ArcNews

Esri | Fall 2018 | Vol. 40, No. 4

Briefly Noted

Esri Geoenables World Bank Software
Esri has entered into a memorandum of understanding with the World Bank, whose mission is to reduce global poverty. Under the agreement, Esri software geoenables the World Bank's Survey Solutions software, allowing staff to improve the accuracy and speed of data collection, analysis, and decision-making that countries need to undertake to address development challenges.

Field-Sourced Data Available Instantly in Microsoft
Survey123 for ArcGIS is now offered as part of Microsoft Flow's connector community, a cloud-based service that makes it easier to automate common tasks and business processes across apps and services. "By becoming part of the connector community, valuable on-site information provided through Survey123 smart forms will be made instantaneously available for other connector apps and services like Box or Microsoft Outlook," said Jeff Peters, Esri's director of global business development.

Living Atlas Advancements
ArcGIS Living Atlas of the World has new capabilities that can help users gain a more complete and dynamic picture of the world. Earth Systems Monitor, a new app (currently in beta) powered by Living Atlas data, allows users to see historical, forecasting, and real-time data for depicting land, the oceans, and the human footprint. OpenStreetMap (OSM) is now available in ArcGIS Online as a vector basemap. And users can now access more than 80 versions of world imagery captured over the past five years with Wayback Imagery. For more information, visit go.esri.com/LivingAtlasUC2018.

ArcGIS Disconnected Apps Transform Hurricane Response in Puerto Rico

After Hurricane Maria roared through Puerto Rico on September 20, 2017, the island was in a state of total chaos. The category 4 storm destroyed the power grid, leaving all 3.4 million residents without electricity; decimated already-aged infrastructure, rendering many roads and bridges unusable; and devastated communication networks, cutting off Internet and cell service almost completely.

Disaster response and recovery efforts were going to be difficult. The unincorporated US territory, which declared bankruptcy that May, hadn't even recuperated from Hurricane Irma, a category 5 storm that grazed the island two weeks prior and left 80,000 people without power.

Within days of Maria, a number of federal and state agencies descended on Puerto Rico to help out. These included the Federal Emergency Management Agency (FEMA); the US Army Corps of Engineers; the Centers for Disease Control and Prevention (CDC); the US Department of Veterans Affairs; and scores of police officers, firefighters, and paramedics from New York, New Jersey, California, Arizona, and elsewhere. The Puerto Rico Planning Board was at the helm, with extensive support from the island's department of transportation, police department, and cadastre unit, along with several private companies and nonprofit organizations.

Once everyone in Puerto Rico was able to get out of their houses and make sure their families were safe—which took a few days—the central government set up an Emergency Operations Center (COE)

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↑ Hurricane Maria caused catastrophic damage all over Puerto Rico, making relief and recovery efforts very difficult.

What's Next for GIS and Our World?

Inspiring What's Next, the theme of this year's Esri User Conference (Esri UC), urged attendees to consider not only what's next in GIS technology but also to contemplate how they can use their expertise to address our world's challenges at many scales.

At the Plenary Session, Esri president Jack Dangermond began by asking the audience to ponder what's in store for the planet and, in turn, what that means for GIS professionals—specifically for their organizations, their communities, and their families. The planet is under pressure, he said, with increasing population, urbanization, climate change, and loss of biodiversity.

"The pace of change is accelerating rapidly…threatening our natural world and, some would say, threatening our future as human beings," he told attendees of the Esri UC, which drew 18,000 people to San Diego, California, for a week in July.

From Dangermond's perspective, all these issues require better understanding and a commitment by all of us to address these problems. GIS is central to this and to collaborating on solutions.

"It's about applying the power of digital geography to create a better future," Dangermond said. "This starts with envisioning what's possible and then looking at all the things that you are actually doing and accelerating them—improving efficiency, making cities smarter, protecting

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A Vision for Geographically Enabling Government

For his entire career in public service, Colorado governor John Hickenlooper has been following a passion for integrating geographic knowledge into government.

"I get a chance to meet with a lot of leaders around the world, and it's my experience that Governor Hickenlooper is one of those very special people who understands the power of geography and how to apply it," Esri president Jack Dangermond said at the Plenary Session of the 2018 Esri User Conference (Esri UC).

Dangermond presented Hickenlooper with Esri's Leadership in Government Award, which is reserved for geospatial pioneers at the local, state, and federal government levels who encourage the use of GIS not only for everyday operations but also for developing enduring innovations.

"He has a unique talent for leading, and he connects people using rational thinking and science-based approaches," Dangermond observed.

This is exactly how writer and journalist James Fallows characterized Hickenlooper when introducing him at the Esri UC's concurrent Senior Executive Summit, where Hickenlooper gave an engaging speech about how GIS has been instrumental in leading the State of Colorado out of some difficult circumstances and spearheading a number of remarkable accomplishments.

← Colorado Governor John Hickenlooper

"I think you can think of him as part of *[a]* movement that can save America," Fallows recounted to attendees. "For the foreseeable future, the national level of politics in the

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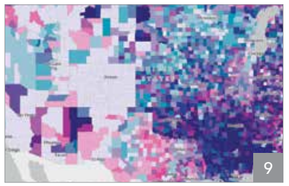
Millions of people around the world flee their homes each year due to persecution, poverty, conflicts, and natural disasters. Many cross international borders, but others remain in-country and become internally displaced persons (IDPs). The International Organization for Migration uses GIS to track and gain a better understanding of IDPs so they can receive the targeted help and services they need.



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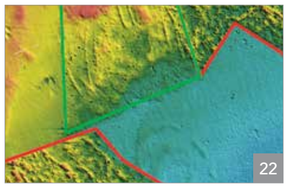

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Transforming the Process of Implementing Fiber Networks Across Ireland

Engineering Firm Applies ArcGIS to Accelerate Site Surveys and Planning

When telecommunications companies roll out new fiber communication networks, the success and long-term profitability of these ventures hinge in large part on the quality of data collected at the very outset. If the data is incomplete or out-of-date—it misses a new road or doesn't identify a piece of land as private, for example—unforeseen issues can emerge that increase costs during the building phase and may even impede the network's efficient operation for years to come.

The traditional approach to collecting the data that informs fiber network installation used to be highly manual. Surveyors brought printed maps, notepads, laptops, and cameras with them to conduct surveys in the field, which took about three days to complete. The surveyors would then spend approximately two days in the office transferring their findings to spreadsheets.

Engineering solutions company 4site, based in Limerick, Ireland, identified an opportunity to streamline this survey process not only to improve the accuracy of the data collected but also to shorten the time required to share it.

A Completely Paperless Process

After evaluating a number of possible GIS solutions for this, 4site selected the ArcGIS platform, including Collector for ArcGIS, as the foundation for creating a customized survey and app.

"The real power of ArcGIS is that you can adapt it," said Niall Looney, the operations director at 4site. "We were able to use products from the ArcGIS platform to develop a GIS-led survey workflow called 4Survey that we believe is the first of its kind in the fiber deployment industry."

Now, 4site's mobile teams use Collector for ArcGIS on smartphones and iPads to view, query, and gather data in the field pertaining to existing and planned fiber networks. Dubbed the 4Survey app, this allows them to complete audits guided by preset drop-down boxes, verify existing network features, take and upload images, validate network maps, and add new data points with attributes.

All the information collected in the field with this mobile app is then transferred digitally back to 4site's planners in the company's Fibre Centre of Excellence, located at its headquarters, in what is a completely paperless process. The planners can see survey data in ArcGIS Online as soon as it becomes available and start designing new networks instantly using ArcGIS Pro.

In the first six months following its introduction, 4Survey was used to provide survey, design, and planning services for the rollout of fiber to more than 100,000 homes and businesses in Ireland and the United Kingdom.

Delivering Fiber More Quickly and Cost Effectively

Using its ArcGIS technology-based survey app and workflow, 4site can now complete fiber network surveys for its clients in half the time it used to take.

The new workflow means that field-based surveyors are significantly more productive when they are out on a job, as they can perform all their required tasks using just one device. They also no longer have to return to the office to type up reports or manually link images to audits.

In addition, 4site's planners now receive complete, accurate survey data directly to their desktops. So as soon as the data is collected, they can carry out the planning and design phase for new fiber installations. It's a much quicker process than it used to be.

"4site has reduced its turnaround time for designing new fiber networks by around 25 percent," estimated Looney. "This means that we can help our clients to reduce their time to market and help them deliver next generation fiber networks to homes and businesses more quickly."

The improved accuracy of the survey data is expected to result in significant cost savings for 4site's clients during the build phase. Fewer unexpected issues will occur as a result of incorrect information, which will reduce the need for making last-minute design changes, coming up with expensive workarounds, and conducting repeat site visits.

"4site's clients could reduce their build costs by up to 20 percent, which, depending on the infrastructure profile, could result in savings of millions of euros," Looney explained.

A Boon for Business

With the higher-quality data now collected during the new 4Survey process, 4site can work with clients to design smarter fiber networks that will optimize future revenues and reduce ongoing maintenance costs. Thus, networks can now be planned to maximize the potential of clusters and ensure that the network extends to as many potential customers as possible.

"We can verify the areas that are seemingly unviable at an earlier stage and develop solutions to make them viable as part of the core fiber rollout," said Looney.

This means that 4site's telecommunications customers will likely experience improved profitability from their fiber investments. That will certainly be a boon for business.

↑ All data gathered in the field with 4Survey is transferred digitally to 4site's planners back at the office, where they can promptly complete the planning and design phase for fiber installation.

GIS Provides Targeted Assistance to Displaced Persons in Iraq

With the Technology, International Organizations Can Monitor and Profile Vulnerable Populations to Get Them the Help They Need

By Riju Stephen, Claudia Pereira, Mohammed Dizaeey, and Laura Nistri, International Organization for Migration

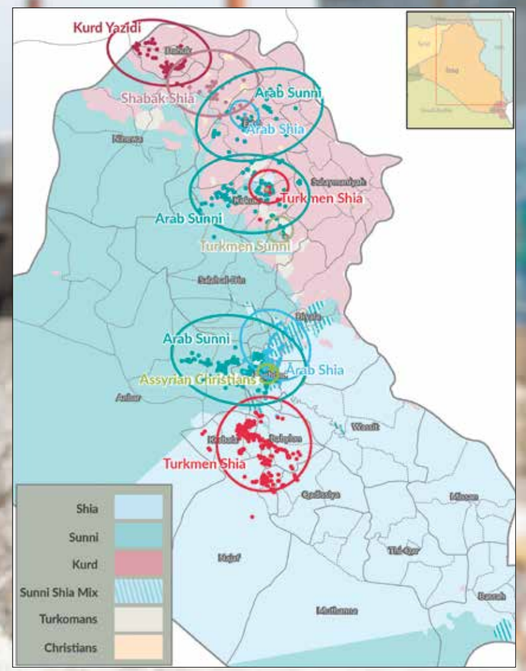
Persecution, poverty, conflicts, and natural disasters around the globe lead to the mass displacement of people in many countries. Some cross internationally recognized borders and acquire refugee status. Many others, however, remain in-country and become internally displaced persons, or IDPs.

In recent years, armed conflicts in Iraq, Syria, Yemen, South Sudan, and Bangladesh along with natural disasters in Haiti and Nepal have caused millions of people to flee their homes in search of safety. When the current crisis in the Middle East peaked in 2015, more than 1 million people fled to Europe due to armed conflict in their own countries. The United Nations High Commissioner for Refugees (UNHCR) estimates that there are 65 million people currently displaced—26 percent of whom are in the Middle East and North Africa.

The UN's International Organization for Migration (IOM) tracks, monitors, and reports on the movement of IDPs and migrants in countries such as Iraq, Yemen, Nigeria, Haiti, Mali, and Afghanistan. To keep track of their locations, conditions, access to services, and humanitarian needs, the organization uses an innovative information system called the Displacement Tracking Matrix (DTM), which has ArcGIS technology as one of the main components.

Devised in 2004 to track IDPs in Iraq, DTM, accessible at iraqdtm.iom.int, is a crucial visualization tool for IOM. It enables humanitarian workers to better target and prioritize all types of humanitarian assistance—from shelter, water, food security, and sanitation to health, protection, and access to other relief services—by pinpointing locations that have urgent needs.

For all DTM operations, IOM deploys field teams to strategic locations throughout a country to gather information. Barring access constraints, these teams collect data at every location where IDPs are present. Using mobile devices that employ different online platforms, such as Open Data Kit, fieldworkers collect both basic and standardized data and then transfer the data to a central Microsoft SQL Server database. From there, DTM's GIS team can visualize and analyze the data using ArcGIS Desktop and ArcGIS Online.



↑ To see if there is a connection between people's ethnicities and religions and where they choose to settle as IDPs, IOM did a hot spot analysis. As expected, there is a correlation. (DTM data from September 2015. Empirical Studies of Conflict Project data from 2012.)

A Surge of IDPs

The security situation in Iraq has been precarious for decades. But the emergence of the Islamic State militant group (also known as ISIS or ISIL) in 2013 marked a dramatic deterioration of stability in the country. Heightened armed conflict drove millions of people from their homes.

To deal with the surge of IDPs in Iraq over the last five years, IOM has strengthened its field operations and brought more technical experts on staff to enhance the DTM. Now, IOM has 125 field staff collecting data on how many IDPs and returnees there are across the country and where they are located.

Split up into rapid assessment and response teams, field staff talk to key informants, such as community leaders, local authorities, and security forces, twice a month to get baseline population data for each area, including the number of families living there, their GPS coordinates, and how they're living—in private homes, camps, religious buildings, hotels, or elsewhere. They also get supplementary data from government registration centers and partner agencies. Currently, IOM has about 9,500 key informants who regularly and systematically provide information for use in the DTM.

Once every three months, IOM's field staff also assess the locations that host IDPs and returnees. They look for any infrastructural damage, additional ethno-religious data, and information on IDPs' intentions—whether to return home, stay put, or emigrate to another country—to address issues such as safety, gender-based violence, employment, and education. This not only helps the organization gather more in-depth, multisectoral information on things like where people get their drinking water and food, how they access health care and education resources, and where their livelihoods come from, but it also further validates the numbers given by population data sources. For IOM updates all IDP and returnee records for Iraq monthly.

Where Populations Cluster

GIS is integral to the DTM. It helps improve the quality of the data, is key to analyzing it for operational use, and makes it easier for IOM to share information with its humanitarian partners.

Due to armed conflict, it is not always possible for IOM field staff to view and verify the locations of IDPs and returnees in person. So IOM uses online web mapping apps in a geoportal to let fieldworkers see where IDPs and returnees are situated and correct any erroneous locations.

Accessible via ArcGIS Online, this geoportal is a standards-based, open-source solution that gives organizations an enterprise-level view of the data they record. It allows users to catalog the locations and descriptions of any geospatial resources in a central repository and then publish that information to the Internet or an intranet. Visitors to the geoportal can then search those resources and use them for various projects, such as getting IDPs and returnees immediate aid for survival or planning out longer-term assistance, wherever they're located.

Staff at IOM also use ArcGIS Desktop to perform spatial analysis so they can prioritize and target certain humanitarian response efforts. For example, a spatial analysis of IDPs' different ethnicities and religions revealed key linkages between these traits and where IDPs choose to settle during their displacements.

In Iraq, the ethnic majority is Arab, and Shia Muslims constitute the dominant religion. Shia Arabs predominantly live in the central and southern parts of Iraq. Arab Sunni Muslims make up the second largest ethno-religious group, and they generally live in central and western Iraq. The country's north and northwestern regions are more diverse. Various ethno-religious groups live there, including Kurds (mostly Sunni and Yazidis); Turkomans (mostly Shia); and minority ethnic groups such as Chaldean, Assyrian, and Armenian (all Christians), as well as Shabak (mostly Shia).

To conduct this spatial analysis, IOM field staff had to first collect the necessary ethno-religious data all across the country. Once they had that, the GIS team used the Hot Spot Analysis tool in ArcGIS Desktop to calculate where features with high or low values are spatially clustered.

With this, IOM could clearly see that Arab and Turkmen Shias cluster in Shia-dominated areas in the north and south, while Sunnis, such as Arab Sunnis and Turkmen Sunnis, form hot spots in Kurdish and Arab Sunni areas. The largest Kurdish group, Kurd Yazidis, form a cluster in the Kurdish region itself, as do almost all Shabak Shia IDPs, who are ethnically Kurdish.

This analysis suggests that religion and ethnicity play a major role in the decision-making process when IDPs are figuring out where to go after being forced from their homes. It also reveals that a larger variety of ethno-religious IDP groups prefer Kurdish areas over other parts of the country, while Arab Sunni clusters are conspicuously absent in Arab Shia areas and vice versa.

A Spatial Decision-Making Support System

The geoportal server also allows IOM to rapidly share critical information with partner organizations. In Iraq, this has made the overall humanitarian response mission more efficient and effective.

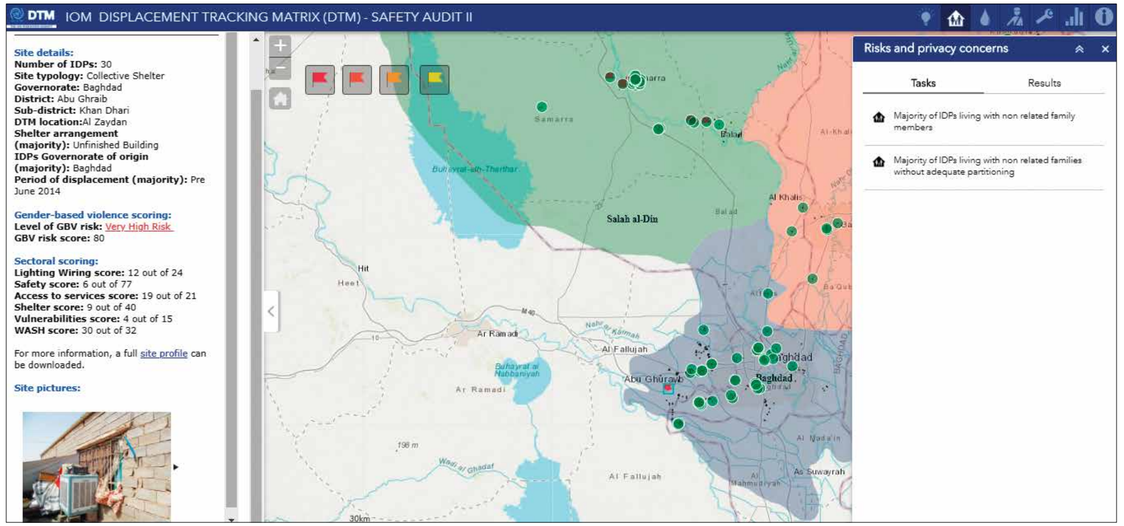
For instance, IOM did a safety audit that evaluated the risk of gender-based violence in certain locations based on infrastructure, security, women's participation in education and seeking gainful employment, and the availability of protection services. The GIS team used ArcGIS Desktop to highlight locations with reported safety issues alongside additional geographic information, such as road connectivity and district and state boundaries. Each area was further broken down into multisectoral indicators, including the number of people without jobs or basic needs like food and water. The team then used ArcGIS Online to present this data in a dashboard-like format—complete with site profiles and photos—and made it available for download on the DTM.

With the ability to visualize this data online via a dashboard, IOM and its partners essentially turned the portal into a spatial decision-making support system. It allows the organizations to zero in on the informal sites reporting the highest vulnerability scores and swiftly target risky areas.

Strengthening Future Humanitarian Responses

With armed conflict happening in so many places throughout the world and climate change affecting various populations, millions more people will likely be displaced in the future. The DTM, which IOM uses all over the globe, is becoming more established as an information management system that provides up-to-date data during ongoing crises and in emergency situations.

IOM continues to refine its data collection and analysis methodologies, adjusting them to new humanitarian needs and changing human mobility patterns. This will ensure that the DTM persists in providing innovative technical solutions to help people understand displacement and aid organizations in planning and implementing humanitarian responses.



↑ For a safety audit that evaluated the risk of gender-based violence in certain locations, the GIS team built a dashboard, available for download on the Displacement Tracking Matrix (DTM), that presents all the available data alongside site profiles and photos.

About the Authors

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ArcGIS Disconnected Apps Transform Hurricane Response in Puerto Rico

↑ Using a customized version of Explorer for ArcGIS, first responders were able to find what they were looking for in rural areas based on the kilometer markers on state roads.

Residents of Puerto Rico have no historic memory of facing a hurricane as bad as Maria. (Photo courtesy of Aurelio Castro.)

at the convention center in the capital city of San Juan. From there, all these organizations began coordinating efforts to restore the power grid, fix roads and bridges, get medical aid and disaster relief to residents, and assess the damage. But with all forms of digital and mobile communication down, they were going to need to get creative.

When staff from Geographic Mapping Technologies, Corp. (GMT), got to the COE, they saw that the organizations were working pretty independently of one another. Many agencies had brought GIS teams, so they were making their own maps and printing a lot of them out to take into the field. Additionally, everyone seemed to have separate maps of key locations: cell towers, gas stations, hospitals, and supermarkets. That wasn't going to get anything done quickly. So GMT, Esri's official distributor in Puerto Rico, stepped in.

With assistance from Esri's Disaster Response Program (DRP), staff from GMT not only integrated everyone's GIS resources into one place, but they also built innovative apps that field crews could use to collect and share data—even offline. This made the response go much faster than it would have otherwise.

"And that's so strange because, for us"—the residents of Puerto Rico—"it took forever," said Glenda Román, GMT's professional services manager.

Data All Over the Place

No one in Puerto Rico anticipated that the aftermath of Hurricane Maria would be as bad as it was.

"We didn't expect to be with everything one day and then nothing the next day," said Diego Llamas, the technical support manager for GMT. "Communications, the Internet, and all the facilities you have using your cell phone—those didn't work."

This was a huge problem for the organizations orchestrating the response.

"Their own apps worked in the field only if there was Internet or *[a]* mobile connection," said Alberto Millán, a GIS analyst for GMT. "When they got to Puerto Rico, they had problems because there was no service."

Scrambling to get their operations under way, the various GIS units started printing out maps—hundreds, maybe thousands of them. The GMT team noticed immediately that this was causing many agencies to duplicate efforts.

"Data was all over the place, and nobody was getting that data," recalled Román.

GMT's president, Aurelio (Tito) Castro, agreed with the planning board that everyone needed to start collaborating—quickly—and begin using the same dynamic data to get a robust response going.

↑ Because addressing in Puerto Rico's rural areas is tricky, Geographic Mapping Technologies, Corp. (GMT), built a composite locator based on data from various agencies and used building- and landowner names to geocode locations.

The Puerto Rico Planning Board already had an ArcGIS Online account, so Castro interfaced with the DRP team—which reached out to him the day after the hurricane to offer GMT any help it needed—to get extra licenses and credits.

"The first thing we did was set up as a hub through the ArcGIS Online account for the Puerto Rico Planning Board," said Román.

"Since that day, we started growing the users in the planning board's system, *[and everyone]* started putting information into the common platform," added Castro.

"We connected all these agencies through creating groups and sharing content," continued Román. "By doing that, we were able to provide one space where all these first responders could gather local data *[on]* roads, hospitals, gas stations, supermarkets, *[and]* criminal incidents."

They also started receiving a steady stream of documents and links from the DRP that contained data, images, and apps from people around the Esri community who were working to help Puerto Rico with the response.

"The *[DRP]* was very, very helpful in providing us with other data that we were not aware had been published by other groups, including services, aerial photographs, *[and]* information published by federal agencies," said Castro.

To continue getting the GIS support it needed, GMT was in constant communication with the DRP in the days and weeks following the hurricane.

"We had many conversations via text in the middle of the night just to get things up and running," said Brenda Martinez, the disaster response and public safety marketing specialist at Esri.

"It's very important that people around the world understand that Esri has this capability 24/7," said Castro. "I called these guys on Sundays, on Saturdays, at 9:00 p.m., at 1:00 a.m. They gave us the support."

A Special Locator and a Customized App

After deploying ArcGIS Online as a hub, the next issue was getting these agencies and organizations off paper maps and onto mobile apps so they could coordinate more seamlessly.

"All these people needed to move in the field, and that's why they were requesting paper maps," recalled Román.

But even with paper maps, rescue and recovery workers were having a hard time finding the addresses they were looking for. That's because addressing outside city centers in Puerto Rico is complicated.

"In urban areas, it would work just as in the US, with street names and numbers," said Román. "But once you get…in the rural areas, you won't have house numbers or even street names."

Even though all the agencies and organizations at the Emergency Operations Center (COE) coordinated their efforts with GIS, disaster recovery still moved slowly in Puerto Rico. (Photo courtesy of Aurelio Castro.)

Instead, the main thoroughfares are numbered state roads that have markers at each kilometer. From there, interior roads branch out like limbs on a tree.

"The closest you can get to a physical address is the kilometer. From that point onward, you have to use references and ask people how to get around," explained Román. "That's the biggest challenge that first responders faced—because how do you reach those areas if you don't have an address?"

