing, thanks, in part, to its innovative imagery strategy. The Michigan Imagery Solution (MIS) is a cloud-hosted repository of imagery that's fed by the Michigan Statewide Authoritative Imagery & LiDAR (MiSAIL) program, which captures fresh imagery and elevation data for the state on a five-year revolving basis.

An important aspect of MiSAIL is that the state and counties participating in it share the imagery acquisition fees. This has saved Michigan $3 million, which contributed to its receiving the survey's prestigious A grade. But while this figure is a compelling return on investment, it's not the whole story. It doesn't include the time and money the state saves on server maintenance. It doesn't reveal the added insights gained from having up-to-date imagery, or the time saved by streaming imagery as a service rather than having to find the latest image on a server. It's also hard to put a dollar figure on how beneficial the new levels of cross-governmental collaboration are.

"We have a strong history of a statewide approach to geospatial data sharing in Michigan, going back to the Michigan Geographic Framework we released in 2001," said Everett Root, outreach specialist at the State of Michigan's Office of Technology Partnerships. "The idea has always been to make more data open and shared across the state."

Michigan's collaborative imagery collection began slowly, at the project scale, before becoming a state program.

"Sharing imagery costs with counties started in 2005 with some of the better-resourced counties *[that have]* higher populations," Root said. "In 2009, when many of the same counties were getting ready to fly again, we found that we only had imagery for 40 of our 83 counties. Rather than just refresh imagery with past partners, we set up a statewide imagery program designed to collect imagery for 20 percent of the state each year."

Constant Collection Despite—and Because of—Clouds

Every spring, Michigan's contracted imagery provider collects imagery for the year's quota of counties. The state specifies that imagery must be collected when deciduous trees are free of leaves, the ground is free of snow cover, lakes are free of ice, rivers and streams are within their normal banks, and the ground is unobscured by fog.

"These are the usual imagery capture standards, but in Michigan, there aren't many days in the year when all of this happens," said Root. "We'll start with some snow and ice on the ground if we have to."

The parameters prove particularly tough on Michigan's Upper Peninsula, which can get more than 300 inches of snow per season. Oftentimes, a compromise must be made, since many areas still have snow on the ground when leaves start to emerge on trees.

"The Great Lakes can also be challenging," added Root. "We can be in the air by 10 a.m., and by noon, clouds start rolling in off the lake and we're done for the day."

Although these kinds of vaporous clouds can make imagery collection difficult, the state still amasses a lot of imagery, which is where its technological cloud comes in.

"We had Michigan State University hosting our aerial photography since 2011, but that was just one server that needed memory and software upgrades, and we had just one failover server without any load balancing," explained Root.

Having to incorporate data from 2005 meant that the data volume became overwhelming pretty quickly. So to make data storage and sharing efficient, Michigan's Department of Technology, Management and Budget (DTMB) instituted a cloud-first provision in the Michigan Digital Strategy.

"The cloud made good sense for the sheer amount of data *[the state was collecting]*," said Mark Holmes, the geospatial services manager for DTMB.

"The move to Esri Managed Cloud Services provided an opportunity to apply best practices—managing users, setting up accounts, and providing streaming services for access in a cloud-based way," continued Root.

The MIS was one of the first projects to use Esri Managed Cloud Services to host and serve imagery and lidar data, porting more than 25 terabytes of imagery at the start in 2016. That data volume has now more than doubled.

Bartering Imagery for GIS Data

As part of the imagery acquisition program MiSAIL, the state launched an innovative initiative in 2017 to exchange its 12-inch-resolution imagery for authoritative GIS data from counties and local governments—without funds changing hands.

"A lot of counties jumped right on that offer, and we've been working on creating partnerships, getting agreements in place, and transferring data," said Root.

Bringing in local, authoritative GIS data to inform programs across all divisions at the state level benefits both state and local objectives. Counties provide property boundaries, associated assessment data, address points, and road centerline data, and in exchange, they receive fresh imagery from the state.

"Some counties have never had aerial imagery before, and we gain local, authoritative GIS data," Root said. "Everyone benefits."

While the state requires imagery capture at 12-inch resolution, local partners in this program can "buy up" and increase it to 6-inch or 3-inch resolution for areas of 10 square miles or more. This simply requires the imagery capture company to fly at the appropriate altitude and flight line spacing.

"It's a very affordable way for counties and local governments to get high-resolution imagery of their entire county or just their urban areas," Root said.

DTMB's online imagery streaming service provides an added incentive from the state. When a county signs up to partner in

the exchange program, in addition to receiving the latest imagery in an offline format that it can import into its own GIS, the county receives accounts for the image service. The image service allows it to stream all the imagery the state has, beyond just the latest. And the imagery tiles are served in three visible bands, as well as near-infrared.

Many people—including archivists, archaeologists, and environmental engineers—are excited about the ability to see how land use has changed for specific sites over the decades.

Data Users, and Uses, Keep Increasing

Streaming imagery can be delivered to both desktop users and users of configured apps. State and local government departments have built a large variety of apps to take advantage of the imagery input.

In addition, many departments throughout the state have employed the imagery to meet specific mandates.

The Michigan Department of Transportation (MDOT) pioneered much of the state's data sharing based on its need for imagery to verify a road's existence and to capture new roads. In fact, it was MDOT that kicked off the initial cost-sharing initiative with counties.

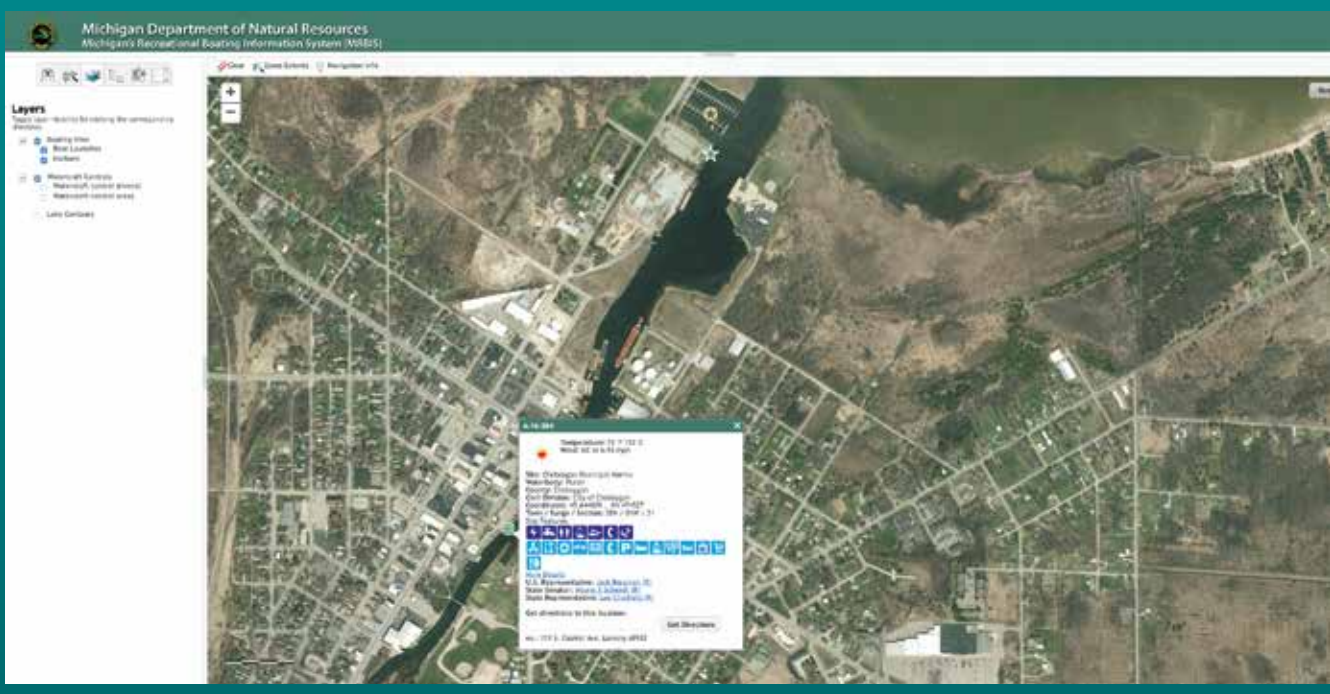
The Michigan Department of Environment, Great Lakes, and Energy (EGLE) administers a program that promotes shoreline protection to reduce erosion. Imagery provides a view of past outcomes to help EGLE recommend proper practices that minimize the effects of waves and ice on shoreline loss.

The Michigan Department of Natural Resources (MDNR) uses the imagery for forest inventory and to advise commercial foresters and private forest owners on practices that balance long-term timber production and the preservation of environmentally significant forestlands. The near-infrared imagery helps foresters detect tree species, vegetation health, and indicators of disease and forest pests. Imagery also forms an important backdrop for MDNR's Mi-HUNT app, which helps hunters find public hunting land.

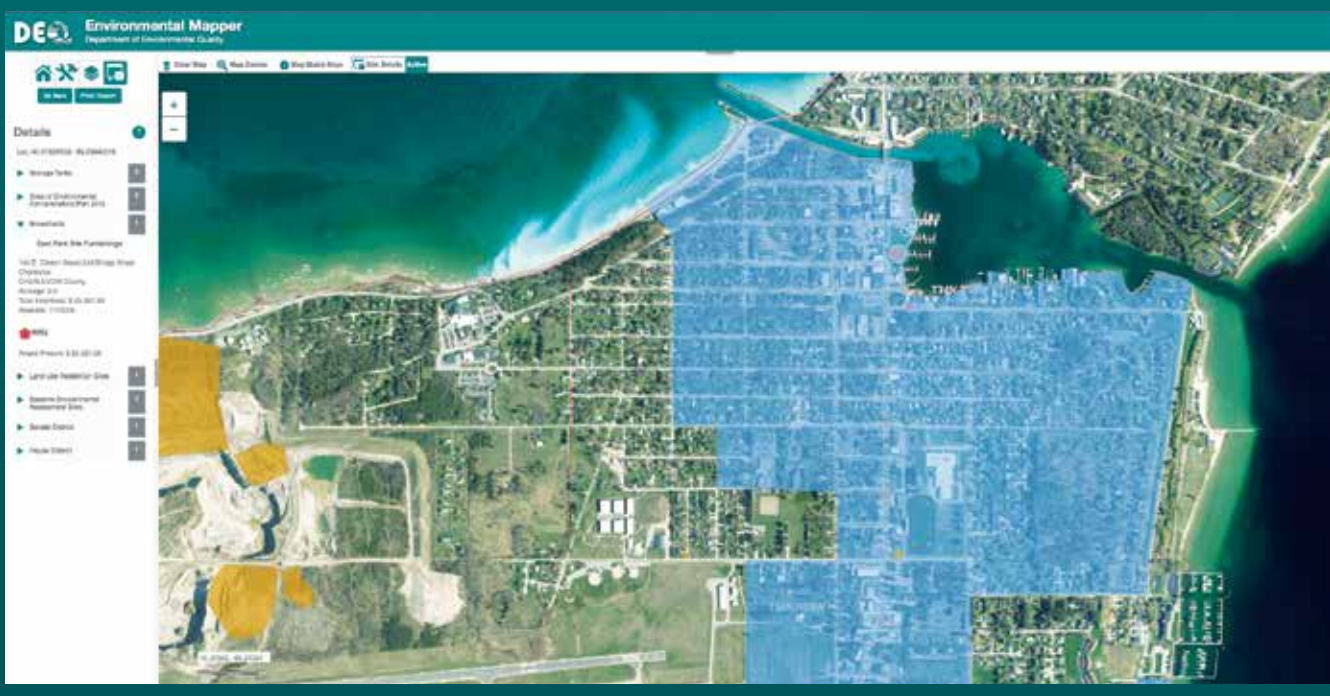
For the Michigan State Police, imagery provides an important input to enhance situational awareness. The department relies on state-derived imagery to furnish a "before" picture that it compares to mission-specific imagery it captures from helicopters.

With so many uses—and so much more data coming online—the number of MiSAIL accounts continues to climb.

"We have a constant increase in users and use of the data," said Root. "The most common reaction from new users is from those who have never seen high-resolution imagery and are instead used to looking at images that are free and available online. Looking at leaf-off imagery with a good resolution really allows you to see what was going on, on the ground at that time."



↑ The Michigan Department of Natural Resources (MDNR) uses imagery for forest inventories, helping hunters find public hunting land, showing boating access sites (as this map does), and more.



↑ The Environmental Mapper, from the Michigan Department of Environment, Great Lakes, and Energy (EGLE), shows various types of land use throughout Michigan, including places that are subject to specific ordinances (in blue) and development restrictions (in brown), as well as brownfield areas that are under redevelopment (highlighted).

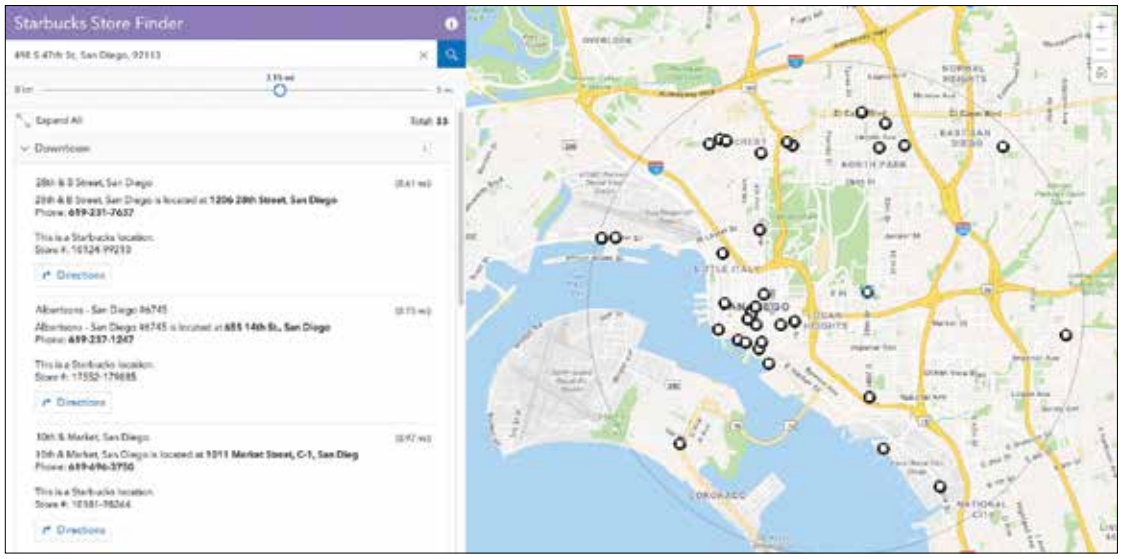
What's New in ArcGIS Online

The October update of ArcGIS Online provides users with more ways to share interactive maps, new functions for transforming data in ArcGIS Arcade, and a convenient means for updating hosted vector tile layers in place.

Improved and New ArcGIS Configurable Apps

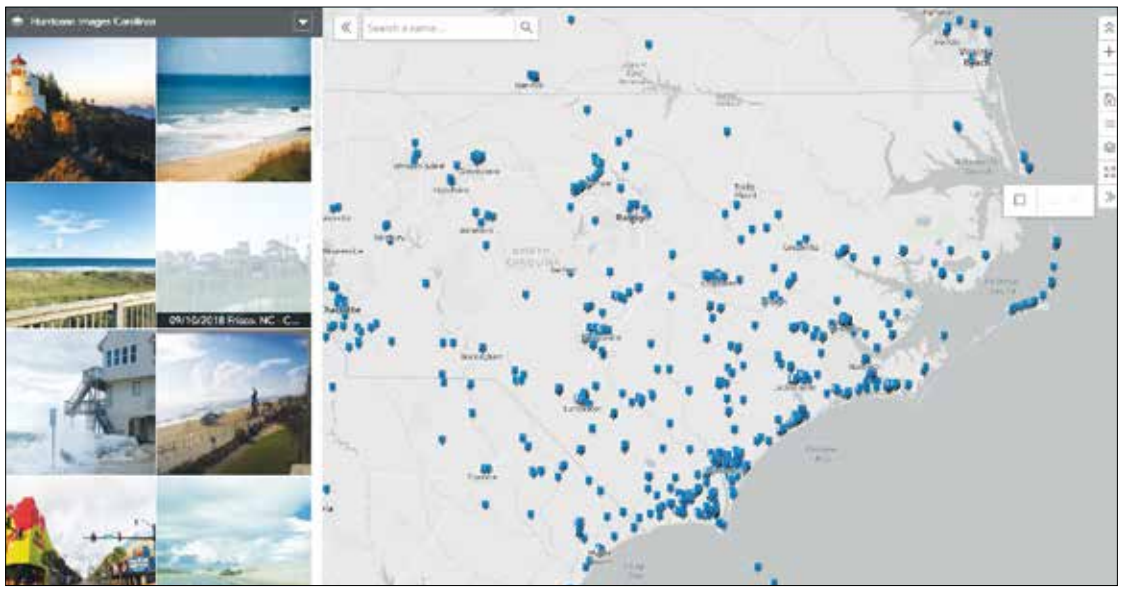
Configurable apps help users easily share their interactive maps. In this latest update, ArcGIS Online got a new configurable app, and two other apps gained significant new features.

The new configurable app, called Nearby, enables users to enter an address and a search radius to find nearby locations. After selecting a location, the app can provide directions to that location. By grouping the results together by layer, app authors can configure the app to answer detailed questions. For example, a user could search for nearby schools and see them grouped by school type: middle schools, elementary schools, and universities. The Nearby app can also be configured to answer questions such as, Where is the nearest pediatrician, How many violent crimes happened near my school, or Where is the nearest dog park?



↑ With the new Nearby configurable app, users can enter an address and a search radius to find specific locations, such as Starbucks, nearby.

Attachment Viewer, the configurable app that provides an immersive experience for users to view features and their attachments, has a couple noteworthy new updates. App authors can now choose between the existing photocentric layout and the new mapcentric layout. In the mapcentric layout, users see a gallery of attachments based on the features within the map extent. Additional configuration options include the ability to display more than one layer, support PDFs as an attachment type, and hide features that do not have attachments. Users can also get more details about the photos they view by zooming and panning.



↑ In the new mapcentric layout of Attachment Viewer, users see a gallery of attachments based on the features in the map extent.

Media Map, the configurable app that delivers a crisp and simple way to share maps, now includes an interactive time slider that animates data as it appears over time, giving users the ability to showcase data that is time enabled. For example, users could spotlight weather patterns, crime incidents, or competitors' locations during a race.

More ArcGIS Arcade Functions

Arcade, a scripting language supported in ArcGIS, transforms data on the fly, without leaving the map. With the October release of ArcGIS Online, there are four new functions available.

The groupBy function enables users to group features within a feature set by a field and then return statistics for each group. For example, if a city wants to know the type and number of trees within each of its ZIP codes, after collecting each tree as a data point, the city can use the groupBy function to query the points, group the trees by species, and calculate how many are in each ZIP code. The city can then share this information with its constituents through pop-ups in interactive web maps.

Users can now also calculate the shortest distance between two points along a great circle—say, between London, England, and Halifax, Canada—using the distanceGeodetic function. This results in a more accurate calculation than using Cartesian coordinates.

↑ With the new distanceGeodetic function, users can calculate the shortest distance between two points—such as London, England, and Halifax, Canada—along a great circle.

The new featureSetByRelationship function makes it easier to access features from layers that have relationships. For example, if a potential home buyer wanted a list of all the house's previous owners, the user could employ the featureSetByRelationship function to gather this information. The function queries each of the related layers (one record per owner), collects the owner's name, and compiles this information.

Users can now also build pop-ups rich with data from any layer within ArcGIS Online and ArcGIS Living Atlas of the World without adding the layer to their map. The featureSetByPortalItem function uses the layer's item ID to access the data without visualizing the layer. For example, say a user wants to map all the libraries within a state. Each library's pop-up could include the population numbers for the ZIP code in which the library resides. Rather than geoenriching and getting another layer, the author could bring in the population data from ArcGIS Living Atlas of the World using the function and the population layer's item ID.

Update Hosted Vector Tile Layers in Place

Users managing hosted vector tile layers can update layers in place using the new Replace Layer option. Replace Layer updates the tiles in the target hosted vector tile layer by swapping the entire tile cache with the layer selected as a replacement. As a result, existing apps and styles that reference the hosted vector tile layer continue to work without having to update them. Previous workflows that required publishing new layers and updating web maps and apps that reference the layers are no longer necessary.

Updating hosted vector tile layers with Replace Layer requires minimal downtime. Users can build, do quality assurance (QA) on, and preview their vector tiles before updating the live layer. This helps ensure a quality update ahead of time. And when replacing the layer, users have the option to archive the old vector tiles. The archive can then be used for reference or to roll back the update.

Update to ArcGIS Runtime SDKs Extends Capabilities for Utility and Public Safety Developers

ArcGIS Runtime SDKs 100.6, released in August, is a milestone for ArcGIS Runtime SDKs both in capabilities and how Esri plans content for releases.

With 100.6—also called update 6—Esri introduces a track-focused road map for ArcGIS Runtime. The three tracks for this update are utilities, defense and public safety, and platform support. While these tracks were the drivers behind adding various capabilities to ArcGIS Runtime, in most cases, the new capabilities can be applied far beyond the specific track that helped bring them to life.

UTILITIES

This is the big one! With update 6, ArcGIS Runtime gains the first phase of support for the utility network. It also boasts improved annotation support, better integration of navigation, more ways to work offline, and fresh-out-of-beta augmented reality (AR) capabilities.

Support for Utility Network

Since the introduction of the utility network to the ArcGIS platform, many Esri users have asked for tools they can use to access and work with their utility network data in mobile field solutions. Update 6 is the first step in providing those tools.

Esri now delivers APIs that can read network element attributes, such as the voltage capacity and whether switches are open or closed. These APIs can also describe associations between network elements and their geographic features, which is helpful when, for example, a switch with many terminals is represented by a single point on the map.

Update 6 also introduces network tracing. Users can set one or more starting points on their network—at a junction or terminal or somewhere along an edge—and, as an option, specify any number of barriers and then perform a trace. Traces are extremely fast, too.

As of this release, all utility network capabilities in ArcGIS Runtime are service based and require a network connection. In subsequent releases, Esri will be adding more utility network functionality, including the ability to work offline.

Improved Annotation Support

Both annotations and reference scale are important for utilities that represent their networks on maps. Together, these capabilities allow mapmakers to specify precisely how text looks as users zoom in and out. These were added to the ArcGIS Runtime SDKs at update 5 as a sneak peek at what would be released in the utility track.

At update 6, users can now take annotation services offline, which is great for working in areas with variable network connectivity. Esri will continue to expand these capabilities over the next few releases.

Easier Navigation Integration

Another new capability that was driven by Esri's utility users but that has a broad range of applications is the navigation API.

ArcGIS Runtime has long been able to deliver turn-by-turn directions, both when connected and when offline, but developers have had to write a fair bit of custom code to provide an interactive navigation experience. The new navigation API makes it easy to integrate navigation directly into ArcGIS Runtime apps.

This first release provides APIs that alert app users of upcoming maneuvers, detect when users have wandered off route, and automatically reroute them if need be (but for now, only when using local datasets). Use of the navigation API in a production app does require a Basic level (or higher) ArcGIS Runtime license.

Enhanced Offline Capabilities

Update 6 also introduces several improvements to working offline—another capability that was driven by the utilities track but is applicable to so many other situations.

The new scheduled updates capability augments preplanned offline workflows by generating and storing periodic, read-only data changes on the server so they're ready for clients to download. An ArcGIS Runtime app can then check the server to see which updates will make it current, download them, and apply them in sequence. This brings the performance benefits of the preplanned offline workflow capability—including being able to generate an offline map once and distribute it broadly without taxing the server—to data updates.

Augmented Reality Is Now out of Beta

For the past year, more than 300 customer development teams have worked with Esri's AR beta program, and those capabilities are now being brought out of beta. With update 6, ArcGIS Runtime is AR-enabled for iOS and Android devices.

It was clear that delivering a truly exceptional AR experience across a range of use cases would require customization, configuration, and calibration. To support that, Esri will be providing open-source toolkit components to help build tabletop (small, model-like versions of a map or scene), flyover, and full-scale AR experiences.