The lack of Internet and mobile connectivity made this worse. But GMT staff had a solution in mind; it would just take a bit of rigging.

Esri had already worked with GMT to improve geocoding so it was more compatible with the needs in Puerto Rico's rural areas.

"We built a special locator for them where they could type in the distance—0.1 kilometers, 0.2 kilometers—along the road and find that location," said Jeff Rogers, the geocoding program manager at Esri. "We'd built this capability for them into online services, and they've been using that for years. But when the Internet went down, we needed to pull together a local, offline solution."

Several teams at Esri worked with GMT for about a week to build a custom search capability, along with a customized version of the Explorer for ArcGIS app, that would enable first responders to go out into rural areas with handheld devices to find and report on people who needed assistance and incidents that required attention—all without Internet or cell connectivity. This entailed building a composite locator based on all sorts of data from different agencies and using parcel data to build the geocoder by name.

"We didn't have addresses, but we did have the names of who owns the land. So we geocoded the names," explained Román. "Then, once you get to the kilometer, you can actually figure out how to move to *[a]* house by identifying the owner's name."

This proved indispensable to getting field crews out to their assignments so they could provide support and do inspections of damaged infrastructure and buildings.

"This was a good test for the disconnected functionality because there was actually no Internet, and it worked superbly," added Román.

Different Agencies, Different Needs

GMT's work didn't stop there. The team built six custom apps in total and collaborated with all the organizations at the COE to get them the GIS services and apps they needed.

"With different agencies, we had different jobs," recalled Llamas. "One of them asked for the geocoding. Other ones asked for surveys. Other ones wanted to collect information."

In addition to Explorer, the team employed Survey123 for ArcGIS, Collector for ArcGIS, Web AppBuilder for ArcGIS, and Operations Dashboard for ArcGIS to help each agency and organization get its work done more efficiently.

The US Army Corps of Engineers, for example, inspected a lot of infrastructure and provided direct aid to residents. Its team members employed the customized Explorer app heavily to figure out where to land helicopters in rural areas and determine how bad the damage was to houses and other structures.

The CDC benefited from having the four or five paper-based forms it was using entered into Survey123 so it could gather and disseminate health data digitally rather than running paper work back and forth across the island.

The GMT team also helped municipalities digitize their data collection efforts and workflows. Staff at the Caguas municipality, for example, wanted to track their progress with clearing roads of downed trees and garbage. They also wanted to update citizens on which roads and bridges were open for transit and which ones weren't.

"We made dashboards and web maps for them, and they used ArcGIS Pro," said Millán.

Once the team from GMT got going, most of the apps took just 10–45 minutes to build, while the more complicated ones required, at most, two or three days. Soon, about 90 percent of the organizations at the COE were using ArcGIS technology, according to Castro's estimate.

"We had to do more with fewer resources, and the ArcGIS platform was crucial to that," he reflected.

A Platform That Made the Difference

With all the agencies using GIS apps both in the field and back at the COE, local police sharing crime data almost constantly, the transportation agency updating people on road conditions every day, and everyone receiving additional data through the DRP—all in ArcGIS, and all without connectivity in the field—disaster response efforts picked up. But things still moved slowly.

"Typically, the response phase lasts a couple of days to a couple of weeks," said Jeff Baranyi, Esri's public safety assistance program operations manager. "For Puerto Rico, they were in response mode for several months. The whole country seemed to be relatively crippled. The magnitude of damage was quite vast."

↑ With help from Esri's Disaster Response Program (DRP), staff from GMT got about 90 percent of the organizations at the COE doing their GIS work in the ArcGIS platform. (Photo courtesy of Aurelio Castro.)

It took the Puerto Rico Electric Power Authority 11 months to report complete power restoration. Washed out roads and bridges are still being repaired. And a study from George Washington University's Milken Institute School of Public Health estimated that in the six months after Hurricane Maria struck, anywhere from 2,658 to 3,290 excess deaths occurred due to the extended relief and recovery process.

"The hurricane was way beyond any historic memory there is here in Puerto Rico," said Román. "But using the ArcGIS platform was a way of bringing together all the agencies, of sharing data on Puerto Rico, *[and]* of helping organize the response efforts and then the recovery efforts. Everything could be easily deployed, and so fast—no programming needed. And I think that really made a difference. Without that, the response would have been slower than what it actually was."

For more information on Esri's Disaster Response Program, visit **esri.com/disaster**.

Maryland's Department of Transportation Moves Forward with Design-Driven Maps

Anyone who travels around the state of Maryland—whether by car, boat, bus, train, plane, bike, or even foot—relies on the Maryland Department of Transportation (MDOT). With that in mind, MDOT works to deliver safe, sustainable, and smart transportation solutions for its more than 6 million residents and 42 million visitors each year.

Recently, MDOT's statewide headquarters—which coordinates five business units including highway, transit, port, aviation, and motor vehicles, along with an authority for tolls and bridges—was looking for a way to incorporate visually engaging, detailed maps into transportation plans, presentations, press releases, and capital programming. The planning team needed its maps to be clean and appealing to help public officials, government agencies, businesses, and citizens better understand proposed or implemented plans.

"As a planner, I create many static maps," said Andrew Bernish, a transportation planner and GIS analyst with the KFH Group, which contracts with MDOT for transit planning. "These maps carry more gravitas if they are well designed."

But while urban transportation planners are often well versed in GIS, they tend to be less experienced in design. That is why Esri developed ArcGIS Maps for Adobe Creative Cloud, which empowers GIS users and creative professionals to work with and design data-driven maps inside Adobe Illustrator CC and Photoshop CC.

Using Familiar Tools

Bernish and his fellow MDOT planners were already using ArcGIS Desktop to manage and gather data, as well as ArcGIS Online for its selection of basemaps and other content, including the public data it gets through the state's MD iMAP Portal (accessible at data.imap.maryland.gov). So Bernish, who was moderately familiar with some Adobe apps, decided to try ArcGIS Maps for Adobe Creative Cloud to really make his maps pop.

"My maps have been referenced more often when I have emphasized design in their execution," he reflected.

Previously when Bernish wanted to make a specifically designed map, he had to open shapefiles in ArcGIS Desktop and export the corresponding geography to Illustrator. He then had to release the clipping masks, ungroup the layers, and go through several more stages to even begin to work with the data.

But with ArcGIS Maps for Adobe Creative Cloud, users no longer have to load geospatial data into the ArcGIS platform only to export it to Adobe. Now, they can add ArcGIS content and local data to a map within Illustrator or Photoshop and then edit the map so it conforms to an organization's own design and branding.

Getting the hang of these processes did require a bit of acclimation, but Bernish watched a series of instructional videos from Esri (available at p.ctx.ly/r/8cee) to learn all he could about the new solution. Then he jumped right in by adding his own data and shapefiles directly into Illustrator.

"Like most things, it takes some practice to get used to the new toolsets," he said, "but it can make your workflow more efficient."

One of the maps Bernish created using ArcGIS Maps for Adobe Creative Cloud shows all the metropolitan planning organizations (MPOs) and urbanized areas in and around Maryland. MPOs help implement transportation planning in localities that have more than 50,000 people living in them, so a map like this is valuable when evaluating grants, programs, and funding.

"This map utilizes several different pattern fills (dots and parallel lines), transparency, and shadowing," Bernish explained. "For instance, the map needed to identify, but differentiate, the geographic areas of MPOs where they fall outside Maryland's state boundary. By using the same color for the MPO throughout, the map can subtly differentiate the portions present in and out of Maryland by displaying a different fill pattern, or swatch. In addition to the MPO boundaries, state borders, county borders, and major roadways, the map needed to depict urbanized areas in order to show what areas the MPOs serve. This required yet another distinct swatch layered in the same geographic area."

Although it is technically possible to make styles like these using only ArcGIS Pro or ArcMap, it is more efficient to create the layering and intricacies of these visual elements using Adobe Creative Cloud, according to Bernish.

The finished map depicts information for local, state, and federal agencies in rich detail. It is now used across several agencies in the state and has also been promoted as a featured printed map on the MD iMAP Portal.

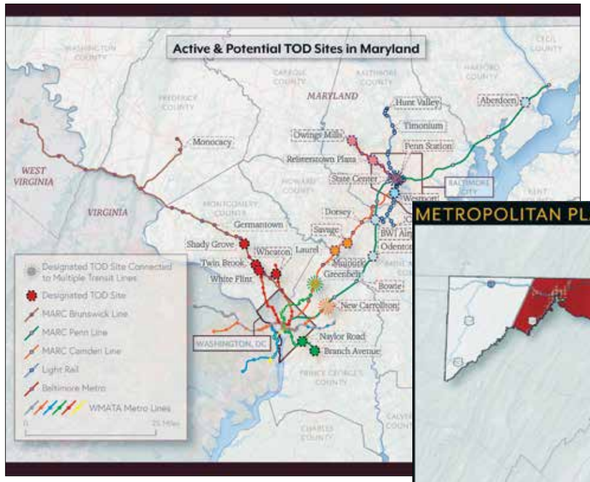
Greater Creative Control

By using ArcGIS technology and Adobe Creative Cloud together, Bernish helped MDOT achieve its goal of producing maps with a design aesthetic intended to better engage with the public.

"There is often a difference between *[the]* design quality provided by public agencies and private firms, but there does not need to be," Bernish said. "Public agencies are taking design into account more often. The public should have direct access to maps with higher design considerations."

The integration of ArcGIS software with Adobe Creative Cloud apps offers MDOT the benefit of having greater creative control while using familiar tools. Employing ArcGIS Maps for Adobe Creative Cloud allowed Bernish to eliminate the sometimes tedious work of transferring detailed GIS data to Adobe. Now, he directly imports shapefiles and pulls content straight from ArcGIS Online into Illustrator CC and Photoshop CC.

"Our agency is quite pleased with the design aesthetics in the maps, and we have received positive feedback," he said. The process of transferring substantial amounts of data into geospatial visual depictions has also become more efficient and enjoyable."



↑ Other maps built for MDOT with ArcGIS Maps for Adobe Creative Cloud include one that shows active and potential transit-oriented development sites, bikeway project awards in each region of Maryland, and geospatial participant data for a survey regarding the upcoming state transportation plan.

→ This map of all the metropolitan planning organizations (MPOs) and urbanized areas in and around Maryland used several different pattern fills, in addition to transparency and shadowing.

WHAT'S NEW IN ArcGIS Online

Esri's ArcGIS Online team is constantly striving to make this collaborative, cloud-based platform more powerful and easier to use.

Find out more about some of the most significant capabilities and resources released over the past few months, including easier ways to find content, creative learning and teaching aids, a new Relationship mapping style, and updated tools for administering organizational accounts.

Authoritative Content

ArcGIS Online contains a rich collection of publicly available geospatial content thanks in large part to the millions of items published and shared by users. Many of these users—from state and local governments to the US Forest Service and the National Oceanic and Atmospheric Administration (NOAA)—provide the most authoritative content for their communities.

To make this kind of authoritative content easier to find, publishers and administrators of verified organizational accounts can add an authoritative badge to the content they upload to ArcGIS Online. Then, when users go looking for publicly shared content, they can select the Authoritative filter to pare down their search results so they only show content that is marked as authoritative.

↑ Publishers and administrators of verified organizational accounts can add an authoritative badge to the content they upload to ArcGIS Online.

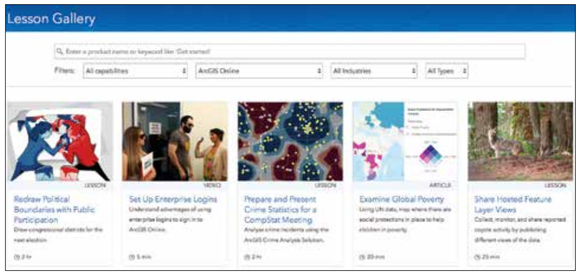
Resources for Learning and Teaching GIS

Esri has released a slew of new resources for learning and teaching ArcGIS Online.

For anyone who wants to experience what is possible with ArcGIS Online, Esri creates learn paths (go.esri.com/LearnPath), curated collections of hands-on resources that help users get more familiar with particular ArcGIS solutions and workflows. There are learn paths for people new to ArcGIS Online, as well as for users who are looking to hone skills like visualization and data analysis.

The Mapping and Visualization learn path, for instance, teaches users how to create maps and make their data visually stunning. The first lesson in this path, which is all about getting started with ArcGIS Online, takes participants step by step through how to produce and share an evacuation map in preparation for an incoming hurricane. In the next lesson, users access ArcGIS Living Atlas of the World to build an earthquake map. The third lesson teaches users how to find predominant patterns in their data by applying smart mapping techniques.

For those who teach with GIS, Esri also has a new implementation guide for teachers, schools, and districts called Teach with GIS (go.esri.com/TeachWithGIS). It contains step-by-step information to help bring mapping and analysis into all classrooms. And the curriculum builder provides a bank of lessons for an assortment of student experience levels and subjects, from mapping population change to teaching world time zones in 3D. The capabilities covered in Teach with GIS include data collection and management, mapping and visualization, sharing and collaborating, real-time GIS, 3D, imagery and remote sensing, and spatial analytics.



↑ Learn paths are curated collections of hands-on resources that help users get more acquainted with certain ArcGIS solutions and workflows.

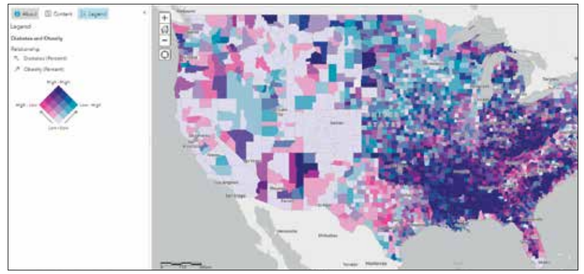
Multivariate Mapping: A New Way to Visualize Relationships

The new Relationship mapping style lets ArcGIS Online users more easily explore possible relationships between two attributes. By employing a mapping technique called bivariate choropleth mapping, this style combines two color ramps into a grid-like legend that shows all pattern combinations across a map.

Say a user has two data patterns, one for diabetes and one for obesity, and she wants to find out if they converge geographically. Looking at the maps individually, she can see that the patterns are similar. But using the Relationship mapping style lets her clearly locate where diabetes and obesity are both high, both low, or occur strongly on their own.

Or how about another user who's wondering if there is a relationship between atmospheric pressure and wind speed during the life-span of a hurricane? The two color ramps—again, one ramp for each attribute—create a spectrum of colors that show where the patterns are high and low both independently and together. The user can now easily see that hurricanes are strongest when they have low pressure and high wind speed.

Of course, it has always been possible to use this mapping technique in ArcGIS Online. However, it used to require more time and customization, and it wasn't really something a beginner could do. Now, the new Relationship mapping style simplifies the process of being able to see these types of connections. All users need to do is select the two topics they want to compare and then choose this mapping style.

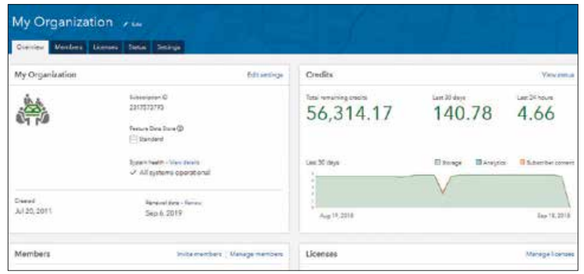


↑ With the Relationship mapping style, users can locate on a map where two attributes, such as diabetes and obesity, are both high, both low, or occur strongly on their own.

Administering ArcGIS Online Organizational Accounts

The My Organization page has been redesigned, making it easier for administrators to manage members, access account information, and generally oversee an ArcGIS Online organizational account.

With the new Overview tab, which appears immediately upon logging in, administrators have quick access to key information—displayed on cards—including a look at system health, a summary of credits and membership, and which licenses the organization is using. The updated Members tab includes additional search and filter functionality so administrators can search by name or user name and filter based on user level or role. This tab also lets administrators look over the details about each user's credit allocation, who's assigned which licenses, and which groups members are part of.



↑ The redesigned My Organization page makes it easier for administrators to manage members, access account information, and generally oversee an ArcGIS Online organizational account.

To learn more about the summer 2018 update to ArcGIS Online, visit **go.esri.com/summer**.

continued from cover

What's Next for GIS and Our World?

biodiversity, and integrating environmental thinking into virtually everything we do."

More than a dozen people took the stage at the Plenary Session to illustrate how their organizations use geospatial technology to design better cities, operate more efficiently and sustainably, protect precious ecosystems, and train tomorrow's resource-conscious workforce. They are truly enriching what's next.

Inspiring Collaborative Urban Design

Like many cities, Boston, Massachusetts, is experiencing a population boom accompanied by massive development.

"Population growth is occurring between our historic downtown Boston and *[the neighborhood of]* Dorchester at an average of 80 large development projects a year," said Carolyn Bennett, the geospatial data manager for Boston Planning & Development Agency (BPDA). "Growth at this scale requires thoughtful planning."

Which is what the BPDA does, helping Boston develop intelligently so it retains its renowned charm while heeding the future. To this end, the organization worked with Esri to design ArcGIS Urban, a new solution that streamlines urban planning and development workflows to keep planners, architects, developers, and citizens on the same page.

Esri account executive Brooks Patrick led the audience through a demonstration, revealing how ArcGIS Urban can affect—and has actually helped revise plans for—Boston's ever-changing urban landscape.

"Zoning determines what you can build and what you can't on a piece of property," explained Patrick. "ArcGIS Urban can be calibrated to the local zoning code and can apply it in scenario planning."

Zooming in to a proposed development on Boston's Dorchester Avenue (or Dot Ave., in local parlance), Patrick first showed what the new development might look like if no changes were made to current zoning. He then altered parts of the zoning code and conceived of another plan with different building height and use requirements, balancing out a largely residential area with a bit more office space.

"We can immediately see how these changes would impact our view corridor down Dot Avenue, towards our historic downtown," Patrick said. "In addition to measuring the amount of building construction, we can also estimate growth capacity for key indicators, such as total population, the number of households, and jobs."

Patrick and Bennett then showed how ArcGIS Urban helped planners visualize a proposed building amid its surroundings—and even prompted developers to reduce its height, since it would have cast too hefty a shadow on the Boston Common and interfered with flight path restrictions around Boston Logan International Airport.

"We now have a standard process to evaluate projects and plans moving forward," said Bennett about ArcGIS Urban. "This collaborative platform ensures a more economically prosperous, resilient, and vibrant city for generations."

Inspiring Collaborative Government

Cobb County, Georgia, employs an extensive enterprise GIS to make its region more prosperous, resilient, and vibrant. Still, its information services department aspired to do more.

"We wanted to build on what we already had and make GIS easy enough and visible enough that anyone could use it to solve their problems—even a non-GIS professional," said Sharon Stanley, director of information services for Cobb County.

Once staff got the attention of county executives—with a distillery tour, no less, built as an Esri story map—the use of GIS began to spread swiftly.

Felicia Alingu, the outcomes program specialist for Cobb Senior Services, had never used the technology before. But she took the Insights for ArcGIS training class offered by the GIS department and immediately recognized how it could be useful.

"Cobb Senior Services has five multipurpose senior centers, and it's my job to help others understand our impact on Cobb's older adults," explained Alingu.

With Insights for ArcGIS, Alingu can easily communicate how valuable the centers and their programs are to the thousands of seniors who visit them each year. Dragging client data onto a map, she can see where the seniors live, which centers they go to and how often, and which activities are the most popular (bingo, of course).

"By 2030, one in three Cobb residents will be aged 55 or better, and the older adult population will be more diverse than ever," she said. "Collaboration with the GIS department helps us find underrepresented groups so that we can work harder to engage all of the county's older adults."

Engaging Cobb County's commuters is a big focus for Lynn Biggs, the GIS manager for the Department of Transportation (DOT). She showed the audience Cobb Commute, a GIS-based mobile app that provides users with road status information so they can see, in real time, whether any accidents or road construction projects will affect their travel.

The DOT also uses GIS to look for ways to improve roads. Reviewing three years of accident data for cars that hit large objects, such as utility poles, Biggs showed how the DOT used a geoprocessing tool to confirm that hills and curves are a major factor in these types of crashes.

"We can now actively look for roadway improvement projects to specifically address fixed-object crashes," concluded Biggs.

Being proactive is one reason Cobb County built a digital twin of an area in its jurisdiction that is undergoing significant development: SunTrust Park—the new home of the Atlanta Braves baseball team—and its adjacent business center, the Battery Atlanta.

Working with an array of Esri partners to get lidar data and other imagery, Cobb County used ArcGIS Pro to construct the digital twin. Now, multiple divisions can use it to see, measure, and analyze details both inside and outside the 41,500-seat stadium.

The police department, for example, used the digital twin to come up with a comprehensive traffic management plan that gets all fans parked before the first pitch and returns traffic to normal flow within 45 minutes of a game ending.

"*[It's]* a plan so detailed that the placement of every cone… is completely laid out," said Lieutenant J.D. Lorens, the special events commander for the Cobb County Police Department.

At the end of each game, Lorens monitors the flow of pedestrians exiting the stadium by using a dashboard that shows maps, charts, and live security camera footage. With all this information readily available, he knows exactly when to change the traffic lights to red in a particular intersection to minimize pedestrian pileups and vehicle queues.

"We successfully manage traffic at the interchange between two of the busiest interstate corridors in the entire southeast," said Lorens. "As a police officer, I never imagined that the platform our GIS professionals utilized would also make me and my team achieve a higher level of success."

Inspiring Precision Forestry

One company using digital geography to achieve higher levels of sustainability is J.D. Irving, Limited (JDI). Headquartered in Canada, its operations include hydro energy, shipbuilding, agriculture, and retail, but its roots are in forestry.

The family-owned company manages 6 million acres in Canada and the United States, with a substantial portion of that land dedicated to producing forest products such as lumber, paper, and toilet tissue. To manage its land records efficiently, JDI started using GIS in 1984. Now the company employs the technology as a digital platform for business intelligence, using a hyperaccurate lidar scan of its forest to propel smarter decision-making.

"Over the last few years, we've been investing in precision forestry," said chief forester Jason Killam. "For us, *[this]* means taking that lidar scan of the forest and transforming the inner workings of our supply chain processes"—tracing JDI's merchandise from seedling to final product.

Using ArcGIS Pro, Killam showed in 3D how the company gains insight into the land and its health.

"We realized early on we needed a novel way to really organize this…big spatial data," he said. "We did this using modeling, random forest algorithms, and the statistical package R to organize our data on 20-meter grid cells, all totaling 200 million grids."

JDI has a precise inventory of its land that shows tree volume, the percentage of live crown on the trees, and even how deep the subsurface water table is. Now, the company can use location intelligence to automate how foresters make complex decisions, such as when to harvest certain trees and where. JDI can employ GIS to prioritize forest areas that need commercial thinning (removing any lands set aside for conservation) and can easily find the volumes of logs, stud wood, and pulpwood that are ready to harvest and deliver to the mills.

Heather Morrison, GIS lead for JDI, said that foresters can also take this data into the field on tablets using Explorer for ArcGIS.

"They are excited to have all our data at their fingertips—even in remote locations without cell coverage and…Wi-Fi," she said.

This allows JDI to ground truth areas that are planned for commercial thinning, which helps trees continue to grow healthily.

"For instance, if I am in the field and see a bird's nest that we want to protect, I can note it so the plan can be modified," said Morrison.

Later this year, JDI will plant its 1 billionth tree. To commemorate that, Morrison and Killam presented a spruce seedling to Dangermond, who was impressed by how the company has embraced digital transformation.

"They are just an incredible company…integrating environmental thinking into everything *[they]* do," he said.

Inspiring the Trillion Tree Campaign

While JDI is close to planting its billionth tree, the Plant-for-the-Planet initiative, with support from the United Nations Environment Programme, has planted more than 15 billion trees worldwide. The organization recently launched the Trillion Tree Campaign, which aims to plant 1 trillion additional trees.

As part of that campaign, Plant-for-the-Planet acquired 55,598 acres on the Yucatán Peninsula in Mexico and hired 100 employees who plant about 6,000 trees per day. This tree planting program is supported by companies that want to be carbon neutral, said Felix Finkbeiner, founder and chairperson of the Plant-for-the-Planet initiative, who spoke at the Plenary Session.

The Yucatán project has been a resounding success largely because it follows best tree-planting practices and heeds the scientific advice of global system ecologist Tom Crowther, an assistant professor at ETH Zürich and head of the Crowther Lab there.

Crowther studies the science of where trees should be planted for restoration projects, as well as which species should be planted and in what types of soil. This is partly why Plant-for-the-Planet's trees have a 94 percent survival rate after the first year, compared to 22 percent for similar projects.

Crowther's research revolves around climate change and its impact on biodiversity, which includes the loss of trees and animals and the regulatory systems that manage the planet.

The best current plan to reduce global warming, according to Crowther, involves managing human emissions, since those account for 9 to 10 gigatons of carbon per year in industrialized parts of the world. But ecosystems like forests can help too.

"They're the lungs that draw down carbon from the atmosphere, and they store it in the soil," said Crowther.

Improving the carbon sequestration capacity of forests needs to be done carefully, however, because it can be damaging when trees are restored in the wrong ecosystem or planted in the wrong soil.

"When *[the trees]* fall and die, those soils get degraded, and nutrients are lost," Crowther said.

To find out more about the ecological consequences of planting trees around the world, the Crowther Lab is mapping tree size, tree density, and the species identities of various forests. Crowther and his team are also cataloging the world's soils to try to identify the ones that can best support new trees.

"If we manage these ecosystems effectively, there's room for an additional 1.2 trillion trees," said Crowther.

And that is where Finkbeiner's Trillion Tree Campaign comes in. (Read "Rooting for Our Planet" on page 12.) The two believe that having 1 trillion more trees on earth could capture up to 150 gigatons of carbon. So Finkbeiner, who is just 20 years old, is getting started—with a bit of help from Esri.

Onstage, Dangermond announced that Esri would contribute to planting 60,000 trees in the Trillion Tree Campaign, offsetting everyone's travel to San Diego and making the 2018 Esri UC carbon neutral.

"Fantastic!" exclaimed Finkbeiner.

Inspiring a New Geospatial Workforce

Planning sustainable communities, running governments and businesses efficiently, and restoring forests all depend greatly on a well-trained workforce. Today, that means people who are knowledgeable about GIS, remote sensing, geodesign, and spatial computing.

The U-Spatial program at the University of Minnesota is a leader in training students, faculty, researchers, and staff in geospatial technologies.

"Nearly every discipline uses ArcGIS to enhance the three-pronged mission of higher education—teaching, research, and outreach," said Len Kne, associate director of U-Spatial. "Each year, 1,000 *[students at the University of Minnesota]* are enrolled in ArcGIS courses. And more than 6,300 students, faculty, and staff have named user accounts in ArcGIS Online."

Kne joined some U-Spatial students and faculty in demonstrating how geospatial technology gives them an edge. He first showed how the university uses enterprise GIS to "manage a city within a city"—conducting sidewalk inspections, for example, and giving that mapped information to campus facilities.

Students then demonstrated their own projects. Coleman Shepard, a master of geographic information science student, showed the audience how he employed Sentinel-2 imagery from ArcGIS Living Atlas of the World, along with ArcGIS Pro, Jupyter Notebook, and Python, to study clusters of earthquakes near the erupting Kilauea volcano in Hawaii.

"Observing these clusters over time, we are able to clearly see that…earthquakes near the caldera are continuing to increase," Shepard said. "By extracting publicly available data on geodetic stations, I was able to measure the displacement of land over time."

Using Jupyter Notebook, Shepard also calculated that the North Pit GPS station, which monitored data for the United States Geological Survey at the volcano's rim, had dropped more than 65 feet.

"This is huge and is representative of the eventual collapse of the crater of Kilauea," Shepard said.

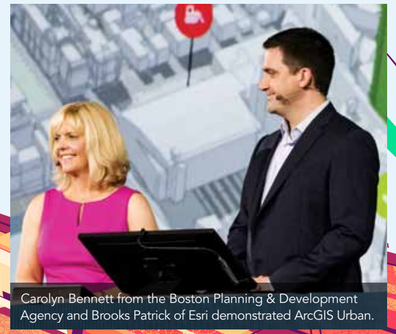
Professor Thomas Fisher, director of the university's Minnesota Design Center, talked about how he sees these students as part of a new workforce that is increasingly nomadic and more of a sharing economy.

"Mobile devices, spatial tools, *[and]* digital apps are allowing us to live more lightly on the planet—to access what we need without having to own it and to pay for only what we use," he said, citing companies such as Airbnb, Uber, and TaskRabbit as examples of this fast-growing economy.

Companies like those, Fisher said, are "squeezing out the inefficiencies of the twentieth century," when too many goods were produced and too many resources were consumed. He anticipates that the sharing economy will free up land and resources to help people live more sustainably—but only if they are spatially informed.

"Spatial thinking is absolutely central to this new economy, helping us access goods and services and…identify underutilized assets that can be used to form community-sharing services that build local economies and expand the capacity of local governments," Fisher said.

He then issued a call to action to the audience. "Every boardroom, every council chamber, every corner office," he said, "needs the skills of spatial analysts and geodesigners to map the opportunities that exist and to make these unseen connections that will help our communities thrive."

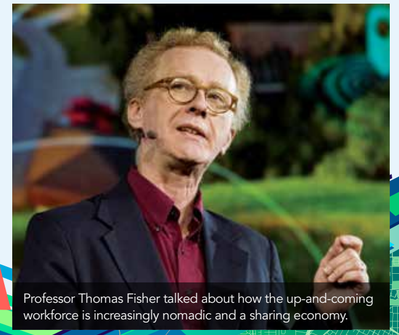


Carolyn Bennett from the Boston Planning & Development Agency and Brooks Patrick of Esri demonstrated ArcGIS Urban.

Felicia Alingu, the outcomes program specialist for Cobb Senior Services, had never used GIS but now finds it helpful.

Jason Killam, chief forester for J.D. Irving, Limited, showed the audience how the company uses GIS for precision forestry.

Global system ecologist Tom Crowther studies the science of where trees should be planted.



Professor Thomas Fisher talked about how the up-and-coming workforce is increasingly nomadic and a sharing economy.

U-Spatial master's student Coleman Shepard (right) used GIS to study clusters of earthquakes near Hawaii's Kilauea volcano.

Rooting for Our Planet

Felix Finkbeiner Sees the Forest and the Trees: 4.2 Trillion of Them

Felix Finkbeiner is out to save the world, one tree at a time.

At age 9, Finkbeiner famously launched Plant-for-the-Planet, which initially aimed to plant 1 million trees in every country in the world. While that seemed like a tall order for the boy and a group of his classmates in Germany, the idea took root, and they rallied youth and adults behind this effort to plant trees to reduce the harmful effects of high carbon dioxide (CO_2) levels in the atmosphere.

At age 20, Finkbeiner was standing onstage at the Plenary Session of the 2018 Esri User Conference (Esri UC) in July with a new message: Help plant or donate toward planting 1 trillion more trees using a new app that the Plant-for-the-Planet launched that day.

"If you want to help us do this, it is very easy," he said. "You take out your phone, you go to trilliontreecampaign.org…and then pledge how many trees you want to plant."

Finkbeiner has been wildly successful leading the Billion Tree Campaign. With support from the United Nations Environment Programme (UNEP), he has recruited thousands of young people and business, government, and environmental leaders to the cause. They've stepped up in a big way—with shovels or donations in hand—to plant close to 15.3 billion trees since 2007.

But Finkbeiner, who was raised in a small town in Bavaria, was never one to think small. The UNEP's goal of planting 1 billion trees has long been surpassed. So in 2013, he asked Thomas Crowther from the Crowther Lab at ETH Zürich—a top science, technology, engineering, and mathematics (STEM) university in Europe—to research how many trees there were on the earth and how many more the planet could sustain.

"*[Crowther]* came back to us *[three years later]* with two important answers," Finkbeiner said. "The first one was that 3 trillion trees already exist. And the second one is that we can restore another 1 trillion trees."

The earth, it turned out, can maintain 4.2 trillion trees. "So we knew what the next step had to be," Finkbeiner said. "We had to transform the Billion Tree Campaign into the Trillion Tree Campaign."

What better way to get youth and many adults, who are highly attached to their smartphones, interested in planting trees than to roll out a Trillion Tree Campaign app with a map that tracks where people or organizations plant their trees? And what better place to launch the app than the Esri UC Plenary Session, with its environmentally conscious audience?

Finkbeiner said the Plant-for-the-Planet initiative, which acquired 55,598 acres on the Yucatán Peninsula in Mexico, hopes to plant 100 million trees there by 2030.

"But to reach our goal of *[planting]* a trillion trees, we need to do much more," he told the crowd. "We need to get millions of people all across the world to help us in planting trees. But how? What we need to do is make it as easy and as fun as possible for anyone to get engaged and plant trees. To do that, we built an app."

This companion app is an integral part of the Trillion Tree Campaign, giving anyone in the world with Internet access the ability to register, document, and map each tree they plant, as well as view where others are planting trees.

Finkbeiner demonstrated how to use the custom web app, built by his organization's team of developers with assistance from Esri using ArcGIS API 4.x for JavaScript. (Plant-for-the-Planet also plans to release mobile apps for Android and iOS devices.)

After signing in at trilliontreecampaign.org and clicking on Explore on the menu on the left, users see an embedded ArcGIS Online map that employs the *World Light Gray Base* map.

Users can mark a check box above the map to see various layers: where trees have been planted worldwide, who planted them, and how many they planted; where current forests exist; and areas where forests can be restored. According to a leaderboard in the app, most of the trees have been planted in China, India, Ethiopia, Pakistan, and Mexico.

Finkbeiner also showed the audience how to use the app to create a personal profile and sign up to plant trees. People can set a target number of trees to plant, register a planted tree, then document and map it.

"I can register the trees I've planted, *[listing]* the exact species, the exact location, and if I want to, I can also add pictures of my tree and measurements," Finkbeiner said.

The app allows people to donate money to a tree planting project as well.

"And for each project, you can see where they plant," Finkbeiner said. "You can see pictures and videos of the project and the survival rates of the trees planted and the cost per tree."

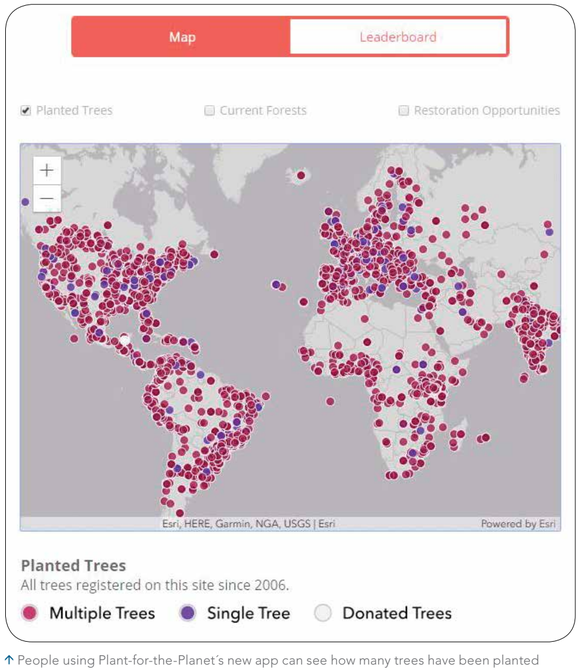
Finkbeiner encouraged the audience to pull out their phones and sign up.

"I'm really excited to see how many trees we can plant together," he said.

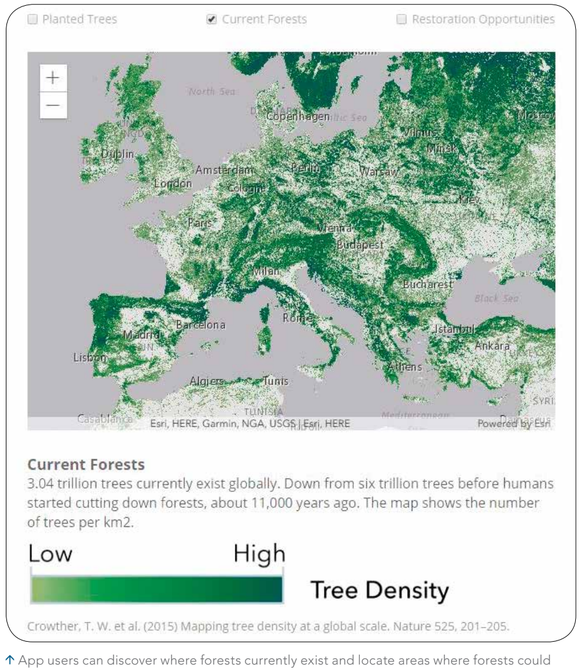
Influenced by Wangari Maathai

How did a young boy get so enamored of tree planting that he grew up to become an influential voice in the environmental movement, speaking, for example, to the UN General Assembly?

The journey began in 2007 when Finkbeiner's fourth-grade teacher had him give a presentation on climate change. At that age, Finkbeiner worried about saving polar bears from global warming.

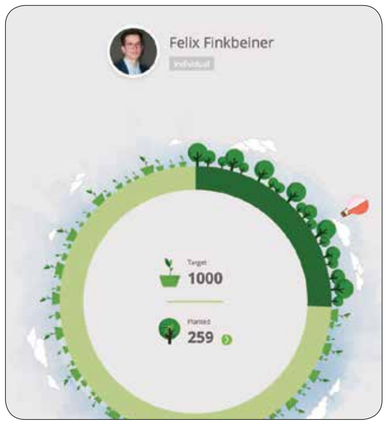


↑ People using Plant-for-the-Planet's new app can see how many trees have been planted around the world.

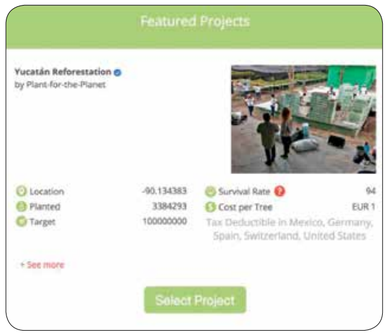


↑ App users can discover where forests currently exist and locate areas where forests could be regenerated.

↑ At the Plenary Session of the 2018 Esri UC, Felix Finkbeiner unveiled a new app, trilliontreecampaign.org, that Plant-for-the-Planet wants people to use to help the organization reach its goal of planting 1 trillion more trees in the world.



↑ Finkbeiner showed the audience how to create a personal profile in the app and then sign up to plant trees.



↑ The app allows users to donate money to a tree planting project, and then they can see metrics, including where the trees get planted and what the survival rate is.

"When I was five years old, I got this huge polar bear *[stuffed animal]* as a gift from my aunt. *[The toy]* was bigger than I was at the time," he recalled. "It was my favorite animal. I found out that the polar bear was in danger, so I really wanted to save the polar bear. That was my motivation back then."

Finkbeiner also read about Nobel Peace Prize winner and environmental activist Wangari Maathai, the founder of the Green Belt Movement, a well-known tree planting campaign that started in the 1970s. The goal of her campaign was to plant 30 million trees to counter deforestation, mainly in Africa, and give women, who did most of the tree planting, an income. Maathai died in 2011.

"Back then, I didn't understand the real depth of what she did," Finkbeiner reflected during an interview at the Esri UC. "I just understood she was planting trees, and *[that]* it was one of the best and easier things we can do in terms of fighting the climate crisis. But as I became older and the more I learned about her, *[I realized]* that's not even the tip of the iceberg. How she used tree planting for women's empowerment was absolutely fantastic, *[and]* how she was able to combine environmental with social progress was great."

Ironically, the same year Finkbeiner gave his talk in school, Maathai gave a powerful keynote about tree planting, poverty, women's entrepreneurship, and environmental sustainability at the Esri UC. (Read her story in the July 2007 issue of *ArcWatch* at p.ctx.ly/r/83o0.)

"She was amazing. *[…]* She inspired many of us and still does," said Esri president Jack Dangermond this year before introducing Finkbeiner. "She also inspired *[this]* young man, who I met when he was about 10 years old. He was just full of excitement about Wangari…and he said, 'I am going to get kids to plant a million trees in every country!'"

Dangermond didn't quite believe that Finkbeiner could accomplish that. "But then he did it," Dangermond remarked.

Finkbeiner recalled the enthusiasm that Maathai's story stirred in him (they eventually met), inspiring him to want to help her in any way he could.

"I told my classmates that we should plant 1 million trees in each country of the world," he said. "Many of my classmates loved the idea, even though I think none of us knew how much a million was or even how many countries existed in the world."

His worries about the polar bear expanded to humankind.

"Soon after, we understood that this was not really *[only]* about saving the polar bear," Finkbeiner said. "This is about our future. We will be the ones suffering from the consequences of the climate crisis."

The Fight for Climate Justice

In 2011, the UNEP handed over the reins of its Billion Tree Campaign to Plant-for-the-Planet. Since then, Finkbeiner has recruited more than 67,000 children around the world as climate justice ambassadors, planting trees and giving talks at schools and organizations in their communities.

Finkbeiner recently earned a bachelor of arts degree in international relations from the School of Oriental and African Studies (SOAS) at the University of London. When he's not studying, researching, swimming, or snowboarding, he crisscrosses the globe, calling for climate justice. He says tree planting is one means of reducing the CO_2 levels in the atmosphere and mitigating climate change.

Before embarking on the Plant-for-the Planet mission, he really wasn't a tree guy. The first tree he ever planted was on March 28, 2007, shortly after he made his class presentation on the climate crisis. Yes, he remembers the exact date.

"It was a big moment," Finkbeiner said, chuckling. "It was a *[crab]* apple tree at the entrance to my school, so I walked past it for the next 10 years."

And how is it doing?

"It's growing," Finkbeiner said, estimating that the tree had doubled in size in 11 years. He said its growth rate is slow compared to the trees his organization plants in the Yucatán Peninsula.

↑ Finkbeiner was deeply inspired by Nobel Peace Prize winner and environmental activist Wangari Maathai, the founder of the Green Belt Movement, a well-known tree planting campaign that started in the 1970s. Maathai's work reached far beyond environmentalism.

"It was not the most beautiful of trees," he admits. "If we would have known this was going to turn into a proper organization, we would have planted an impressive tree."

It might surprise some people, but Finkbeiner doesn't have a favorite tree. For him, it's more about what trees can do holistically for the planet.

"It doesn't matter why you plant the tree, it will still…absorb *[about]* 10 kilos *[22 pounds]* of CO_2 each year," said Finkbeiner, who has become more fascinated by the science of trees.

The Crowther Lab is helping Plant-for-the-Planet determine what species of trees need to be planted and where they are likely to grow successfully.

"It's not just about how many trees we plant, but it's *[also]* about planting these trees well," Finkbeiner said.

Crowther, who spoke at the Esri UC as well, said that only about 30 percent of trees planted in tropical areas around the world grow to maturity.

"What *[forest]* restoration projects need…is information about which species to restore, which soils can support them, and what the ecological consequences will be," he said.

Finkbeiner offered some tree planting tips to individuals and organizations that want to join the Trillion Tree Campaign.

- Seek advice from a local forester to find out which species will grow well in specific areas.
- When planting trees at a large scale, plant a variety of species rather than monocultures.
- Take care of the trees after you plant them, making sure they have enough sunlight.

And Finkbeiner wants to learn more about trees. Next, he will pursue a PhD in forest ecology from ETH Zürich. He plans to learn how to use ArcGIS technology at the Crowther Lab to find out, essentially, how to make the Trillion Tree Campaign a lasting success.

"There are still so many unanswered questions in *[relation to]* global forest restoration," said Finkbeiner. "We have to improve the maps of where we can restore forests and develop better maps regarding where we should prioritize *[tree planting]*. And we need to model what impact this forest restoration would have on climate change in terms of how much carbon these forests will compute over the next *[several]* decades."

Finkbeiner's Trillion Tree Campaign presentation inspired many people in the Plenary Session audience, including 16-year-old Zachary Linton of Lander, Wyoming, who recently learned how to use ArcGIS and is mapping the movement of a herd of bighorn sheep in his state. He hopes his project will ultimately help to restore the population of bighorn sheep in Wyoming.

"There is a lot of opportunity in the GIS world," said Linton. "Young people can really make a difference, like Felix Finkbeiner and his Trillion Tree Campaign. It gives me hope that someday I might make a difference in the world with one of my projects."

A Digital Transformation for Parks

ArcGIS Enterprise Is Revolutionizing How Minnesota's Three Rivers Park District Manages Land, People, and Projects

Three Rivers Park District in suburban Hennepin County, west of Minneapolis, Minnesota, operates more than 30 parks, 150 miles of regional trails, and recreational facilities in an area the size of Rhode Island. It is no small feat maintaining 28,000 acres of land, providing education to the public, and taking care of natural resources for 11 million visitors each year.

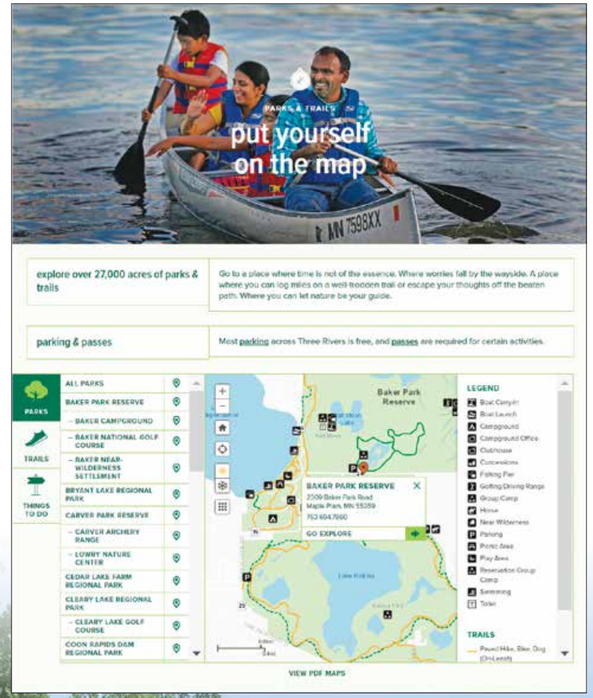
The park district, with 500 full-time employees and 1,500 seasonal workers, runs a robust GIS, complete with both ArcGIS Enterprise and ArcGIS Online. With 180 active users participating in an extensive range of GIS projects, this approach truly allows Three Rivers to live up to its mission of "enhancing the quality of life through recreation and education." But this wasn't always the case.

More than 10 years ago, GIS use at Three Rivers consisted of a dozen non-GIS employees across the district using various GIS products on their own, accessing siloed folders of data and performing individualized workflows. Because these methods lacked the efficiency needed to scale and modernize, the park district recognized the need for a centralized GIS program to replace that approach.

↑ ArcGIS Online is the access point for end users because they were already familiar with it.

Over the years, the GIS department has done just that, transitioning from making static maps to creating solutions that provide value for every park district department, from maintenance to public safety. The park district's GIS team also supports a vibrant volunteer base that helps with various activities, including field data collection. The team even uses GIS products for onboarding new employees and volunteers.

The department now splits its GIS projects into four primary categories: GIS administration, environmental stewardship, recreation education, and community engagement.



← The department splits its GIS projects into four primary categories: GIS administration, environmental stewardship, recreation education, and community engagement.

"Our biggest goal is to make GIS as prominent a tool as Microsoft Office for the average person," said Chris Martin, technology director of Three Rivers Park District. "If we can do that, we've really succeeded."

Raising the Profile of GIS

The turning point for Three Rivers Park District came, according to Martin, when departments started wanting what the GIS team could provide without the GIS team having to sell it to them.

"In the early days, we decided we were not going to kick somebody's door down and say, 'Hey it's the GIS guys, this is how we're going to save you!'" said Martin.

Instead, the team quietly sought out departments whose processes could be improved by GIS and started building them solutions using ArcGIS technology. When these departments were out in the field using GIS, other teams would find out what they were doing.

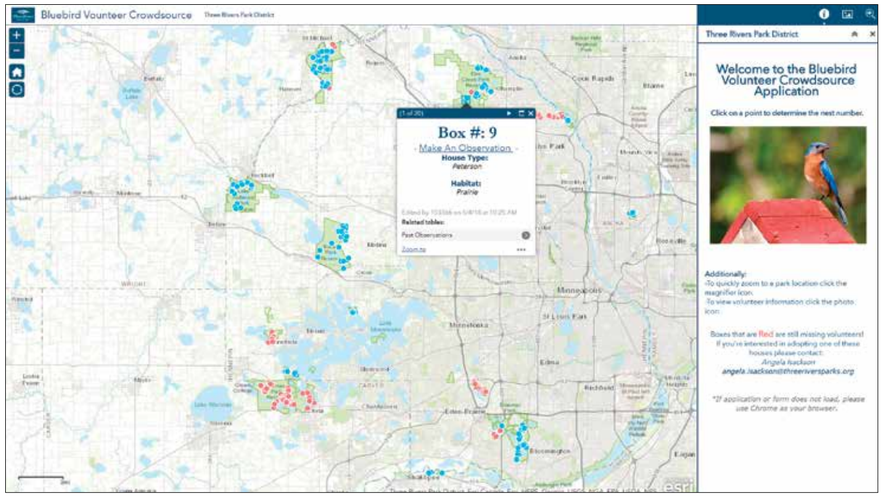
"When others see that and say, 'You can do that? Let's call Simon!' we got to a point *[where]* we didn't have to sell anything," recalled Martin. "They came to us."

The Simon that Martin referenced is Simon Morgan, now the senior manager of GIS and business applications, who joined the district 11 years ago. As the GIS team demonstrated its value over time, more and more Three Rivers Park District employees—from the public safety and maintenance departments to natural resources, the outdoor recreation school, and information technology—reached out for help.