DEFENSE AND PUBLIC SAFETY

Defense and public safety organizations often have specific—and critical—rules about how their maps are styled. Military symbology, for example, has to be broad, flexible, and information rich yet highly readable and immediately recognizable. Additionally, since these organizations usually can't adopt external authentication and security patterns, they generally require apps to integrate with their existing patterns. Update 6 addresses both of these matters.

Symbology Powered by ArcGIS Arcade

With update 6, Esri introduces improved support for military symbology—and this is being built into the ArcGIS platform, not just ArcGIS Runtime. This refreshed, customizable solution accesses symbols in a style file and is powered by ArcGIS Arcade.

While this supports defense users' needs, it also exposes complex, attribute-driven rendering for use in any kind of app. For example, with a little Arcade customization, an app could display restaurants with symbology that shows not only their locations and types but also their customer ratings, when they're open, and if they're kid-friendly.

More Support for OGC

Many services that are published according to Open Geospatial Consortium, Inc. (OGC), standards use parameter-based authorization schemes for access, and that affects a number of defense and public safety organizations. Esri now supports using these authorization keys—and, for that matter, any custom parameters—for Web Feature Service (WFS) layers, Web Map Service (WMS) layers, and Web Map Tile Service (WMTS) layers.

Update 6 also adds creation and editing capabilities to Keyhole Markup Language (KML) files. This means that users can now modify a KML file or author one from scratch, save it, and share it with others directly from an ArcGIS Runtime app. Creating and editing a KML file in a production app does require licensing ArcGIS Runtime at the Standard level (or higher).

PLATFORM SUPPORT

In addition to the updates focused on utilities and defense and public safety, Esri has released some other capabilities that were driven by the needs of the ArcGIS platform as a whole. Highlights of these include the following:

- Mobile map packages now support group layers.
- ArcGIS Runtime opens WFS layers from a web app.
- Users can now identify and select features in a point scene layer.
- Scene layers, feature layers, and graphic overlays can have a vertical offset defined for use in a scene.

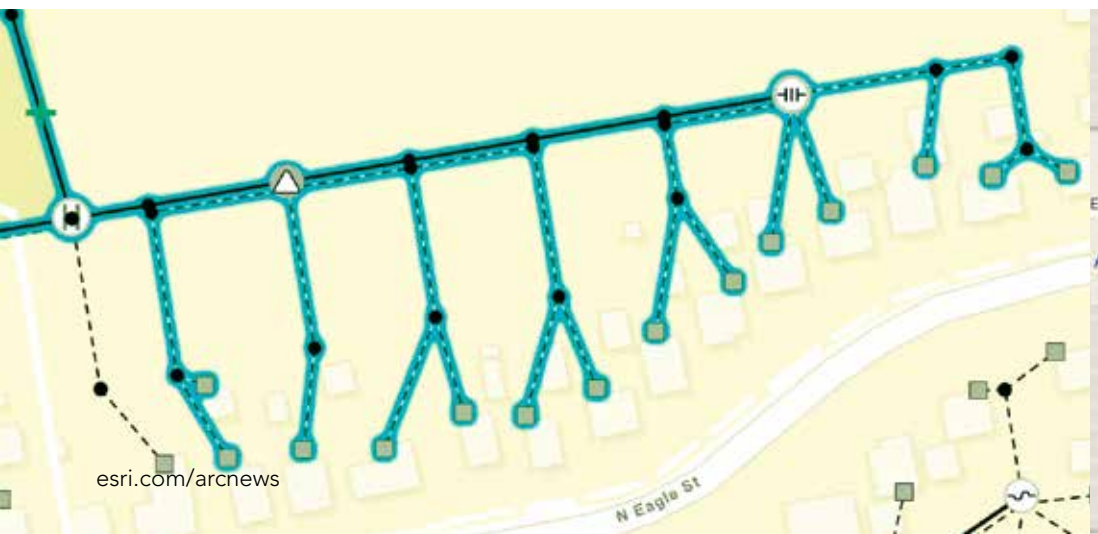
Esri has also fixed multiple bugs in ArcGIS Runtime and made some big improvements to performance and memory usage—in particular, with dictionary renderers, Arcade, and working with mobile map packages.

DOWNLOAD AND GET STARTED

There is a lot of important and foundational new technology in update 6 of ArcGIS Runtime SDKs, much of which is only the start of what the team has planned.

To get 100.6, go to the ArcGIS for Developers website (developers.arcgis.com), look for the ArcGIS Runtime SDK you want, go to its web page, and download the SDK. If you're new to developing with ArcGIS Runtime and don't have an ArcGIS Developer subscription, sign up for a free account at developers.arcgis.com/sign-up and get access to everything you need to create your app, including tutorials, samples, and rich documentation.

↓ Update 6 to ArcGIS Runtime SDKs introduces network tracing. Users can set a starting point on their network, specify any number of barriers, and then perform a trace.



↓ With ArcGIS Arcade customization, an app can now display restaurants with symbology that shows their locations, their food types, customer ratings, when they're open, and more.

App Gives Southern Californians Up-to-Date Air Quality Information

↑ Users can choose one or more areas they want to keep track of, making it easy to check air quality at a glance.

Knowing when and where the air quality is good, bad, or somewhere in between is important to Southern Californians. While the air in greater Los Angeles is cleaner than it was from the 1950s through the 1980s, there are still times when and places where it's smart to stay indoors or skip strenuous exercise.

Getting accurate, up-to-date, and location-based air quality information is now just a tap away, courtesy of a new mobile app from the South Coast Air Quality Management District (South Coast AQMD). Developed in part using Esri's ArcGIS Runtime SDKs, the South Coast AQMD app, which can be downloaded at aqmd.gov/mobileapp, offers users air quality updates and other useful information in four Southern California counties: Orange County and major portions of Los Angeles, Riverside, and San Bernardino Counties, including the Coachella Valley.

Maps are an integral part of the South Coast AQMD app. People who download the app will find a map showing the current and next day's air quality information and another map displaying locations of alternative fuel stations for places they select. By enabling the geolocation features on the app, users will receive the most up-to-date air quality information in their current city.

"We are used to checking the weather on phones, and *[we]* wanted to make it as easy to get our air quality," said Jo Kay Ghosh, South Coast AQMD's health effects officer.

The app, available for Android and iOS devices, includes the following information:

- Current hourly location-based air quality readings displayed on a color-coded map
- Current hourly air quality index (AQI) readings shown on a corresponding color-coded dial
- The air quality forecast for the next day
- An animated background for current weather conditions
- The main pollutant in the air—ozone, PM2.5, or PM10
- The current temperature
- A map of alternative fuel stations based on location and fuel choice (electric, hydrogen, clean natural gas *[CNG]*, or propane), along with driving directions
- A phone number to report air quality-related problems
- South Coast AQMD alerts, announcements, and events

South Coast AQMD acts as the pollution control agency for vast portions of Los Angeles, Orange, San Bernardino, and Riverside Counties. It is in charge of monitoring and controlling stationary sources of air pollution, from area factories to neighborhood dry cleaners. Recent wildfires have exacerbated the pollution problem, too.

The agency keeps the public informed about the air quality in the 10,743-square-mile region it covers. Knowing what the air quality is like on any given day or even hour is important to all estimated 17 million residents but especially the elderly, young children, and those with conditions such as asthma or heart problems. The American Lung Association, in its recent State of the Air report, named greater Los Angeles the smoggiest area in the country. It's recommended that people sensitive to air pollution, including ozone or particulate matter (PM), avoid or limit outdoor activities or even stay indoors on certain days.

Ghosh said the app offers real-time air quality information plus the forecasts for the next day, which are available after noon, because "the level of air pollution can change throughout the day." She added that newly available hourly AQI updates can help people plan for when they exercise outdoors.

A Visually Pleasing App

Several years ago, South Coast AQMD used ArcGIS Online to create a browser-based map showing air quality conditions and had dabbled with an earlier version of a mobile app. But when Ron Moskowitz came on board as the agency's assistant deputy executive officer for information management in 2017 (he's now the deputy executive officer and chief information officer), he decided to up the ante technologically by totally redesigning the mobile apps.

↑ The map and color-coded dial show what the air quality is like in different areas on any given day. The ratings go from green (good) to dark red (hazardous).

Moskowitz said he envisioned creating a "one-stop shop" app where people could find the most relevant information from South Coast AQMD. He wanted both the iOS and Android versions to be visually pleasing with maps and other indicators that display air quality data and alternative fuel station locations. In addition, Moskowitz thought the app should be easy to navigate and provide people with a way to connect with South Coast AQMD either by reporting air quality issues using the 1-800-CUT-SMOG number or finding the times and locations of South Coast AQMD meetings they could attend.

"I really wanted to create something that engaged the public *[and was]* simple and easy to use," Moskowitz said. "We developed a beautiful app that is intuitive."

ArcGIS Runtime SDK for Android and ArcGIS Runtime SDK for iOS were used to add mapping capabilities to the apps and consume content and services from ArcGIS Online.

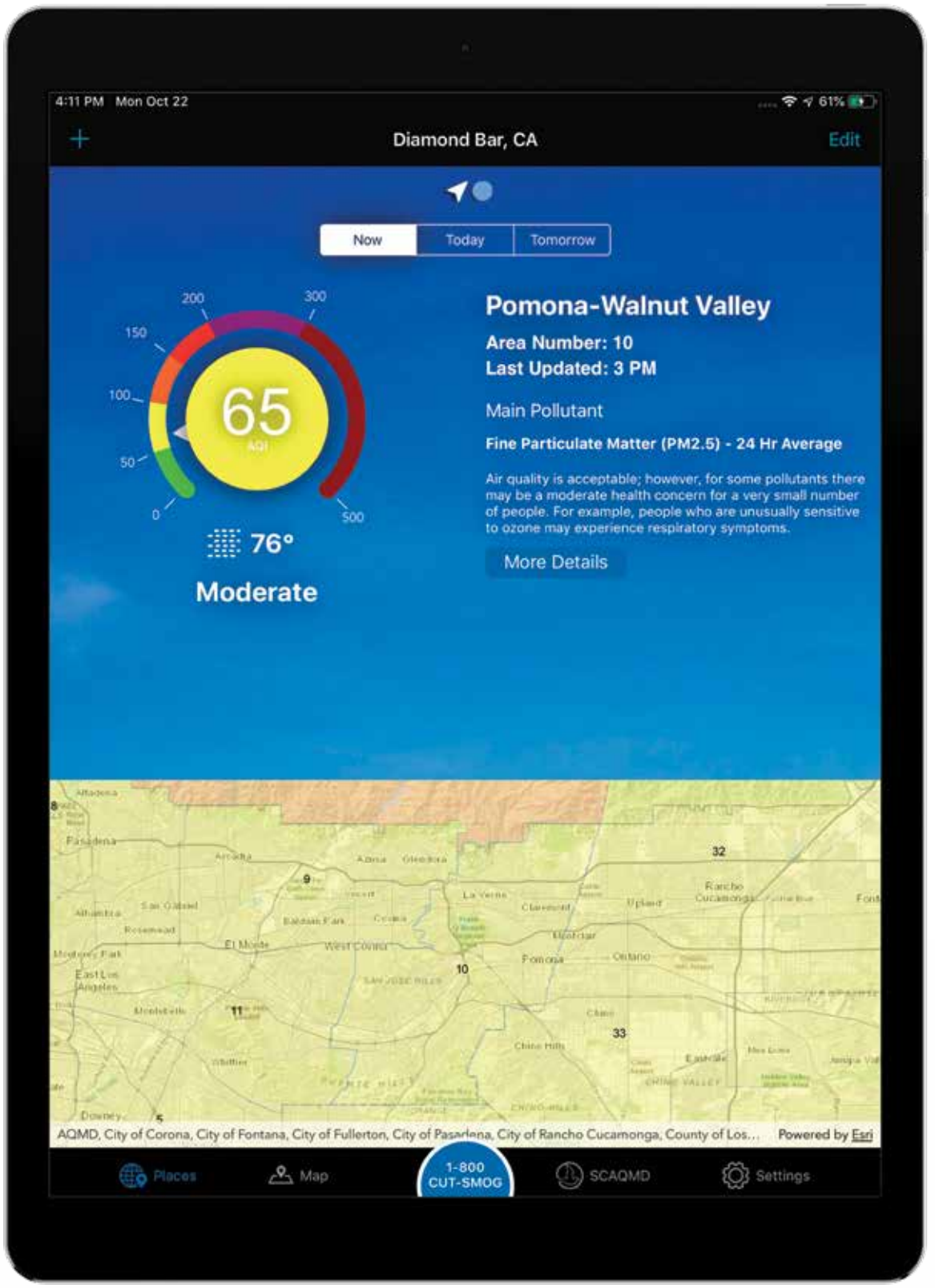
"We are using the SDKs to render those maps. The features are hosted in ArcGIS Online," Moskowitz said.

The AQI values in the dial are retrieved from feature attributes using ArcGIS Runtime SDKs, too.

Moskowitz said ArcGIS Runtime worked well for this project and that the mapping features were easy to integrate into the app.

"It met all our needs of what we were trying to communicate," he said. "And we had good support from Esri."

↑ The app includes a map of alternative fuel stations based on location and fuel choice: electric, hydrogen, clean natural gas (CNG), or propane.



↑ The air quality maps display numbers from 1 through 38, which represent the locations of 38 source receptor areas (SRA) that each have at least one Environmental Protection Agency (EPA)-approved air quality monitor. Central Los Angeles is in area 1, and Diamond Bar is in area 10.

Making Data Understandable

The maps in the South Coast AQMD app and the ArcGIS Online map use colors to display the AQI levels geographically. For example, on a day in June, the map of both Riverside and San Bernardino Counties was colored yellow for moderate, meaning the AQI was between 51 and 100. However, the map of east San Gabriel Valley in Los Angeles County was colored orange for unhealthy for sensitive groups, meaning the AQI was in the 101–150 range.

"Using maps and color-coded dials helps communicate information visually, making data such as the AQI values easier to understand," said Jia Yuan Li, a South Coast AQMD systems and programming supervisor who worked on the app project. "Colors help *[people]* interpret the data. It is The Science of Where—data has to be interpreted to be understandable, and that's where the map really comes in."

The air quality maps also display numbers from 1 through 38, which represent the locations of 38 source receptor areas (SRA) within South Coast AQMD's jurisdiction. Each SRA has at least one Environmental Protection Agency (EPA)-approved air quality monitor. Selecting the number reveals the area being monitored (e.g., 1 is for central Los Angeles), its AQI value, the reading time, the main pollutant, and more.

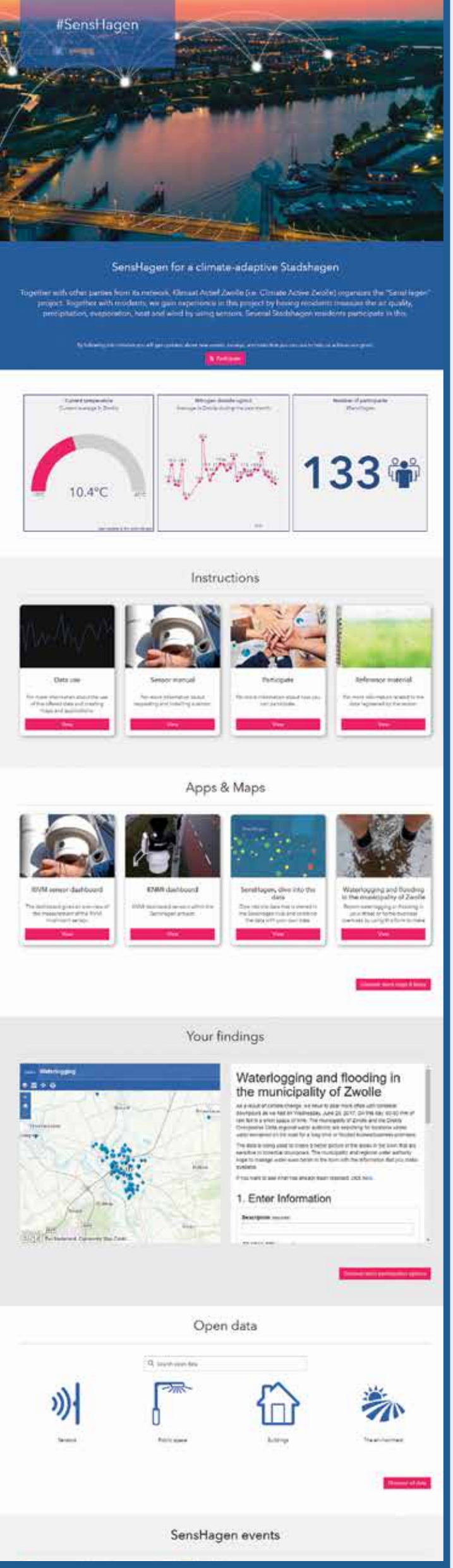
The app also lets users choose one or more areas they want to keep track of. They just tap the Places icon at the bottom of the app and use the plus sign (+) to add a new place, either with the name of a city or a ZIP code. Users can also set up air quality alerts based on the color level they select in the Air Preferences setting (green, yellow, orange, red, purple, and dark red).

"We recommend setting it to orange or higher," Li said, adding that otherwise, you might be peppered with too many alerts. "We don't want it to be an app that's intrusive."

Recently, the app received two awards from *Government Technology* (GovTech) and AT&T for technology innovation in the Citizens category, while Moskowitz was recognized in the Leadership category.

Future plans for the app include making the AQI data more granular on the map—something that would be possible as more sensors are added throughout Southern California.

"You could find out the air quality in your neighborhood," Moskowitz said.



↑ Part of what makes SensHagen successful is that citizens can go to the hub website to view and explore their own data.

Using ArcGIS Hub, Local Government Partners with Residents to Study Climate Change

The Dutch municipality of Zwolle, in northeastern Netherlands, sits amid three rivers. Zwolle is known as one of the country's greenest cities, most notably because of its 33 scenic parks and the municipality's efforts to maintain them sustainably.

With a growing population of more than 125,000 residents, the City of Zwolle is tasked with helping the town remain healthy and thriving. To preserve its citizens' quality of life, the city is proactively researching climate change and its impact on Zwolle—and it is enlisting residents to help.

Using high-tech sensors, residents are now playing an important role in this research by gathering crucial climate-related data from across Zwolle. In addition, the city has created an online platform to engage residents and increase transparency by sharing city initiatives that are aimed at keeping the community a wonderful place to live.

"We believe technology can help us face the challenges we have as a city and achieve our goals, especially when we get citizens engaged," said Maarten Veeger, director of strategy for the City of Zwolle. "We truly believe in the participation of our citizens. When you engage people, they can contribute and be a part of the solution."

Residents Add Value to Data

The City of Zwolle wanted a platform to improve collaboration and promote public engagement. So in 2018, a cross-departmental group at the city developed Smart Zwolle Hub using ArcGIS Hub, a unique community engagement platform. Smart Zwolle allows the city to communicate information about current projects and let citizens know how they can get involved. This is why Marcel Broekhaar, the city's smart society program manager in the department of information provision, says it works so well.

"With ArcGIS Hub, you can change the citizens' perspective by showing them what they can do and why we're working on certain issues," he said. "We believe in transparency and letting residents know what we're working on and why."

In the past, according to Broekhaar, residents were dependent on receiving information from the local government.

"But now they can see for themselves what's going on," he added. "It's not just our information anymore. Residents can now explore data and add value to it."

The City of Zwolle was already using the ArcGIS platform and Operations Dashboard for ArcGIS, so implementation of the smart hub was simple. The team was also able to use its current content and apps, so Broekhaar said it was easy to create Smart Zwolle Hub.

Likening the city to an intelligent nervous system, Broekhaar said he hopes that the smart hub will connect all the dots.

"We work often on issues like mobility, health, and other things that impact our city," he said. "I hope that, as we continue to use the hub for relevant issues, we can connect those matters and get a better view of how the city works."

The smart hub gives the City of Zwolle the information it needs to make data-driven decisions—an area where Broekhaar wants the organization to grow in the next five years. It has also enabled the city to partner with local groups for the Smart Zwolle Alliance, a coalition of strategic partners that collaborate and learn from one another.

"The organizations in the Smart Zwolle Alliance have their own data and people with expertise, and we are bringing it all together under one umbrella, using the hub to facilitate it," explained Broekhaar.

Understanding Patterns Before Something Goes Wrong

To better understand climate change and its impact on the municipality, the City of Zwolle started gathering data for research and got citizens to help.

While the country's national weather service—the Royal Netherlands Meteorological Institute (known by its Dutch acronym KNMI)—collects and analyzes weather data for agricultural areas, Broekhaar wanted data that was more relevant on an urban scale.

"We haven't seen significant climate change effects in Zwolle yet, but we don't want to wait until something is wrong," he explained. "We want to see patterns, understand this problem, and gather data."

To that end, the city created a network of sensors for Zwolle's weather stations to examine and monitor changes in air quality. The project was named SensHagen, a combination of the word sensor and Stadshagen, the neighborhood where the project got started. The National Institute for Public Health and Environment (abbreviated as RIVM in Dutch) made the air quality sensors. Now, in addition to having weather stations collect data about temperature, wind direction, wind force, and precipitation, air quality sensors measure fine dust and nitrogen dioxide.

In partnership with KNMI and RIVM, the City of Zwolle also gave sensors out to citizens to place at or near their homes. Thus, Zwolle residents gained an important role in data collection.

Broekhaar and his team held neighborhood meetings to tell people about the project and to recruit participants. Although SensHagen started with just five volunteers, the initiative now has around 150 participants, and that number continues to grow as more residents learn about it.

Part of what makes the project successful is that citizens can go to the SensHagen website to see their own data. The site also contains an events calendar, which residents can use to find information about upcoming events and opportunities to get involved. They can even use the website to sign up to participate.

The SensHagen program has become part of a larger European research project aimed at understanding the impact of climate change on the local level, not just at a global scale, according to Broekhaar.

"We are excited about this project and hope that we can contribute to not only Zwolle but the world," he said.

Myriad Ways to Improve the Community

The City of Zwolle is focused on gathering as much information as possible over the next few years to improve decision-making. The accumulated data will be analyzed by KNMI and RIVM.

"To take action, we need more data and information. If we didn't have data, we couldn't act at all," said Broekhaar. "We are doing analysis now with the data so we better understand how the neighborhood is working."

The city is introducing other initiatives using the Smart Zwolle hub as well, including one aimed at monitoring floods.

Flooding is an ongoing problem for the area, so the City of Zwolle built an app with Survey123 for ArcGIS that people can use to report when and where flooding occurs. Respondents can also use the app to submit pictures of flooded areas, and the information is added to what the city calls a wet feet map.

"With this wet feet map, we better understand where water is standing, but we don't know how long it takes before the water is gone," Broekhaar noted.

With that in mind, a group of residents took this project even further by building a wet feet sensor, which not only gathers flooding data in real time but also reports how long it takes for the water to dry up.

"It's an idea that came from the citizens, and I think it's a great contribution to this project," said Broekhaar.

The City of Zwolle also offers educational classes to get kids involved and teach them about climate change and technology. Broekhaar and his colleague Ryan Hoekman, with whom he began the SenHagen initiative, looked at Stadshagen's demographics and noticed that there were a lot of families with young children. They thought it would be a great way to connect with Zwolle's youngest citizens.

Local organizations contributed curriculum that currently consists of 11 modules, each with a different subject. For example, one lesson revolves around going on a sensor walk, where kids walk through their neighborhood and see where measurements are being taken. Instructors help them understand what the sensors are monitoring and why.

In 2020, the team will try to get more schools involved in teaching the curriculum.

"Through this project, the kids begin to understand what technology is and how it can help the world," said Broekhaar. "They think it's cool that they can bring this message home and talk to their parents and say, 'Well, I've learned about this, and we should do something.'"

Overall, getting citizens involved in various aspects of the City of Zwolle's work will help ensure that the health and well-being of the town is preserved for years to come.

"People love that they can get involved in this way and we are standing side by side," said Broekhaar. "Now, we are all working together to better our community."

↑ Marcel Broekhaar and his team held neighborhood meetings to tell people about the project and recruit participants.

→ The city offers classes to kids to get them involved and teach them about climate change and technology.

Future Citizen Engagement Plans

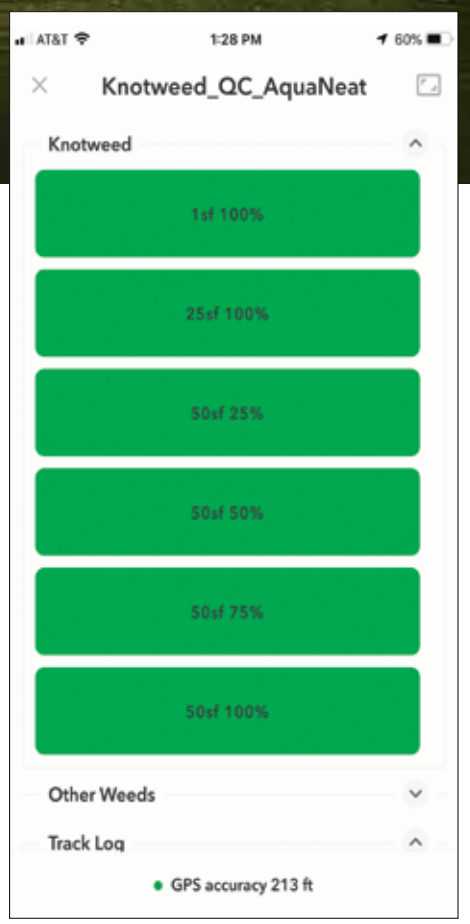
Broekhaar and his team see these climate initiatives as the first experiments for the Smart Zwolle Hub and hope to follow the same pattern of engaging with citizens and partners in the community on other issues, including energy transition, livability of public spaces, and urban housing challenges.

"The Smart Zwolle Hub is starting a movement. It is a movement in our town and region in which authorities, institutions, businesses, and residents can work together to focus on and monitor policy and activities," said Broekhaar. "*[It]* better equips everyone to develop new services and products because they can act with reliable information. This is the difference between the Smart Zwolle Hub and regular open data portals. It is a shift from the passive open data portal to a proactive collaboration platform."

↓ Residents of Zwolle are using high-tech sensors to gather crucial climate-related data across the city.

Noxious Weed Removal with Real-Time Data

Using ArcGIS QuickCapture, King County, Washington, Improves Information on Invasive Plants



↑ Field staff now use ArcGIS QuickCapture to collect data in real time on noxious weeds around King County.

→ ArcGIS QuickCapture allows field crews to track the exact locations of weeds and monitor whether they are decreasing in size over time.

Preserving the unique ecosystem of King County, Washington—home to diverse landscapes, animals, and exotic native plants—requires tailored programs and dedicated individuals. In this area, noxious weeds pose a danger to regional habitats. These invasive, non-native plants threaten crops, local ecosystems, and fish and wildlife habitats; cost millions of dollars in lost agricultural production; and harm the environment.

In 1996, King County introduced its noxious weed control program to reduce the impact of invasive plants, including knotweed, across the county. Knotweed primarily affects riparian areas—the spaces between land and a river or stream—and completely alters the habitat where it is present.

"Knotweed has had a major ecological impact on our rivers and plant communities," said Sasha Shaw, King County's communications specialist. "It's outcompeting the native plants, and that has really had a big impact on the in-stream salmon habitat. It has also reduced diversity for birds, native wildlife, and native plant habitats."

The program's staff work with private agencies and landowners on detection and prevention, conduct public education and outreach, and perform crucial field surveys. Collecting data in the field is essential for tracking and reducing noxious weeds. For this, crews used to rely on paper forms. But in July 2018, the county implemented Esri's new ArcGIS QuickCapture app, which allows users to record locations, photos, and other attributes in the field and send them back to the office in real time with a single tap on a mobile device.

"ArcGIS QuickCapture was an instant hit," said Patrick Sowers, one of the program's noxious weed specialists. "It was the perfect data collection app for us to use in the field and gives us the ability to get the information we need in real time."

A Time-Consuming, Labor-Intensive Process

According to Sowers, field crews control large areas and are responsible for tracking the exact locations of weeds to monitor progress. They document the areas they inspect and note whether a weed is decreasing in size over time.

To do this, crews were using paper forms to record data and take notes on individual weed infestation points. After the fieldwork was done, the weed specialists combined these paper notes with downloaded GPS data back at the office and manually entered the resultant information into a geodatabase. Additionally, crews were responsible for manually recording attributes on cards that captured GPS points and were processed at the end of weed season in the fall. Weed specialists then entered all this data into ArcGIS Desktop so it could be mapped, analyzed, and shared. Each point had to be manually updated with attribute data.

Staff described this process as time-consuming and labor-intensive. And because so much manual processing was required, this also meant that information was not immediately available, making it difficult to share in a timely manner.

Program staff needed a way to streamline field data collection, eliminate manual data entry, improve data accuracy, and reduce the amount of time it took to process information.

"There's a lot of communication *[involved in]* sharing *[our]* data because our program interfaces and communicates with other agencies, other crews, and members of the public," explained Shaw. "And because we didn't have the data until the end of the year, we weren't able to share that data in real time and when it would have been useful."

Staff Give ArcGIS QuickCapture a Go

To streamline field data collection, noxious weed control program staff sought a solution that was app based, GPS aware, and available on handheld devices. The team chose ArcGIS QuickCapture, an app that can help the crew improve field collection and reporting, transmit information in real time for instant viewing and analysis, and monitor progress.

Program staff did a trial of ArcGIS QuickCapture for a few days in 2018 to track knotweed locations along river corridors. They started with 15 users on iPhone 6s and 7s and had such confidence in the data collection that they ended up using ArcGIS QuickCapture for the remainder of the season.

"We selected ArcGIS QuickCapture because it allows us to rapidly collect data and has an easy-to-use interface," said Sowers. "It seemed like the best option to do what we were looking for."

Both the implementation of ArcGIS QuickCapture and the training process were straightforward. Field crews had already been using iPhones, so the app was just added to their current devices with no need for additional equipment. Also, because the crew had been collecting similar data in past years, training was simple: staff were shown an overview of the app and how resultant data was displayed.

Improved Accuracy with Real-Time Data Capture, Transmission

Since employing ArcGIS QuickCapture, King County's noxious weed control program has seen significant improvements in work processes, both inside and outside the office.

The switch from manual processing to real-time data transmission streamlined the team's workflow. The program has reduced postfield-work processing times by 90 percent, which translates to days and weeks of time saved. Staff now have more time to continue their work in the field and focus on other projects.

Harkeerat Kang, a GIS specialist-master with King County, said the ability to configure the buttons quickly in ArcGIS QuickCapture has simplified data collection and reduced the complexity of capturing data in the field. Sowers added that the speed of data collection substantially improved with ArcGIS QuickCapture, noting that staff can now record data points rapidly. In addition, field staff no longer need to take their devices back to the office to download data.

"ArcGIS QuickCapture enables us to get real-time data back, since we don't have to download data off the units, which has been one of the biggest time-savers," said Sowers. "That—and the manual postprocessing of data—was a lot of extra work that QuickCapture got rid of."

Data accuracy has also improved with ArcGIS QuickCapture. Kang explained that with the end-of-season processing, it was difficult to remember changes in the data or to know whether something had gone wrong during recording. However, with real-time data, staff can review collected data fast and make changes on the spot, if needed, to ensure accuracy.

Real-time data transmission also improved field coverage. According to Sowers, staff wouldn't know until the end of the season which areas had been visited by field crews. Now, staff have the data they need to ensure better area coverage and can see, in real time, the places that still need a visit during the season.

ArcGIS QuickCapture also provides data in a hosted format that's ready to share. In the past, King County's noxious weed control program collected, processed, and stored GPS data locally and then information was sent to requesters via email. Now, staff have the option to send maps with live views as opposed to static images.

"Being able to show where the weeds are in time for *[external agencies and field crews]* to actually control them will improve the overall management of the noxious weeds in the long term," said Sowers.

No Downsides So Far

The successful implementation of ArcGIS QuickCapture is engendering its use in other areas of the program as well. For example, staff are employing it this year to track plants on roadsides. Additionally, external agencies that work with the program, such as the Department of Ecology's Washington Conservation Corps, will use the app to collect field data.

A total of 30 people at King County are now using ArcGIS QuickCapture in the field, and that number is growing.

"The users really like it, and so far, it's *[received]* really good reviews," said Sowers, referring to the app. "We don't have any downsides yet. We are excited to keep using it to improve how we share and collect data."

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—Karisa Schroeder '18
MBA—Location Analytics
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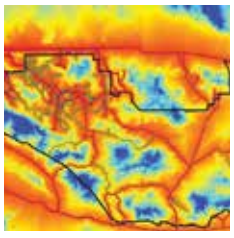

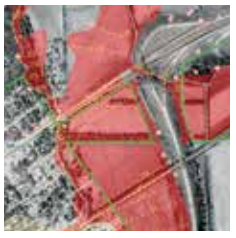

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As Agriculture Continually Transforms, Land O'Lakes Uses GIS to Manage Strategic Assets

In the agriculture industry, efficiencies (and profits) are often influenced by the distance between the farm and various assets—how far away is the nearest feedlot, grain elevator, or crop nutrient facility?

In the early days of farming in the United States, when many facilities were built, transportation wasn't as efficient as it is today. So grain elevators were set up in locations that farmers could reach via horse-drawn carts over the course of their workday. Later, these storage facilities were built in locations that could be served by railroads. Today, semitrucks provide greater flexibility in transporting grain, feed, and other agricultural commodities. However, existing storage facilities are sometimes located in suboptimal areas to serve the farms' current customers, and new facilities are often built on the same footprints as the ones they replace without taking into consideration more strategic locations.

The Land O'Lakes agricultural cooperative was founded nearly 100 years ago by 320 creameries to improve the quality, consistency, marketing, and economics of its dairy products. Today, it is one of the largest co-ops in the United States and is composed of about 4,000 members and more than 10,000 employees. Its industries include dairy products, animal feed, and crop inputs and insights. Sales total $13–$15 billion per year.

About six years ago, the co-op formed a Strategic Asset Management (SAM) team, a consulting group within Land O'Lakes that provides services to the company's ag retail-owners. The team has used GIS technology from the beginning.

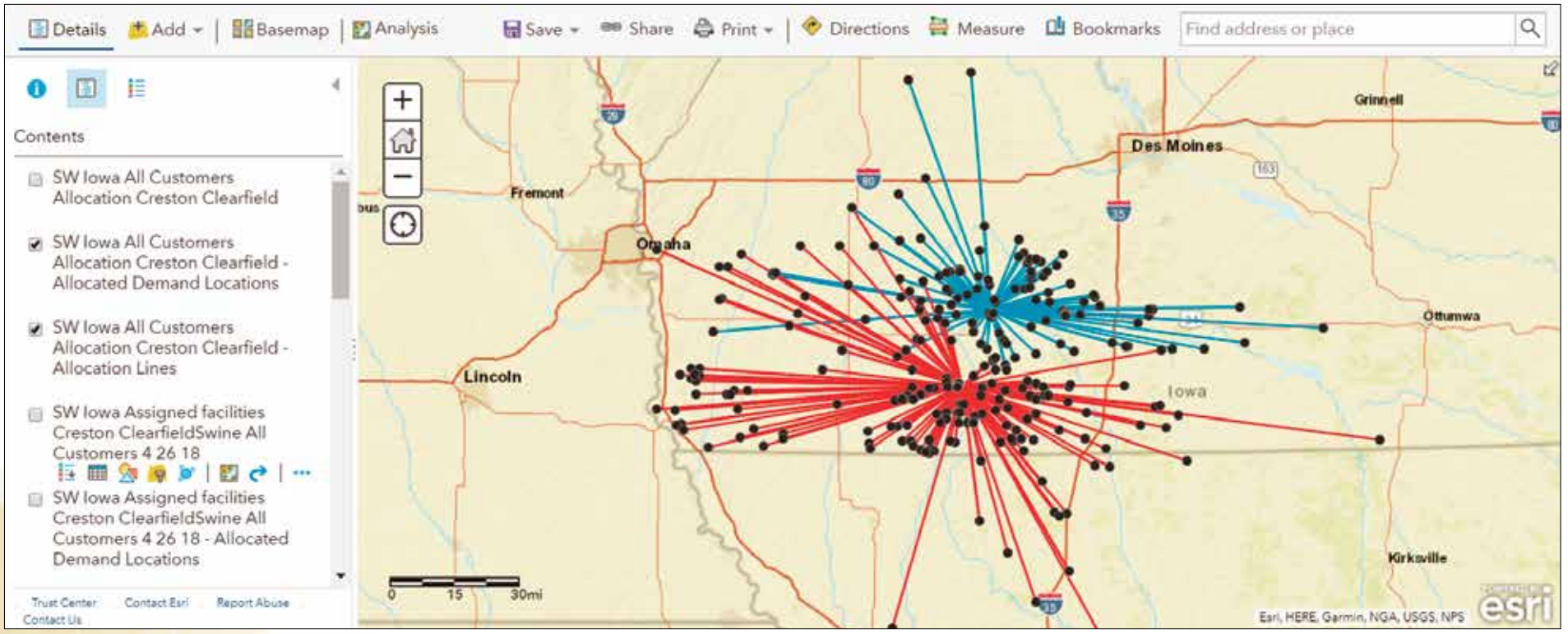
The Geographic Dynamics of Business

Land O'Lakes employs GIS in three distinct ways. First, the SAM team uses geospatial technology for the consulting projects it conducts for co-op members, providing them with insights and solutions for their businesses.

"We show them mapping and locational information about the trade areas for *[a]* project—where the trade area is, where their facilities are within the trade area, and where the competitors are located," said Josie Taylor, the SAM team's consulting manager. "This allows us to visually tell them a story about the geographic dynamics of the trade area we are analyzing and how we are thinking about improving it."

The second way the team uses GIS is for field data collection. "We often need to go out and look at the facilities that the co-ops are running and analyze how they are operating them. What are the capabilities of those facilities? How old are they? Can we expand those facilities?" Taylor said. "We use *[Survey123 for ArcGIS]* to capture a comprehensive and consistent set of data about the facilities."

The third area in which Land O'Lakes uses GIS is for analytical purposes. As Taylor explained: "If we've got multiple facilities that are close together, we analyze where the trade areas overlap. We also perform transportation analysis to determine how products are currently being delivered to our customers and if there is a more efficient way to do it. That's often about reallocating customers to a specific facility—that is, analyzing the facility they are currently using compared to one that is more appropriate for their use based on distance, functionality, future growth, and so on."



↑ With GIS, the Strategic Asset Management (SAM) team can show co-op members the customer allocations for various facilities—in this case, two mills.

Land O'Lakes, an agricultural cooperative with about 4,000 members, streamlines the quality, consistency, marketing, and economics of the farms' dairy products.

→ To help co-op members determine if they need to build new facilities or make use of already existing ones, the SAM team performs geography-based business assessments.

In addition, Taylor and her team use GIS to explore drive-time routes within specific trade territories, as well as to do some route planning. "But that's a little bit more on the fringes of what we do," she said.

Market Analyses Steer New Facility Construction

Agriculture is a dynamic industry that is affected by many factors, including changes in strategic assets, such as the consolidation of existing facilities and the construction of new ones. This can spontaneously create trade area overlaps, gaps, and redundancies, which inevitably impact efficiency.

A big part of facility rationalization is understanding how much capacity an operation has and how much is needed to service existing and future customers. Before building new facilities, the SAM team performs a business assessment to evaluate the project based on the future needs of the marketplace and the potential return on investment. The assessment is based on factors such as the current feed business, customer needs, competitor capabilities, asset efficiency, financial performance, regulatory compliance, market trends, and the risk and exposure of the project.

"Another one of the things that our group does is make recommendations to our members about how to change the way that their transportation or distribution model looks," said Taylor. "For example, suppose you are currently operating seven feed mills for hog producers. Two of those mills are old, and you don't want to put any more money into them. With some investment, another mill could be operated for an additional five years before you need to replace it. In addition, your market is growing, and you need to increase capacity as the market expands. So the question is, Where is the best place to put a new facility—to replace the three that are outdated—that can manufacture feed in a way that's more efficient, safer for employees, and implements a tracking mechanism to meet the consumer transparency demands that are needed today? There are a whole host of things that we consider to create greater operational efficiencies in the supply chain for a feed manufacturer, and a transportation study is only one part of the analysis we do to make those recommendations."

Land O'Lakes also uses transportation studies to examine operating expenses and future transportation costs as part of its financial analysis for capital investment purposes. Questions in this type of analysis include: How many miles do truck drivers have to go today to reach distribution facilities? How many miles would they have to drive if a new transportation model was implemented to accommodate a different set of distribution facilities? And will there ultimately be cost savings, or will costs increase by building new facilities in different areas?

"Other components of our market analyses include an examination of the trends that are happening in an area in terms of where the demand for our products is coming from," explained Taylor. "Going forward, is that demand changing? Who is driving the demand? How much growth has happened in the market historically? Where are the growth opportunities in the future? Who are the competitors? What are they doing differently than *[us]*, and what is their impact on the market? So we make a recommendation about what should be changed to meet the future needs of an operation."

GIS Is Critical for Adapting to Change

The SAM team also uses GIS extensively to conduct market and logistics analyses when working on whether or not cooperatives should make large-scale capital investments.

"In our consulting practice, we are seeing increased demand for projects that provide long-term solutions in the changing agricultural industry, and GIS is critical in performing the necessary analyses," said Taylor.

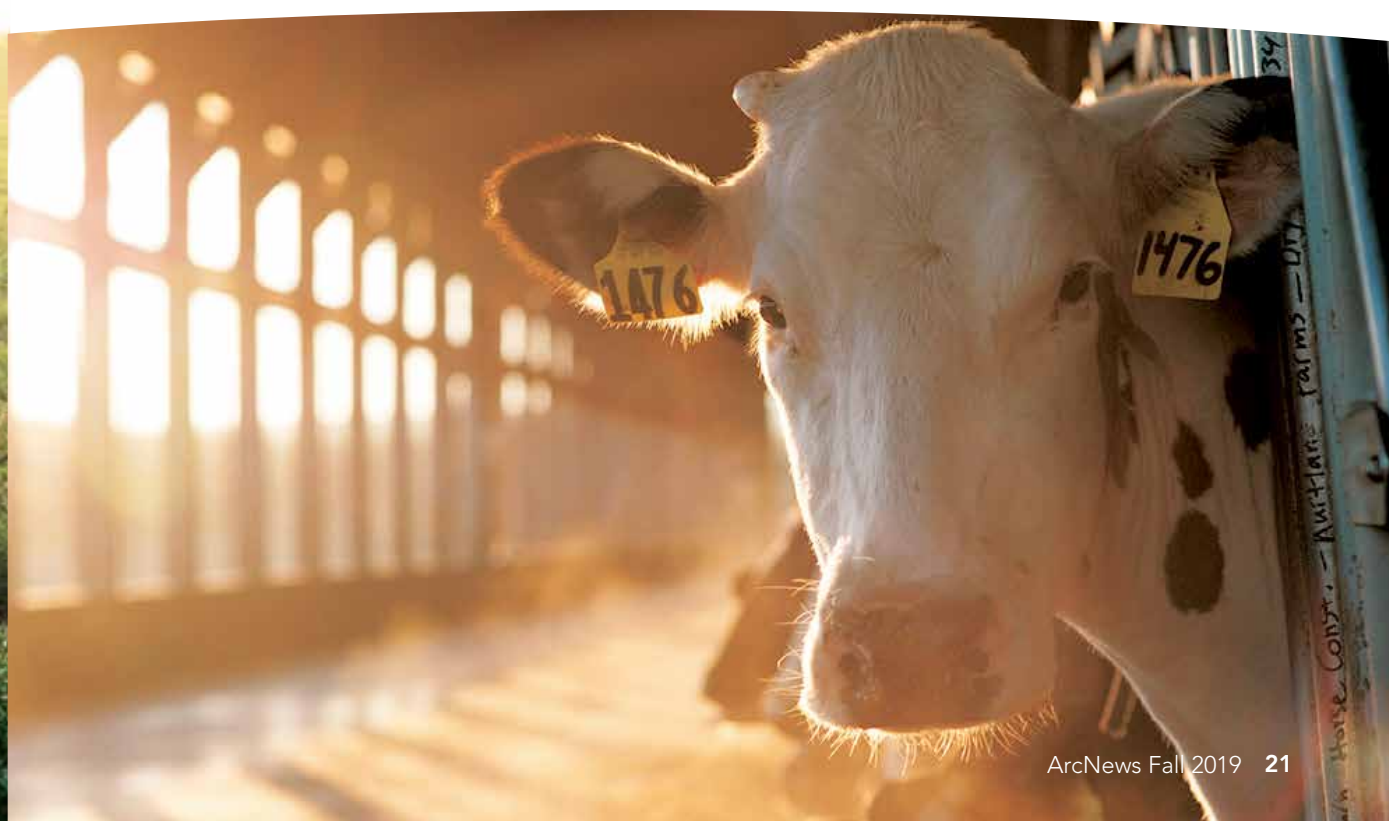
For instance, hog production in the United States is currently driven by a robust demand to export it, and production needs to be efficient. According to Taylor, one of the team's recent projects—a feed market assessment in Iowa—focused on how to keep up with strong market growth in areas where animal inventories have been increasing by an impressive 5–6 percent annually. Because sale margins are so thin for the feed mills that supply large production facilities, these mills need to create as many efficiencies in the supply chain as possible. The team identified both potential growth opportunities and areas for savings that could be achieved by having the co-ops leverage their current assets.

"During the course of the project, we identified opportunity for business expansion coupled with labor savings of 23 percent and additional operational benefits," said Taylor. "By using Esri's ArcGIS Online analysis tools, we were able to identify relative transportation efficiencies for potential sites and make recommendations that improve customer serviceability. This will be realized through new facility construction that promotes sharing the current production load among producers and an efficient reallocation of our customers to existing and new facilities."

Continuing to Enhance Decision-Making for Long-Term Planning

For the SAM group, the challenge, according to Taylor, is keeping up with retail owners' business needs and development. GIS helps Land O'Lakes do that by offering different ways to examine how the co-op's members manage their supply and inventory both in season and out of season. With this data, the team can help them continually hone their operations.

"A lot of our work isn't about the day-to-day operations of the business. It's about long-term planning—how…you build out your facilities and make investments in order to keep up with the continual changes in the agricultural market," said Taylor. "Our goal is to be the adviser of choice for significant retail agricultural business decisions, whether it's capital or business investments, partnerships, acquisitions, mergers, or achieving the best operational efficiencies."



City of Los Angeles Tracks Zoning and Land-Use Data Edits, Enabling Smart and Agile Growth

By Jay Strahan, City of Los Angeles Department of City Planning

Urban planning departments direct growth within their cities. Through regulations and permit approvals, they evaluate land use and manage development. Naturally, changes to regulations can cause land-use conflicts, which developers are likely to challenge. That is why planning departments need to have a full record of changes to land use and zoning for parcels, complete with supporting documents that verify that regulations were applied correctly.

The City of Los Angeles Department of City Planning has simplified this process of keeping complete records. For more than 10 years, it has used ArcGIS Workflow Manager, Esri's job tracking system, for database editing to ensure data quality.

With Workflow Manager, users can trace edits and link to parcel documentation. This enables the department to maintain crucial metadata about edits in more detail than traditional geodatabase archiving alone. Additionally, because Workflow Manager is an extension for ArcGIS Desktop, staff interact with the data via the normal ArcMap interface—a program they already know. When they select an area of interest, they see all the job tracking identifiers associated with that location. From there, they can dive deeper to look at scanned maps, ordinances, history, and why any changes were made.

"ArcGIS Workflow Manager helps us respond to the most important people we serve: our citizens," said James VanGerpen, director of the planning department's Information Technologies Division. "The system allows us to research a parcel and its history across multiple edits and understand when and why certain actions took place. With Workflow Manager, we reliably answer citizen's questions about parcels within an appropriate time frame and reliably inform the decision-making process."