Morgan recalled that one of the initial departments to benefit from GIS was the maintenance group, responsible for putting buoys on the lake. Before, buoys—used to mark swimming areas so boats stay away and swimmers stay safe—were placed using rudimentary measurements that weren't cross-referenced on a map.

"It used to take them two to four days because they *[would]* have to put the buoys out, go back to shore to check *[for accuracy]*, then go back out to adjust as necessary," said Morgan. "Now we have the buoys where they should be located on a map, and it takes the team less than four hours."

Three Rivers Park District operates more than 30 parks, 150 miles of regional trails, and a number of recreational facilities.



↑ The GIS department built a web app that volunteers can use to record their field observations on bluebird nests.

Examples like this raised the profile of GIS and grew the concept of using GIS as a service within the park district.

Scaling Technology with Distributed Collaboration

The GIS department's first step to modernizing its system was to tackle its myriad datasets, moving from a disjointed system that contained thousands of datasets spread across folders to an organized, centralized enterprise geodatabase. The second step, implemented concurrently, was to migrate the district's mature, on-premises standalone server to the full stack of ArcGIS Enterprise. An added benefit of doing so was having the ability to leverage apps, such as Collector for ArcGIS for field data collection, across the organization.

A major focus of the GIS department—which, at that time, had only two team members—was to ensure that the solution could scale to serve its many users without having to scale the department itself. Data sharing and access were challenges, especially with teams in the field.

"Because users wanted to use the data in Collector, we would add the data to ArcGIS Online, manually registering the services from ArcGIS Server and making it available to them," said Morgan. "It was a lot of legwork."

But ArcGIS Enterprise and ArcGIS Online both have functionality to address the issue: distributed collaboration. This allowed Three Rivers Park District to provide users with the right data at the right time.

Now, the park district maintains data in ArcGIS Enterprise using enterprise geodatabases that automatically synchronize with feature layers in ArcGIS Online. The seven different groups of data collectors can then easily access the data layers for more than 20 parks. Each of the district's 10 data owners is responsible for assigning permissions and authorizing changes within their own enterprise geodatabase.

The team chose to use ArcGIS Online as the access point for end users because Morgan wanted to build a strategy off a system that users were familiar with.

To kick off the park district's collection season this spring, the solution was deployed for a few groups, including wildlife and forestry.

"We've designed it so well that they don't even realize how much has changed, except now they have the ability to make the changes in the field when they want to," Morgan said. "Probably the best compliment I can give is that we haven't noticed *[the collaboration capability]* since we turned it on, meaning it just works. It made it so much easier to deploy *[ArcGIS]* Enterprise but keep ArcGIS Online."

GIS for Employee Training and Asset Management

Three Rivers Park District's more modern GIS has proved useful not just for collaboration across workgroups but also in training new employees and managing assets and facilities.

For instance, when long-term employees of the park district retire, GIS has become the way to preserve institutional knowledge.

"The biggest way GIS has helped the park district is getting data and information out of the heads of people and into areas *[where]* anyone can access it," said Morgan.

Story maps are central to this endeavor. For example, the outdoor recreational school uses an Esri Story Maps app to train seasonal staff who work for up to six months at a time. Information, such as where locks are kept or where to set up climbing towers, is put into a story map so new staff who are unfamiliar with the parks can be onboarded in an efficient and interactive way.

"We need maps, we need data…to be able to get them to where we need them quickly and efficiently, without having them spend weeks getting to know the park before we can even train them," said Morgan.

Asset management has also been revolutionized in the forestry department, where inventory used to be paper based. Before, plant crews tracked plant materials—from seed to seedling to ready-to-plant tree—by hand. They gave paper notes to an office assistant, who typed the data into a system. No matter how hard the office assistant worked, the sheer volume of data she dealt with meant that she was always three months behind.

"We are now at the point where expectations are so high that we actually get complaints if the inventory system is out of date by 15 minutes," said Morgan. "GIS has significantly improved *[data]* accuracy and *[the]* speed *[at]* which data is updated."

> "Our biggest goal is to make GIS as prominent a tool as Microsoft Office for the average person. If we can do that, we've really succeeded."
>
> **Chris Martin**
> Technology Director, Three Rivers Park District

Future Plans for Enhancing Visualizations

The digital transformation at Three Rivers Park District has only just begun. Next up, the department plans to implement 3D GIS and the forthcoming ArcGIS Indoors mapping system.

"GIS has always been about visualization. 3D takes that to the next level and will help us better understand how our parks work," said Morgan, who expects to utilize 3D for the park district's ski areas.

As for ArcGIS Indoors, Morgan sees it as the natural evolution of GIS to turn indoors, where asset management is drilled down to the building footprint level. Knowing exactly where everything is inside a facility will enhance that experience.

Revamping Bird Research

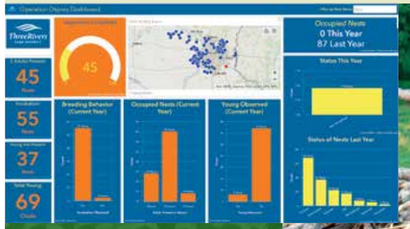
One key project that has really benefited from Three Rivers Park District's digital transformation is its osprey and bluebirds research, part of the wildlife management program.

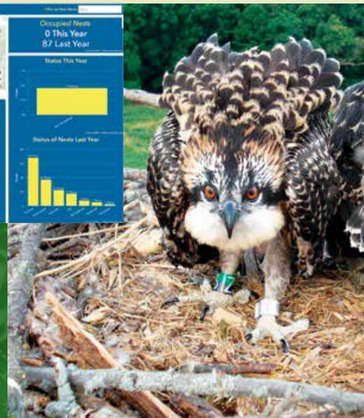
The wildlife management crew relies on volunteers to report on the birds' nesting activities. Collecting and logging observations was a key challenge for the program. So the switch from manual to digitized data collection has been pivotal.

"People used to email observations, call in their observations, or drop off pieces of paper at the front desk," recalled Morgan. "It took someone several days, even weeks, to collect all the information in a way that could be interpreted to see the health of the osprey nest."

To improve this workflow, the GIS department used Web AppBuilder for ArcGIS to create a web app that volunteers can use to record their field observations. Meanwhile, Three Rivers Park District staff monitor these reporting activities in real time using Operations Dashboard for ArcGIS.

Now, instead of scribbling down notes, volunteers—who receive minimal training—can submit their observations using a smart form that guides them, in a scientific way, through the information the park district needs. It's then easy for the program manager to pull the data and get a real-time idea of the health of the osprey and bluebird nests, along with the number of hatchlings being produced.





↑→ Three Rivers Park District uses Operations Dashboard for ArcGIS to monitor volunteer reports of osprey nest sightings.

GIS Hero

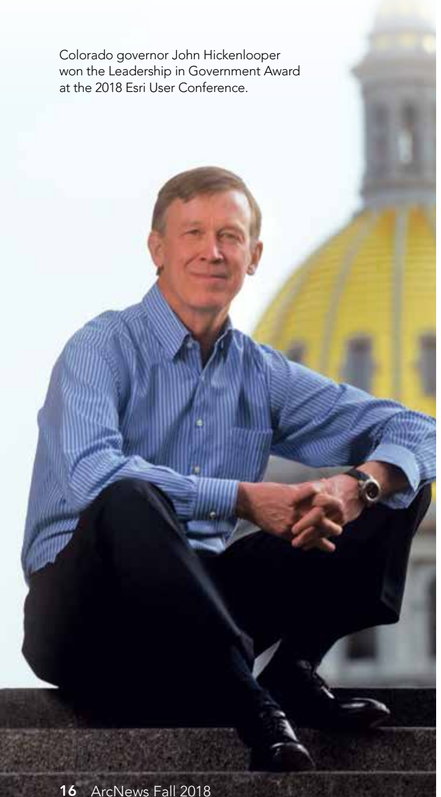
continued from cover

A Vision for Geographically Enabling Government

United States and a number of other democracies, too, seems to be a zero-sum contestation: in order for me to win, you have to lose."

But at the local, regional, and state levels, there's a very different spirit, argued Fallows, with people emphasizing practical compromise, positive achievement, and win-win solutions that can help these areas develop successfully in the long run.

"I contend that the next wave of leadership in the United States will be somebody from that tradition…somebody that has made his or her reputation bringing people together, being able to do things that build popularity and prosperity and comity and inclusion, and all the other things we would like to think Western democracy and the United States are for," said Fallows. "We don't know where this next wave of leadership will come from, but… there are many, many examples across the country, of whom Governor Hickenlooper—now ending his successful second term as governor of Colorado—is an illustration."



Colorado governor John Hickenlooper won the Leadership in Government Award at the 2018 Esri User Conference.

A Spatial Thinker, Always

Hickenlooper has a profound understanding of the power of data and mapping to inform decision-making, business, and policy.

He is reportedly the only practicing geologist to ever become a practicing governor in the history of the United States. And according to Fallows, he is only the second ever beer brewer to hold the position; Samuel Adams was first as governor of Massachusetts in the late nineteenth century.

In all phases of his career—from working as a petroleum geologist to opening a string of brewpubs and restaurants to being mayor of Denver and eventually governor of Colorado—maps have been crucial to Hickenlooper's success.

When he was a master's student in geology at Wesleyan University in Connecticut in the late 1970s, he lived and died by maps, he said.

"That was actually when GIS was paper maps," Hickenlooper recalled during a recent phone interview. "We would use transparencies to overlay different rock formations on our maps, which is in essence what we learned to do when GIS actually came into being as a technology. It took us forever—days—to make those transparencies line up properly and transfer information. Now, you can cross-coordinate information and line up data with the flip of a finger."

Hickenlooper eventually got a job as a geologist for Buckhorn Petroleum in Colorado. But during the oil bust of the 1980s, he got laid off—along with pretty much every other petroleum geologist.

So he and some friends decided to open a brewpub in Denver's then-derelict lower downtown. Hickenlooper wanted the bar top of their new Wynkoop Brewing Company to be a map, or at least a representation of one. A friend concocted a fictitious place, and they built a map of it into the bar top with concrete, copper, and shale—a callback to Hickenlooper's geology days.

"We got more comments on that because people thought it was a real place," he told the summit audience.

Building on the success of their first venture, Hickenlooper and his business partners opened more than a dozen brewpubs and restaurants across the Midwest.

At the same time, Hickenlooper became somewhat of a staple in the Denver community—no doubt in part because Wynkoop was eventually credited with influencing the revitalization of Denver's lower downtown, which is now home to popular restaurants, shops, and nightlife. (The addition of Coors Field, where the Colorado Rockies baseball team plays, didn't hurt, either.) So he decided to run for mayor. And in his first ever political contest, he won.

Given his background in geology and business, it was natural for him to use GIS to help run the city better, according to Esri government strategist Pat Cummens.

"He's always been a spatial thinker," she said. "He knows the value of data and that you need data to drive good decision-making."

During his eight years as mayor of Denver, Hickenlooper's administration used GIS to map all the trees in the city to ensure diversity in the canopy, find sources of pollution in the Platte River, work out where kids were suffering from lead poisoning, and more.

In 2011, he was elected governor of Colorado, and his penchant for GIS didn't fade. It shows no signs of waning now, either, even with his time in the governor's office coming to a close.

"For so many of the challenges of modern life, GIS is the last great hope," he said. "It's not the solution to everything, but I think, in a funny way, it's a partial solution to almost everything. One of the challenges we face is how rapidly the world is changing, whether you're talking about natural disasters and hundreds of thousands of people being displaced or you're talking about how pollution works and how we can clean the air and the water. Those solutions are all going to come down to our ability to use GIS effectively. The patterns of drought and therefore wildfires and therefore floods, medical epidemics, public health issues around nutrition and the spread of virus—all these things are very, very complex challenges that demand GIS responses."

Over the last eight years, Hickenlooper and his administration have employed GIS to come up with solutions for all these problems and more. In 2012, when Colorado experienced drought that led to some of the worst wildfires in the state's history, the government used GIS to map the fires and predict where they were going to go so it could better allocate its resources. When that wildfire season ushered in ruinous flash floods the following year, the government used GIS again to map and redesign highway contours and prompt all the repair crews to collaborate. Not only did this allow evacuated residents to return to their homes much quicker than initially thought, but it also helped the state rebuild those highways so they were stronger, safer, and more resilient.

"When people have lost everything…you can't come and say, 'Well, we're going to build it back,'" said Hickenlooper. "You've got to come back and say, 'We're going to build it better.'"

Having accurate data and being able to map it dynamically is a big part of that.

A New Golden Age

Hickenlooper believes that we now live in the golden age of data, which is also the golden age of maps. This is because, while maps of the past were made of what already existed (the landscape, animal tracks) and eventually became records of what we created ourselves (roads, bridges), they can now show what we hope to build (cities with clean air, rural communities with strong economies). Essentially, modern-day maps can illustrate the future.

"This is a moment that is going to have unbelievable transformational capacity, not just for elected leaders but *[also]* for businesses *[and]* nonprofits," he told the audience at the summit. "Maps…are a powerful tool by which people work together and collaborate—another natural resource that we seem to have in short supply."

But with leaders like Hickenlooper, maybe this kind of data-driven collaboration is about to arrive at its golden age, too.

A Vibrant New Data Model Keeps a Solar Field Beaming

By Ryan Smith, City of Loveland Water and Power Department

↑ The City of Loveland can now manage all the assets in its new solar facility—from combiner boxes and track motors to inverters and transformers—in a repeatable and efficient way.

In 2013, a series of floods ravaged Colorado—including the city of Loveland, which lies about 50 miles north of Denver. Flooding there razed the Idylwilde Dam, which generated hydropower for the city. This forced officials to rethink how they could produce electricity.

Using a grant from the Federal Emergency Management Administration's (FEMA) Alternate Project funds, Loveland ended up replacing its hydroelectric power source with a solar field. By the end of 2016, the Foothills Solar and Substation project had more than 10,000 solar panels up and running, producing 3.5 megawatts of electricity—over three times the capacity of the dam's 900 kilowatts. That's reportedly enough to power 574 homes in Colorado for an entire year.

The City of Loveland needed a way to manage all the assets in its new solar facility—preferably in a repeatable and efficient manner. The Water and Power Department wanted to be able to track not only assets but also maintenance schedules and all the costs associated with that. This would include everything from mowing the grass and cleaning the photovoltaic panels to replacing inverter air filters and inspecting the motors that enable the panels to track the sun. Additionally, the Water and Power Department wanted to use the city's existing Cityworks asset management system from Esri partner Azteca Systems, LLC, since a number of other departments also use it for maintenance management and work order tracking.

To meet all these requirements, staff decided that employing a schema and organizing the assets into features in ArcGIS would be the best way to do this. But that would mean that every single component of the solar field would have to have a feature and/or related asset record in ArcGIS. That was going to be a big project.

Initially, the Water and Power Department tried to find an already-existing asset-driven data model or related database schema for solar fields. After scouring the Internet and contacting several organizations—including Esri, the National Renewable Energy Laboratory, Colorado State University (which has a solar facility), multiple solar construction companies, and other municipal agencies—to get input, staff realized that Loveland's project was unique. There were many examples of data models and schemas being used for solar site selection, but it seemed that nobody was actively employing Esri technology alongside Cityworks to manage assets in a solar facility. The city was going to have to build its own data model from scratch.

It took the Water and Power Department three months to create and start using the asset data model. First, the small team working on the project used ArcGIS Pro 2.2 to convert CAD drawings of the solar field into feature classes. Then the team took city-owned aerial photography and used the conflation tools in ArcGIS Pro to ensure that the CAD drawings matched the images. The team also went out in the field with Collector for ArcGIS to give each piece of equipment a unique ID and verify that nothing went missing during the CAD conversion. All this data was stored in the city's existing Microsoft SQL Server geodatabase.

Once the data model was deployed, the Water and Power Department built the work order requirements and their related workflows in Cityworks. Finally, staff were able to attach work orders to specific assets.

Now, every single asset in the facility—from combiner boxes and track motors to inverters and transformers—is stored in this system of record, which staff also use to keep track of maintenance schedules, including the time it takes to perform maintenance, how much time passes between repairs, and how long each asset has been in use. This allows the Water and Power Department to conduct more preventive and lower-cost maintenance as opposed to always having to replace pieces of equipment.

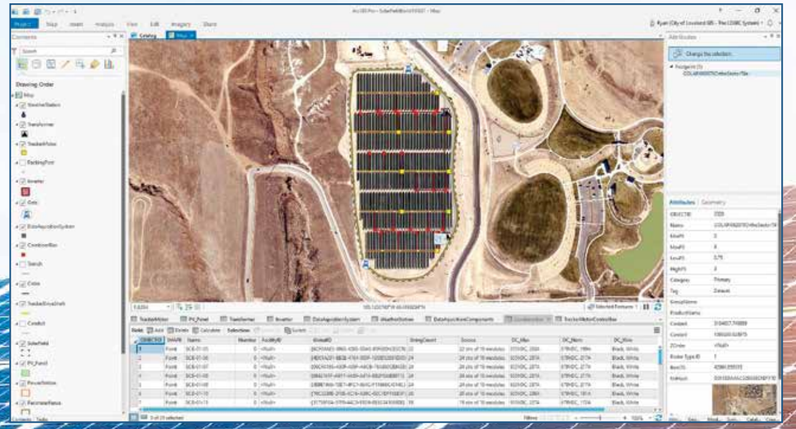
Additionally, with Cityworks mobile, field crews can take asset management requests and perform maintenance in the field—all from their mobile devices. Because the entire data model was built in ArcGIS Pro, field staff can make their edits quickly and precisely, too.

The City of Loveland has been using Cityworks, ArcGIS Pro, and the data model to monitor and manage assets in its new solar field since May—and staff are impressed by the results. Because each work order contains detailed information about associated equipment and assets, including costs, the city can manage warehouse materials, stock levels, and spare parts more accurately and efficiently.

"As we begin tracking historical data, we can better understand each job and its associated cost," said Sterling Overturf, a business analyst at the City of Loveland. "This is impressive in itself and helps us better manage our equipment and staff time—and it will lead to better management of the facility overall."

In the future, the City of Loveland intends to expand its solar data model alongside any augmentations of the solar field, so it can seamlessly handle additional assets and their maintenance, upgrade, and replacement schedules. This way, the Foothills Solar and Substation project can keep powering a growing Loveland for years to come.

↓ The Foothills Solar and Substation project has more than 10,000 solar panels that produce 3.5 megawatts of electricity, reportedly enough to power 574 homes in Colorado for a year.



About the Author

Ryan Smith is a senior GIS specialist for the City of Loveland's Water and Power Department. After 18 years in the consulting business, he joined the city to administer GIS projects for local water and power facilities. Smith's responsibilities run the gamut—from creating web-based apps, mobile maps, and dashboards to examining enterprise systems and testing new technology. For more information on Loveland's solar field asset management project, contact Smith at ryan.smith@cityofloveland.org or 970-962-3599.

Hitting the Trails, with a Bit More Information First

Web Map, Created with Esri Technology, Guides People to Colorado's Great Outdoors

A group of hikers traverse a trail in Colorado's backcountry. (Photo courtesy of Colorado Parks and Wildlife.)

Every day, Colorado's vast network of wilderness and urban trails beckons hikers, cyclists, horseback riders, runners, and all-terrain vehicle (ATV) riders.

To point Colorado residents and visitors to the trails appropriate for the type of recreational activities they are interested in pursuing, Colorado Parks & Wildlife (CPW) created the new Colorado Trail Explorer (COTREX).

The web app, developed using Web AppBuilder for ArcGIS (Developer Edition), was built to support Colorado governor John Hickenlooper's Colorado the Beautiful initiative, a plan that's meant to ensure that within a generation, every Colorado resident will live within 10 minutes of a park, trail, or green space.

"The Colorado Trail Explorer builds on our Colorado the Beautiful initiative by giving people quick and easy access to recreational opportunities and more readily connects people with the outdoors," Hickenlooper said in a press release. "Consolidating trail information that traditionally exists in dozens or hundreds of places into a single application makes it easier for Coloradans to find the trail options that might be just beyond their back door or near a favorite destination."

Eighty-one contributors—including the United States Forest Service; the National Park Service; and cities such as Lakewood, Fort Collins, and Denver—provided data on more than 39,000 miles of roads and trails for COTREX, which has both desktop and mobile-friendly versions.

"This is an amazing tool," said Lauren Truitt, CPW's public information and website manager. "There are plenty of map books out there, *[but]* this is the first in digital form, and *[it's]* very accessible to everybody."

While Coloradans live in what Truitt described as "an outdoorsy state" that brims with lakes, streams, mountain trails, and bike paths and lanes, residents may need a nudge to get out into nature. Some people let technology gobble up most of their free time, or they are unaware of the vast networks of trails or cycling routes within a short distance of their homes.

"Technology has inundated our life," Truitt said. "How can we use technology in a positive way to connect people to the outdoors?"

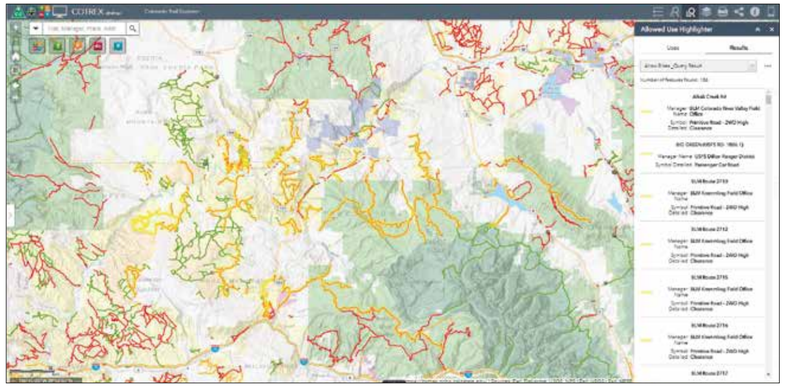
Truitt hopes the answer lies with COTREX, a web map with a set of interactive tools that people can use to search for and find the perfect trail or route that suits their activity of choice.

About 17,000 trails have been mapped throughout the Centennial State, including West Grouse Creek, which is designated for hikers and horseback riders only; Two Elk, which allows bikes and horses; and Wagon Gulch, which is open to motorized vehicles, horses, pack animals, and bikes.

The digital map is intuitive to use. When users click the green, orange, red, or blue buttons on the toolbar, the map displays a corresponding color-coded network of trails and roads—nonmechanized-vehicle trails in green, multiuse trails in orange, motorized trails and roads in red, and cycling routes in blue. When users click a specific trail, a box that contains useful information appears to the left of the map. This includes the name and length of the trail or road; the trail manager (e.g., Bureau of Land Management); a link to the organization's website; whether horses, pack animals, bikes, and off-highway vehicles (OHVs) are allowed; and whether the trail is wheelchair accessible.

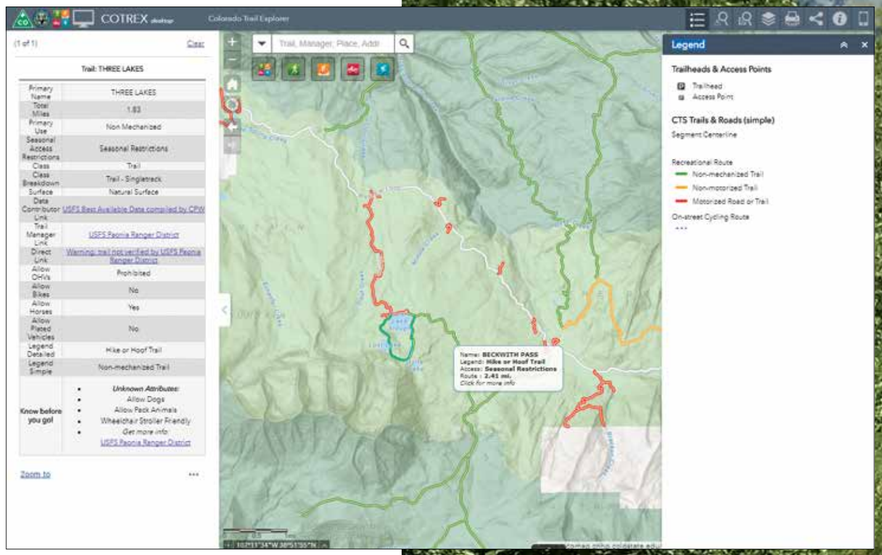
To search for the trails around a specific location—a home, a place of business, or a hotel—users just type its address into a Search box or place a pin on the map. The app then populates the map with nearby trails, generating a list of those trails by name, as well as information such as the length of each trail in miles.

Say a longtime resident of Fort Collins is at a coffee shop near the intersection of West Elizabeth Street and City Park Avenue. She has her computer with her and decides that she wants to go for a hike in a couple of hours. Starting the COTREX app on her computer, she goes to the List Trails Near tool and types the address of the coffee shop into a Search box. A map appears that displays all the trails and cycling routes within a radius of 25 miles. She could also narrow her search to a 2-mile radius and find choices like Mason Trail (1.47 miles away) and West Spring Creek Trail (1 mile away). A list of all the trails by name and the length of each one, along with its primary use (nonmotorized-vehicle trail, for example), will also appear on the right side of the map. If she clicks a segment of the trail on the map, a more detailed, "Know before you go," description of the trail—including information such as whether dogs or bikes are allowed—will appear to the left of the map.