From Paper Workflows to Digital Ones

Using Esri technology, the Los Angeles planning department keeps track of more than 880,000 parcels in 58,000 zoning polygons and 53,000 general plan land-use polygons. Managing this database used to be overwhelming due to the number of changes made to the zoning and land-use datasets throughout the years.

Before implementing the digitized job tracking system, GIS editors' work assignments were based on tiled coverages in ArcGIS Desktop—a total of 1,916 for the city. But supervisors could not decipher or trace edits made to the data. In the planning department's early days, cartographers marked the changes they made to zoning and land use on paper maps, so if someone else took over the assignment, that person would have to follow a paper trail to find clues about ongoing tasks.

Around 2005, department leaders decided to modernize the data management system by implementing a GIS job tracking system. They wanted the technology to make editing more efficient, ensure healthy data, trace previous transactions, and have the agility to evolve and grow. With managers and directors driving the initiative, paper workflows were scrapped in favor of digital ones and staff were reorganized to improve data flows. This leadership-driven flexibility resulted in a successful implementation.

Constantly Advancing Workflows Improve Productivity

Early in the implementation phase, Esri staff and consultants from Esri partner NorthSouth GIS LLC (NSGIS) worked with the planning department's GIS team to configure Workflow Manager so it matched the department's editing requirements. The team created automated workflow standards to ensure data continuity, which involved adding custom tools to Workflow Manager using its robust API.

As the app's technological capabilities advanced, the City of Los Angeles continued to work with Esri to improve editing performance. In 2009, each GIS specialist performed 700–800 edits in Workflow Manager on three tracked layers. Today, they each perform around 2,000 edits per year.

This is possible because the team has set up automated workflows for editing tasks, version management, geoprocessing, and archiving. The workflows create a version for each job or user, clean up old versions, and reconcile and post changes. What's more, the centralized system streamlines transactional work processes and tracks feature edits. Now, each edit job takes, on average, 5 to 10 minutes to complete.

Since Workflow Manager was deployed in 2007, GIS specialists have executed around 300,000 transactions. That has more than doubled productivity.

More Accurate Data Makes Quality Control Easier

The planning department maintains 68 datasets that contain information on administrative planning boundaries, city planning case details, and more. Workflow Manager tracks data for the three most critical layers: Zoning, General Plan Land Use, and Centerlines.

↑ ArcGIS Workflow Manager tracks the edits made to data in its three most critical layers: Zoning, General Plan Land Use, and Centerlines.

The information in these layers is critical to public interest, since it informs how areas of the city can be used and developed, so it must be accurate and accessible. What's more, the department makes zoning and property information publicly available via the Zone Information and Map Access System (ZIMAS) website (zimas.lacity.org).

To ensure the integrity of this public-facing spatial data, editors and supervisors from the planning department visually review it to document, correct, and verify its quality. They rely on the repeatable workflows in Workflow Manager to establish data standardization and consistency.

Tracking Jobs Is Effective and Reliable

Each year, the planning department tracks around 10,000 data edits. Using Workflow Manager, the GIS team creates weekly status reports for the IT directors that show all the information associated with each job. A custom reporting tool aggregates the number of edits made to each dataset, tracks the types of edits (e.g., whether information gets inserted, updated, or deleted), and creates a full history of actions by recording each job that gets edited within the three tracked layers. With this information, managers can see how productive GIS editors are over time.

The ability to track jobs like this in Workflow Manager has been especially helpful when the planning department has to address legal matters, including changes to zoning codes and discrepancies in old records. Because Workflow Manager accounts for every change made in the geodatabase, planning department employees spend less time and effort researching these matters. Additionally, for several cases that have been taken to court, the department has provided sworn declarations to demonstrate the competency of the changes made to its database records.

A Data Architecture That's Ripe for Revisions

The Department of City Planning's successful implementation of Workflow Manager has been vital to its data architecture—and that still resonates today.

Recently, the department launched Re:CodeLA, a comprehensive revision of the city's existing zoning code system, which has been in use since 1947. The initiative seeks to make it easier for urban areas to evolve and change, and it requires the planning department to rezone every parcel throughout the city.

The GIS team anticipates that the new zoning code will triple the number of zones in its database. To make this a smooth transition and maintain continuity in the rezoning process, Workflow Manager will be instrumental in assigning tasks to each editor.

About the Author

Jay Strahan is a GIS specialist with the City of Los Angeles Department of City Planning. He focuses on geodatabase administration and ArcGIS Enterprise. Previously, Strahan was a geodata analyst for Esri. He studied geography at Michigan State University.

Local Government in South Carolina Better Coordinates Field Assignments with App, Dashboards


Photo courtesy of Jessica Norrell Photography.

The City of North Augusta, South Carolina, is considered part of the greater Augusta, Georgia, metropolitan area. Approximately 22,000 residents enjoy the advantages of being near a major metro area while gaining the benefits of living in a small town, including very dedicated staff within local government departments.

The city employs 244 full-time employees in the 21-square-mile boundary known as South Carolina's Riverfront, a reference to its location along the Savannah River. While the City of North Augusta has used ArcGIS technology for more than 10 years, in the beginning, GIS was mostly for the planning department.

When GIS analyst Kevin Whaley joined the city 10 years ago, however, he knew that GIS use needed to expand. As the team lead for the city's GIS Services Department, Whaley has championed the use of GIS across city departments. Today, the technology supports the mapping and geospatial needs of municipal water, wastewater, and storm water utilities; sanitation services; parks and recreation; and public safety. Whaley and his colleagues work diligently to provide useful tools—specifically, information-rich digital maps with layers of accurate asset data—to their internal stakeholders to help them easily locate city assets.

"GIS has grown from mapmaking to decision-making," said Whaley. "Departments use various apps to aid in their daily workflows and projects."

To stay current with ArcGIS technology and hone his skills, Whaley is active in the local South Carolina ArcGIS Users Group. When he attended the group's annual conference in 2016, he went to a session on new Esri solutions and learned about a new app for coordinating field work assignments: Workforce for ArcGIS.

Workforce is a mobile app used to manage field projects and dispatch assignments to employees. Fieldworkers use it to receive assignments and report on their status. In the web app, a dispatcher can see each worker's location and status, making it easier to manage calls that require immediate attention.

Whaley contemplated whether Workforce could replace North Augusta's City-wide Action Tracking System (CATS). This system had a record of each property and made it possible to coordinate calls from constituents for various services with paper work orders. Constituents could ask for assistance by calling the city or submitting a service request on the city's website. As requests came in, they were handed off to a dispatcher who entered them into CATS. Then, a hard copy of the request was printed and used as a work order. It was a cumbersome and inefficient process.

Working with the city's Esri account manager, Whaley scheduled a demonstration of Workforce in April 2017 for the utility department's director, supervisors, and dispatcher. The presentation featured a simple project scenario and used the city's digital map with its utility layers, so staff could see how Workforce consumed and applied the data. The utility director and staff requested that Workforce for ArcGIS be implemented as quickly as possible.

Whaley recognized that implementing and deploying Workforce would depend on acquiring a clear and thorough understanding of each step of the fieldwork process. He met with stakeholders from the utility department to define the requirements for each person and part of the process. Next, Whaley and the dispatcher met to determine how the required tasks for recording constituent service calls and assigning them to field staff could translate in the new digital system.

Finally, armed with a schema that he and the dispatcher had defined, Whaley created the city's first Workforce for ArcGIS project. When a call came in that demanded immediate attention, the dispatcher was able to identify the resource nearest the call and quickly arrange a response—all from looking at the location of the fieldworkers on a Workforce map from her workspace monitor.

The paper work orders that the city used previously were no longer needed because the assignments were all managed digitally. Fieldworkers now receive their assignments through the Workforce mobile app on their city-issued smartphones and report back throughout the day with status updates as they go from task to task. Fieldworkers no longer have to start the day in the office picking up work orders, nor do they have to return throughout the day to get new ones or go back at the end of the day to drop off completed assignments.

Despite fieldworkers' initial skepticism, they quickly adopted the technology. They liked being able to sort their assignments by proximity and appreciated not having to carry paper work orders. Best of all, they increased productivity, bringing the time it takes to complete an assignment down from an average of 1.5 days to 8 hours. They also started driving less, which saved on fuel.

The dispatcher reported feeling a greater sense of control over assigning and monitoring tasks and was happy to not have to transcribe notes and data from paper reports. For the first time, she was able to accurately identify the status of any service call in the system and could even report progress based on worker, area, or type of call. When a constituent called in with an urgent need, the dispatcher could now enter the assignment in the system, fill it out, and assign it to a fieldworker before hanging up the phone.

City leaders were excited about the increased productivity and data accuracy that Workforce afforded. To help directors and supervisors see the progress of field activities, Whaley created an executive dashboard using Operations Dashboard for ArcGIS. It displayed the Workforce data with the help of visualizations, such as gauges and bar charts, that compared data by week, month, quarter, and year.

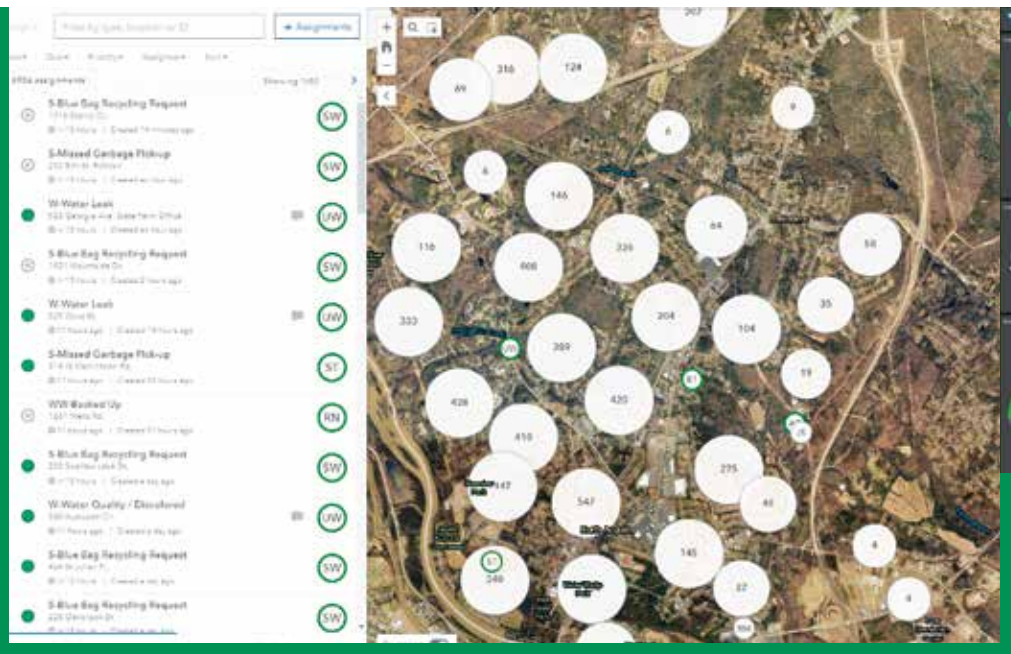
"The implementation of a dashboard within Workforce has brought us a dynamic, real-time view of calls for service in the City of North Augusta. By delivering a live, visual, location-based representation of these calls for service, our crews are much better positioned to prioritize and streamline their workload," said IT director Chuck Ursy. "Workforce also assists our ability to project future staffing needs by having detailed call data at our fingertips."

For fieldworkers, being able to use Workforce on their phones and tablets not only streamlined the work order process but also gave them a reliable map of the utility network that was more accurate than the paper maps they used before. When changes are made to the map, workers see the updates in real time, so they are always working with the most current city maps and data. Now, fieldworkers are champions of the new digital system.

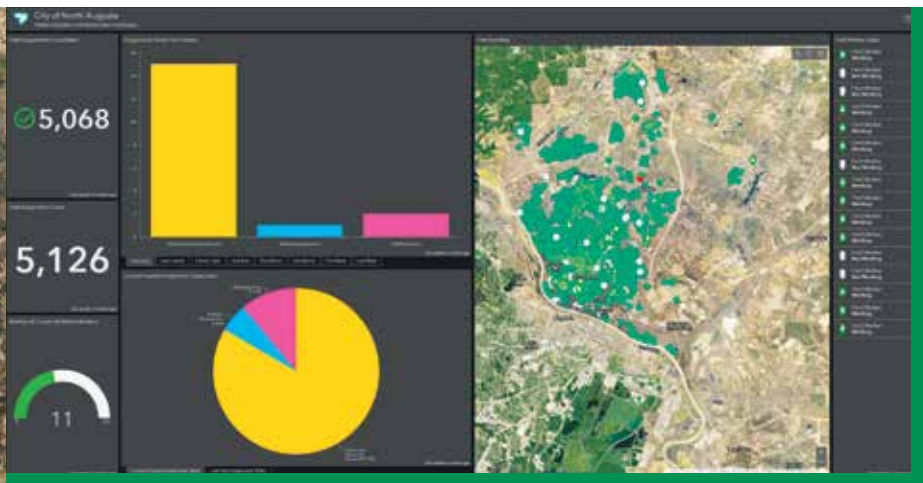
The city administrator, utility director, and staff members value the insights the dashboards provide as well. It gives them greater control over planning and day-to-day operations, including staffing needs, dealing with aging infrastructure, and analyzing assignment data to inform decisions.

While Whaley is pleased with the success of the city's Workforce for ArcGIS implementation, he sees many opportunities for using ArcGIS field operations apps to further improve workflows in other departments. He routinely receives new requests to use GIS data to inform decision-making. Recently, the environmental coordinator was able to use wastewater reports to analyze whether backups had occurred in the city's watershed or basins—information that is required for compliance reports. The ability to do this did not previously exist.

Since implementing Workforce for ArcGIS, there has been a huge increase in the volume of data the city has collected. Whaley knows that he and his team are just scratching the surface of how GIS will be used to enhance quality of life in North Augusta.



← With Workforce for ArcGIS, the dispatcher can accurately identify the status of any service call in the system and report progress based on worker, area, or type of call.



↑ An executive dashboard, made with Operations Dashboard for ArcGIS, lets city leaders visualize utility operations in a location-based way that better informs decision-making.

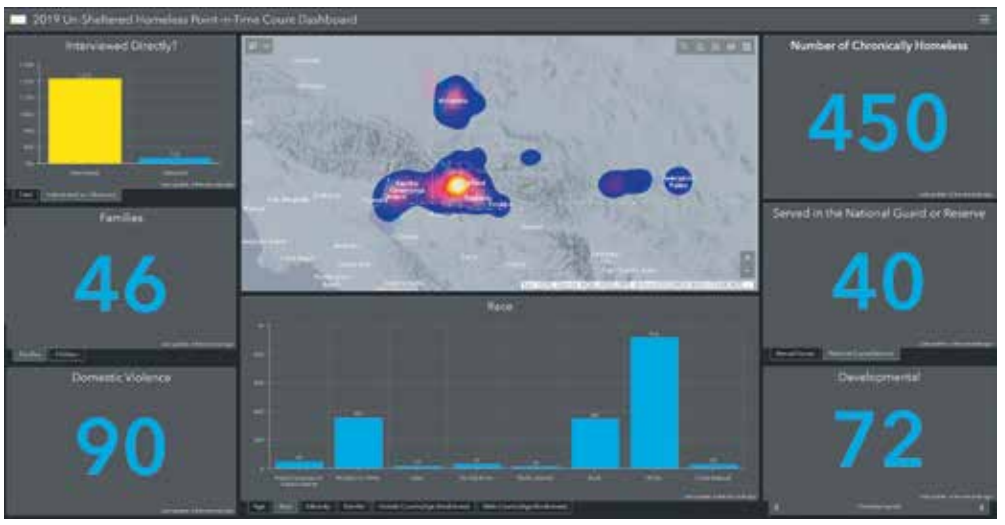
Smart Surveys Give San Bernardino County a Better Way to Measure Homelessness

By Lindsay King, County of San Bernardino

On January 24, 2019, hundreds of volunteers arrived before dawn at deployment centers across San Bernardino County to get their assignments. Donning orange vests and carrying bags of supplies, they set out to walk city streets.

Across the United States that day, volunteer crews convened to do the same thing: count the homeless population. But this year was different in San Bernardino County, California. For the first time ever, the county used mapping technology to plan, execute, and analyze the results of the count. This meant that volunteers just needed their smartphones to do their work. And it gave the County of San Bernardino a much better understanding of its homeless population.

As the results poured in, what was once just numbers on a spreadsheet became a living map. This time, each person experiencing homelessness was not just counted but was seen.



↑ The dashboard displayed up-to-the-minute information from the surveys that volunteers were submitting in the field.

↑ Using Survey123 for ArcGIS drastically simplified the surveying experience for San Bernardino County's 2019 point-in-time count (PITC).

Making This Year's Point-in-Time Count More Efficient

Currently, local governments are having to ask difficult questions about homelessness. The homeless population is growing across the United States, which poses many risks to the individuals experiencing homelessness and puts added strain on communities. Local governments are looking toward new solutions that can help address homelessness from a data-driven perspective.

That is where homeless population counts come in. While there is a long-standing debate over the best way to count the number of people experiencing homelessness, point-in-time counts (PITCs) are commonly used both in the United States and internationally.

To conduct a PITC, groups of volunteers go out on a single day and interview people experiencing homelessness to get an understanding of demographics and total population numbers. The information garnered through these counts is crucial to providing resources to homeless populations and targeting the right communities for interventions. Time, however, is a limiting factor for volunteers.

Over the past year, the San Bernardino County Sheriff's Homeless Outreach and Proactive Enforcement (HOPE) team has been using Esri's Survey123 for ArcGIS app to map and record all their interactions with people experiencing homelessness. This information gives the sheriff's department and, thus, the county a historic account of where homeless people are congregating.

For this year's PITC, that data from the HOPE team was used to tell volunteers where to go. This helped ensure that volunteers used their time efficiently by covering areas where they were most likely to be effective.

An Earlier Look at Numbers and Patterns

The benefits of using the ArcGIS platform were immediately evident to the count's volunteers, as well as project leaders and stakeholders.

For the volunteers, the survey form in Survey123 was configured with conditional logic to only display relevant questions. When interviewees indicated that they had slept in a vehicle, for instance, follow-up questions about what type of vehicle and how many people had slept in it would appear next. This conditional logic drastically simplified the users' experience, allowing them to quickly conduct the survey from top to bottom without having to skip questions. This got overwhelmingly positive feedback from the count's volunteers, who found the new survey easier and faster to use.

As volunteers conducted each interview, Survey123 also did several calculations behind the scenes. For example, establishing whether an individual is experiencing chronic homelessness according to the definition specified by the United States Department of Housing and Urban Development (HUD) requires working out a relatively complicated formula that, in years past, had to be calculated in the weeks after the count. Using Survey123, however, made it possible for the calculation to be done on the fly, allowing stakeholders to get a much earlier look at the numbers than had previously been possible.

Completed surveys were written directly to the Esri Geospatial Cloud via ArcGIS Online, which not only helped maintain the integrity of the data but also made it immediately available to stakeholders. On the day of the count, project leaders were gathered in a command center equipped with a dashboard built using Operations Dashboard for ArcGIS. This dashboard displayed up-to-the-minute information from surveys being submitted from the field. Leveraging the dashboard in the command center enabled stakeholders to monitor the progress of the count and get an early glimpse at the data. Neither had been possible when paper surveys were used.

Another benefit to project leaders and stakeholders was that Survey123 leveraged the GPS location of each volunteer's device, providing far greater insight into geographic patterns in homelessness than ever before. Whereas in past years it was only possible to know how many people experiencing homelessness had been surveyed in each community, this year, staff at the County of San Bernardino were also able to see precisely where the surveys were conducted, which can help target assistance programs more effectively.

Less than 24 hours after the count was completed, stakeholders from the county's Homeless Partnership, Board of Supervisors, and Information Services Department gathered in a conference room and used a configuration of Web AppBuilder for ArcGIS to explore the count's data. By applying a sequence of filters, they were able to get a breakdown of numbers and locations where certain populations of interest—such as chronically homeless veterans or women with children who reported fleeing domestic violence—had been encountered and interviewed. Stakeholders also used a web mapping app to overlay data from the PITC with data from the HOPE team to identify areas where the HOPE team had historical contact with the homeless community but that had not been canvassed by PITC volunteers. This allowed the sheriff's department to deploy the HOPE team the following week to canvass these areas and help ensure that the PITC was as complete as possible.

Standardized Data Collection Will Help Future Counts

The County of San Bernardino's 2019 PITC is believed to be the most precise count conducted yet, thanks to the ArcGIS platform.

"The use of *[ArcGIS technology]* gives us a more realistic sense of the growing problem we are facing, making the 2019 point-in-time count numbers the most accurate to date," said Josie Gonzales, vice chair of the San Bernardino County Board of Supervisors.

Looking forward, the county plans to continue using Survey123 for subsequent PITCs, which will standardize data collection from year to year. In the future, it will be possible to compare data through the years to evaluate how patterns in homelessness change over time, as well as how those patterns relate to the county's outreach efforts and availability of services.

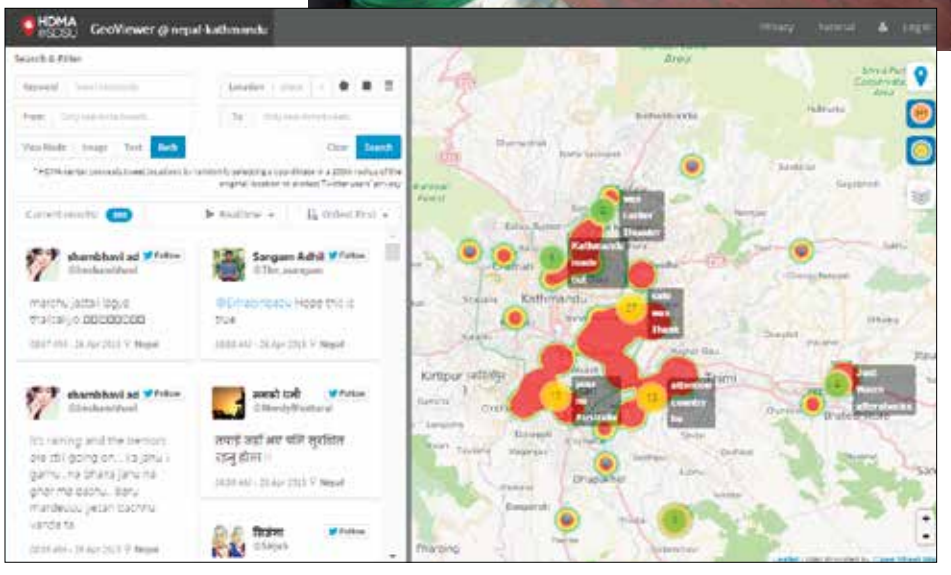
To learn about how ArcGIS technology can help communities gain a better understanding of homelessness, explore the Reduce Homelessness web page from the ArcGIS Solutions for Local Government team at p.ctx.ly/r/9ktb. For more information on how the County of San Bernardino leveraged GIS for the 2019 PITC, email GIS business systems analyst Lindsay King at lindsay.king@isd.sbcounty.gov.

About the Author

After starting her GIS career at Esri, Lindsay King is now a GIS business systems analyst at the County of San Bernardino, California. In her role at the county, King assists various departments with adopting GIS technology to increase efficiency and enhance workflows.

Human Behavior on Social Media Is Big Data, and GIS Makes It Actionable

→ At the Center for Human Dynamics in the Mobile Age (HDMA), students and faculty members work on research projects.



↑ GeoViewer is a web-based mapping app that visualizes the results of the geotagged social media analyses HDMA performs.

Today, humans are awash in an endless stream of online information channeled by social media platforms. The content, posted mainly by the general public, includes commentary, criticism, observations, photographs, and videos about virtually anything and everything. Often, the postings prove to be little more than a distraction in people's hectic, day-to-day lives.

Still, social media is a powerful communication mechanism. Market research company Statista estimates that there are 2.77 billon regular users of social media today. Technology has driven its growth with progressively more powerful servers, faster internet speeds, and mobile devices that are increasingly common throughout the world. In addition, social media platforms often deliver application programming interfaces (APIs) that allow developers to access their databases so they can create apps that make use of social media data. In turn, data scientists can aggregate and analyze social media posts in real time and apply that data to a wide range of studies. This includes figuring out how to mitigate traffic congestion on roads, monitoring and responding to national and international events as they unfold, and detecting potential disease outbreaks and uncovering their impacts on society.

At San Diego State University (SDSU) in San Diego, California, the Center for Human Dynamics in the Mobile Age (HDMA) was founded in 2013 with the aim of transforming academic research into serviceable information that can lead to making real-time decisions and sound public policy changes. HDMA works across disciplines, including geography, computer science, civil engineering, sociology, public health, linguistics, management information systems, accounting, communication, social work, digital humanities, and public affairs. And it develops scientific theories and computational models for human dynamics (which includes people's interactions on communication networks), big data, social media, and data science.

"Programs of this type point to the future of education because they have the potential to address real needs, rather than purely academic research," said Ming-Hsiang Tsou, a professor of geography at SDSU and the director of HDMA.

Tsou also believes that geography is the key to understanding real-world big data and integrating it into people's daily activities and operations to provide actionable solutions. That's because geographically based data sources, such as GPS devices, environmental sensors, and other monitoring instruments, specify where things occur and provide contextual knowledge for big data.

"By its nature, this data is big, messy, unstructured, and noisy," said Tsou. "The key concepts of geography—place, time, and scale—can help data scientists clean the noise, understand the context, and answer the questions *when* and *where*. This can provide greater insight and knowledge for data analytics."

For example, analyzing a flu outbreak using Twitter posts that include a geographic location can help public health agencies allocate vaccines to the right places at the right time.

"Our research focuses on the location-based analysis of geotagged social media data," said Tsou. "This allows us to identify hot spots and compare our results within city districts or between local regions for analysis and action."

Recently, HDMA did a project to determine urban land-use patterns in Beijing, China. The group collected 9.5 million geotagged social media messages from the social media platform Sina-Weibo for six months in the urban core areas of Beijing and compared them with 385,792 commercial points of interest (POI) from Datatang, a Chinese digital data content provider. To estimate urban land-use types and patterns, the team created a grid measuring 400 x 400 meters to divide the urban core areas into 18,492 cells.

"By analyzing the temporal frequency trends of social media messages within each cell using the K-means clustering algorithm, we identified seven types of land-use clusters in Beijing: residential areas, university dormitories, commercial areas, work areas, transportation hubs, and two types of mixed land-use areas," explained Tsou. "Text mining, word clouds, and the distribution analysis of POI were used to verify the estimated land-use types successfully. This methodology can help urban planners create and analyze up-to-date land-use patterns in a cost-effective manner and better understand dynamic human activity patterns within a city."

↑ SMART Dashboard is a search tool for geotagged social media messages. It provides insight into how a local population is responding to an event or situation.

HDMA has developed several computer programs to automatically or semiautomatically collect social media data from Twitter, Sina-Weibo, Google Places, and Reddit. The data is saved in MongoDB, a NoSQL database. NoSQL provides a way to store and retrieve data that is not modeled in tabular relations, the method used in relational or SQL databases.

The data is also exported from MongoDB to the ArcGIS platform to create point and kernel density maps, among other analyses. In addition, HDMA has installed ArcGIS Enterprise for its GIS and ArcGIS GeoEvent Server capabilities for a special project it's doing for the County of San Diego's Office of Emergency Services. The project involves collecting and processing real-time traffic data feeds from Waze, the community-based traffic and crowdsourcing navigation app. GeoEvent Server will host the data layers created for an ArcGIS Online service the county is putting together.

The center has also created two software toolsets to analyze and display the data it collects from social media platforms. The first is SMART Dashboard, a search tool for geotagged social media messages. It monitors and aggregates the dissemination of information related to changes in social behavior and provides insight into how a local population is responding to an event or situation. It has been used to track the spread of Ebola, ovarian cancer clusters, wildfires, hurricanes, and marijuana legalization initiatives.

The second is GeoViewer, a web-based mapping app that visualizes the results of the geotagged social media analyses performed by HDMA. Its geospatial functions are easy to use and include the ability to display hot spot and cluster data layers; store multimedia images, including photos and videos; and map historic and real-time social media data. Tsou believes that this can be an important asset for emergency response.

"The metadata collected by social media platforms includes quite a bit of information, such as the identity of the author, when the post occurred, a geotagged location of the post, the content of the post itself, number of reposts, and so on," said Tsou.

While all that data is incredibly useful, it also brings up concerns about privacy, which Tsou and his team are acutely aware of.

"Our research at HDMA is concerned about privacy issues, and we try to protect the users' privacy as much as we can," he said. "For example, our GeoViewer software includes geomasking techniques to randomize the actual geotagged locations of users within a 100-meter radius, even though this may slightly reduce the accuracy of our spatial analysis results."

Tsou thinks that GIScience and data science will only become more tightly integrated.

"That will allow the creation of a new discipline that I call geospatial data science," he said. "I see it as a transdisciplinary field that will extract knowledge and insight from geospatial big data using high-performance computing resources, spatial and nonspatial statistics, spatiotemporal analysis models, GIS algorithms, machine learning methods, and geovisualization tools.

He also expects the Esri Geospatial Cloud to play a key role in this new field because of its comprehensive cyberinfrastructure.

"Its seamless technology stack includes a geodata hub for sharing assets and facilitating community engagement, cloud services, online analytic tools, real-time big data processing, and a nice set of presentation options," Tsou explained. "I believe that geospatial data science will facilitate critical spatial thinking and problem solving for various applications and industries and enable the exploration of new scientific theories."

To Advance Global Geodesign, We Need Multidisciplinary Collaboration

By Carl Steinitz, Harvard University; Brian Orland, University of Georgia; and Tom Fisher, University of Minnesota

Over the next decade, the earth will undergo dramatic social and environmental change. This means that a large number of people—perhaps 10,000—will need to be knowledgeable about the world and the analytic and synthetic methods of geodesign (multidisciplinary design at a geographic scale).

The most efficient way to achieve this is to educate today's university students in these matters and do it in a manner that enables multidisciplinary collaboration and mutual learning not only inside the university but also across institutions and nations. That is the aim of the relatively new International Geodesign Collaboration (IGC), whose members include teams from universities around the world. It is a bold goal.

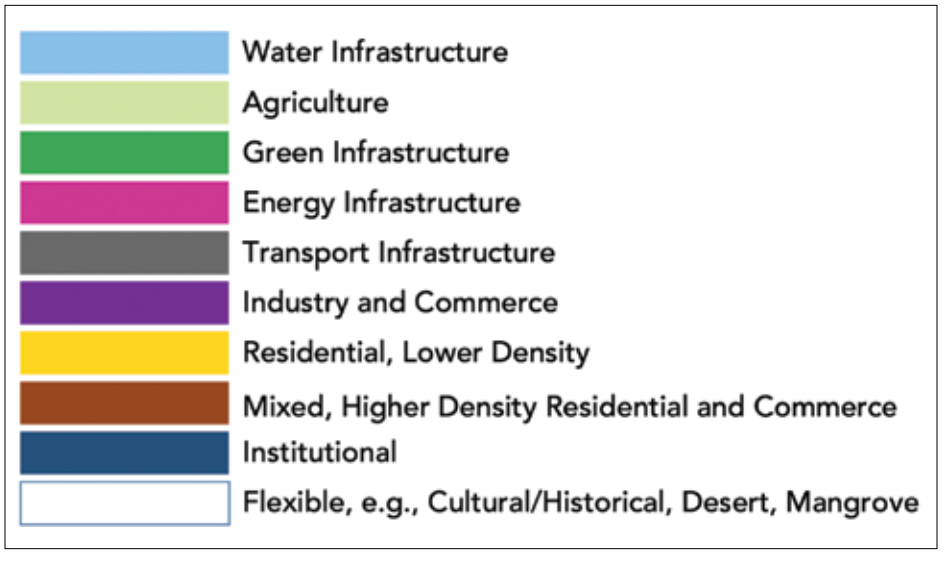
Harvard University professor emeritus Carl Steinitz first aired the idea for the IGC at the Esri Geodesign Summit in 2015 and then again in 2016. In January 2018, the rest of us—University of Georgia geodesign professor Brian Orland, University of Minnesota professor emeritus and director of the Minnesota Design Center Tom Fisher, Esri project manager Ryan Perkl, and Esri global education manager Michael Gould—agreed to organize the collaboration. By March 2018, via invitation and word-of-mouth promotion, research teams from about 90 universities had joined the IGC.

The IGC focuses on a specific and exceptionally complex problem: how to identify and share the lessons and practices developed by a globally dispersed array of experts so the resultant knowledge can be leveraged to solve our most pressing societal and environmental needs. Coming up with solutions will demand deep integration across the traditional expertise residing in the physical, natural, and social sciences. These solutions will also need to be articulated through the landscape- and city-shaping skills of planners, designers, and engineers.

The IGC is interested in how multidisciplinary teams in multi-institutional and multinational groups consider and respond to the environmental, economic, and social impacts of development and change happening in natural and increasingly engineered systems, while taking into account cultural and governmental differences. Almost every university in the world studies these issues. Yet each university and each unit of government acts in its own set of geographies and societies, with its own content, definitions, methods, languages, color codes, and representation techniques. This makes it extremely difficult to compare otherwise related projects and learn from each other.

To ensure that comparisons and mutual learning can take place much more easily, the IGC seeks to greatly increase sharing and the standardization of communication across those boundaries.

The International Geodesign Collaboration (IGC) focuses on a specific and exceptionally complex problem: how to identify and share the lessons and practices developed by a globally dispersed array of experts so the resultant knowledge can be leveraged to solve our most pressing societal and environmental needs.

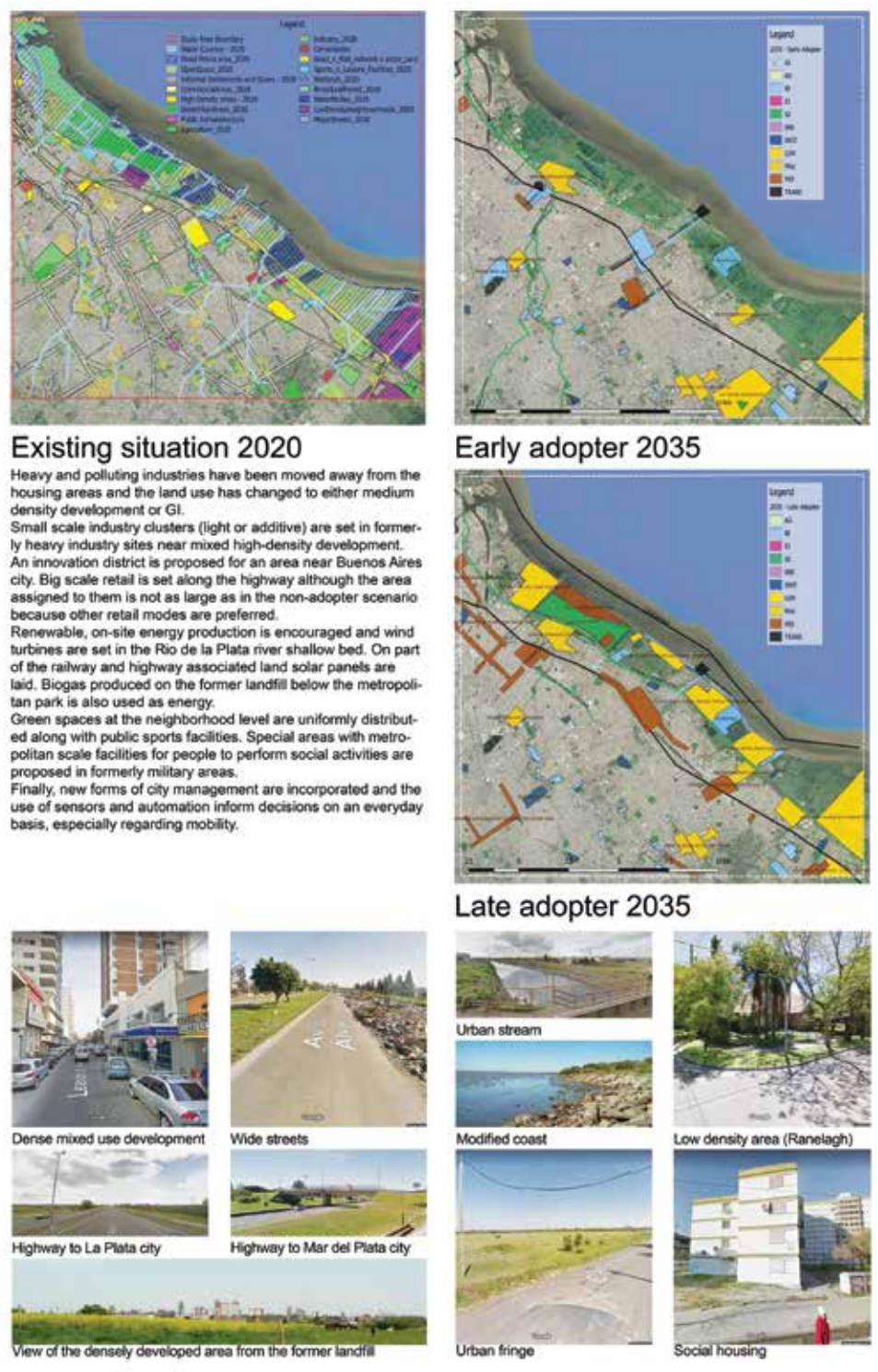


↑ As the basis for their scenarios, teams adopted nine International Geodesign Collaboration (IGC) systems with the option of adding a 10th, locally relevant one and represented these in a specific color code.

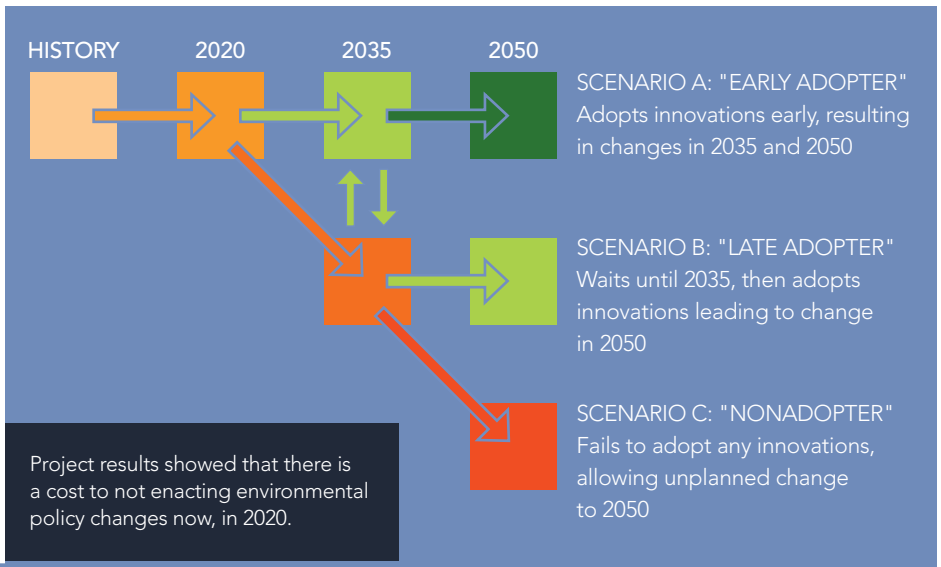
We believe that a central aspect of effective global collaboration and eventual action is—and will continue to be—public understanding of complex issues. Furthermore, that can and must be accomplished without using professional or scientific jargon.

Under the umbrella of this broad goal, the IGC has a number of specific objectives. They include the following:

- Through repetition by multiple teams, reveal fundamentally important design responses that cut across national boundaries and are less influenced by local political concerns.
- Use global-level geodesign studies to address national, regional, and local needs at the space and time scales of larger, longer-term societal and environmental issues.
- Publish and exhibit open-format work internationally in both English and machine-translatable local languages.
- For public education, build a library of shared resources around the design and planning issues that matter most for society and the environment.
- Educate future leaders who are capable of organizing and managing geodesign at global, national, regional, and local scales.



↑ Teams demonstrated what would happen in certain regions—such as along the southern coast of Buenos Aires, Argentina (shown here)—if decision-makers adopted innovative environmental policies in 2020, in 2035, or not at all and mapped the likely results.



Early adopter 2050

Early adopter scenario

In this scenario the areas that are already dense are consolidated, water management measures are mandatory for new construction or renewal. The widest streets in the area are set to collect, temporarily retain and/or infiltrate water. The streams are open and most of the informal settlements on the alluvial plains have been moved to more suitable areas, mostly to formerly industrial space. Low-density development is limited and high density on suitable, already consolidated areas is preferred. New gated neighborhoods are not allowed because of the large changes needed on the open areas. A policy restricting housing on the flood-prone area is set early and new development isn't allowed. Most of the undeveloped area North-East from the highway is kept as GI. No coastal flood defense is set and the relatively more frequent flooding is not affecting the people because adaptations like stilt houses allowed the already settled areas to cope with it. Some areas are dedicated to urban agriculture. Small community vegetable gardens are spread along the railway and highway. Transportation nodes allow for change between boat, bus, train or bike commuting modes. Pedestrian streets are also established in the mixed-use areas along with bicycle exclusive lanes.

Late adopter 2050

Late adopter scenario

In this scenario the areas already planned for dense development have been consolidated and densified. The coastal defense has been set in place allowing development to take place in flood-prone areas, although not as much as in the non-adopter scenario. Water management on site is mandatory for new buildings, and small treatment plants are scattered. Green infrastructure consists of two metropolitan scale parks and a network of small green spaces that were mostly set in place after the land-use change of big plots of land, so the distribution is evenly distributed on the less dense south-east. Much of the heavy industry has moved away from the densest parts of the city to industrial parks farther away. The informal developed areas have been urbanized and some of the people inhabiting the unsuitable land have moved to social housing. Transportation is the same as in the other scenarios although the nodes mostly coincide with today's ones. Energy is generated off-site although the park over former landfill is used to get biogas and renewable energy harvesting is encouraged on new buildings. An area for urban agriculture is set on the coast and smaller gardens are spread on former industrial sites.

Nonadopter 2050

Nonadopter Scenario

Green infrastructure consists in smaller (typically 1Ha or less) and fewer green public spaces. A metropolitan park over the former landfill is the only big GI area. A long coastal flood defence with regularly spaced pumping stations have been set along the coast. Cut and fill earthworks allowed for the development of the green open areas between the river and the highway. Part of the green open space beside the river on 2020 was taken up by high density mixed development (a project already pushing for approval) and a new area has been added by land reclamation (a historical way of gaining more land in Buenos Aires). Other parts of the formerly green areas are now low-density housing (gated neighbourhoods) or urbanized informal settlements.
In general, the areas already planned in 2020 for medium or high-density housing and commercial land-use have now high density, with a gradient of density lowering from north-west to south-east.
Industrial areas near Buenos Aires city turned into dense housing (if the area is already densifying), low-density housing or into informal development. On the land beside the highways big scale retail is set and encouraged. Regarding Blue infrastructure, new buildings on former industrial areas are required to retain the rainwater and / or install green roofs.

A key observation driving the IGC is that universities' current methods of sharing tend to obscure rather than enable collaboration. People use their own idiosyncratic map layouts, highlighting specific items of local interest, with graphic and cartographic conventions that are determined by either national standards or personal preference. Project areas are usually complex polygons that sometimes—but not always—include a contextualizing buffer of the parts of the surrounding landscape that influence and are influenced by the project itself. Moreover, while a project's expressed intent may be to solve problems that have global consequences, people rarely reveal the assumptions they've made, which makes it difficult to compare and learn from each other.

In hopes of combating the shortcomings of contemporary research, the IGC asked its current member teams to map a region of their choosing and show what might happen if decision-makers adopted a set of innovative environmental policies early, in 2020; late, so not until 2035; or not at all, continuing business as usual until 2050. Adopting IGC-generated assumptions about expected change in systems such as infrastructure, agriculture, and urban development, the teams then assessed the potential impacts on their study areas in 2035 and 2050, updating, in a few iterations, what their regions might look like at each check-in year.

To enable comparison among the diverse studies, the IGC introduced some organizing principles that enable different projects to express similar ideas in the same ways. Project participants had to adhere to the following:

- Select one or more square study areas that correspond to a scale of standard escalating sizes: 0.5 x 0.5 kilometers, 1 x 1 kilometer, 2 x 2 kilometers, 5 x 5 kilometers, etc., all the way up to 160 x 160 kilometers.
- Adopt nine agreed-on IGC systems—such as green infrastructure and industry and commerce—with the option of a 10th, locally relevant one as the basis for their scenarios, and represent these in an agreed-on color code.
- Identify and implement innovations that address the challenges facing each region.

With assistance from Esri and Geodesignhub.com, participating schools acquired software and minimal support for a range of key tools at no cost. Beyond that, they had to supply their own technical support. All results had to be ready to present in map form, in a common graphic format that included explanatory text and charts, and in English by the first IGC Summit, which coincided with the Esri Geodesign Summit this past February.

Each team defined its own project. Adapting systems data and models to local conditions, participants scaled and parameterized the assumptions and projected regional innovations to their specific areas.

Since every team followed the IGC's recommended graphic layout, which was based on consistent square study areas, it was possible to compare like with like. Thus, even though the projects covered widely dispersed locations in 37 countries, the overall results showed that there is a cost to—and very little to gain in—not enacting any environmental policy changes now (i.e., in 2020). Given these conclusions, project participants were able to outline the most important steps that decision-makers need to take in each region.

The teams presented their conclusions to each other at the 2019 IGC Summit. Since everyone followed a specified design process and adhered to the same constraints, they were able to share their experiences at a depth of understanding that has never been available before.

Building on this momentum, the IGC is continuing to develop and grow. At the 2019 Esri User Conference, the organization's work was featured in the Map Gallery and in a special session. Esri Press is also putting together a book about the organization and its initial project.

Currently, IGC membership is at well over 100 schools. The goal is to have at least one university from every country and major region represented. Please help spread the word so that more people around the world can apply the principles of geodesign to the challenges confronting their regions.

About the Authors

Carl Steinitz is a professor emeritus of landscape architecture and planning at Harvard University's Graduate School of Design. Brian Orland is a professor of geodesign in the College of Environment and Design at the University of Georgia. Tom Fisher is a professor emeritus at the University of Minnesota's College of Design and the director of the Minnesota Design Center.

To find out more about the IGC and review all the projects, visit geodesigncollab.org.

The next IGC Summit will take place February 22–24, in Redlands, California, right before the 2020 Esri Geodesign Summit.

GIS Educator Leaves No Facet of the Field Untouched

For 25 years, Anita Palmer has been a leader in teaching GIS—and not only to students but to hundreds of teachers as well.

"She's one of those rare birds that does teacher training, materials development, and some technical development; has participated in academic research; and has taught," said Esri education manager Tom Baker. "I don't think there's a facet of GIS education that she hasn't worked in."

"Where she excels is with early learners," added Charlie Fitzpatrick, Esri education manager for K–12. "Lots of people who get good at GIS want to spend more time getting deeper into dramatic technology. But Anita has been very good about focusing on the people who are just getting in and being as interested in them as with the people who are well down the road."

Palmer started out as a high school technology teacher, ended up founding an educational technology consulting company, and is currently the National Geographic Society's first ever GIS-focused Education Fellow.

"GIS speaks differently than any other technology," said Palmer. "I used to teach spreadsheets and Lotus, and I loved it. I love technology. But when you connect a map to technology or a spreadsheet, patterns and visualizations emerge. Things we couldn't see before in that spreadsheet, in those lists and columns, all of a sudden appear, and we can see what we need to do."

That's sort of how Palmer's career in GIS unfolded, too: all of a sudden, when she saw what she needed—and wanted—to do.

Originally from Burbank, California, Palmer had been interested in geography and travel as a kid.

"We would always be in the '56 Chevy going places, like camping up Route 1 or to Lake Gregory or the Grand Canyon," she recalled. "My mother would be sitting in the passenger's seat with the big map."

Palmer initially didn't think of making a career out of maps, though, and she ended up in accounting. Twenty years down the road, however, she decided that she really wanted to teach, so she studied social studies and technology education at the University of Nevada, Reno, and got a job at Carson High School in Carson City, Nevada. She then immediately started pursuing her master's degree in geography.