↑ COTREX includes the Allowed Use Highlighter, which means if a user clicks Allow Bikes, all the trails that permit bikes get highlighted in yellow on the map.

↓ The COTREX web map shows noteworthy details about each trail, such as whether dogs or pack animals are allowed and if it is wheelchair accessible.



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CPW used Web AppBuilder for ArcGIS (Developer Edition) to build the app, which gave developers the ability to use standard widgets provided by Esri and customized widgets from users collaborating on GeoNet.

They tweaked some of the widgets to create the handy Allowed Use Highlighter on the toolbar. This list includes Allow Bikes, Allow Horses, Allow Pack Animals, and Allow OHVs. If users click Allow Bikes, they can see all the trails, highlighted in yellow, within the map extent that permit bicycles. The names of the trails and the field manager offices are listed to the right of the map, too. When users click the name of one of the trails in the list, the map zooms in to that trail.

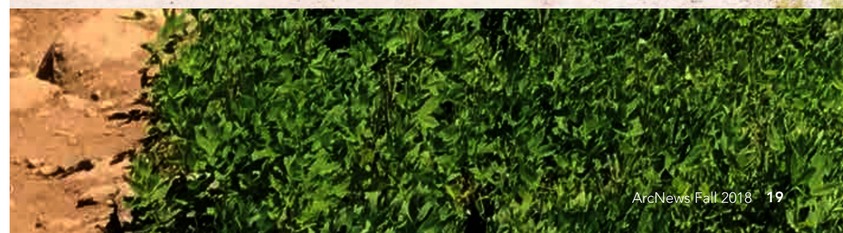
There's another plus: the app is both desktop and mobile friendly. The desktop version comes with a full complement of tools, while the browser-based mobile version contains a map with the color-coded trails, pop-ups that display the names of the trails, a Search box, and a few basic tools.

CPW customized the app to a great extent. Data from Colorado government agencies and nonprofit organizations was mashed up with Esri data to create the basemap. This was made possible by Esri's allowing developers to customize Esri vector tile basemaps. The app also includes data from the Esri World Hillshade basemap, protected-lands parcel data from COMaP, and roads and trails from Esri vector tile basemaps.

To access COTREX and discover some of Colorado's spectacular trails, visit https://cts.state.co.us/cotrex.

CPW received a Special Achievement in GIS Award at the Esri User Conference in July 2017 for the creation of COTREX.

The web map specifies which trails allow horses. (Photo courtesy of the Bureau of Land Management.)



A Farm Goes Back to the Land

Employing the Principles of Geodesign, Plas Newydd Farm Opts to Restore Biodiverse Habitats

By Chris Watson, Plas Newydd, LLC

"We're approaching a problem in the loss of biodiversity comparable to climate change," renowned biologist E. O. Wilson warned in a video recorded for the 2018 Esri User Conference. "We've jacked up the extinction rate *[of species]* at least 100 times."

According to Wilson, natural ecosystems that are millions of years old are being erased swiftly—and irreversibly.

"Climate change, we can reverse that. But we can't reverse the loss of three-fourths of the species on the earth," he continued. "If we could save half of the earth's surface in protected areas, that will give us security for 85 percent of the species."

At a time when many landowners are jumping on the real estate development bandwagon, the Morgan family, which owns and manages the Plas Newydd, LLC, farm, has decided to restore and conserve 876 of its 1,650 acres of farmland to its native Pacific Northwest habitat.

But how can one family take more than half of its farm and return it to the biodiverse Columbia River floodplain it used to be? With geodesign, of course.

A Farm with Ecological Value

Just north of Vancouver, Washington, at the confluence of the Lewis and Columbia Rivers, lies the heart of Wapato Valley. First mapped by the Lewis and Clark expedition in the early nineteenth century, the explorers gave the area its name because of how dominant the herbaceous, arrow-shaped wapato plant was in the ecological and cultural landscape.

The land that constitutes Plas Newydd Farm has been used for agriculture since it was first homesteaded in the 1840s. Levees and dikes placed on the rivers in the early 1900s blocked native fish access to prime floodplain wetlands and off-channel nursery habitats. Since that time, road construction, farm infrastructure, and pasture management practices have further impacted many native plant communities and wildlife habitats.

When the Morgans purchased the farm in 1941, they sought to not only be productive farmers but also good stewards of the land. Over the last two generations, however, the amount of agricultural acreage in the area has declined and prices for agricultural and timber products have fluctuated wildly.

Given the land's prime location, the Morgans have always faced pressure to sell or develop it. But the family wanted to sustain the land's working spaces and preserve its ecological value. So the Morgans managed the farm for sustainable forestry and leased cattle grazing and duck hunting while searching for ways to remain solvent.

After looking into several options, the current generation of family owners decided that dedicating a large portion of the land as a mitigation and conservation bank would be the way to go.

Capitalizing on Natural Assets

In the state of Washington, when roads, bridges, railroads, buildings, utility assets, ports, docks, or other infrastructure are built or maintained, the companies and government entities doing the work have to offset the environmental impacts of that development. This is where mitigation comes into play, which falls to various regulatory agencies, including the state's Department of Ecology and the US Army Corps of Engineers.

One goal is to maintain the size and function of Washington's current—and very ecologically important—wetlands. To that end, these agencies approve mitigation bank projects throughout the state so landowners can sell mitigation and conservation credits to restore aquatic habitats on their properties.

In 2015, state and federal agencies issued a public notice to start the process of setting aside 876 acres on Plas Newydd Farm for mitigation and conservation. Now, staff for the Plas Newydd Conservation Program are working closely with seven federal, state, and local agencies to create the Wapato Valley Mitigation and Conservation Bank.

"A mitigation and conservation bank allows us to capitalize on our natural assets rather than selling them for development," said Kelley Jorgensen, Plas Newydd's president of conservation. "In essence, we're banking on biodiversity."

Geodesigning Renewed Freshwater Habitats

The proposed bank site is located in the middle reaches of the Lower Columbia River, where Willamette Valley, the Puget Trough, and the Pacific Flyway converge. This freshwater habitat, which is influenced by tides from the Pacific Ocean, supports incredible biodiversity.

↑ While gathering baseline data and doing the initial site characterization, field staff generated more than 16,000 GPS points along with several terabytes of additional raster and vector data.

↑ The design of the Wapato Valley bank leveraged generations of local knowledge, maps from the General Land Office, and historic photos. This photo of the farm dates back to 1945.

↑ The team incorporated translation ecology into the design process, which considers traditional and local ecological knowledge and scientific expertise. Here, a member of the field crew examines beaver markings on a tree.

↑ At a time when many landowners are jumping on the real estate development bandwagon, Plas Newydd Farm is returning 876 acres of farmland to its native Pacific Northwest habitat.

One of the design goals of the bank is to remove the man-made constraints that have been added to the landscape over the last 175 years. The objective is to restore natural processes to that area to the greatest possible extent, given the constraints of an ecosystem in which nearly all the usual disturbance regimes—flood and fire, for example—have been extinguished.

"We're taking human-made constraints back off the land. We're unbuilding," said Jorgensen. "Humans love homogeneity, *[but]* nature loves heterogeneity. So we're putting back messy things."

To control what it could of this intentional mess, Plas Newydd Conservation Program staff decided at the outset to design the Wapato Valley bank using GIS. Going through the Esri Conservation Program, Plas Newydd received a grant that included ArcGIS Desktop, ArcGIS Online, ArcGIS Spatial Analyst, and ArcGIS Geostatistical Analyst—all of which proved invaluable while the team was gathering baseline data, doing the initial site characterization, and putting together the design.

In this phase of the project alone, field staff generated more than 16,000 GPS points that reveal the exact elevations on the floodplain where different species thrive. They also produced several terabytes of additional raster and vector data that helped facilitate the design process and are contributing toward making predictive, elevation-based models of fish habitats. Using existing lidar data, the team specifically employed the ArcGIS Spatial Analyst extension in ArcGIS Desktop to create digital surface models (DSMs) and digital terrain models (DTMs) of the proposed mitigation and conservation area to examine grading options, restoration scenarios, hydrology regimes, planting plans, and various habitat change possibilities.

"Every aspect of the design goes through GIS to adequately display the information in a clear and clean way, allowing the diverse stakeholders to see the change on the ground without the need to translate CADD drawings," explained David Morgan, Plas Newydd's managing partner.

A Values-Driven Technology

Employing GIS has also allowed the Morgan family and Plas Newydd Conservation Program staff to conceive of the Wapato Valley bank in a way that puts the land and its habitats first and is mindful of the family's values—both of which are the very core of geodesign.

"The best way to improve the farm is to be on the farm," said Rhidian Morgan, a second-generation family manager on the farm. "Listen to the land and pay attention to what it has to say."

Drawing on the family's unique knowledge of the farm, as well as an extensive cache of historical documents and hand-drawn maps that stretch back to the early 1800s, the team is employing GIS alongside translational ecology. A team-oriented and action-driven applied science, translational ecology incorporates traditional and local ecological knowledge that's typically held by nonscientists such as landowners, land managers, funders, and policy makers.

Given that so many people from various disciplines, backgrounds, and generations are so deeply involved with the project, GIS has been critical not only to gather and organize data about the land but also to communicate information about the Wapato Valley bank—in large part because of its visual nature.

"We use it with equal success to tell our story to those family members who own the land but live far away, family who are still local, the farm manager and farmhands, regulatory agencies, permit writers and the bank certification decision-makers, our future credit buyers, neighbors, the local community, funders, and lawyers," said Jorgensen. "For everyone involved, this framework generated a profound appreciation for the complexity of both the social relationships and the hydrology and biology that drives and constrains habitat-forming and -maintaining processes in the Columbia River estuary."

The result is a floodplain restoration design that will reinstate hundreds of acres of upland, wetland, and aquatic habitats—bringing biodiverse flora and fauna back to a place that has lost them. Juvenile salmonids, for example, will benefit from having a larger expanse of cold-waterfed, off-channel rearing habitats that allow them to feed and grow. Additionally, the team is creating a planting plan for the bank that encompasses more than 10 different plant communities.

"The development of this planting plan has been a dynamic, iterative process *[that has adapted]* to new field data collected on-site and *[has allowed]* us to take advantage of opportunities and avoid potential issues as they become known to us," explained Karen Adams, Plas Newydd's senior wetland ecologist and monitoring lead.

With the multiple layers generated during the baseline data collection and site characterization process—including ground and water surface elevations and soil, wetland, and habitat types—the team was able to map the layout of these plant communities. The layers also helped describe the types of restoration for these plant areas, quantify the changes they would experience (in size, extent, and makeup), and provide clear direction to the consultants who create the engineering plans for the Wapato Valley Mitigation and Conservation Bank.

"The efficiency of ArcGIS…permits us a level of responsiveness and ecologically sensitive design that would not be possible without these GIS tools," said Adams.

Get on the Biodiversity Bandwagon

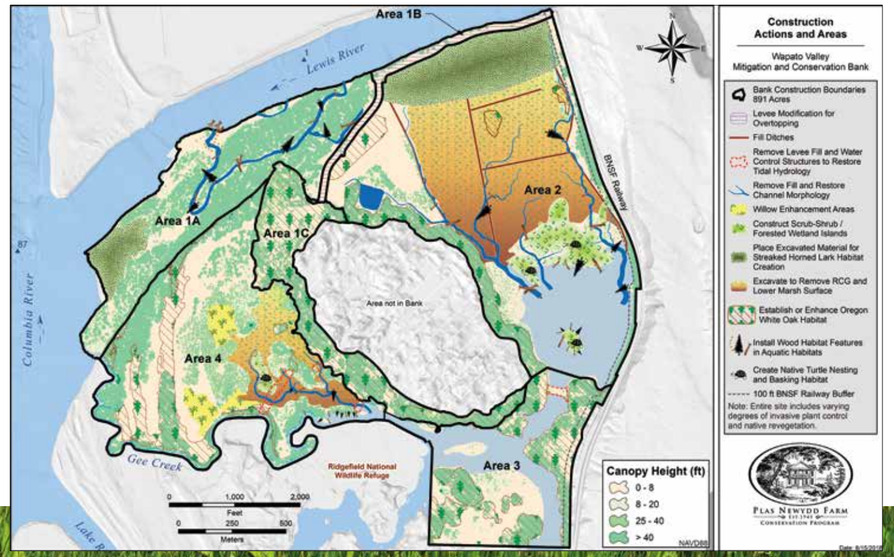
The success of the Wapato Valley bank lies at the convergence of geodesign and translational ecology. And thanks to GIS, combining the two specialties is working.

Plas Newydd is leading by example, demonstrating that there are opportunities to have a positive impact on biodiversity without "losing the farm." The Morgans understand their property in a landscape context, and that has allowed them to not only avoid developing the property but also improve the land their family has loved by making biodiversity work for them.

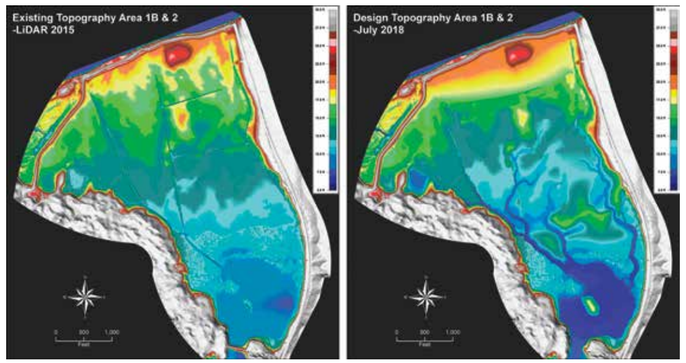
If more landowners do the same, we can heed Wilson's counsel and use geodesign and translational ecology to save some land in protected areas and provide security for 85 percent of species all over the world. It's now or never.

About the Author

Chris Watson, GISP, is a GIS/project manager and geologist at Plas Newydd, LLC. He has worked in the GIS industry since 1998. Watson has been a consultant team member on more than 20 National Environmental Policy Act (NEPA) projects in the Pacific Northwest and has spent the last 10 years working on river and habitat restoration projects on the lower Columbia River. For more information, email him at cwatson@pnfarm.com.



← To unbuild 876 acres of farmland, the team has to perform a series of sequential steps, such as filling ditches and removing levees.



↑ Using lidar data along with ArcGIS technology, the team created digital surface models (DSMs) and digital terrain models (DTMs) of the proposed mitigation and conservation area to examine grading options, restoration scenarios, hydrology regimes, planting plans, and various habitat change possibilities.

Restoring Oyster Habitats Requires Geodesign

By David Bruce and Stephanie Westby, National Oceanic and Atmospheric Administration, Chesapeake Bay Office

Oysters aren't just a food source for humans; these mollusks are also estuarine engineers. In addition to filtering the water around them, they create complex hard-bottom habitats that support a diverse ecosystem and stabilize the seabed and shorelines.

This is crucial to estuaries dominated by fine sediments, such as the Chesapeake Bay in the eastern US states of Maryland and Virginia. But oyster populations in the Chesapeake experienced precipitous declines starting in the early 1900s, largely due to overexploitation, habitat degradation, and disease-driven mortality.

To remedy these losses, the Chesapeake Bay Program is leading the effort to do large-scale oyster habitat restoration and revitalize native oyster populations in 10 bay tributaries by 2025. Centered on sanctuary (i.e., nonharvest) areas, this requires augmenting reef ecosystem habitats, promoting oysters' water filtration services, and conserving mature oyster brood stocks to ensure that a steady source of wild larval oysters can colonize surrounding areas that are open to commercial harvest.

Given the scale and complexity of this project, the National Oceanic and Atmospheric Administration's (NOAA) Chesapeake Bay Office focused on geodesigning these new habitats so they could evolve in ways that jibe with the Chesapeake's natural ecosystems. Employing ArcGIS technology was key to making this work.

Consistency, Communication, and ArcGIS

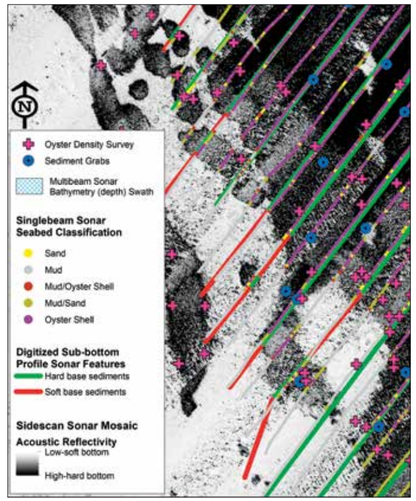
Harris Creek, Maryland, was the first tributary in the Chesapeake Bay to undergo large-scale oyster restoration. The 350-acre project took three years to plan and implement and was completed in 2015. Dubbed the world's largest oyster restoration project by The Nature Conservancy, it now serves as a template for the other in-progress and planned oyster restoration efforts taking place throughout the Chesapeake.

Extensive oyster restoration projects like these are typically planned, funded, and implemented by regional workgroups and staffed by federal and state agencies, municipalities, nongovernmental organizations, and academic institutions. With so many distinct actors, consistency and communication are important.

For the Harris Creek project, restoration partners agreed to a series of standard oyster reef success metrics—the most important being a threshold density of 15 live oysters per square meter with a target density of 50 live oysters per square meter.

But achieving those goals isn't as simple as dropping oysters into the bay and hoping that they flourish. Rather, the team employed ArcGIS solutions to integrate datasets; plan boundaries; create a restoration blueprint; coordinate on-the-ground operations; document progress; and share spatial data among restoration partners, oyster researchers, and other resource managers.

↑ The Chesapeake Bay Program is leading the effort to revitalize native oyster populations in 10 Chesapeake Bay tributaries by 2025. (Map courtesy of the NOAA Chesapeake Bay Office.)



↑ Sonar surveys characterize seabed habitat and locate areas where there are fewer than 50 oysters per square meter. This helps the team pinpoint where oyster restoration sites should go. (Map courtesy of the NOAA Chesapeake Bay Office.)

What Makes a Stable Oyster Reef

When oyster larvae come into existence, they are free floating. To thrive, however, they need to settle on clean, hard substrates. In the Chesapeake Bay, most of the original oyster reefs no longer exist, and where they do, oyster numbers are generally depleted.

In places where there are very few or no oyster shells to build on, restoration usually begins by constructing 3D reefs and then either seeding them with juvenile, hatchery-produced oysters or letting wild larvae naturally colonize the area. These new reefs are made of quarried stone, fossilized oyster shells, shells from seafood processors, or crushed concrete. For existing reefs that do have a good supply of natural oyster shells yet lack sufficient live oyster densities, restoration consists solely of adding hatchery oysters.

Whether natural or man-made, reefs need to be located on firm, stable seabed to minimize loss by subsidence. To ensure that this is the case, workgroups rely on bottom mapping and other georeferenced survey data that shows water depth, sanctuary boundaries, navigational aids, and more.

"High-resolution habitat mapping is absolutely essential for successful oyster restoration," said Dr. Romuald Lipcius, a professor and oyster researcher at the Virginia Institute of Marine Science. Otherwise, "oyster restoration in subtidal waters would be largely *[done]* by trial and error, which is inefficient and ineffective."

A Blueprint for Restoration

For the Harris Creek project, the Maryland Oyster Restoration workgroup began by creating a feature class in ArcGIS Desktop that identified the distribution of natural oyster shells, as well as hard and soft nonshell bottoms. To do this, the workgroup used side-scan sonar mosaic imagery, which identifies the distribution of hard and soft seabed; single-beam sonar seabed classification points, which distinguish seabed bottom types; and sediment grab point data, which is derived from sediment samples. The resultant habitat polygons were then used to draw up an oyster population survey in ArcGIS Desktop.

With this survey data, the workgroup then employed geoprocessing tools in ArcGIS Spatial Analyst to interpolate the density of live oysters in certain areas. The output grids were reclassed into two bins that identified areas that do not meet the density target (50 or more live oysters per square meter) and areas that do.

Using the seabed habitat feature classes and the live oyster density grids, the workgroup created a polygon-based blueprint of the entire restoration site. This blueprint defined the site's boundaries and indicated where reef construction and hatchery oyster seeding would occur.

To ensure that restoration sites are not subjected to the low levels of dissolved oxygen that are prevalent in deeper Chesapeake waters during the summer (since that kills oysters), the workgroup used a course-scale water depth grid to limit the blueprint boundary polygons to depths less than 20 feet. Geoprocessing tools also removed portions of the blueprint that intersected with buffer polygons around navigation aids and channels, marinas, and private docks.

A three-year-old crushed shell reef in Harris Creek contains an abundance of live oysters and associated organisms. The vertical orientation and density of oysters indicates that this site has not been disturbed by commercial fishing activity. (Photo courtesy of the NOAA Chesapeake Bay Office.)

To finalize the boundary geometry for the new reefs, restoration partners conducted subsequent acoustic and ground truthing surveys on the blueprint sites. They did additional depth surveys using sonar to ensure that the reefs were built in areas that were deep enough so they didn't cause new navigational hazards. They used digitized features from sonar-based sub-bottom profiling surveys to verify that subsurface sediments could support the weight of the new reefs. And they employed new sediment grab points to verify the presence or absence of oyster shells to avoid constructing new reefs on top of existing natural habitats.

Workgroup members then collaborated to review the blueprint polygons in ArcGIS Desktop so they could complete the site boundaries for all the available survey and regulatory datasets. A team of consulting scientists with expertise in oyster restoration then reviewed the blueprint. After that, the Maryland Oyster Restoration workgroup unveiled the project maps at scoping meetings, which were open for public comment.

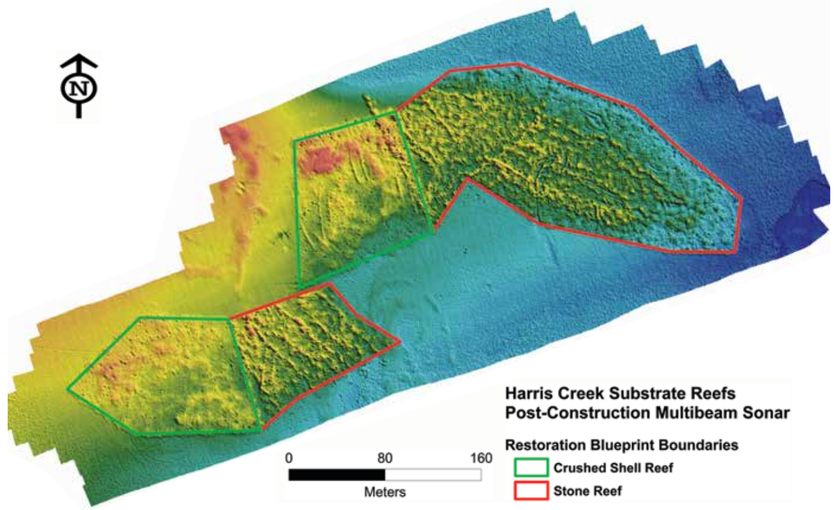
Once the review process was done, construction and oyster seeding contractors were able to take the coordinates of the restoration sites from the final blueprint to ensure that all materials were placed in the correct locations.

Additional Blueprint Users

Since the restoration project was completed in 2015, the blueprint has helped the Maryland Oyster Restoration workgroup document progress over time. It contains reef construction and oyster seeding dates, reef specifications like height and material, and postconstruction monitoring schedules.

The geodatabase is an ideal environment for storing and integrating the blueprint feature class, population survey data, layers denoting areas that are excluded from the blueprint, annual seeding records for hatchery oysters, and ancillary oyster research.

"Because we were diligent in recording detailed oyster data in the geodatabases, we are able to calculate restored areas *[and]* track reef types, construction dates, owners, and base material quickly *[to put into]* reports and charts," said Karen Dridge, the GIS lead for oyster restoration for the US Army Corps of Engineers, Norfolk District.



↑ A digital surface model shows the new reefs in Harris Creek. Warm colors indicate higher-elevation reefs and, thus, shallow water, while cool colors show lower-elevation reefs and deeper water. NOAA will use digital surface models like this to update its nautical charts. (Image courtesy of the NOAA Chesapeake Bay Office.)

The geodatabase also allows the workgroup to efficiently share data with outside organizations. In fact, resource managers and academic scientists who are interested in using the oyster restoration data in their own work frequently request access to the geodatabase.

Exceeding Expectations with Geodesign

By all accounts, the Harris Creek reef restoration project has been a success.

According to postrestoration population surveys, "oyster biomass and productivity results on one-foot-high stone reefs are equal to or greater than *[those on]* shell reefs," said Dr. Angie Sowers, an integrated water resources management specialist with the US Army Corps of Engineers, Baltimore District.

Indeed, oyster numbers on Harris Creek's stone reefs have exceeded expectations. Average oyster densities from all 13 reefs surveyed in 2016 were above the 50-oysters-per-square-meter restoration success target and actually ranged from 130 to 388 oysters per square meter.