Around the same time, Palmer also got involved with National Geographic's Alliance Network in Nevada, which brings together educators who want to support geographic literacy. That's where she first heard about GIS. A fellow Alliance member, whose husband was the GIS manager for Washoe County, Nevada, told her that they needed to get the technology into their classrooms, so Palmer got on board.

In 1993, Fitzpatrick set both teachers up with ArcView, which they installed on borrowed computers that really couldn't keep up with the software. The two persisted anyway. And while Palmer wanted to use the technology to teach geography, her school had other ideas.

"I became the tech coordinator for the school and then got involved with the district," she said. "We brought one of three high-tech centers in the state to Carson City. It was a co-op between the high school and the community college. So we used it up until 3:00 p.m., and the college came in and used it through the evening."

Palmer's students loved the tech classes, so they took every course they could from her.

"I was like, OK, well, here's this GIS software. Learn it, and then teach me," she recalled.

Once the tech center was up and running, Palmer applied for, and received, a grant through the National Science Foundation to teach GIS to Hispanic female students who spoke little to no English.

"We had a real cultural divide with the girls during the regular school day," she recalled. "So we had them come in at 7:00 in the morning to learn GIS."

There were no educational materials available at the time, so Palmer was writing them from scratch as fast as she could. The students elected to not have the lessons translated into Spanish to better learn English.

"It was empowering for them. These girls started getting on student council, and they graduated," said Palmer. "The program was quite successful, and it kept going for several years. It really became an inclusive process."

At the same time, Palmer started learning how to teach GIS to other teachers so they could use the technology in their own classrooms.

"I really became so passionate about GIS right in the beginning that I thought, this is it; this is where it's at," she said.

In 1998, Esri hosted an intensive GIS workshop for 32 teachers, and Palmer was one of them.

As it turned out, "all the teachers were married except for one other person, and that was Roger Palmer," whom she later wed, she said. "But we did start a GIS education business together before we got married: Educational Technology Consultants," which they later shortened to GISetc.

Palmer ended up leaving the classroom to devote herself entirely to this new endeavor, which included working with Roger and Esri education manager Joseph Kerski (who at the time was a geographer with the US Geological Survey) to hold GIS teacher training workshops around the United States.

"Teachers were coming from all over the place, and it was really wonderful. The connections were amazing," she remembered. "One time we counted that the three of us got 12 hours of sleep the entire week because we were writing curriculum and activities all night long. But the workshops were great fun. Teachers would have this aha moment, and it was like, 'Oh my gosh, I'm going to use this back in my classroom!'"

But Palmer, Kerski, and Baker—who was also involved—wondered if teachers were actually implementing GIS in their classrooms. They later confirmed through research that implementation rates weren't very high without classroom materials. So Palmer decided to produce a book. She got two additional coauthors on board—fellow teachers Lyn Malone and Christine Voigt—and, with help from Fitzpatrick and George Dailey (who also used to be on the Esri education team), they pitched the idea to Esri president Jack Dangermond.

"That's how *Mapping Our World: GIS Lessons for Educators* was born," Palmer said. "Jack threw a massive amount of resources at it, Esri Press just dug in, and it came out like a storm."

The 535-page book, which is painstakingly scripted with screenshots and step-by-step lessons, spoke mainly to early adopters of GIS. Over the years, Palmer has helped update it for new technology, break it down into smaller sections, and even adapt parts of it into GeoInquiries—short, instructional activities that teachers can have students do using ArcGIS Online.

"*Mapping Our World* laid the foundation for a lot of instructional materials both at Esri and at universities and schools that were doing materials development," said Baker.

Palmer, now based in Dallas, Texas, has continued to host teacher trainings. And she and her husband have taken participants to remote places around the world—mostly in Costa Rica but also in Peru, Ecuador, Australia, Kosovo, and New Zealand—to learn GIS.

"We'd be out in the Amazon rain forest with two hours of generated power every day, and we were like, 'If you can do GIS here, you can do it back in your classrooms,'" Palmer said.

For one project in Costa Rica, which prompted the Palmers to start a nonprofit called Geoporter, teachers helped kids map where they picked up trash and then worked with community elders to place mini recycling and trash centers in appropriate areas.

"It really transformed the community," said Palmer, "and then other communities asked to be shown what they were doing."

With her breadth of experience and depth of commitment to geography and GIS, it seems natural that Palmer was chosen as one of National Geographic's eight Education Fellows for 2019—and the first focused on GIS.

"Palmer's thought leadership in the education space…will help to elevate the work and reach of the National Geographic Society's educational offerings," stated a press release about her selection.

Her main project is to work as a liaison with a collaborative group from Esri and the education and digital teams from National Geographic to develop the next generation of MapMaker Interactive, a map interface from National Geographic that teachers and students have used for years to assemble, draw on, and annotate maps. Palmer is also working to design curricular materials and workshops to use in MapMaker Interactive, version 2.

"I am part of a really great team," she said. "We've done interviews with teachers about how they've used MapMaker Interactive and what they really want to get out of a mapping instrument. There's still a lot of hard, grinding work to be done, but we're moving forward, and we will prevail!"

GIS Hero

The Relevance of Cartography

A Cartographer's Perspective

A column by **Barbara P. Buttenfield** and **Sarah M. Kelly**,
University of Colorado Boulder

Teaching Cartographic Best Practices Is a Must

Many colleges, universities, and high schools are adding course offerings in GIScience. GIS certificate, degree, and professional master's programs are starting up everywhere in response to the continuing demand for trained professionals who understand the technologies and techniques of GIS.

To be competitive on the job, students need to learn more than just the sequence of commands within a software platform that will produce a model, tables, or other output. The best preparation for students entering the GIS marketplace revolves around three fundamental elements. The first is critical thinking—understanding which GIS and statistical methods solve a given problem when multiple alternatives are available. The second is responsible use of data, which includes understanding data error or uncertainty and data management. The third is visualization and graphic design for effectively communicating GIS results using maps and graphics.

Nearly every GIS operation begins and ends with a map, an image, a chart, or some type of graphically presented data, and best practices for designing all these visuals fall within the scope of a cartography class.

When famed GIScientist Roger Tomlinson was asked at the 2013 University Consortium for Geographic Information Science (UCGIS) what the real power of GIS is, he answered with a smile and said, "GIS gives us the ability to ask and to answer questions about our world using well-made maps with data of known reliability." Because maps (and graphics) are the foundation for so much of what is accomplished in a GIS environment, we must educate GIS professionals on how to design, create, and use maps effectively. And not as a sidebar to other topics but as a primary focus on concepts, skills, and aesthetics in and of itself.

Cartography is a fundamental need in any GIScience degree program. Ideally, students should complete a hands-on technical introduction to cartographic design and implementation prior to enrolling in GIScience courses.

The University of Colorado Boulder (CU) follows this curricular plan. Every undergraduate geography major is required to take the introductory cartography class called GIScience Mapping as well as an introductory statistics class. GIScience majors must complete these two classes before they can enroll in their first analysis-based GIS class. After finishing those three courses, students can enroll in several GIScience electives that cover topics including modeling, spatial programming, web mapping, and project management. The university's undergraduate certificate in GIS and Computational Science has similar requirements.

Four full-time faculty members teach the curriculum. This staffing level and curricular design falls in the middle of what's offered elsewhere—some schools have more courses and faculty; some have less. Even with only one or two instructors, every GIScience class can and should incorporate cartography into exercises. Grading for all GIS assignments should include comments on map design and visual logic. All the CU courses are taught using ArcGIS technology, along with open-source packages such as Python, RStudio, and Jupyter Notebook.

What should be part of a cartography course today? Basic skills, such as working with map scale, projections, symbolization, and typography, can be coupled with discussions about humans' visual abilities. For instance, a professor could introduce Jacques Bertin's system of visual variables and Cynthia Brewer's advice about color (available at colorbrewer2.org) alongside examples of optical illusions that might cause people to misinterpret a graphic display. Examples of dynamic graphics—such as map animations, terrain flyovers, dynamically linked data views, immersive spatial displays, interactive web mapping, and augmented reality (AR)—help students grasp what can be accomplished with well-designed maps and graphics.

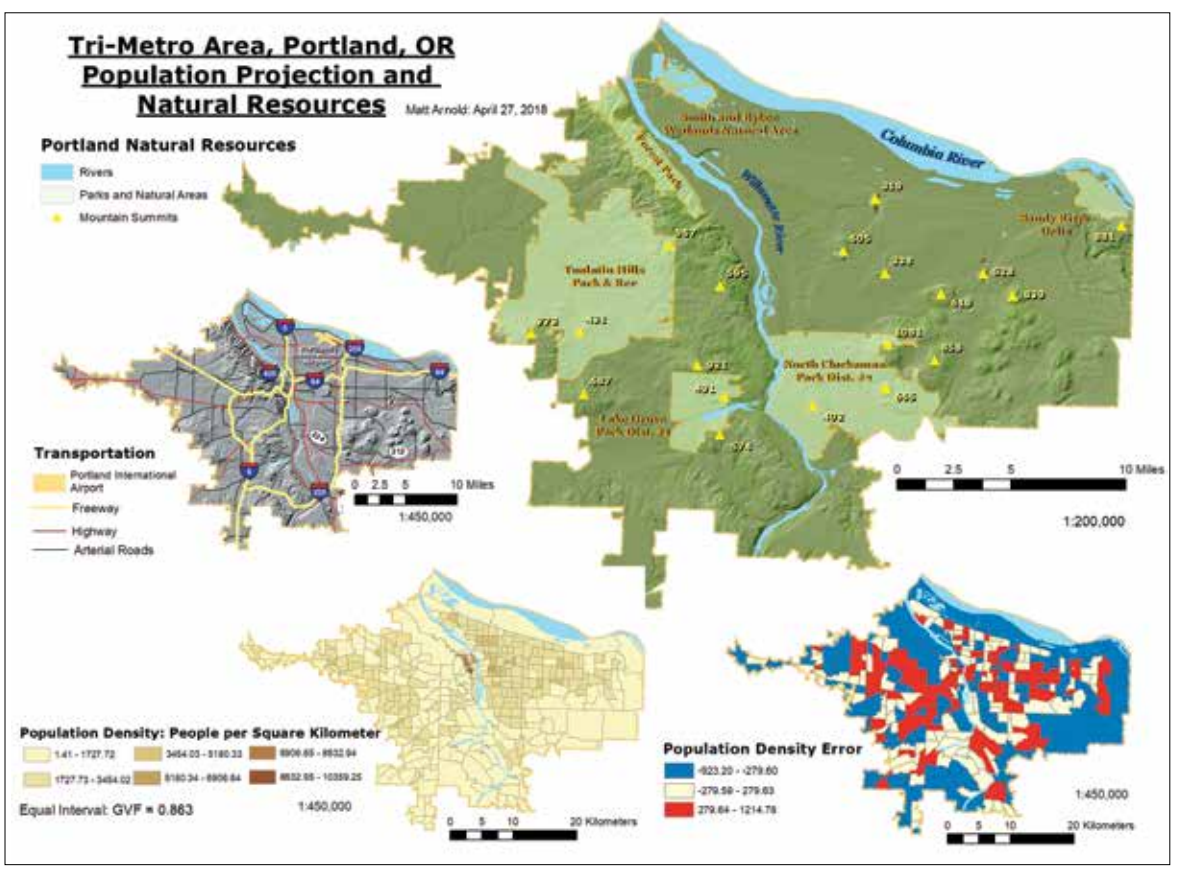
Cartography skills can support a basic understanding of spatial dependence (following Waldo Tobler's First Law of Geography that closer things tend to be more similar than distant things), scale sensitivity (how changing scale or resolution can impact the appearance of geospatial information as well as spatial relationships), and that errors and uncertainty vary across every geospatial dataset and, thus, every map. In a cartography class, students will come to realize that these characteristics vary across data layers, too (for example, terrain and water are more scale sensitive than vegetation or administrative boundaries).

The CU cartography course includes weekly lecture and lab periods. In the first part of the term, students complete thematic mapping exercises as they learn to navigate the ArcGIS interface. Each exercise is tied to a scenario—for instance, designing an evacuation map to help people avoid flooded areas following a storm surge. Students are provided a digital elevation model (DEM), a transportation network, a landmarks data layer, and a storm surge polygon. Their task is to select schools, churches, and hospitals; overlay the various layers; and determine a set of seven landmarks that will lie outside the storm surge and can be deemed safe sites along evacuation routes.

In the second half of the course, students build a geodatabase to design a multipanel map, to be presented at a fictitious town council meeting, that shows natural recreation opportunities and population density. They learn to process one layer of data each week (i.e., resample the terrain and generate a hillshade, select and label spot heights, simplify river and stream features, bind type along curved features, and place road and interstate labels appropriately). Students add processed layers to the geodatabase each week. Instructors provide US Census data and teach students choropleth mapping, metric data classification, and residuals analysis. By the end of the course, students have learned geodatabase creation and organization; worked in ArcCatalog; learned the differences between topographic and thematic map design; and established confidence in using ArcToolbox and the map layout functions in ArcMap. They are then ready to move on to modeling, topology, and data editing in the GIS analysis class.

So what can a GIS educator do who is beginning to teach GIScience and wants to teach best practices? Our advice is to start small and grow your curriculum. In 1996, when Barbara Buttenfield arrived at CU, the GIS curriculum was essentially a blank slate. A single class taught the older ARC/INFO command line interface, and a single cartography class used only graphics software. The faculty at CU built the curriculum one step at a time, one instructor at a time, before instituting an undergraduate certificate program. Recently, we added a graduate certificate program that is evolving into a professional master's program. Along the way, we've received great data, technical support, and advice from many Esri staff and managers.

And if you're aspiring to enter a career in GIS, how can you strengthen your skills? Develop a strong set of cartographic abilities, including good data management and map design. Also gain confidence in communicating the results of your work in map form!



← Students use ArcGIS technology to work with a dataset from Portland, Oregon, to design a multipanel map that shows population density alongside natural recreation opportunities. This multipanel map has a balanced layout and an effective data classification and shows error clearly. (Educational image used with permission.)


Barbara P. Buttenfield


Sarah M. Kelly

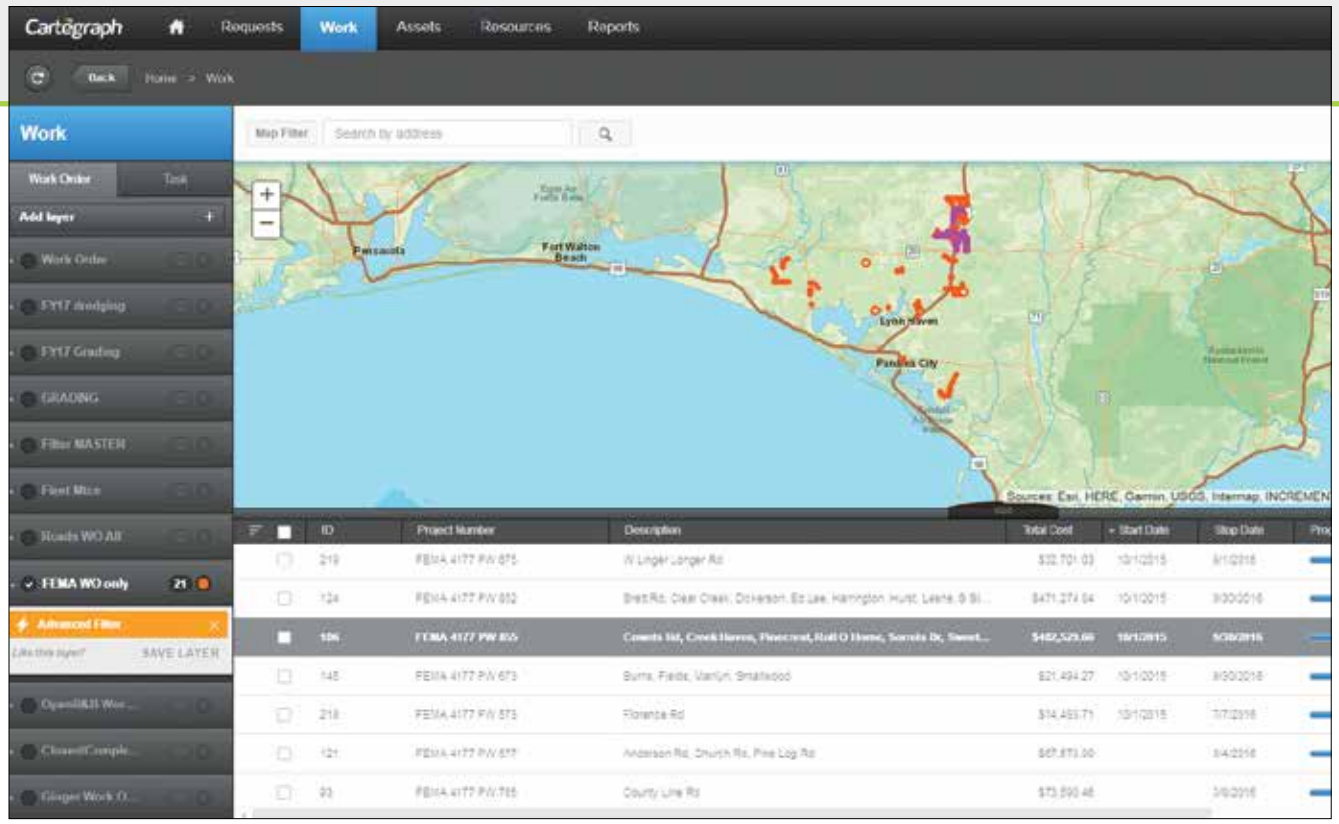
About the Authors

Barbara P. Buttenfield is a professor of geography at CU and the director of Meridian Lab, a research facility focused on visualization and modeling geographic information and technology. Sarah M. Kelly is an instructor of geography at CU, where she has been for three of her eight years of teaching. She has also done environmental modeling work for the public and private sectors. For more information about GIScience curriculum, email Buttenfield at babs@colorado.edu and/or Kelly at sarah.kelly@colorado.edu.

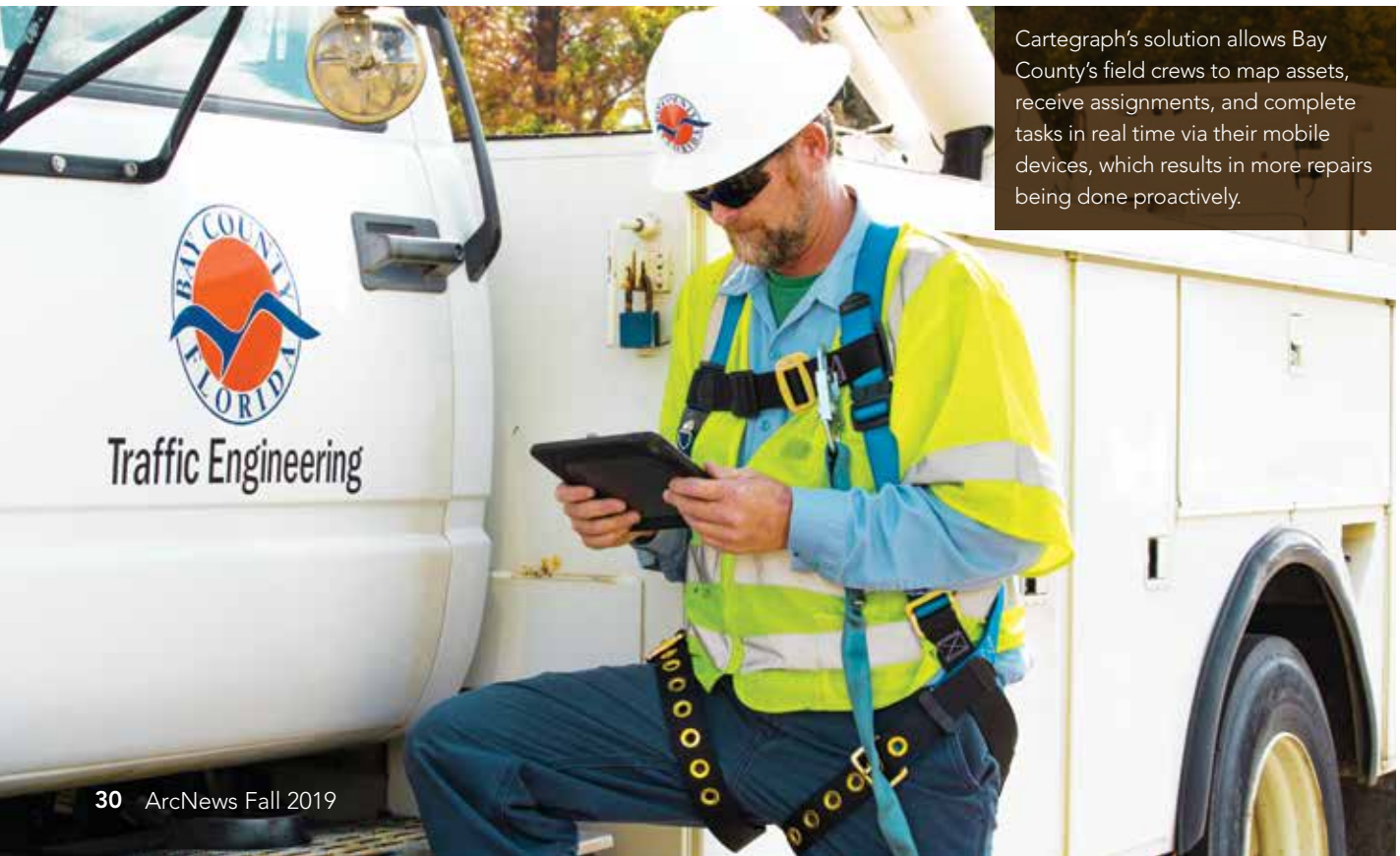
Esri Partner Solution Stories

Helping Users Do Their Work

These four articles describe how Esri partners are helping users with innovative solutions and comprehensive services. They illustrate capabilities that range from managing assets and facilitating data sharing to helping with GIS upgrades and setting up cloud infrastructure. The companies that make up the Esri Partner Network can help organizations get the most out of data and take full advantage of the innovations they have made in Esri technology.



↑ With ArcGIS Enterprise and Cartegraph, Bay County can easily track the activities, time records, materials, and photos it needs to file disaster reports with the Federal Emergency Management Agency (FEMA).



Cartegraph's solution allows Bay County's field crews to map assets, receive assignments, and complete tasks in real time via their mobile devices, which results in more repairs being done proactively.

County in Florida Recoups Millions After Natural Disasters

Bay County, located on the coast of the Florida Panhandle, is prone to flooding from hurricanes, tropical storms, and surging rainfall. For many years, the county's Public Works Department didn't have clear insight into how it was spending its time or what condition its assets were in.

"We were relying on paper and maps and a lot of memories to manage our infrastructure," said the county's public works director Keith Bryant. "The challenge is, when you lose employees, you lose that historical maintenance information. So we needed a way to record our data."

The problem became especially apparent when Bay County had to assess damage and repair costs on its assets after natural disasters. It would take weeks, or even months, for the county to compile damage assessment information into reports to send to the Federal Emergency Management Agency (FEMA). The team often felt that it was leaving money on the table.

The Bay County Public Works Department turned to **Cartegraph** (cartegraph.com) to implement a system that could fix these problems. By integrating the mapping capabilities of ArcGIS with Cartegraph's operations management system, Bay County was able to start managing its infrastructure in one centralized, real-time database.

Public works team members now assign an overall condition index (OCI) to each asset. Those OCI data points enable them to generate automatic work orders so they can do more repairs proactively. The system has eliminated stacks of slow-moving paper work.

In addition, the Public Works Department uses ArcGIS Enterprise and Cartegraph to track maintenance costs down to the penny. This means that when disaster strikes, the team members can compile FEMA reports with ease and recoup millions of taxpayer dollars.

"When we have these major flood events, we're able to go and show FEMA exactly what we did: we had this many people respond with this equipment, it took us this long, and this is what it cost us," said Bryant. "And we can just hit Print and give the data to FEMA. It's that easy. That's millions of dollars back to the county, and we couldn't do that without Cartegraph."