It appears that having access to high-quality survey information, along with the ability to integrate a variety of spatial datasets during the planning phase, is highly effective for restoring oyster habitats. This is surely geodesign at its best.

About the Authors

David Bruce is an ecologist for NOAA's National Marine Fisheries Service in the Office of Habitat Conservation at the organization's Chesapeake Bay Office. Stephanie Westby is the Chesapeake Bay oyster restoration coordinator for NOAA Fisheries, Office of Habitat Conservation, and Habitat Restoration division. For more information, contact Bruce at david.bruce@noaa.gov.

Esri Partners Develop Matchless Solutions

Esri partners are engaging major businesses and communities in remarkable ways, increasing efficiencies and giving more people access to geospatial information.

Find out how five Esri partners have used a range of ArcGIS solutions to help big businesses, local governments, city departments, and utilities do in-depth analysis, perform damage assessments, gain situational awareness, and implement enterprise-wide GIS solutions.

Not only do they work with The Science of Where, but they extend it as well.

Amazon HQ2: Seeing Beyond the Statistics

In September 2017, Amazon put out a call for bids to find a location for a new corporate headquarters, Amazon HQ2. The Metropolitan Washington Council of Governments (MWCOG) was keen to respond on behalf of its member jurisdictions, which include the District of Columbia and communities in Maryland and Virginia.

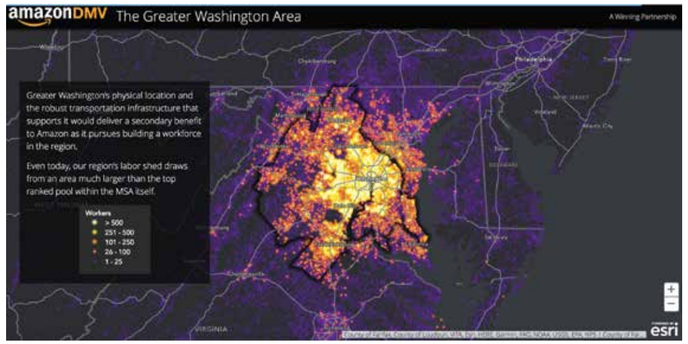
Known by many as the DMV (DC-Maryland-Virginia), the region is home to more than 5 million people and has one of the strongest economies in the United States. The DMV's workforce is highly educated, diverse, and oriented toward business and technology. There is a dependable housing market and easy access to multimodal regional transit and cultural amenities. These are all attractive qualities for Amazon HQ2.

To ensure that the DMV was a key player in the bid, MWCOG contacted **Datastory Consulting** (datastoryconsulting.com), which, in early 2017, had helped keep Marriott International's corporate headquarters in Montgomery County, Maryland.

Datastory first developed analytics that compared the DMV to other metro areas. It then deployed these insights to MapDash, a business dashboard that leverages ArcGIS Online and Esri's vast collection of demographic data to help users organize and analyze data. From this, Datastory created an Esri Story Maps app that highlights the region's strengths in terms of demographics, the workforce, transit access, housing, and quality of life.

The story map enabled Amazon to see beyond the statistics and experience the data through interactive, colorful maps and photos of neighborhoods that exhibited workforce information, transportation routes, and housing trends and also showcased the region's commitment to sustainability. It let MWCOG tell an engaging story that conveyed how robust the DMV would be as Amazon's new home.

The result? Out of the 238 cities that submitted bids, Amazon announced that 3 of the 20 finalists were in the Greater Washington area.



↑ By showing the reach of the DMV's extensive transportation network, the story map illustrated how strong and diverse the candidate pool would be for Amazon HQ2. (Image courtesy of MWCOG.)

The story map Datastory built for MWCOG (available at AmazonDMV.com) won second place in the Infrastructure, Planning, and Government category in the 2018 Esri Storytelling with Maps Contest.

Discovering What's Left with Before-and-After Imagery

In December 2017, Southern California was engulfed in multiple wildfires. The Thomas Fire was the most destructive, destroying more than 1,300 structures over 440 square miles in Ventura and Santa Barbara Counties. To date, it is the second-largest wildfire in state history.

Following the Thomas Fire, a catastrophic mudslide in January left roads and properties inaccessible in southern Santa Barbara County. Officials couldn't travel around to assess the damage, and evacuated property owners were unsure of what they would come home to, if anything. So the county turned to **EagleView Technologies** (eagleview.com) and its Pictometry imagery.

While the Santa Barbara County Planning and Development department mapped debris flow layers in ArcGIS Desktop, EagleView captured Pictometry imagery for the assessor's office. Once available, the imagery became the basemap for parcel layers built in ArcGIS—a critical view given the number of parcels that were unidentifiable.

EagleView then used Web AppBuilder for ArcGIS to make Pictometry imagery from 2015 and 2018 available to county residents (p.ctx.ly/r/8bxv), enabling them to see the condition of their properties.

"We wanted constituents to…be prepared for what they'd face once they were able to access their properties," said Aimee Strub, the information systems manager for Santa Barbara County's Clerk, Recorder, Assessor and Elections Office.

In addition to providing home and business owners with high-resolution views of their properties, the powerful combination of Pictometry imagery and ArcGIS technology gave county public safety agencies before-and-after perspectives of areas they couldn't access. Santa Barbara County was also able to assess property damage in half the time it usually takes, which expedited residents' tax refunds.

"Uploading the orthoimagery into ArcGIS was such a simple process with Web AppBuilder, and the oblique imagery proved to be invaluable for our appraisers," added Strub.

↑ EagleView Technologies used Web AppBuilder for ArcGIS to build a swipe map that showed Pictometry imagery of Santa Barbara County from 2018 (left) and 2015 (right) so evacuated residents could see the status of their properties after a Thomas Fire-induced mudslide.

Street-Level Imagery Changes the Game in NYC

Just as the New York Yankees up their game each summer for a shot at the world series, the City of New York is playing a new game with GIS and street-level imagery. This game is transforming city operations and keeping public safety personnel and citizens safer.

The New York City Fire Department (FDNY) has more than 11,000 firefighters and fire officers and 4,200 emergency medical personnel. Combined, they respond to more than 1.7 million calls annually. FDNY has created innovative, interactive GIS tools for fire and emergency medical services operations using street-level imagery from **CycloMedia** (cyclomedia.com) along with Web AppBuilder for ArcGIS. These tools help plan response and operational procedures, as well as support incident maps with dispatch integration and a ground-level image view of incident locations. FDNY collects and displays critical information for incident locations with GIS and extracts asset data from the street-level imagery, creating more accurate situational awareness for responders and incident commanders.

"Web AppBuilder has really revolutionized the way we're building and presenting maps," said Captain Mike Brady, the commanding officer of FDNY's GIS unit, in his presentation at the Public Safety Summit at the 2018 Esri User Conference.

The imagery was initially adopted by New York City's Department of Finance—one of the many GIS players in the city—which experienced a dramatic transformation in its daily workflows. In the first year alone, the department did more property assessments while greatly reducing field visits. This drove a significant increase in direct revenue for the city.

Adopting CycloMedia's street-level imagery has been so successful, the city now captures imagery of New York twice a year. A real game changer, right?

↑ The New York City Fire Department (FDNY) used Web AppBuilder for ArcGIS along with street-level imagery from CycloMedia to create innovative, interactive GIS tools for fire and emergency medical services operations.

Joining Three Utilities on Five Islands Under One GIS

The Hawaiian Electric Company consists of Hawaiian Electric on the island of O'ahu; Hawai'i Electric Light on the big island of Hawai'i; and Maui Electric, which serves Maui, Molokai, and Lanai.

To support more coordinated grid management, the Hawaiian Electric Company wanted to move each utility from its own GIS to a company-wide enterprise GIS implementation. In July 2015, the company began working with **UDC** (udcus.com) to design the system, which would incorporate ArcGIS software and ArcFM from **Schneider Electric** (schneider-electric.us), a solution that helps utilities better track and maintain their assets.

One major focus of the project was building a common business approach for how to represent assets and then determining how those assets would be managed going forward. A significant challenge was migrating all the data from each of the utilities and moving it to the new enterprise architecture. UDC designed a data governance and organization strategy that the Hawaiian Electric Company implemented to facilitate the enterprise GIS arrangement and maintenance.

To build this system of record and engagement, each electric company worked with UDC to deploy both ArcGIS Desktop and ArcGIS Enterprise. UDC also configured and deployed Schneider ArcFM in conjunction with its custom-built quality assurance and quality control tools to monitor and manage the data migration. Additionally, UDC's integration team assisted the electric companies with incorporating a number of apps, including the Oracle Utilities Network Management System, which helps manage outages.

Once the enterprise GIS project was completed, the Hawaiian Electric Company was able to leverage its already existing investments in Oracle and other apps across the enterprise. This single system implementation has allowed the utilities to standardize and streamline business processes, improve cross-training of team members, and reduce operating costs.

↑ UDC assisted the Hawaiian Electric Company in implementing enterprise GIS to improve grid management.

A Progressive Utility Maintains Its Enterprising Essence

When the City of Independence, Missouri, fired up its first power plant in 1901, electrical power was considered cutting-edge technology. More than 115 years later, Independence Power & Light (IPL) is still a progressive electric utility, as evidenced by its investment in Cityworks (cityworks.com), a GIS-centric asset management system from **Azteca Systems, LLC**, that replaced IPL's homegrown work and asset management program.

The utility chose Cityworks to address its primary challenges: integrating the diverse software landscape that supports putting together design templates, reserving materials for future projects, and dealing with workflow data and scheduling. Though the existing management system was working, it was being far outpaced by more efficient technologies.

Because IPL needed to bridge several technology gaps to develop a successful solution, it chose to partner with **POWER Engineers** (powereng.com), which specializes in formulating cohesive engineering solutions.

POWER Engineers seamlessly integrated an inflexible financial asset program from JD Edwards that runs on IBM's AS/400 mainframe server with Cityworks. The company then brought in the Automated Utility Design (AUD) development team from Spatial Business Systems to enable the two systems to effortlessly share data.

Now IPL can create new designs in its AUD software, link it to a Cityworks work order, create a list of materials and the quantities needed (including estimates for labor and construction design drawings), and load these into the work order for construction crews. The tasks generated in Cityworks then trigger calls to the JD Edwards financial asset program to retrieve the actual materials and labor hours and populate the Cityworks work order. This allows IPL staff to compare estimates with actual costs to budget more accurately.

In the first five months following the deployment of this new system, IPL staff created more than 5,700 work orders that correctly captured all work activity on field assets.

"The ability to provide the true history of an asset through its life cycle is a first for our utility and will offer a wealth of benefits in future planning," said Janna Weir, IPL's systems program supervisor.

↑ With Cityworks, IPL can track work orders by asset, which makes it easier to put together accurate budgets and perform preventive maintenance.

For IPL's customers, this means that their rates stay stable, they get more comprehensive customer service, and IPL responds faster to outages. The data gathered and shared through Cityworks allows IPL to ensure that aging infrastructure remains reliable. The company can also stay ahead of the curves of growth and demand for electrical power, develop better business plans for capital projects, and reduce waste by doing paperless communication and documentation for projects.

From aiding with new subdivision builds to making monthly billing more efficient, IPL's new ArcGIS software-enabled asset management system makes Independence a better place to live.

Esri's global partners provide customer-focused, geoenabled solutions that span dozens of industries. Products and services range from configured apps and custom-built solutions to complete ArcGIS system implementations and content. Search for and discover partners, solutions, and services that meet your needs at **esri.com/partners**.

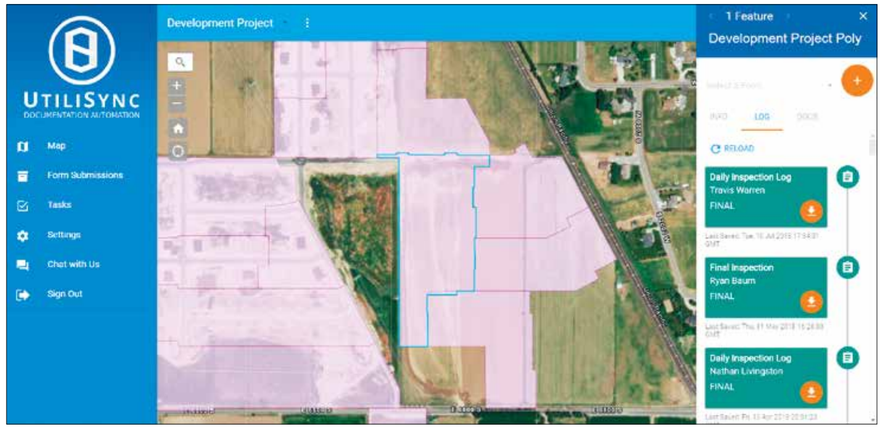
With GIS-Based Smart Forms, Startup Streamlines Review Process for New Developments

In Fast-Growing Spanish Fork, Utah, Field Crews Now Use UtiliSync to Complete Inspections

The City of Spanish Fork has always strived to be at the forefront of GIS in the state of Utah.

In 1995, the city invested in GIS to better manage how it did business. However, while this GIS-centric approach was quickly adopted in the office, field personnel were slow to embrace it. So although Spanish Fork was able to enjoy some of the benefits of GIS, it was still heavily dependent on paper-based inspections and other forms, which perpetuated inefficiencies.

One area in which the city really struggled was keeping track of the various reviews that need to be done for new developments. To be truly GIS-centric, officials at Spanish Fork knew they needed to find a way to get field crews and inspectors to enter data in real time while out in the field. For this, they turned to UtiliSync (utilisync.com), which helps organizations automate their workflows with GIS-based mobile forms.



↑ UtiliSync combines maps with ArcGIS Online feature services and smart forms.

An Inefficient, Paper-Based System

"Here at Spanish Fork City, we are growing at an extremely fast rate," said Travis Warren, the city surveyor.

But when it came to reviewing proposals for new developments, the process was quite disorganized. As with most cities, developers in Spanish Fork have to submit plans for various reviews—the preliminary plat review, the final plat review, and the site plan approval, for instance. This requires evaluations from multiple city departments.

Additionally, once a development is approved, office staff and field crews need to be able to communicate throughout the various stages of construction, from the preconstruction meeting to daily inspections to the final walk-through. City-based field crews are also responsible for keeping track of the time they spend on a particular job, since the city bills the developer for those hours.

But all this information was being recorded on paper. Oftentimes, when inspectors would go to start a new inspection, the stacks of paper would get swapped, and they would end up using old data instead of the most recent results. Sometimes corrections were made to an old report, but inspectors weren't informed. So they relied on contractors to follow them around and keep track of areas that had been surveyed and inspected.

The GIS team suffered, too. Each December, the utilities departments used to drop off huge stacks of paper with more than a month's worth of data in them, which staff had to enter into ArcGIS Desktop and map before the end of the year.

"It made it miserable trying to get all that paper work input in such a short time frame so that we would be ready for year-end reports," said Shawn Beecher, the GIS administrator for Spanish Fork.

It was also difficult to keep the city council, the building department, and the city manager up-to-date with the latest information.

So Spanish Fork decided to digitize its workflows. The city looked first for an asset management program but found out quickly that it could use its existing GIS infrastructure to collect inspection information right in the field—at no additional cost. With Collector for ArcGIS, inspectors could gather field data directly in the city's geodatabase using maps created in ArcGIS Online. This was big because it would allow Spanish Fork to set it up so that field crews could see the work they'd done the very next day.

The GIS department then found out about UtiliSync, available for use via ArcGIS Marketplace. UtiliSync takes a GIS-centric approach to document management by allowing users to attach custom forms to their GIS features. It can then turn these forms into PDFs and automatically distribute them to anyone who needs them.

"UtiliSync forms have allowed us to fully automate our inspection process," said Warren. "This gives management, developers, and contractors real-time updates as inspections are completed."

"Moving completely digital with ArcGIS Online, Collector for ArcGIS, and UtiliSync has made it so that information is more accurate, more easily accessible, and more up-to-date," added Beecher. "There is no more waiting to get the information that the various departments throughout the city need *[so we can]* make more informed decisions."

A New Way to Track Tasks

For development reviews, field crews now document all the work they do using UtiliSync.

To get the process started, the city's GIS department uses ArcGIS Desktop to create a polygon or polyline for each construction project. Field crews, office staff, and anyone else that has access to this data can now edit directly in the database. And all of it is immediately viewable in UtiliSync.

From there, users can tap on a GIS feature in UtiliSync and complete one of the many smart forms attached to it, including plat reviews and daily inspection forms. Once a form is filled out, UtiliSync automatically creates a PDF of it, saves it to an archive, emails it to a dynamic list of recipients, creates a related record in the GIS database, and updates the GIS attribute in Spanish Fork's enterprise geodatabase.

By using UtiliSync's smart forms, field inspectors can focus on their evaluations. They don't have to do anything extra to make or distribute a PDF of their work, and they know that the GIS attributes will be updated promptly.

"UtiliSync *[enables]* us to track our daily tasks with an easy-to-use, map-based interface while allowing us to store and edit the data in our geodatabase, *[which]* is being consumed by ArcGIS Online via our services in ArcGIS Server," explained Warren.

Furthermore, with all the inspection data stored in Spanish Fork's ArcGIS Online account, city managers and department heads are able to use Operations Dashboard for ArcGIS to track the progress of development reviews. They can see, among other things, how many hours inspectors have logged for the current month and where they have conducted inspections.

More Consistent, Accurate Information

With UtiliSync, all stakeholders for a new development—from administrators, inspectors, building crews, and city council members to citizens, investors, and store owners—are able to view the up-to-date status for any development project in Spanish Fork. The information is more consistent than it used to be, and nobody has to waste time tracking down a specific inspector to get the current paper work from his or her truck.

"The accuracy of the information gathered increased exponentially," said Warren. "All data from in-house, as well as outside contracts, is stored in one location."

No more scrolling through lists or shuffling through stacks of printouts to find the right development. Inspectors can conduct their reviews at the correct locations, despite often receiving inaccurate addresses, since development projects tend to have unassigned street numbers on unnamed streets. Rather, they can find a specific development on a map and know exactly where it is.

Additionally, building inspectors can view final checklists for a development review just by clicking on a particular development on the public-facing web map hosted on the city's website. This allows them to easily update contractors on their projects and inform owners of when they can take possession of their buildings.

And in the two years since the city started having field crews use UtiliSync to report the hours they work at each site, Spanish Fork has experienced a 187 percent increase in inspection fees. This is because the city can now accurately track the time its field crews spend on specific projects, according to Warren.

"UtiliSync has been an essential tool in our time-management and inspection processes," he concluded.

For more information about UtiliSync, head to ArcGIS Marketplace (p.ctx.ly/r/8dqw) or email UtiliSync founder Matt Stayner at mstayner@utilisync.com. For more information about how Spanish Fork integrates all its GIS and UtiliSync technology, email Shawn Beecher at sbeecher@spanishfork.org.

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

Open Data Strengthens Lean Government

In Gilbert, Arizona, ArcGIS Hub Helps City Departments and Citizens Collaborate

Lean governments—that is, governments that eliminate wasted time and effort while still providing citizens with quality services—find better ways of doing things.

One measurement used to determine whether a government is lean or not is a city's employee-to-population ratio. Despite its growing population, which the US Census Bureau estimated at 242,000 in 2017, Gilbert, Arizona, has managed to keep its employee-to-population ratio at one staff member per 193 residents. This is, in part, because the city's Office of Digital Government helps the community do more with less.

The Office of Digital Government strives to connect residents with Gilbert's local government, which is why the department decided to enhance the city's existing geospatial platform by incorporating an information hub. With this, departments and citizens throughout Gilbert can access open data and maps via one data portal to gain a better understanding of what is happening in the community.

Since Gilbert was already deeply invested in the ArcGIS platform, the Office of Digital Government used ArcGIS Hub to open up its data to citizens. A capability of ArcGIS Online, ArcGIS Hub can be used to increase public awareness of the various services offered by the government, as well as any community projects that affect residents. This is exactly what Gilbert needed it for.

Now with the Gilbert Open Data Portal (alex.gilbertaz.gov), residents have access to information that helps them make sense of local issues so they can aid in coming up with solutions. Moreover, citizens can see this data in a geographic context, which enables them to conduct more thorough research so they can clearly articulate their ideas and concerns when presenting them to government administrators.

An Organic Start to Open Data

In Arizona, cities are not required to make government data available. Some municipalities give a nod to transparency by providing information only to people who ask for it. But oftentimes, people think their governments are participating in transparency activities solely to comply with federal mandates that try to ensure that leaders are acting honestly.

Gilbert's open data initiatives, however, began organically a couple years ago. That's when the town hosted its first SPARK App League, a coding competition in which junior high and high school students try to make the best apps and games using local government data.

Gilbert's Office of Digital Government, along with the town manager, quickly realized that it might be beneficial to release this same information to all residents.

"We don't want our citizens to have to ask us for information about a government building that is already going up in their area," said Derek Konofalski, a data and technology analyst in Gilbert's Office of Digital Government. "We want them to know what's going on from the start."

Some departments were already exchanging data with outside agencies prior to even launching the open data hub. But the data they were sharing had typically been manually entered onto spreadsheets. Those departments immediately saw the value of being able to share open data via a digital platform. Additionally, GIS users within the city understood that having an information hub would simply make data sharing easier.

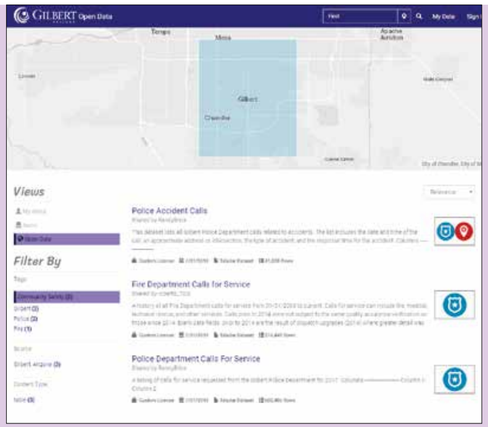
Getting Past the Skepticism

To begin the hub project, the Office of Digital Government hosted a committee meeting that included one representative from every city department. Each attendee had a bird's-eye view of what kinds of data their departments had and how they used the information.

Some committee members were skeptical. They questioned the wisdom of making their data open and accessible internally and especially externally. Reluctant departments wanted to maintain ownership of their data and dole it out only when someone specifically requested it, which is what they had always done. They couldn't imagine how a data portal might help them get their work done more efficiently.

The Office of Digital Government pointed out, however, that the data was not really theirs to stockpile but rather belonged to residents. The office also showed committee members how sharing data could make their work easier. In the end, all departments agreed to participate in the open data initiative.

To make the transition simple, everyone on the committee agreed that employees would use the GIS tools they already had access to and experience with to interact with open data. In addition, ArcGIS would be integrated into non-GIS users' workflows in ways that were compatible with familiar processes.



↑ The city shares datasets about community safety on the Gilbert Open Data Portal. This way, residents can easily find information about accidents called into the police department, fire service calls, and more.

↑↓ Alex, Gilbert's open data avatar, helps residents connect the dots between datasets.

"*[We]* definitely moved the needle," said Konofalski. "I would say that staff are no longer resistant. The town's departments are undergoing a culture shift from owning data to proactively thinking about data possibilities. Staff are learning to think holistically and considering what additional data they need to create a bigger picture. Furthermore, while deciding what data they need to present project proposals, they are also thinking about other types of data that will add greater context to their proposals."

Now that open data is a widely accepted concept throughout the Town of Gilbert, more staff members, directors, and residents are requesting datasets. This means the city needs to prioritize them.

To do so, managers ask questions such as, Which existing projects and strategic initiatives would benefit from open data sharing? Is there an upcoming initiative that would gain from having published data to help residents better understand it? How might this data help citizens?

Alex, the Open Data Avatar

With managers thinking about their data in terms of how it can serve Gilbert's citizens, the next step was to ensure that members of the public could find the data they need. To that end, the Office of Digital Government created Alex, an open data avatar that walks residents through various datasets and shows them exactly how the town is using this data to make decisions on behalf of residents.

Alex helps citizens connect the dots between datasets and visualize data in different ways. In the future, Alex will also integrate with platforms such as Facebook Messenger, Amazon Echo, and iOS and Android devices via Esri's Sonar, a chat bot (that is currently an open-source project) that lets users ask questions about their communities via voice or text and then searches for answers by way of open data.

The Gilbert Open Data Portal also organizes datasets into categories. Users can select Community Safety, for example, and see datasets for all the calls made to the police department about accidents and all the service calls made to the fire department. The portal links to ArcGIS Online, where users can then add the data to a basemap to better visualize it. Other data categories include Growth and Development, Recreation and Culture, Finance and Operations, and Transportation and Facilities. Eventually, users will also be able to see datasets about Gilbert's strategic initiatives, which are outlined in each year's strategic plan.

Better Communication by Sharing More Information

Being able to prioritize projects based on residents' needs has been a good way to introduce the open data initiative to the community. Citizens can see the open data that's directly related to upcoming projects. Furthermore, if Alex appears on a sign or website, it means that Gilbert has provided additional data about the project on its open data site.