San Diego City and County Streamline Data Maintenance and Sharing

To optimize efforts and resources, the City of San Diego and the County of San Diego in California share a GIS landbase and data warehouse, which are managed and maintained by the San Diego Geographic Information Source (SanGIS). This arrangement, called a Joint Powers Authority (JPA), allows the two separate government organizations to combine resources to meet common objectives—in this case, sharing data and providing up-to-date information to the public.

For SanGIS, its mission is to maintain and promote the use of GIS data for landbase maintenance, data warehouse management, and public access to GIS data. To achieve those goals, SanGIS partnered with **Quartic Solutions** (quarticsolutions.com) to implement the Esri Geospatial Cloud by setting up ArcGIS Enterprise on Amazon Web Services (AWS).

Once this environment was established, SanGIS used it to publish regional imagery, gathered by third-party vendors, that the City and County of San Diego—as well as the public at large—could consume and use for basemaps, code enforcement, planning, and other endeavors. This saves these agencies and other organizations the cost and effort associated with hosting the data themselves.

SanGIS also uses the Esri Geospatial Cloud to create and maintain San Diego County Assessor map books. Previously, two different organizations did data entry: the County of San Diego Assessor's Office entered parcel data in CAD first, and then SanGIS reentered that data into its GIS and added lot data. This resulted in data duplicates. But with ArcGIS Enterprise on AWS, each organization now enters its data directly into the GIS, eliminating duplicate entries and enabling the data to be published much faster than in the past. The operating costs associated with creating and maintaining the map books have been reduced as well.

Centralizing these workflows required moving the maintenance of a number of mapping activities from CAD to ArcGIS. To accomplish this, Quartic Solutions created custom GIS edit, report, and publication tools to mimic the CAD system's functionality, as well as its product outputs. Now, the City of San Diego and the County of San Diego can reliably send data back and forth, which also saves time. In the future, the county assessor plans to expand this system to include other types of updates for the landbase. This versatility has allowed SanGIS to use a single solution to meet two goals: data sharing and collaborative database maintenance.

↑ County of San Diego senior analyst Brenda Maldonado uses the custom GIS tools that Quartic Solutions developed to maintain the assessor's office's map books.

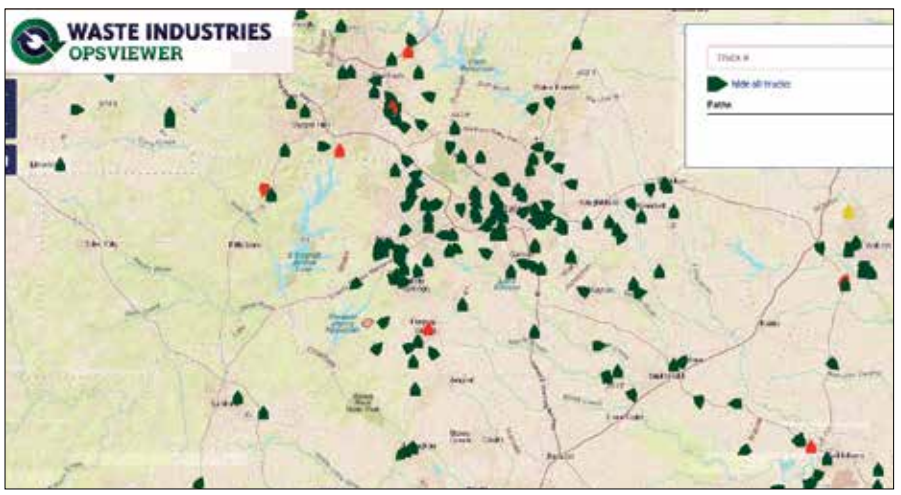
Waste Services Company in Canada Stays Up-to-Date with ArcGIS

Canadian waste services company GFL Environmental Inc. leverages GIS to streamline all areas of its commercial business, from waste management to infrastructure development. To stay on top of Esri offerings and keep the ArcGIS platform at the core of its operations and workflows, GFL Environmental has partnered with **GISinc** (gisinc.com) for nearly a decade, taking advantage of many of its premier GIS services.

For example, GISinc worked on capacity planning and architecture design for GFL Environmental's upgrade from ArcGIS Server 10.3.1 to ArcGIS Enterprise 10.5.1. The Esri partner also implemented ArcGIS GeoEvent Server and ArcGIS GeoAnalytics Server for asset tracking and history analysis. Additionally, GISinc assisted with platform configuration, customer development, documentation, and custom training.

GFL Environmental stays up-to-date with GIS technology by making upgrades part of its yearly plan. When the company upgraded to ArcGIS Enterprise 10.6.1, for instance, it leaned on GISinc to plan and execute the upgrade, as well as for script updates and extending the use of ArcGIS Enterprise across the organization. To allow GFL Environmental better visibility into how the system performs, GISinc also set up ArcGIS Monitor.

As a result of its partnership with GISinc, several of GFL Environmental's teams—including marketing, operations, GIS/IT, and leadership—have seen returns on investment in their business areas. Using the Ecommerce Tool that GISinc built, the marketing team is able to bring in higher sales volumes and execute a quicker sales process, all while getting fewer calls to customer service. With OpsViewer, the operations team can see truck locations in real time and the routes that trucks have traveled, while a mobile app shows where clients are located. This ensures that employees can make faster, better-informed decisions in the field, which ultimately saves travel time while maximizing employees' effectiveness. In addition, leadership now has an overall view of analytics, ensuring that this team can easily identify areas for improvement or potential investment.



↑ At GFL Environmental, the operations team can view truck locations in real time and see how long some trucks have been idle.

Public Safety Organizations Get an Innovative View of Cell Coverage Data

It is critical for public safety agencies to know precisely which mobile carriers have coverage where and how well it works. That's why Virginia-based technology consulting firm Televate, which specializes in interoperable communications infrastructure, devices, and software, recently developed a coverage collection and analysis service called Pinpoint. It enables users to crowdsource cellular network availability and performance data for various carriers and then see this information on maps and dashboards.

The Pinpoint mobile app collects more than 50 unique data elements, including service availability, ping loss, ping delay, device location, signal strength, signal quality, network latency, and data throughput. The mobile app integrates with Televate's geospatial cloud service to aggregate and analyze the data and then provide end users with high-quality visualizations of carrier coverage.

Pinpoint relies on Esri technology and a geospatial cloud infrastructure, thanks to Televate's partnership with **GeoMarvel** (geomarvel.com). The Esri partner, based in Washington, DC, builds lasting, scalable GIS infrastructure and software solutions that address its customers' goals and initiatives.

In Televate's case, the company wanted to offer comprehensive client-side data visualizations. With GeoMarvel's help, Televate used ArcGIS Enterprise, ArcGIS API for Python, and ArcPy to geospatially enable Pinpoint on an associated cloud infrastructure built on Amazon Web Services (AWS), including Amazon Elastic Compute Cloud (Amazon EC2), Lambda, CloudFront, API Gateway, and Amazon Relational Database Service (Amazon RDS).

The Pinpoint dashboard contains a great deal of information about the collected data, such as service state, signal level, ping success, and upload/download speeds. Now, public safety agencies can visualize this data all in one place and get a complete view of network carrier coverage.

↑ The Pinpoint dashboard shows users the state of service, the signal level, ping success, upload and download speeds, and more.

Esri partners represent a rich ecosystem of organizations around the world that work together to amplify The Science of Where. Their products and services range from configured apps, add-ons, widgets, and custom-built solutions to complete ArcGIS system implementations, content, and hardware. Discover partners, solutions, and services that meet your needs at **esri.com/partners**.

A Model of Popular Fishing Locations Aims to Reduce Pressure on Certain Species

By Madison Dowdy, Florida Fish and Wildlife Conservation Commission, and Bridgette Froeschke, University of Tampa

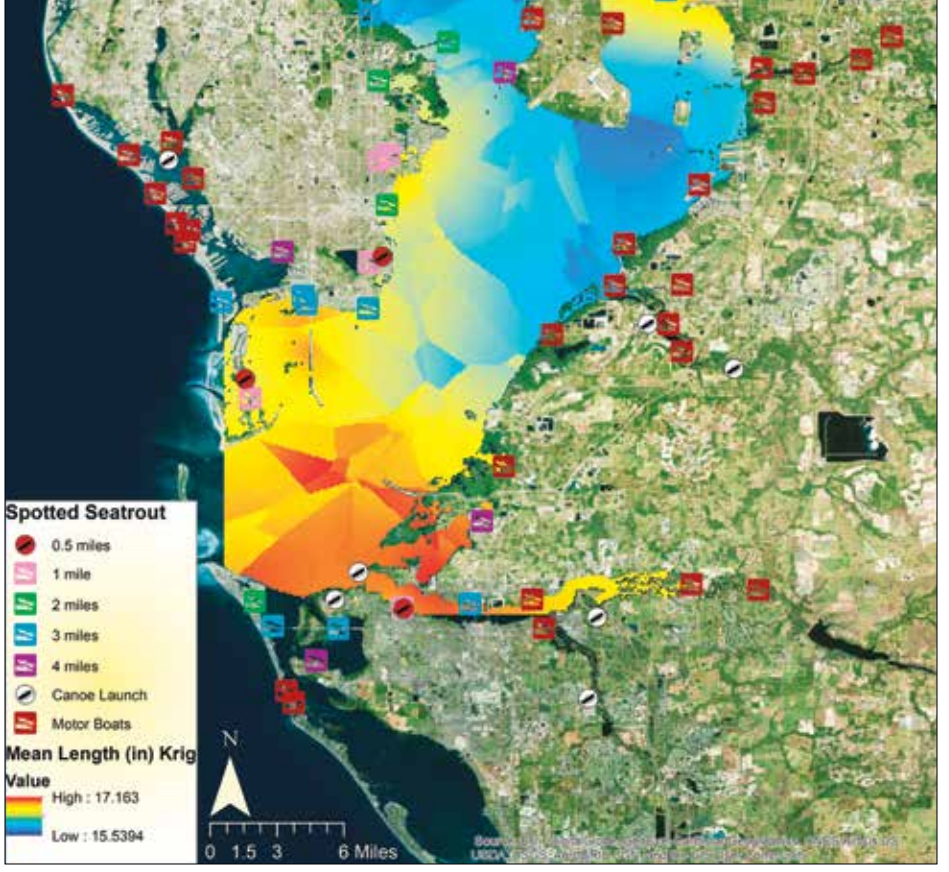
Human activities, including overfishing, ocean disposal, oil spills, the destruction of coastal ecosystems, land-based contamination, and climate change, have all altered marine habitats to the point that their numbers are declining precipitously. Fisheries around the world have been extensively exploited as well, causing much concern among scientists.

Ecosystem sustainability is essential to keeping the earth and all its inhabitants in equilibrium. But getting to that point requires substantial fieldwork, from collecting environmental samples to monitoring species' movements, which is often very time-consuming and costly.

Two common field research methods for marine habitats are conducting catch-and-release studies in areas where people fish for pleasure and administering surveys to recreational anglers. Catch-and-release methods are very localized, though, considering that the fish must be hungry, curious enough to take the bait, and swimming underneath the watercraft. And when it comes to doing surveys, anglers can be quite selective about whom they give their fishing information to, for fear of losing their secret spots. So there's a risk of getting dubious answers.

To properly manage fisheries, however, the federal and state governments need to take an ecosystem-based approach that addresses interactions among the physical, biological, and human components of aquatic environments. This means that resource managers need to identify quality habitats to study, as well as take into consideration the economic values that both these spaces and their inhabitants can produce.

With this goal in mind, we set out to reduce the time and effort it takes to find popular fishing locations. The idea was twofold. First, we wanted to help resource managers figure out where certain fish populations are under pressure from sport fishing. Second, we wanted to be able to show anglers where to find the specific fish species they want to catch. This information could then be used to encourage anglers to cast their lines in less popular fishing areas to reduce the strain on certain locations that are prone to overfishing. Using Tampa Bay, Florida, as our study area, we generated a model that could predict where particular fish species can be found in different seasons, as well as which boat ramps are optimal launching points for targeting them.



↑ A raster surface, made using the Kriging tool, shows the variation in size of individual fish species in Tampa Bay.

To start, we got more than 20 years of spatial fisheries data for Tampa Bay from the Florida Fish and Wildlife Conservation Commission (FWC). For each fish caught during various FWC studies over this period, the data showed the coordinates for where it was caught; the date it was caught; the fish's length; and other aquatic parameters, such as water depth and temperature, associated with the catch.

We then focused the study on 10 fish species, including red drum, sheepshead, spotted sea trout, pinfish, and black drum. The first question we wanted to answer was whether popular recreational fisheries had a random assortment of fish or if there was a distinct spatial pattern for each species' size class. To begin the analysis, we used the Hot Spot Analysis tool in ArcMap to determine areas that have large fish in them by comparing the mean length of one species of fish at each site to the mean length for all the fish in that individual species' dataset. We then used the Kriging tool to interpolate a raster surface that shows, more evenly, the variation in size of individual fish species throughout Tampa Bay.

The next step was to figure out where large fish tend to congregate in relation to Tampa Bay's boat ramps. Using the Hot Spot Analysis tool in ArcMap once again, we identified clusters of large fish that were isolated from the full dataset. We then set up buffers at various distances—from 0.5 miles to 4 miles—around the identified cluster sites and established which boat ramps intersected with them. This allowed us to see which boat launches around Tampa Bay are optimally located for fishing the 10 focus species of the study. If there are groups of these large fish close to multiple boat ramps, those clusters are likely prone to overfishing. However, if there are collections of the same (or similar) species just a little farther away, anglers could go there instead and relieve some of the ecological pressure on their preferred fishing spots.

Once the model was set up, we had to determine whether it was accurate, so we rounded up students from the University of Tampa's Spatial Ecology Lab to visit several boat ramps in Tampa Bay that were deemed optimal for catching large fish. There, students asked anglers who were pulling their boats in from the water what types and sizes of fish they caught, how far they traveled from the boat ramp, and why they launched at that particular spot.

The completed surveys ended up corroborating the ArcMap model, showing which areas throughout Tampa Bay faced the most fishing pressure. For example, the model predicted that at the Fort Desoto boat ramp, on the north end of Madelaine Key, the main species caught would be sheepshead and spotted sea trout. The anglers surveyed at that location confirmed that 50 percent of the time they catch sheepshead, and the other 50 percent of the time they catch spotted sea trout.

These findings were a huge step in the right direction, as they indicate that using the model—which could be replicated for other aquatic environments—can reduce the amount of time and effort it takes to find key marine habitats and determine some of the human-induced pressures they face.

Currently, we are finalizing the model so that resource managers can use it to monitor species distribution and overfishing in other marine ecosystems. In addition, a small subset of anglers in Tampa Bay is already using the maps generated by the model to target their preferred fish species.

About the Authors

Madison Dowdy, who was a senior at the University of Tampa when this project was conducted from August 2018 to May 2019, graduated with a degree in biology and is now a biological scientist I at FWC. Bridgette Froeschke, PhD, is an assistant professor in the biology department at the University of Tampa, where she teaches GIS, biostatistics and experimental design, and microbiology.

Crossing Borders

A column by Doug Richardson
Distinguished Researcher
Harvard University

Creating and Sustaining the GIS and Geography Community

Contemplating my recent decision to retire as the longest-serving executive director of the American Association of Geographers (AAG), I am struck by how privileged I have been during my career to have worked closely with a dynamic international community of thousands of talented and creative geographers, scientists, humanists, and passionate GIS specialists from all walks of life.

Supportive communities and successful organizations—whether in the public, private, or academic sectors—are fragile. They don't carry on and grow by accident. They require constant nurturing, wise and knowledgeable leadership, hard work, and some modesty—but most of all, goodwill. The thriving GIS community, or ecosystem, that has developed over the past 40 years is a unique asset and a special "home" for all of us, not to be taken for granted.

Countless people have contributed to this community; but over the decades, both in business and friendship, Jack and Laura Dangermond have quietly and consistently been at the forefront of developing an inclusive, open, and innovative GIS and geography community. Their influence has been so effective because they lead by example, hard work, and collaboration—not just talk—and have helped build, guide, and sustain a worldwide GIS community.

I first met Jack and Laura in 1980 when we were each trying to grow new companies with exciting new ideas. My private sector company, GeoResearch, Inc., which developed and patented the first real-time, space-time-integrated GPS/GIS mapping technology, was one of Esri's first business partners. Both our organizations benefited from each other's continual innovations.

During my years as executive director at the AAG, Jack served as a sounding board for me as I greatly expanded the AAG on many fronts, from membership to research programs to inclusiveness, all while building a strong financial foundation for the association. While I tried to not ask too much of Jack (because so many others do), I always knew that I could count on him when the stakes were high and the issues were important to the geography and GIS community. Jack and Laura have my deep respect and admiration, and I thank them for all they have done—particularly for helping to bring geography and GIS more closely together.

This column will be my final one in the long-running Crossing Borders series in *ArcNews*. I have contributed a column to the magazine since 2003 and have never missed an issue. I would like to thank Esri for giving me the opportunity to engage both the geography and the GIS communities, which are inextricably intertwined, in common conversations and collaborations through these columns. I also would like to thank my Crossing Borders editors, Citabria Stevens and Tom Miller, for their insight and patience. (While I have never missed an issue, I cannot say the same for interim deadlines.) This Crossing Borders series also forms something of an informal chronicle of some of the key ideas and issues in geography and GIS over the past couple of decades. To view the full Crossing Borders column series, visit p.ctx.ly/r/9l8e.

While I look back with satisfaction on what I have accomplished in geography and GIScience, I also plan to have a long and active post-AAG retirement career, with more time for my family and staying in touch with all the friends I have made around the world over the years. I will continue writing, editing, and publishing journal articles and books and will stay on as editor in chief of the 15-volume *International Encyclopedia of Geography: People, the Earth, Environment, and Technology*. I also already have a surfeit of requests to give international presentations and lectures that will keep me as busy as I want to be with travel.

Finally, as a capstone to my long and productive career in geography and GIScience, I have accepted a position as distinguished researcher at the Center for Geographic Analysis at Harvard University. I look forward to continuing to interact with you and our vibrant GIS community, and I invite ideas and collaborations on important research needs for our geography and GIS community in the future.

Please keep in touch. My new contact information is below.

Douglas Richardson, PhD

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The Power of Location Analytics in the Solar and Wind Energy Industry

When wind and solar energy developers need to improve their alternative energy construction and operations, they can turn to Esri partner Aegean Energy Group. Its Maps to Megawatts solution, which is based on the ArcGIS platform, supports development, on-site analysis, site control, and reporting.

Recently, Aegean Energy extended the capabilities of Maps to Megawatts by enhancing it with ArcGIS Insights. This allows the company to streamline field data collection and deepen location analytics.

Field Data Identifies Obstacles to Development

Maps to Megawatts helps Aegean Energy clients with planning, strategy, and development. For developers looking for wind and solar opportunities, Aegean Energy does suitability analyses to identify any costly or challenging obstacles that might arise, such as safety, civil, or environmental issues. But the company needed a more efficient way to gather field data for analysis and promptly make the results available to stakeholders.

"Field information is important to us internally," said Woody Duncan, senior vice president of Aegean Energy. "It also helps clients be strategic and methodical in project development, which is a time-saver and critical in this day and age. We have to have greater insight as we look for energy opportunities."

How Aegean Energy received information from the field was in need of retooling, though. The company gathers large amounts of data about a project during construction, but processing that data was slow. From project photos that required cataloging and filing to paper forms that staff manually entered into a Microsoft Excel database, the workflow caused a significant lag in distributing information from the field. The company estimated that these sluggish and burdensome processes took around three months to complete. Moreover, Aegean Energy wanted to find a more efficient way to conduct analysis and quality assurance/quality control (QA/QC) when analyzing data.

Doing So Much More with Data

In 2018, Aegean Energy implemented ArcGIS Insights to streamline data input, analysis, and reporting. This analytical software allows users to perform data analysis, document their workflows, and share analysis results with others. Now, the company uses Insights in various stages of the assessment process.

"We use Insights for quality control, reporting, tracking schedules, and budgets," said Clint Cook, senior vice president of engineering and construction at Aegean Energy. "It's exciting because we can now do so much more with data."

Maps to Megawatts' functionality includes construction monitoring that tracks inspection status. Using Survey123 for ArcGIS, field operations teams complete data forms to help Aegean Energy identify potential development issues. Once an operator submits a Survey123 form, the data gets processed in ArcGIS Online and loaded into a dashboard. Insights then automatically flags tasks that are open and ready for inspection. This gives inspectors an easy-to-see visual representation of where work needs to be done. Inspectors can then use Survery123 to update the task's status, instantly closing the loop, and Insights tracks that change. This simple workflow has improved inspection efficiency.

Aegean Energy also uses the new Link Analysis tool in Insights to trace form entry errors—another aspect of QA/QC. Using a network of interconnected links, the tool identifies and analyzes relationships that are not easily seen in raw data. For instance, say a fieldworker inaccurately enters two locations on an inspection form. Since each inspection status task links to a specific solar pad number or wind turbine location, only one form can be entered for each. A link chart, with a clear graphic representation, shows a pad number with two different statuses, which indicates a data entry error.

"Using this tool saves hours of work," said Duncan. "Previously, somebody would have to spend many hours trying to dig through the reports and figure out if information had been entered twice or if there was another issue. But with Insights, we can immediately find the problem. It's like pulling a needle out of a haystack in an instant rather than months later."

Aegean Energy also uses other products in the Esri suite to publish analysis results and expedite reporting. After staff members conduct suitability analyses, they make the results available to clients via the internet or through ArcGIS Online. Companies then use the results to do constructability assessments in the field.

In addition, Aegean Energy has made its data capture processes more efficient by implementing not only Survey123 but also Collector for ArcGIS. Employees use these apps to collect and organize data, quickly connect to the office, and share it with stakeholders.

"Using Collector and Survey123...allows our field folks to fill out all the information in the field and simply press a button to report results," said Duncan. "*[Viewing]* that linkage during construction and across multiple dimensions is tremendous. To have the ability to go through an enormous amount of information and simplify it into what we need to see is terrific."

Increased Accuracy, Collaboration, and Efficiency

For Aegean Energy, using ArcGIS Insights plays a valuable role in ensuring the accuracy of project-related documents. Fieldworkers and administrative staff simply log in to the app to easily view completed forms and make sure they are correct.