Given that initial efforts focused on residents rather than the government, increasing interdepartmental collaboration within the Town of Gilbert is phase two of its open data strategy and what the town is looking toward doing in the future.

"Once we have information that's useful for residents, we're going to start connecting the dots internally and making those connections public," said Konofalski. "As connections to open data grow, city departments will better communicate and share information."

Looking ahead, the Office of Digital Government plans to extend its data to the community in ways that are tangible. For instance, if citizens can easily find out—through open data and maps—that the city has filled the potholes they skirt every day or that it has fixed the streetlight on that dark corner, then they will be able to see that their government is indeed working to make everyone's quality of life better.

To learn more about Alex, Gilbert's digital open data avatar, visit alex.gilbertaz.gov/about-alex.

Putting Public Safety Issues on the Map

By Shawn Carson and Lisa Brown, City of Rock Hill, South Carolina

In the City of Rock Hill, South Carolina, some datasets have traditionally been kept in silos. Only police used and analyzed crime data. Code enforcement data was the responsibility of the housing and neighborhood services department. And information about fires was the sole domain of the fire department.

In the summer of 2016, the city's management team embarked on a project to synthesize various datasets and information using GIS. The team requested assistance from the information technology services (ITS) department's GIS division to evaluate and better understand some of the city's datasets. Specifically, the team was looking to get a handle on the geography of public safety and code violation events. It wanted to analyze data together and use mapping to visually demonstrate patterns and gain a holistic view of the community.

The ITS/GIS division employed several ArcGIS solutions to help unearth the full story of public safety in Rock Hill. The result? The management team requested that the city council implement new policies for specific neighborhoods.

"Ideally, we would have enough money to solve all the problems of our neighborhoods," said Rock Hill mayor John Gettys. "But realistically, this gives us a tool by which we can justly focus our resources on the areas with the highest needs."

Finding Correlations Among Data

To begin the project, the ITS/GIS division obtained data that is available to most municipalities. The team acquired a complete crime dataset from the city's crime analyst and a list from the fire department with all the information about local fire incidents. ITS/GIS staff gleaned foreclosure data from the county's website, which showed all the parcels that were on the docket for foreclosure. They pulled data from the city's cloud-based Mobile311 site to find potential code violations, such as overgrown grass or abandoned vehicles. They also got income and demographic data from the US Census Bureau.

GIS analysts then used ArcGIS Desktop to geocode the data against the city's street layer and join all the datasets to the city's address and parcel layers. The Polygon to Point, Frequency, Spatial Join, and other overlay tools in ArcToolbox were particularly helpful for this project.

Next, the city manager's office did a regression analysis in Microsoft Excel using the data from ArcGIS Desktop to find any correlations among variables. One of the more interesting datasets was a polygon layer built using census block groups that showed income and demographic data along with frequency counts for specific incidents, such as foreclosures by year, violent and property crime, fires, and code enforcement issues.

For the first time, the team saw that a large number of foreclosures were in more affluent parts of town. Nobody would have guessed this without seeing the data on a map. Staff had not previously targeted these areas to receive foreclosure prevention information, but with this new picture emerging, that was going to change.

An Easy-to-Use, Interactive Visualization Tool

To share all this information with city leaders and officials in a clear and understandable way, the ITS/GIS division created a web app. GIS analysts used ArcGIS Server to publish the data as a service before feeding it to a web map in ArcGIS Online. Employing Web AppBuilder for ArcGIS, the team built a web map app that contained interactive heat maps of the various incidents.

The final web map app was presented to both the management team and the city council, and the reception was extremely positive. Decision-makers finally had a tool that was easy to use and presented data in a logical way.

"From a citywide perspective, it was an enlightening process to have an interactive map by which we could see the greatest issues negatively impacting our local neighborhoods," said Gettys.

It turned out, there was indeed a relationship between incidents like fires and boarded-up homes, or residents who make frequent calls requesting medical assistance and code enforcement issues on their properties. Neighborhoods with the highest number of correlated variables clearly needed attention from the city.

Quantifying Long-Held Suspicions

The neighborhood at the top of that list was Catawba Terrace, an old, once-prosperous area of Rock Hill that had been in decline for a few decades.

Staff verified that several of the issues in this neighborhood were related to the fact that it consisted mostly of rental units. More than 80 percent of houses in Catawba Terrace were being rented out, and rental units accounted for 83 percent of code enforcement violations in the area.

The city had long suspected that these rental properties were a key contributor to why this neighborhood was in disrepair, but it never had the data to back that up. Finally, city staff could see that the high concentration of unregulated rental housing in Catawba Terrace was constraining people to live in substandard housing that posed safety risks. What's more, over a third of the rented properties were owned by a handful of landlords.

↑ In Catawba Terrace, local organizations and churches are planning events to rehabilitate run-down houses.

"The story that we were able to tell using the compilation of the various datasets and their correlations provided us with a strong foundation to make a fact-based case for regulating rental properties within a particularly challenged neighborhood," said Jennifer Wilford, the director of Rock Hill's housing and neighborhood services department. "It allowed us to quantify long-held suspicions and shape policy."

The City of Rock Hill began hosting community meetings to address Catawba Terrace residents' concerns regarding broken streetlights, dilapidated sidewalks, crime, and more. Concurrent with these efforts, the city council approved a pilot ordinance wherein the housing and neighborhood services department inspects rental properties prior to new tenants moving in. Inspectors look into basic safety issues: Does the water work? Can windows be opened for ventilation? Are all mechanical and electrical systems properly installed and maintained?

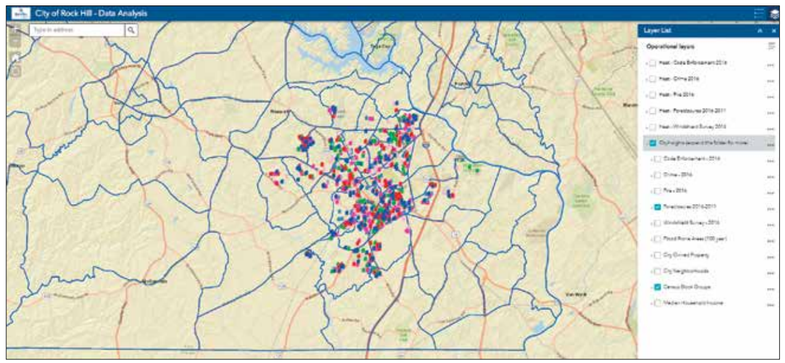
Although landlords initially expressed misgivings about these inspections, the city has worked tirelessly to develop their buy-in by making the process quick and easy. Now, rental units in Catawba Terrace are in better condition than they were before, and landlords have access to a rental database that gives them information on potential tenants, like whether they caused damages at their previous residences or if there were any issues with police.

Catawba Terrace residents are now taking more pride in their neighborhood. Civic organizations and churches in the area are rehabilitating run-down houses, and incidents of crime, fire, and code violations have been steadily decreasing.

The Power of Collaboration

GIS allowed decision-makers in Rock Hill to not only integrate multiple data sources but also visualize their relationships via maps. This gave staff the ability to make data-driven decisions and create a workable program that has a positive impact on neighborhoods such as Catawba Terrace.

"By using the power of ArcGIS to take disparities in data and combine them into an easily understood cross-referencing system, it tears down the natural silos in an organization and begins to show the power of collaboration to improve decision-making," said Vince Simonowicz, the city's chief information officer. "As a result, GIS is quickly becoming the lifeblood of a progressive and growing municipality."



↑ Without seeing the data on a map, nobody would have guessed that a large number of foreclosures in Rock Hill were in more affluent parts of town.

About the Authors

Shawn Carson is the GIS manager in the information technology department at the City of Rock Hill. With 28 years of experience in the field, he has worked in various capacities in GIS, including in local government, as a federal contractor, and at Esri. Lisa Brown is the strategy and performance manager in Rock Hill's city manager's office. Previously, she served as the city's budget analyst. For more information, contact Carson at shawn.carson@cityofrockhill.com or 803-329-8723 or Brown at lisa.brown@cityofrockhill.com or 803-326-3814.

Crossing Borders

A column by Doug Richardson
Executive Director, American Association of Geographers

THE NEW IMPERATIVE
Spatializing Health Research and Practice

Over the past two decades, there has been a dramatic increase in how much geospatial data is generated for health research, as well as in the number of related tools and spatial methods used to study that data. From analyzing infectious disease outbreaks and patterns in cancer rates to modeling how environmental risks impact substance abuse levels, these new datasets, technologies, and processes are transforming our understanding of how environmental factors and social influences interact with health.

But we have not yet achieved the full potential of what new developments in GIScience can do for health research. That will require interdisciplinary collaboration among geographers, biomedical scientists, and public health practitioners.

Given that health researchers now increasingly have access to highly detailed genetic and epigenetic information, there is a similar need to get more precise information about environmental or social contexts that may factor into health issues. This is where geography—with its emphasis on place, integrative science, and methods for spatially organizing and understanding coupled human and natural systems—becomes essential. It is also where GIS—with its capacity to integrate and correlate vast amounts of detailed quantitative environmental data with observed conditions (such as infectious diseases, cancer, obesity, mental illness, and addiction)—becomes critical, especially for medical research and practices that aim to address the complex ways in which genetics and environmental factors relate to disease.

Developments in distributed computing are further enabling new research frontiers in health. It is now possible to use GIS services remotely to perform sophisticated spatial analyses and model complex spatial health processes at the individual level rather than solely for the aggregate. For example, if researchers equip an asthma patient with a GPS device that tracks air quality in real time, they can get meaningful measurements of his or her exposure to disease-causing pollutants, such as particulate matter or sulfur dioxide. Indeed, this is far more precise than tracking this at the county or population level.

Additionally, the Internet of Things (IoT) has given value to the embedded GPS and GIS in so many consumer devices that individuals now have the power to gather their own geospatial data and participate in various online-based citizen science health projects. Despite the obvious issue of quality assurance, it is clear that the crowdsourced georeferenced health data being volunteered by millions of people has fascinating potential not only for medical research but also for delivering health services.

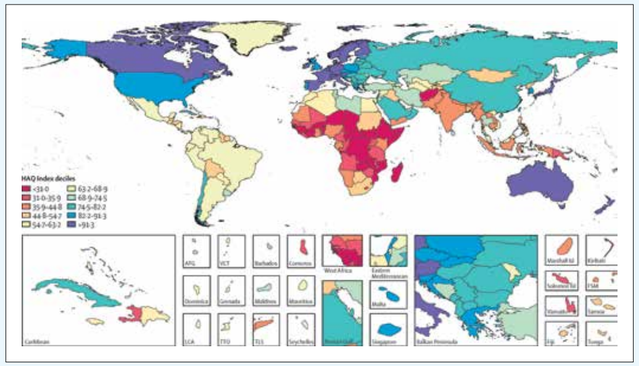
Of course, making advances in the spatial analytical methods for mining and interpreting this kind of data will be integral to implementing promising new approaches in health service delivery, including mobile health services (mHealth) and electronic medical records. More breakthroughs will also be needed to make health care accessible to everyone and to fix ongoing global health disparities.

The American Association of Geographers (AAG) has worked with leading geospatial health scientists from around the world to form a new organization, called the International Geospatial Health Research Network (IGHRN), that will share the latest research in geospatial health methods and technologies. The group is also responsible for fostering international health-based collaboration across borders, as well as bridging the gap between GIScience health research and the needs of health practitioners on the ground.

The stakes are high. It is incredibly challenging to control traditional and newly evolving diseases. And, as Microsoft cofounder Bill Gates recently pointed out, we are falling short in preparing the world for the "significant probability of a large and lethal modern-day pandemic occurring in our lifetimes." Based on studies from several global health research institutions, he is urging the United States government to take the lead on this. It is imperative that we advance and implement new spatial health research, methods, and infrastructure to address these health challenges.

AAG's collaborations with organizations around the world also suggest that we need new institutional and educational models for integrating geography more fully into health research and practice. Public policies and institutional initiatives that incorporate spatial data and analysis into global health research and practice can generate extraordinary discoveries in health research and produce new efficiencies in delivering health services to people no matter where they live.

For more information on IGHRN, visit IGHRN.org. To engage with these issues more deeply, consider participating in the special IGHRN symposium that will be held during the AAG's annual meeting in Washington, DC, April 3–8, 2019.



← Researchers Nancy Fullman, Jamal Yearwood, Solomon M. Abay, et al., studied where access to quality health care has improved and declined from 1990 to 2016. Countries and territories colored purple, blue, and green showed the most improvement, while countries in yellow, orange, and red showed declines. (Map courtesy of *The Lancet*, Vol. 391, Issue 10136.)

IGHRN

Contact Doug Richardson at **drichardson@aag.org**.

Use GIS Technology in the Classroom, Both On-Campus and Online

It Could Steer Some Students Toward Careers in STEM

By Shireen Hyrapiet, Houston Community College

As a geographer with limited knowledge of geospatial technologies, exploring the world of GIS was a challenge for me. But in early 2014, I joined a team of professors from Oregon State University, where I was an instructor at the time, in a spatial thinking and web mapping workshop led by Joseph Kerski, a geographer and education manager at Esri. This got me excited to introduce my students to geospatial technologies.

In the ensuing years, my students and I have together gone from building one-off story maps on myriad topics in geography to using ArcGIS Online to assemble and maintain a vast geodatabase that shows where people can obtain health services throughout Asia and Africa.

It was not easy: I had a hard time coming up with a grading rubric; I neglected the importance of data standardization; I ended up with duplicate data entries in a dataset with more than 4,000 data points—and I am still cleaning that manually. But when using geospatial technologies in the classroom starts working like a well-oiled machine, as it is now doing in my classrooms, it is beautiful to see students create engaging geospatial work that, for some, piques their interest in software and could take them down a career path geared toward science, technology, engineering, and mathematics (STEM).

Many teachers are hesitant to use GIS in the classroom. I was, too. Which is why I am presenting my raw, honest lessons learned in hopes that other teachers and professors who may not be technologically inclined are encouraged to give it a try. It is achievable.

TO START

Story Maps

I began using Esri Story Maps apps in on-campus courses in the fall of 2014, when I was teaching a geography of Asia class with more than 65 students in it. I split them up into teams and asked them to select any topic about an Asian country that appealed to them. They then had to generate a coherent story about it.

Esri Story Maps apps are relatively easy to work with from an instructional perspective because students nowadays are so familiar with online apps. The issue I had, however, was with grading them. I had developed a simple A-through-F grading rubric, which worked to some extent but did not provide students with sufficient information on the grading criteria.

After doing this one-term test run in a traditional classroom setting, I introduced the same story map assignment in my e-campus courses. This time, I developed a video tutorial (p.ctx.ly/r/8do6) and elaborated on the grading rubric.

I set up the assignment in Oregon State's learning management system as a multipart project, which allowed me to provide students with substantial feedback as they proceeded. Now, I grade each portion of the rubric as complete or incomplete, and points are only awarded for the final submission.

So far, I have used Esri Story Maps apps in both on-campus and e-campus courses on the geography of Asia, human-environment geography, and environmental justice. Students have created some fantastic story maps, including recent ones on the forgotten farmers of the United States (arcg.is/PzKCS), how eminent domain has disproportionately affected African-Americans (arcg.is/1X4GTn), and how Guam's militarized marinas have contributed to the environmental degradation of native lands (arcg.is/0u091e).

NEXT UP

ArcGIS Online

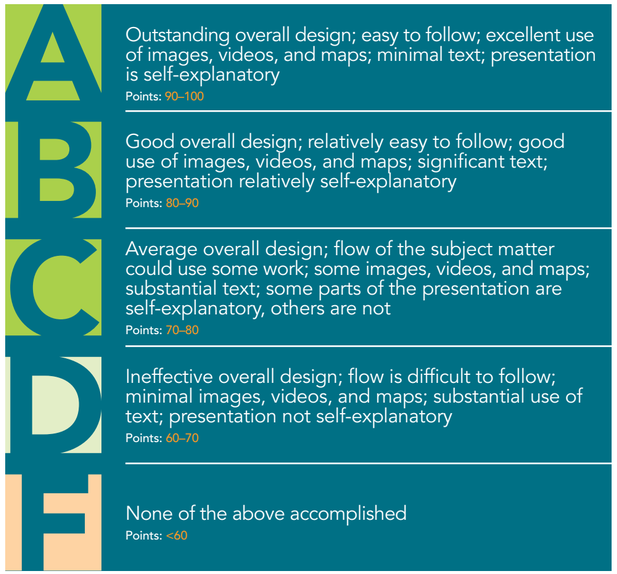
Two terms later, I mustered up the courage to engage with ArcGIS Online in my on-campus geography of the non-western world course, which had a small class size of about 35. I wanted students to learn the process and utility of mapping, in addition to working with the software.

They selected a topic as a class—concert venues in Southwest Asia—and then determined which attributes to map. I split the students up into groups and assigned each group a country to research. I guided the teams through the process of creating mappable data: putting together spreadsheets with appropriate column headers and clearly recorded data, saving the spreadsheets as .csv files, and then uploading them to ArcGIS Online.

Eventually, I collated all their data in one spreadsheet and built a web map with it in ArcGIS Online (p.ctx.ly/r/8don). At this point, however, I did not know how to configure a pop-up window. I also failed to pay attention to data standardization. So while some students entered concert venue sizes textually, as *four hundred*, others entered it numerically, as *400*. This inconsistency caused distortions in the legend.

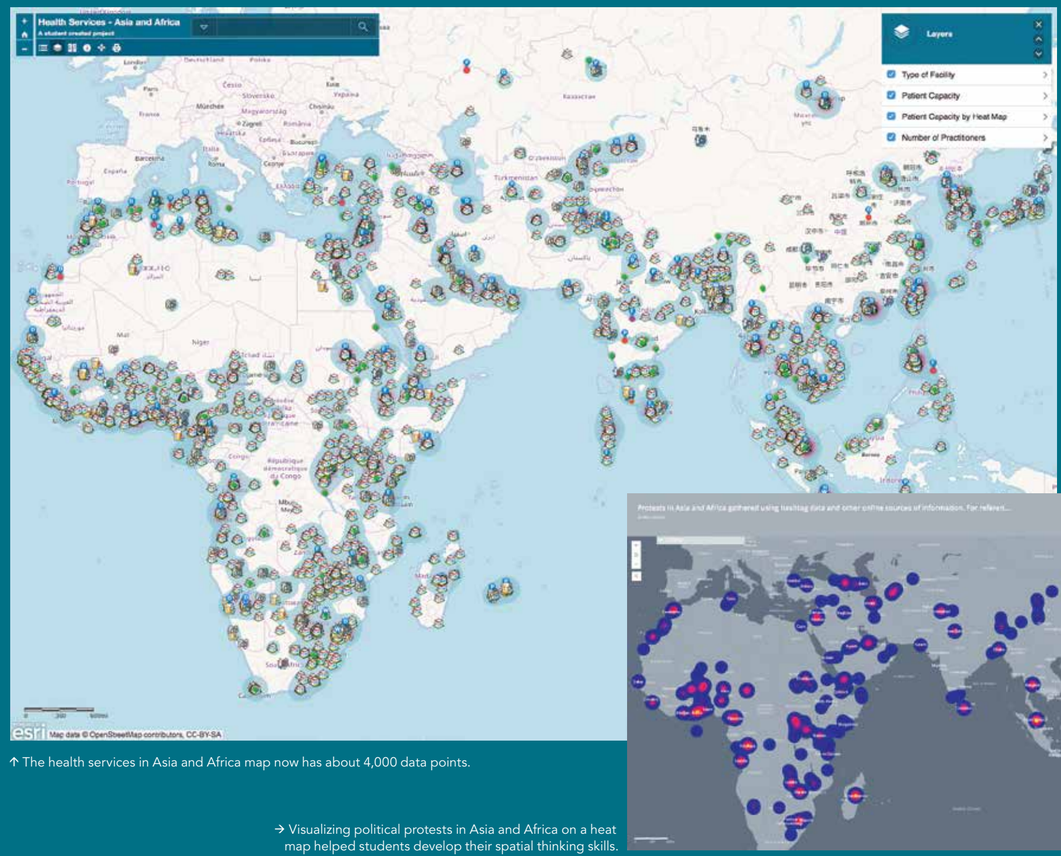
Regardless of the shortcomings of this web map, students enjoyed the interactive nature of the platform and appreciated the uniqueness of visualizing spreadsheet-based spatial data. Through this exercise, I also realized that latitude and longitude are a relatively unfamiliar notion for college students. As teachers, we can't take even the most basic concepts for granted.

In the spring of 2016, I went all in on a similar project in the same course, which, this time, had more than 250 students and two teaching assistants. The students in each lab section were put into groups and assigned a country in Asia or Africa. After brainstorming topics, the class elected to map political protests from 2010 to the present.



↑ The simple A-through-F grading rubric did not provide students with sufficient information on the grading criteria.

↑ This grading rubric allowed students to receive more substantial feedback as they developed their story maps.



↑ The health services in Asia and Africa map now has about 4,000 data points.

→ Visualizing political protests in Asia and Africa on a heat map helped students develop their spatial thinking skills.

Following the same process as before, the class produced a heat map of political protests in Asia and Africa (arcg.is/CWfmG). Visualizing these events on a map and seeing their spatial extent enabled students to further develop their spatial thinking skills.

Once again, the class was focused on the procedural and organizational aspects of the assignment, so we overlooked trying to standardize the data. For the second time, students recorded sizes both textually and numerically, which resulted in inconsistent attribute data. We were able to configure the pop-ups, though.

A SHIFT

Integrating Google Tools with ArcGIS Online

Over the summer of 2016, I considered more effective ways to collate the data. I decided to use Google Forms, since it was a free way to collaborate on data documentation that imposes a degree of standardization. Google Forms allowed me to set up check boxes for specific attributes, such as number ranges; require students to enter coordinates in decimal degrees; and mandate uppercase letters when necessary.

The following year, using Google Forms, I introduced another 250-plus on-campus students to ArcGIS Online when we mapped health services in Asian and African countries. While I had finally learned to standardize data collection, some of the data quality was questionable. In the map, certain images were not displaying in pop-up windows. I soon realized it was an error on the data collection end: students were submitting URLs to Google search results as opposed to URLs to the dedicated images.

In the subsequent term, my class continued developing the health services topic. This time, I gave students access to the dataset in Google Sheets and asked them to locate new data points for their assigned countries. My teaching assistants worked with each group of students on data collection and entry, as well as mapping.

During this time, I read one of Kerski's GeoNet blog posts (p.ctx.ly/r/8doa) and learned how to use a Google spreadsheet with autorefresh features in ArcGIS Online. This eliminated the need to re-create the map with each new class and set of data points. Students continued to enter their data in Google Forms, and I manually copied and pasted it all into the spreadsheet that links to the health services map I was maintaining in ArcGIS Online (arcg.is/1LOXPr).

GOING BIG

Taking ArcGIS Online to the E-campus

By the summer of 2017, I had worked out the majority of the issues I was having with my on-campus courses, so I ventured to use ArcGIS Online in my e-campus course. I created a two-page manual to guide students on how to use ArcGIS Online and dedicated a discussion board to addressing any problems that came up.

To my surprise, teaching ArcGIS Online via an e-campus course went relatively smoothly. I did have to adjust the manual to include a few steps on how to fix individual maps. But the only big challenge I face now is locating additional information, since my previous students have already mapped what was readily accessible via simple Google searches. Students have begun mining apps such as Facebook, Twitter, Yelp, and Instagram and even scouring hashtags to locate more health centers in Asia and Africa. We will see what kinds of data that produces.

The dataset has now reached approximately 4,000 data points. Although I have gotten pop-up windows and data standardization under control, I continue to struggle with duplicate data entries—even though I've given students access to the dataset to check their work. Currently, I am compelled to clean the data manually.

TAKING THE LEAP

Using GIS in the Classroom

The geography program at Oregon State University made a conscious effort to introduce undergraduate students to fundamental GIS functions in Esri Story Maps apps and ArcGIS Online so that upper-division courses could go well beyond the basics. While this was certainly motivating, a program need not require faculty to make that leap. A few professional development opportunities can move the needle in that direction.

So I urge any and all educators—whether you are comfortable with technology or not—to consider using GIS in your courses. It promotes active learning and challenges students to consider how geospatial tools can be used to solve the world's most pressing problems.

About the Author

Dr. Shireen Hyrapiet has a PhD in geography from Oklahoma State University and was a senior instructor of geography at Oregon State University. She currently teaches geography at Houston Community College. Email her at shireen.hyrapiet@hccs.edu and follow her on Twitter at @hyrapiet.

A City Council Agenda Goes Visual

In Oak Hill, West Virginia, City Business Now Gets Shared Via Story Maps

This is the story of how the manager of a small city in West Virginia came up with a big idea: Use an Esri Story Maps app to convert the city council agenda from a drab document to a lively account of municipal business.