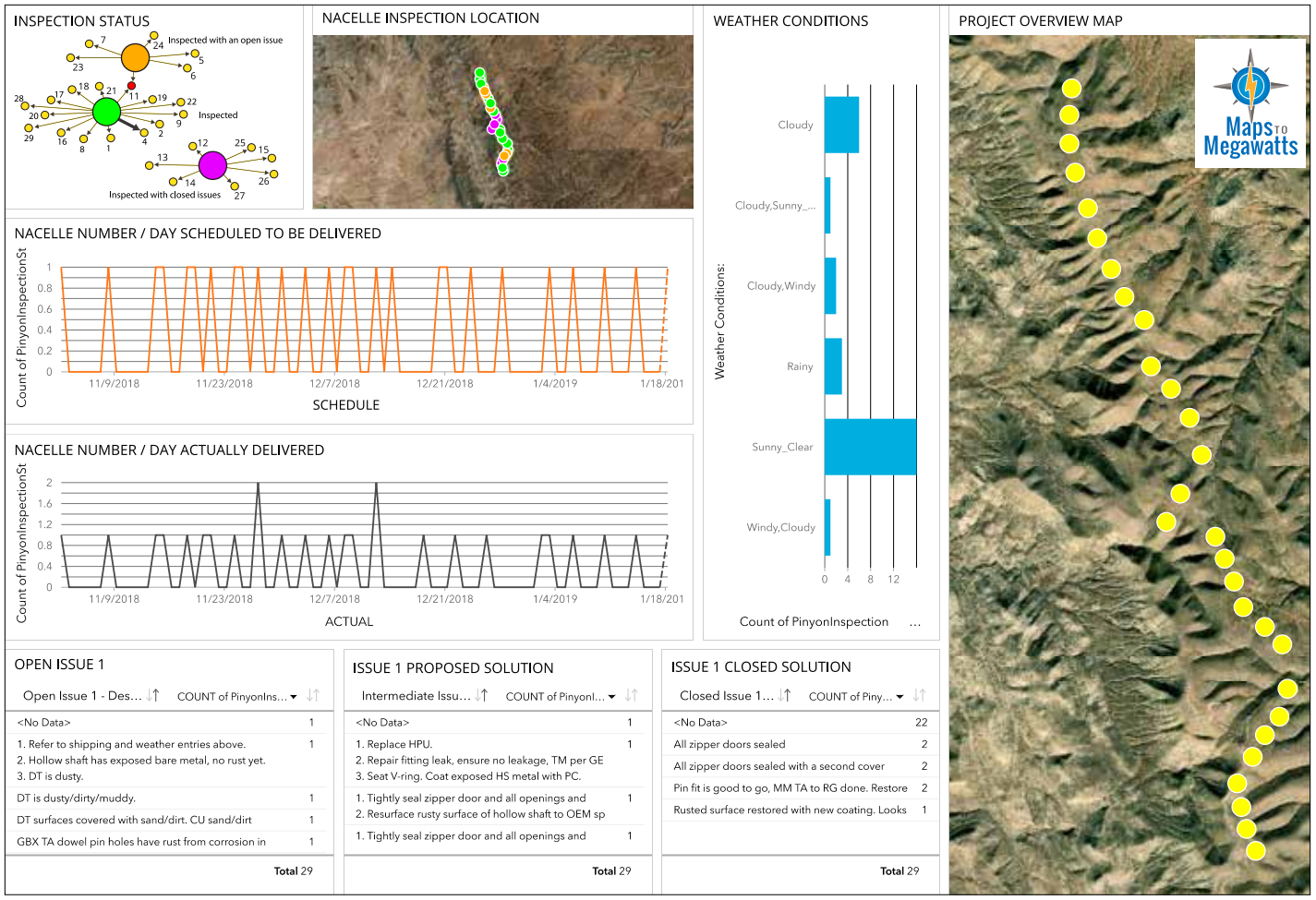
Insights also fosters collaboration by allowing stakeholders—no matter where they're located—to view data and project-related developments. With web-based data and results available in one location, project managers, senior executives, site administrators, and other stakeholders can quickly pinpoint any issues, as well as whether a project is progressing on time and on budget.

And when it comes to data collection, staff at Aegean Energy no longer have to spend hours at the end of each day sorting through and sending forms and photos. The ease of transmitting field data has boosted efficiency and continues to help the company digitally transform its processes.

The newly streamlined workflows and location intelligence tools benefit employees both inside and outside the office. Fieldworkers now use tablets and mobile devices to complete forms and quickly share information and results on the web, while both the company and its customers have found great value in being able to view issues and track projects in Survey123 and Collector.

By enhancing the Maps to Megawatts solution with tools from Esri, Aegean Energy offers energy companies a clearer understanding of their operations and progress when undertaking wind and solar power development.

"For us, we live in maps. Everything we do is tied to *where*," said Cook. "So the spatial data we gain from Insights is incredibly valuable. Otherwise, it's just data."

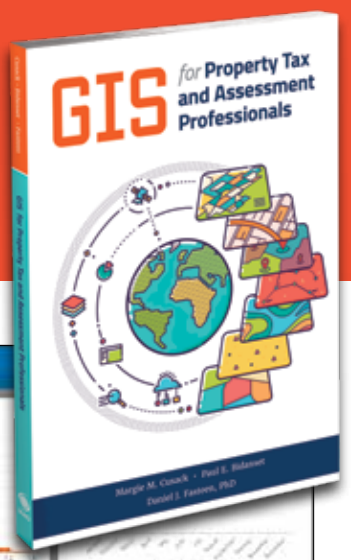


↑ At Aegean Energy Group, ArcGIS Insights workbooks display inspection statuses for different audiences. For instance, site managers can see open issues and scheduled nacelle deliveries, while site managers can look at the link analysis to make sure data entry is going smoothly.

How Assessors' Offices Can Use Dashboards to Aid Decision-Making

By Daniel Fasteen, Thomson Reuters

→ *GIS for Property Tax and Assessment Professionals* provides an in-depth look at how professionals in the property assessment and tax administration field can use GIS.

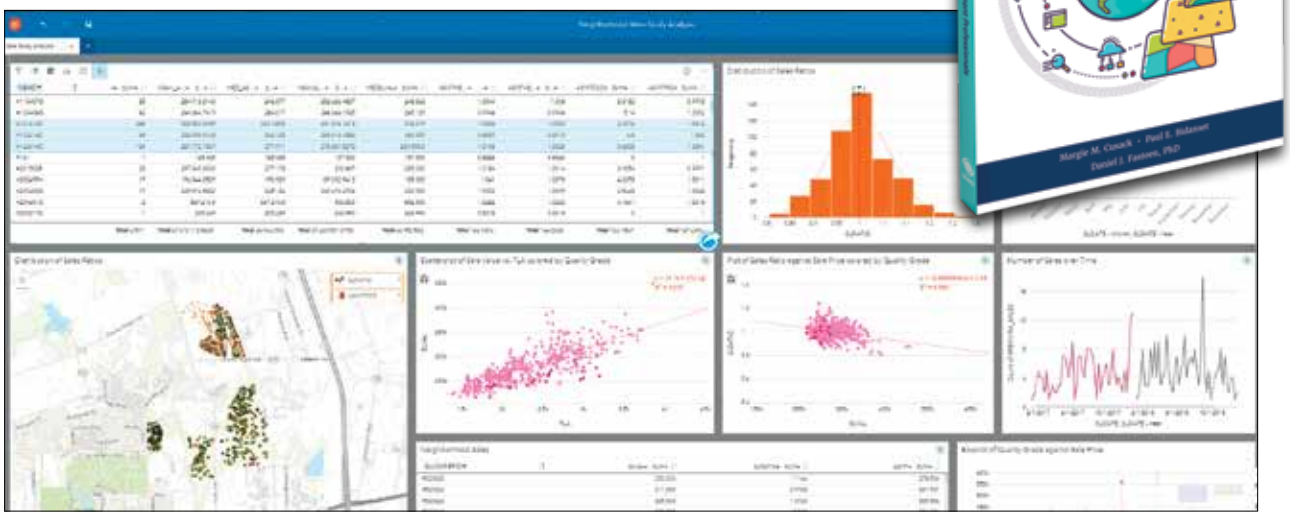


Many local government organizations are searching for quick, cost-effective ways to get more out of their data. Dashboards are a great tool for presenting operational, analytical, and other kinds of data. But while they are becoming more popular across various industries, local governments appear to be adopting them at a much slower rate. That is because impediments—such as lack of staff resources, budgetary constraints, having too many other priorities, and a shortage of expertise—oftentimes slow the growth of technological innovation at the local government level.

With local governments collecting ever-increasing amounts of data, however, there needs to be an easy way for managers and officials to see this information so they can stay informed and make critical decisions. Dashboards do just that, providing officials with access to data in real time or near real time so they can drill down into it quickly and effectively.

The property tax assessor's office—which identifies, lists, and values all the properties within its jurisdiction in a fair and equitable manner—amasses an especially large amount of data. Although GIS is still an emerging technology in many of these offices, particularly when it comes to contextual solutions that make assessors' jobs easier, using dashboards can help with a range of processes, from collecting data and conducting analysis to streamlining workflows and ensuring compliance. What's more, dashboards can be deployed quickly to help property tax assessment professionals better understand how their assessments are performing compared to actual sale prices via industry-specific metrics.

Two types of dashboards in particular—operational dashboards, which provide a high-level glance at information, and analytical dashboards, which furnish more in-depth analysis of valuation trends—can together help property tax assessors better understand their data.



↑ ArcGIS Insights can help property tax assessors evaluate business intelligence data in myriad ways.

Operational Dashboards Help Guide Managers, Appraisers, and Administrators

Operational dashboards, such as those made with Operations Dashboard for ArcGIS, are often very illuminating. They can provide assessors with important contextual information about how their assessments are performing, the efficiency of their workflows, the rates at which appraisers are doing inspections, and more. They also usually convey these details in real time or near real time.

For example, to stay on top of heavy workloads, assessors' offices often track the number of property appraisals and appeals they need to process in a given day, week, month, or other time frame. Using Operations Dashboard, staff in an assessor's office can visualize all these metrics and more in one place and then create a to-do list to better identify everyone's workloads and determine where to concentrate efforts.

At the manager level, an operational dashboard can provide metrics on the distribution of staff workloads. For instance, if one appraiser has 500 appraisals left to do and another one has none, a manager can redistribute some of those outstanding inspections as the deadline for finishing them approaches. These kinds of managerial dashboards can also be used to see the number of building permits the assessor's office has to process or how current assessments in particular areas are performing (i.e., how equal or uniform they are).

For appraisers and administrators, an operational dashboard can provide them with a breakdown of their individual workloads. For example, an appraiser could see how many inspections they have to do in each neighborhood, or an administrator could keep track of how inspections, sales, and building permits are spatially distributed within the appraisers' respective areas.

All this data, visible in an easy-to-understand operational dashboard, can help decision-makers allocate resources appropriately and foster continual improvement.

Analytical Dashboards Allow Deeper Data Dives

Analytical dashboards enable staff members to gain an understanding of the distributions and relationships among their data. When it comes to making sense of business intelligence data, these kinds of dashboards equip analysts to draw concrete conclusions, give good recommendations, and make better decisions.

Assessors are often looking for information to analyze how well their assessments are performing at various levels of the spatial hierarchy—in certain market or submarket areas or neighborhoods. Assessment inequity, or dissimilarities among assessments of similar properties, can be caused by many factors, such as field appraisers miscoding a property's features or outlier sales that aren't representative of an entire neighborhood. This can play into how data analysts define assessment models and draw market areas.

ArcGIS Insights can help property tax assessors evaluate business intelligence data in several different ways. For example, assessors need to understand how property assessments compare to existing sales prices—a metric known as the sales ratio. Sales ratio studies are used throughout the industry to measure the overall level of assessment and uniformity, both of which show how accurate assessments are. The International Association of Assessing Officers (IAAO) provides industry standards for evaluating assessment level and uniformity throughout a jurisdiction. Additionally, in the United States, most states have their own regulations to ensure the level and uniformity of assessments.

Using Insights, assessors can visualize sales ratio studies at different levels of aggregation—by the market, submarket, or neighborhood level, for instance. This helps assessors see where they are performing well and where assessments may need to be shored up or reevaluated.

Insights is easy to deploy and use. Assessors can select property data and drag it onto a card to visualize it as a map, chart, or table. The cards can be linked, which makes digging deeper into the data quick and easy. To concentrate on one data selection, such as market area or quality of construction, a user can pick that row in a table to automatically change the maps, charts, and graphs in Insights so they center on that data selection.

Analytical dashboards, like the interactive maps, charts, and tables available in Insights, can help keep analysts apprised of performance metrics throughout their jurisdictions and remain compliant with IAAO standards and state regulations.

Resources for Implementing Dashboards

There are great resources available for local governments that want to implement more GIS—and location-based dashboards—into workflows at their assessors' offices.

The IAAO recently published a book called *GIS for Property Tax and Assessment Professionals*, which provides an in-depth look at the use of GIS within the assessment field. The book was written with two audiences in mind: GIS professionals looking to understand the technology's role in the assessor's office and assessment professionals who want to enhance their analyses and workflows using GIS.

In addition, there is the annual GIS/Valuation Technologies Conference, presented by the Urban and Regional Information Systems Association (URISA) and the IAAO. The conference shows professionals in the property assessment, tax administration, mapping, and information technology fields how GIS and other integrated technologies can help with valuation and assessment. The next conference, in Louisville, Kentucky, in March 2020, is themed Thriving in a Disruptive Tech Era. The keynote speaker, Louisville's chief of civic innovation and technology Grace Simrall, will share her experiences implementing new and emerging technologies in city government.

About the Author

Daniel J. Fasteen is a product specialist with Thomson Reuters, where he coordinates and designs analytical solutions for GIS and mass appraisal. He has a PhD from the University of North Dakota and has been in the property valuation profession since 2010, working for local government jurisdictions in North Dakota and Minnesota. Fasteen is coauthor of the book *GIS for Property Tax and Assessment Professionals*.

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

Training

New Instructor-Led Courses

Esri's instructor-led courses are developed in-house by subject matter experts who have a deep understanding of ArcGIS best practices and recommended workflows. All instructors have Esri Technical Certifications and CompTIA CTT++ certification.

Whether you are a lidar neophyte, an experienced intelligence analyst who needs a grounding in geospatial concepts, or someone who could use some time-saving tips for maintaining accurate GIS data, there are ArcGIS tools and capabilities that can help you get what you need out of Esri technology. You can learn about them by taking the following courses:

- **Working with Lidar Data in ArcGIS**
  This one-day course teaches the basic concepts of light detection and ranging (lidar) data. Participants discover the many beneficial uses of lidar data as they practice managing, editing, visualizing, and sharing lidar-derived 2D and 3D information products using ArcGIS Pro.
- **Introduction to Geospatial Concepts for Intelligence**
  Intended for analysts in the defense, intelligence, and national security communities, this course provides a strong foundation in geospatial concepts that support the intelligence cycle. In scenario-driven exercises, attendees get hands-on practice using ArcGIS Pro to prepare, visualize, analyze, and disseminate data that supports intelligence operations.
- **Creating and Editing Data with ArcGIS Pro**
  This course is for GIS technicians, specialists, and others who need to maintain the accuracy of their organization's authoritative GIS data. ArcGIS Pro offers many time-saving tools to update 2D and 3D geographic data, and attendees of this course learn how to use those tools to streamline the editing process.

ArcGIS Course Bundle for Utilities

Esri is offering a course bundle for GIS professionals and administrators at water, electric, gas, and other utility organizations that are transitioning to the ArcGIS Utility Network Management extension. Courses in the bundle cover key concepts and recommended workflows for ArcGIS Pro, ArcGIS Enterprise, and ArcGIS Utility Network Management. Together, the courses teach the skills practitioners need to deploy a modern utility network that helps improve asset management, customer service, and real-time situational awareness. Courses are available online, at Esri training centers nationwide, and on-site at customer organizations. View bundle details at go.esri.com/utility-network-training.

Certification

Did you know that Esri offers no-cost learning plans to help people prepare for technical certification exams? Each learning plan provides a curated set of resources—including web courses, training seminars, tutorials, instructor-led courses, and white papers—that reinforce skills and concepts related to the exams. Learners can easily track their progress through a plan on the Esri Training website. Take a look at all Esri Technical Certification learning plans at go.esri.com/certification-plans.

The Results Are In

Esri-certified individuals recently provided valuable feedback about how their certification achievements support their personal and professional goals. The 2019 Esri Technical Certification Survey responses reinforce long-standing trends and reveal a few surprises.

ArcGIS Desktop Associate continues its reign as the most popular exam. Interestingly, about 10 percent of surveyed individuals have already earned a Specialty certification, which is a new exam type that debuted earlier this year. Almost half of respondents reported taking a recently released version of a core exam, and 85 percent said they were likely to pursue another Esri Technical Certification.

The surveyed individuals clearly perceive value in achieving a technical certification. As one respondent put it, "Passing gave me the confidence that my skills were up to speed, as well as learning the questions that are important to understand to leverage the full value of the ArcGIS platform."

To explore the latest Esri Technical Certification exams, visit esri.com/training/certification. Also join the Esri Technical Certification groups on LinkedIn and GeoNet to connect with other professionals and discuss all things certification.

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

Esri Press

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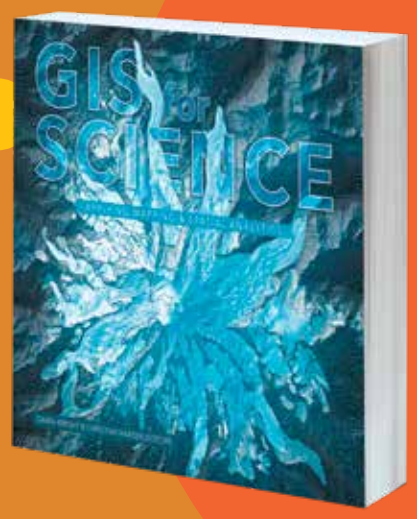
GIS for Science: Applying Mapping and Spatial Analytics

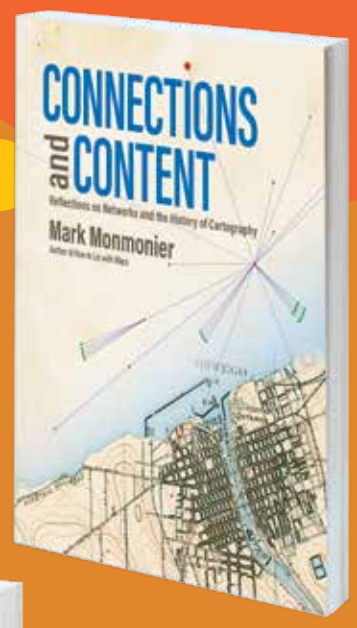
Edited by Christian Harder and Dawn J. Wright



A collection of real-world stories about modern science, *GIS for Science: Applying Mapping and Spatial Analytics* highlights a cadre of scientists who use mapping and spatial analytics to expand their understanding of the world. The accounts in this book are written for a broad audience, including professional scientists, the swelling ranks of citizen scientists, and people with a general interest in science and geography. The volume shows how GIS technology brings scientific data to life, allowing both scientists and nonscientists to study a range of issues that are relevant to Earth's natural functions, as well as the impacts of human activity. In a race against the clock, the scientists profiled in this volume are using remote sensing, web maps, ArcGIS StoryMaps, and spatial analysis to document and solve big problems that have a geographic dimension—from climate change, natural disasters, and loss of biodiversity to homelessness, lack of green infrastructure, and resource shortages. The geospatial ideas presented in these stories can be applied across disciplines, making *GIS for Science* relevant to a diverse audience. June/July 2019, 252 pp. E-book ISBN: 9781589485310 and paperback ISBN: 9781589485303.

Connections and Content: Reflections on Networks and the History of Cartography

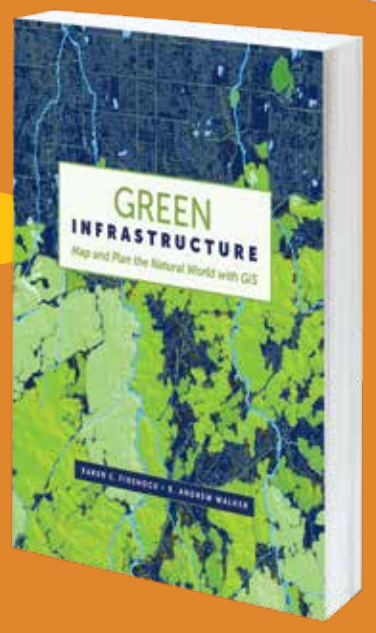
By Mark Monmonier



Behind every great map is a network, and behind every great network is a map. In *Connections and Content: Reflections on Networks and the History of Cartography*, cartographic cogitator Mark Monmonier shares his insights about the relationships between networks and maps through a collection of essays. Relying on historical maps, he explores the triangulation networks used to establish the baselines of a map's scale; the astronomical observations, ellipsoids, geodetic arcs, telegraph networks, and GPS constellations that establish latitude and longitude at control stations; the cartographic symbols that portray network features on a map; the survey networks used to situate and construct canals, railways, roads, and power lines; and the topological networks that underlie modern census enumeration and satellite navigation systems. Connecting the past to the present via maps and reflection, Monmonier extends his contributions to cartographic scholarship by demonstrating the network as a unifying concept for understanding and using maps. August/September 2019, 290 pp. E-book ISBN: 9781589485600 and paperback ISBN: 9781589485594.

Green Infrastructure: Map and Plan the Natural World with GIS

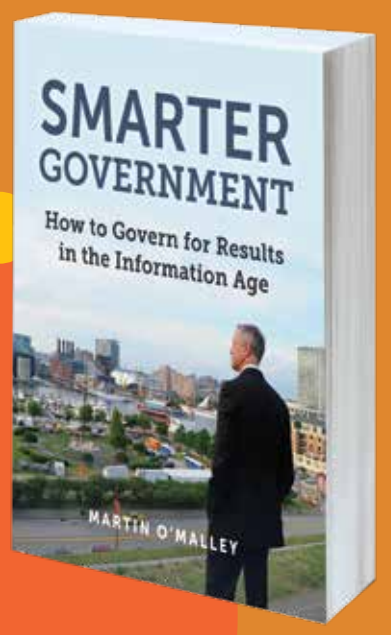
By Karen E. Firehock and R. Andrew Walker



To conserve our natural assets—our green infrastructure—we need to map them and plan for their protection. *Green Infrastructure: Map and Plan the Natural World with GIS* describes the *why* and *how* of green infrastructure (GI) mapping and implementation through text, maps, and online illustrations. Authors Karen E. Firehock and R. Andrew Walker explain how to employ the national green infrastructure model that Esri has built with the Green Infrastructure Center's (GIC) methodology. Using print and online map layers, the book demonstrates how to develop a prioritized strategy for conserving or restoring the highest values to natural resources. It also outlines how this analysis is then employed to inform a host of planning applications, from protecting drinking water and conserving endangered species to designing recreation areas and preserving culturally significant landscapes. The book uses actual data to create two case studies—one for a western landscape and the other for an eastern one—that show how the Esri model can be adapted with local data to create a custom GI plan. *Green Infrastructure* also illustrates how data from ArcGIS Living Atlas of the World can be included and used to customize maps. June/July 2019, 282 pp. E-book ISBN: 9781589484924 and paperback ISBN: 9781589484863.

Smarter Government: How to Govern for Results in the Information Age

By Martin O'Malley



What if health-care providers and public health officials could securely share all patient records and hospital admissions information? What if city officials knew where crime was happening in real time and could deploy more police officers there to prevent it? What if every parcel of land could be ranked for its ecological value to better protect critical natural lands and open spaces? That's all possible, and this is the new way to govern. The time has come for the rise of the tech-savvy executive: an individual who understands the need to elevate the use of technology within and throughout an organization, all to the same level, all at the same time. As mayor of Baltimore and then governor of Maryland, Martin O'Malley did that—and more. In *Smarter Government: How to Govern for Results in the Information Age*, O'Malley looks at how using GIS technology can provide real solutions to real problems while guiding readers through how to develop a data-focused management strategy that will profoundly change any organization. November 2019, 332 pp. E-book ISBN: 9781589485259 and paperback ISBN: 9781589485242.

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Software Developer—Cartography: Create an end-to-end cartographic desktop publishing experience in ArcGIS Pro that enables users to produce professional-quality mapping products.

Software Developer—3D Analysis: Use your experience in 2D and 3D programming to design and develop world-class software products that support urban planners, architects, engineers, and others who work with geographic information.

Mapping Product Engineer: As part of the mapping team within the core ArcGIS Desktop group, combine your cartography expertise with your programming skills to help build the next generation of mapping and symbology tools in ArcGIS.

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Product Manager—Field Operations Apps: Work with UI/UX designers and the development, engineering, sales, and marketing teams to build fieldwork products that Esri users love.

Product Manager—Spatial Analytics & Data Science: Shape the future of spatial data science as part of a team that's working to pioneer technology in big data, machine learning, and artificial intelligence (AI).

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Technical Writer—Focused Geospatial Systems: Are you a writer who's interested in GIS technology? Help Esri users be successful by creating documentation for ArcGIS products.

Product Engineer—Test Automation: Advocate for quality in Esri products by automating processes, expanding testing to web and mobile, and generating new performance testing ideas.

Solution Architect: Work closely with users to implement proven IT and GIS strategies for their platform architectures. Help evangelize GIS and develop strategic visions for critical clients.

Business Development

Business Development Manager—Production Mapping/Global Geospatial Authorities: Help Esri's government users harness advancements in production mapping systems and geoanalysis to build national geospatial infrastructures to support evidence-based policy making.

Sales Director—Nonprofit: Champion GIS and increase awareness of it as an essential enterprisewide solution for the nonprofit market.

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Presales and Solution Engineering

Solution Engineer—Partners and Startups: Proactively craft and propose solutions that clarify how GIS brings business value to Esri partners by addressing their critical business challenges.

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Enterprise Analyst: Can you solve any problem through research? Do you love helping others? Provide high-quality technical support and customer service to Esri users through effective communication and efficient troubleshooting.

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