Another main character in the plot line, of course, is the city's lone GIS employee. He tenaciously works to bring his boss's idea to fruition each month. Using the Esri Story Map Series app, he creates an itemized, interactive agenda that describes each order of business and provides supplementary maps, photographs, and links to documents such as reports, legal notices, and correspondence.

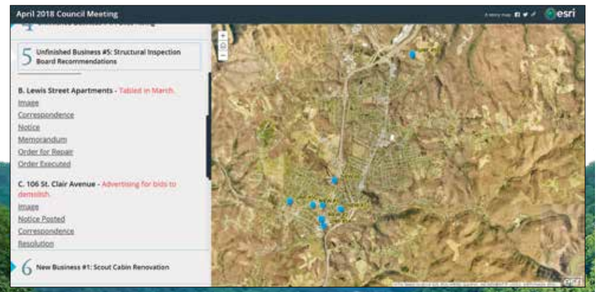
As many people know, one document guides city council meetings: the tried and true agenda, which lists items up for discussion or a vote. The typical agenda, often available via PDFs posted on city government websites, tends to be written in a bureaucratic style and is usually void of visuals like maps, photographs, or other multimedia.

But that's no longer true for Oak Hill, West Virginia, a city of 8,500 people that lies just west of the 70,000-acre New River Gorge National River. There, the city council replaced its static presentations with an animated story map (available at gis-cityoh.opendata.arcgis.com) to guide its monthly meetings.

Earlier this year, city manager Bill Hannabass spotted an Esri story map for the first time and immediately thought, "Gosh, I could use that for the council presentation. It's visual." Currently, seven story maps apps are available at no additional cost to ArcGIS Online account holders like the City of Oak Hill.

Hannabass was shown the story maps app by Esri account manager Daniel Peters from Charlotte, North Carolina, who was in West Virginia to meet with him and other local government officials earlier this year. Having used maps to view assets when he served in the US Army, Hannabass was naturally drawn to their ability to tell a story visually and tell it quickly. He was also impressed that the cloud-based interactive maps from the city's ArcGIS Online organizational account could be used in the story maps.

↑ In Oak Hill, West Virginia, the city council replaced its static agenda with an animated story map to guide its monthly meetings.



↑ One of the agenda items that Davis worked on for the April city council meeting dealt with structural inspection board recommendations on several buildings that needed to be repaired or demolished.

Oak Hill is located near the New River Gorge National River, which is well-known for white water rafting.

Davis mapped the buildings' locations in the story map and added links to images of those structures, as well as related documents such as demolition orders and bids.

"It makes *[the agenda]* informative," Davis said about the story map format. "*[Viewers]* get the geographic context of that issue and get all the information at their fingertips."

Oak Hill City Council members and local media outlets receive the story map agendas in a ShareFile packet that Hannabass sends via email prior to meetings. During the city council meetings, Hannabass also goes through each numbered item on the story map agenda, which is displayed on two screens in city hall.

Agenda items often have geographic reference points, so Hannabass said using a story map as an agenda makes it easy for him to answer questions if any come up.

"If there are four dilapidated structures that I have to tear down, and someone asks, 'What street is that *[building]* on?', I can pull up a map," Hannabass said.

And because photos and legal or other documents can be linked in the story map, those are easy to access and view, too, if necessary. No longer does Hannabass need to display the agenda as a Microsoft Word document or a PowerPoint presentation. Gone are the PDFs and scanned images of maps.

"If *[anyone]* asks questions, there is a ton of information in *[the story maps]* I can dig into," said Hannabass. "You don't have a ton of boring PDFs to flip through."

Hannabass said online story maps are an excellent medium for sharing information with a city council, board of directors, or other public or private groups. People are often

↑ GIS coordinator Marvin Davis creates the city council agenda in the story map format each month.

overwhelmed by reams of paper they receive before a meeting. So he put an end to paper-based agendas in Oak Hill some time ago.

"Our council packets were three to five inches thick," Hannabass said. "It is crazy to have that much paper work."

Davis said that Hannabass has been a strong advocate for a municipal GIS, first bringing him on board as GIS coordinator and recently by helping to forge an enterprise license agreement between the city and Esri. That agreement, which began in July, is increasing the number of city employees with access to GIS and beefing up capabilities to do analysis.

"Hannabass has been my biggest champion here," Davis said.

The city also started sharing the city council story map agendas with the public on its new open data site, making it easier for Oak Hill residents to stay informed about what's happening in their community. Now, city council members, the media, and residents can study the city council agenda plus all the related documents in one online app before the meetings begin.

"That is transparency that is beyond what is typical," Hannabass remarked.

Davis said that because there's often a geographic component to city business, sharing information via a story map agenda makes perfect sense. If viewers want to take a closer look at zoning designations or a proposed new one-way street, for example, they can use the story map to pan around and zoom in on those locations. A PDF or a scanned image of a map restricts their view.

"I am biased," said Davis, referring to his interest in geography and his job in GIS, "but I think *[the story map agenda]* offers a more informed view. You are able to look at pertinent documentation and a map."

Since Esri released the first Esri Story Maps app in 2014, people around the world have built about 640,000 maps. But Oak Hill's story map designed specifically for city council agendas seems to be a first.

The city's adoption of the Story Map Series app to produce the agendas impressed Allen Carroll, who leads the Esri Story Maps team and is program manager of storytelling at Esri.

"We're always thrilled to see fresh and unexpected new uses of Esri Story Maps," Carroll said. "Oak Hill's use of our Story Map Series app to present its council agenda is a delightful example of the versatility and power of map-based storytelling."

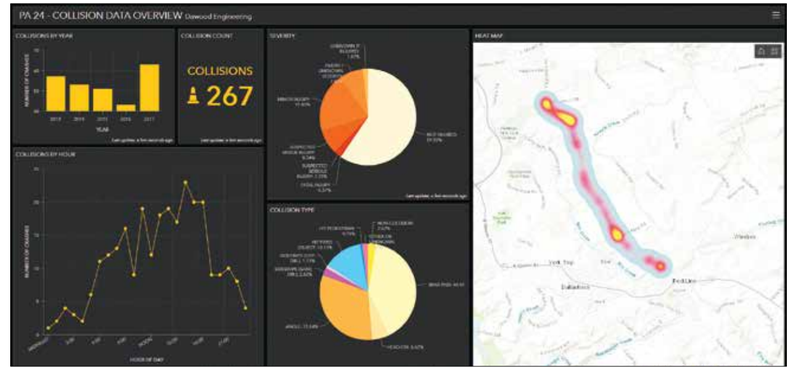
Standing Out with Story Maps

By Jodie Gosselin, Dawood Engineering

Standing out in today's marketplace is a challenge that every company faces. But Dawood Engineering, Inc., a multistate engineering firm headquartered near Harrisburg, Pennsylvania, has found a new way to gain an edge. Instead of using trite slide presentations in meetings and demonstrations, the company now uses Esri Story Maps apps.

These interactive, engaging web apps allow Dawood's GIS and marketing teams to customize their content—including text, images, videos, and immersive maps—using a variety of templates. When thoughtfully designed, story maps are intuitive and flow logically. They're versatile, too: users can share them with a simple hyperlink or have them replace traditional tools, such as Microsoft PowerPoint, in formal presentations.

Dawood capitalizes on this flexibility and uses story maps for business development, project summaries, team meetings, and presentations. Here's how.



↑ With story maps, the transportation team can explain the results of its road safety audits using interactive maps and dashboards that show detailed crash data.

A Powerful Tool for Business Development

In years past, Dawood employees used to hand out one-page service sheets at meetings and conferences that outlined what the company could do, from site design and permitting to large transportation projects and land-use planning. But oftentimes, these handouts didn't foster much meaningful interaction with the recipients.

Now, the GIS and marketing teams illustrate the company's capabilities using story maps. Taking advantage of its GIS database of all project locations, Dawood's GIS team can add project-specific details and images to the database. Then, anyone building a story map can include those elements as pop-ups in interactive web maps.

One story map, for instance, summarized all the projects Dawood had completed for the Pennsylvania Department of Transportation (PennDOT) and broke them up by county. An interactive map showed the density of projects across the state using a color gradient, while pop-up windows highlighted one specific project per county, complete with photos and a summary of the work Dawood did.

Dawood's employees can access the finished story maps online using their laptops, tablets, or smartphones. This portability enables staff to pull from a variety of previously developed apps that they can showcase during impromptu conversations. Additionally, having the hyperlink for a story map is an effective means of sharing this information via email with existing and potential clients.

Since making the switch from pamphlets to story maps, the management team has noticed an uptick in the number of engaging conversations it has with potential customers and existing clients.

"All marketers want a great story to tell," said Jim Rodgers, chief strategic officer for Dawood. "With story maps, we can show real project data as part of the marketing process. It's a much more powerful tool than a static pitchbook."

Making Project Presentations More Dynamic

Dawood has also started using Esri Story Maps apps for individual projects.

The transportation team, for instance, now employs story maps to show the results of its road safety audits. Traditionally, Dawood presented these via PowerPoint. But the transportation team wanted to do something more dynamic.

With story maps, the team can incorporate interactive mapping and dashboards of crash data into its presentations. These powerful visuals are far more effective at highlighting safety concerns than just using raw numbers or anecdotal evidence. And the feedback has been positive. Both the Federal Highway Administration and PennDOT have lauded this inventive way of summarizing road safety audits.

Dawood's geotechnical group, which investigates the subsurface of each project and provides recommendations for site design based on its findings, also uses story maps to supplement its final reports.

Conventional geotechnical reports can run hundreds of pages and have countless figures, logs of soil bore findings, and construction diagrams. By putting all this information into a story map that includes embedded web maps, the group can more easily summarize all aspects of its investigation. What's more, field crews can now access the geotechnical group's story maps and view all this critical information on-site throughout construction.

Engaging citizens is a priority for just about every civil construction project, and story maps are a great resource for that, too. They can be exhibited at public meetings or featured on municipal websites in lieu of large print maps or rigid PDFs.

Finding a Template That Fits

Esri offers a variety of templates for its story map apps, and choosing the right one is important.

Many of the story maps made at Dawood employ the Esri Story Map Cascade template. It reads like a web page, letting users design a scrolling story map that seamlessly incorporates text, images, video, maps, and other immersive content.

Story Map Series is a great option for presenting project summaries at meetings. It provides tabbed navigation, which is helpful when viewers need to toggle among different sections of content.

Story Map Tour showcases key points along a route or timeline. When Dawood celebrated its twenty-fifth anniversary, it chose this template to illustrate how the company had expanded in both size and geography over the years.

For doing before-and-after comparisons—to show pre- and postconstruction plans, for example—Story Map Swipe and Spyglass is a good choice. The template makes it easy to juxtapose aerial photos taken at different points in time, as well as proposed designs versus existing conditions.

There are several other templates to choose from, and the story maps team at Esri is always developing more. Head to storymaps.arcgis.com to discover what else is available.

Tips and Tricks for Creating a Successful Story Map

A user's experience ultimately defines how well a message comes across on any medium. Story maps are no different. Here are some tips and tricks for building an effective one.

- Keep story maps simple and on point. Only present the information a viewer absolutely needs to see. Limit pop-ups and minimize how many layers a user can toggle on and off.
- Creating a well-defined storyboard or outline ahead of time can help organize content and determine which template is most appropriate. Develop sufficient text, images, and videos and determine early on which pieces of content will be interactive.
- Embedding one story map within another is a clever way to present different types of material. For instance, Story Map Cascade could serve as one tab in a Story Map Series app, providing an overview of the project. Story Map Cascade could give the background information, such as topography or soils, needed for the project being outlined in the main story map.
- Using static images of maps within one immersive section is a great way to present multiple viewpoints, like all the different utilities on a street (fire hydrants, manholes, catch basins, etc.). This lets users keep scrolling while the images update seamlessly, making the map look interactive. Not only does this give users a more focused experience, but it also saves on bandwidth.
- Take screenshots of the story map or use the Export to PDF function to make a backup copy. Nobody wants their presentation to go from *Whoa!* to *No!* if technology lets them down.
- Have a nontechnical user test each story map to ensure that it makes sense to people who are unfamiliar with that project or presentation or even GIS.

Story maps are a powerful communication tool that have helped Dawood unlock its GIS data and make it available for colleagues, clients, and members of the public to see. Why not try making a story map for your next presentation?

About the Author

Jodie Gosselin, GISP, is the GIS manager at Dawood Engineering, a multidisciplinary design firm founded in 1992. She has 15 years of experience in GIS with a focus on utilities and asset management. Gosselin is on the board of the New England chapter of the Urban and Regional Information Systems Association (NEURISA) and serves as the chapter advisory board representative to URISA. For more information on this topic, contact Gosselin at jgosselin@dawood.cc or 855-432-9663. Follow her on LinkedIn at p.ctx.ly/r/8egt.

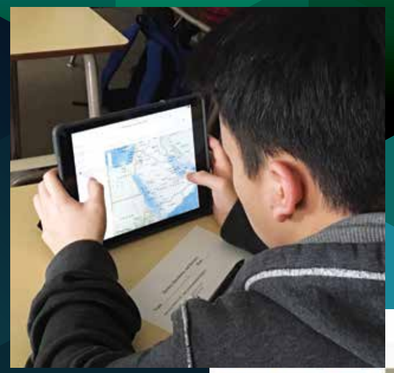
Getting Teachers Started with GIS

GeoInquiries Can Help Educators Teach Their Subjects More Effectively

If GIS helps people understand the world and solve problems, then it's a great tool for students to get their hands on early in their education. But how can a typical overworked schoolteacher easily engage with this technology?

GeoInquiries can help. These short, standards-based instructional activities use ArcGIS Online to teach common elements of US curricula to K–12 students. With 155 activities, GeoInquiries (available at esri.com/geoinquiries) are designed to help teachers teach their subjects more effectively. They align with the most common textbooks in use today and can run in any classroom environment that is minimally equipped with a projector and a computer or mobile device.

GeoInquiries, which Esri first released in 2014, are not GIS skill builders but rather rich sources of map-based content that most teachers are required to teach. The lessons employ established pedagogies that teachers tend to learn during their teacher education programs.



↑ Students can explore a GeoInquiries map using an iPad or Chromebook device.

Subject-specific collections include US History, World History, Government, Human Geography, Earth Science, Environmental Science, Upper Elementary, Mathematics, and American Literature. Each collection contains 15 two-page Level 1 activities, which don't require teachers or students to sign up, log in, or install software.

In this configuration, teachers can stand up in front of the class and deliver the activity to students. Alternatively, in classrooms where each student has a device, such as an iPad or a Chromebook, teachers can distribute the lesson's map URL to students and then verbally guide learners through the inquiry.

This past summer, Esri also began releasing Level 2 GeoInquiries in the US History, Human Geography, Government, and Earth Science collections. Unlike the Level 1 activities, these inquiries require a free school software bundle from Esri (available at esri.com/schools) and at least one login for the teacher who is demonstrating the activity. In Level 2 GeoInquiries, students and teachers engage with analysis tools and use premium data from ArcGIS Living Atlas of the World.

For example, in the Level 2 US History GeoInquiry Dust Bowl: Population Shift, learners use the Summarize Within tool in ArcGIS Online to aggregate and describe the change in farm counts and farm acreage before and after the dust bowl, which decimated agriculture in the Great Plains of the United States during the 1930s.

When Stacey Greer, a former education programs consultant at the California Department of Education, presented a similar dust bowl GeoInquiries lesson to her colleagues, she was impressed by how fascinating these teaching professionals found the software.

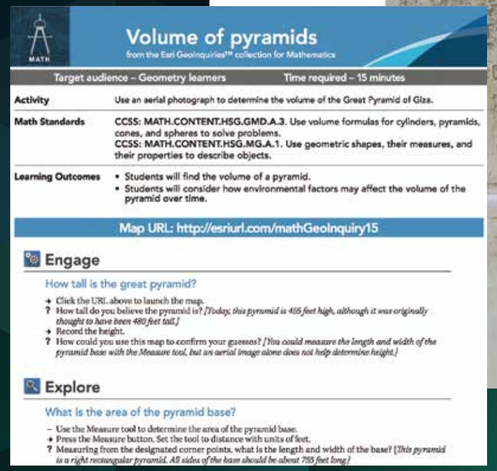
"I've never seen another division activity create so much buzz," said Greer, who now directs The History Project at the University of California, Davis. "Folks did not want to leave the computers."

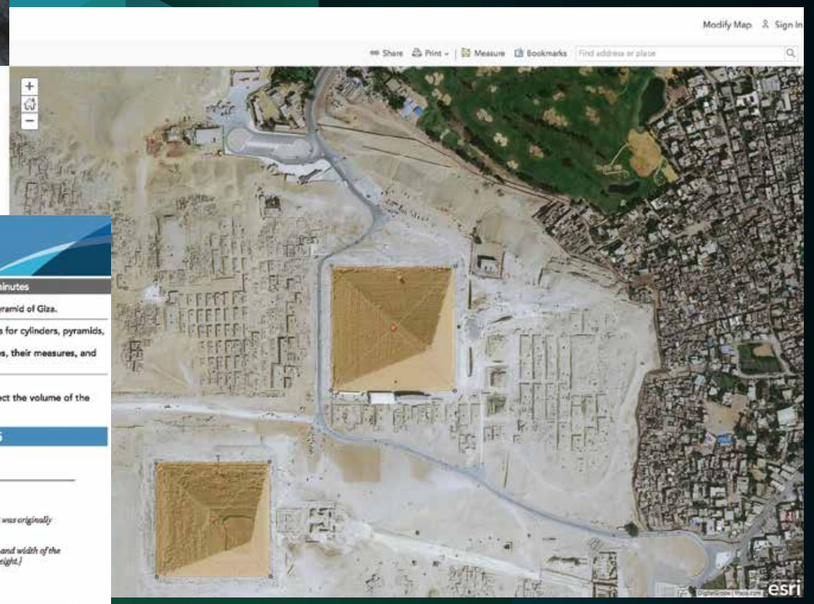
Educators around the United States are also beginning to modify existing GeoInquiries and even build their own to fit their state education standards. In Georgia, Cobb County public schools are creating new GeoInquiries based on the state's history. And the Texas Geographic Alliance is building GeoInquiries lessons to teach students about the region's geography. Teachers can find state-based activities on the GeoInquiries GeoNet site (p.ctx.ly/r/82lg), as well as a planning guide and replication templates.

Although GeoInquiries are easy to set up and intuitive to use, some educators need a bit of prodding to get started. To introduce a teacher to these GIS-based lessons, email him or her the GeoInquiries URL and invite the educator to explore the lessons and get familiar with the tools. Follow up after a few weeks to get feedback, and show the teacher how to modify the ArcGIS Online maps. If the educator has requested an ArcGIS Online organizational subscription through the free school software bundle, show him or her how to save ArcGIS Online maps to the school's account.

Getting teachers going with GeoInquiries shouldn't require the full support of a GeoMentor, since the materials are designed to be intuitive, specifically for educators. Once teachers become proficient in using and teaching GeoInquiries, they will likely gain interest in doing more with GIS in the classroom.

For more information on GeoInquiries, contact the Esri GeoInquiries team at geoinquiries@esri.com.





←↑ The collections for algebra and geometry let students explore math-based concepts via real-world examples—like using the formulas for calculating volume to find the volume of the Great Pyramid of Giza in Egypt.

The Relevance of Cartography

A Cartographer's Perspective

A column by Menno-Jan Kraak
President of the International Cartographic Association

Can We Do It Again?

The scientific method is getting quite a bit of attention these days. How scientists work and produce results is under widespread scrutiny.

Of course, scientists have conducted innumerable studies that have followed the appropriate process of testing ideas and theories via observations and experiments and then verifying the results. But some individuals, from various scientific disciplines, have made up data, executed false experiments, and followed biased reasoning—all resulting in irreproducible results.

A Dutch psychology professor, for example, published several experiments that attracted a lot of attention. One allegedly proved that trash-filled environments can lead people to have racist tendencies. In another experiment, he claimed that eating meat made people less social and more selfish. Both experiments, however, were based on fabricated data and dubious research methods.

It is claimed that behavior like this happens because of the heavy pressure put on scientists to publish their work—that this is what stimulates carelessness and even fraud.

Two keywords that go with the scientific method are *reproducibility* and *replicability*. Reproducibility refers to using the same data with the aim of getting the same results. It requires original data and an overview of all the processing steps and results. Replicability refers to using new data but following the same workflow, as closely as possible, to get similar results.

I thought it would be an interesting exercise to see how using the scientific method would affect cartography—principally because if five professional cartographers are given the same dataset to visualize, they will produce five different map designs that could all be classified as good. So how do reproducibility and replicability work here?

To answer that question, it is best to start by looking at the definition of the discipline. The International Cartographic Association (ICA) defines cartography as the art, science, and technology of making and using maps.

The science part of cartography is related to gaining a systematic understanding of the data that needs to be mapped. It also involves taking into consideration the primary objective(s) of the map and who its potential users might be. But let's concentrate on the data analysis first.

In short, a cartographer needs to establish the character of the data: is it qualitative or quantitative? The mapmaker also needs to define the perceptual properties of the symbology that will be used. For instance, with quantitative data, the symbol should evoke the perception of amounts. This indicates that the symbols should be variable in size and able to be applied in relevant map types. Because this part of the workflow is based on fixed rules and guidelines that can be found in any cartographic textbook, it is very likely that it can be executed in a reproducible way.

Why, then, do we still get five different map designs? Well, because of the art part of cartography—the cosmetics of the map.

The reproducible theory stops at *a point symbol that changes size*. Nobody tells us if the symbol should be rectangular or circular in shape. Sure, there is literature explaining which shapes work best for which situations. But this does not yield clear, definitive results.

So out of the five cartographers, one might select a circle, another a square, and yet another might opt to use a pictorial symbol. Even if somehow they all choose circles for the symbology, each cartographer still has enough artistic freedom to make them all different. One might make them bright red, green, and orange circles with shading. Another might use pastel colors without gradients. The options are unlimited, yet they could all result in forming a good, communicative map.

Does this disqualify cartography as nonreproducible? Personally, I do not think so. The science part of the cartographic workflow—the cartographic data analysis—is reproducible. The artistic part of the workflow is not 100 percent reproducible, but one's choices can often be explained.

Of course, given the context in which the map will be used and the message it's supposed to convey, cartographers can still deviate from the expected artistic logic. Assuming most people associate green with good and safe, what if a cartographer chooses green colors to indicate polluted areas or places with high unemployment rates? In theory, the choice is not wrong. But from a moral standpoint? In other words, if we see a map like this, can we still reason why the cartographer made these artistic choices?

If we look at the *use* part of the definition of cartography, then cartographers should be very much involved in usability research to judge whether or not their map designs make sense. Here is where reproducibility and replicability play a significant role.

But the protocols of usability research are still in full development. Usability experiments have proven to be difficult to reproduce, not only because the authors of research papers don't describe the conditions well enough, but also because the original observational data is rarely still available. Questions abound on how to reproduce similar test environments, which maps should be used, and who should take the tests.

These days, researchers are obliged to keep their data from all steps of the research process. For cartography, that means cartographers should describe how they applied the scientific method when making the map and document why they made the design choices they did (e.g., why the orange circles?).

This would help validate the scientific elements of cartography. On the other hand, it introduces another burden—that of the time-consuming process of putting together detailed procedural workflow descriptions, similar to writing extensive metadata descriptions. That is a topic we will have to keep an eye on.

About the Author

Menno-Jan Kraak is professor of geovisual analytics and cartography at the University of Twente in the Netherlands, where he has been teaching since 1996. He has a degree in cartography from the Faculty of Geographical Sciences at Utrecht University and received his PhD in cartography from Delft University of Technology. Kraak has written extensively on cartography and GIS. His book *Cartography: Visualization of Spatial Data*, written with Ferjan Ormeling, has been translated into five languages. He also wrote *Mapping Time: Illustrated by Minard's Map of Napoleon's Russian Campaign of 1812*, published by Esri Press in 2014. Kraak is a member of the editorial boards of several cartography journals, including the *International Journal of Cartography*. He currently serves as president of the International Cartographic Association.

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.

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- **Configuring Web Apps Using Web AppBuilder for ArcGIS**
  Believe it or not, it's possible to create and share focused web apps with an ArcGIS organizational account without doing any coding. This one-day course shows learners how to use existing web maps, themes, and configurable widgets to build apps that feature an organization's branding and deliver geospatial capabilities to end users.

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Esri learning plans cover a variety of GIS concepts and ArcGIS topics—and anyone with a free Esri account (get one at accounts.esri.com) can enroll in them. Available on the Esri Training website, each plan contains a set of sequenced resources that learners work through at their own pace.

Some people like to use them to achieve a specific learning objective, while others see them as a starting point for creating their own individualized plans. Either way, users can make a copy of an Esri learning plan and, if they want, add or remove resources to it to reflect their personal learning goals and interests.

It is easy to build a plan from scratch by adding items directly from the *Training* catalog. Additionally, managers and educators can assign employees and students to certain plans and then track learners' progress as they go through them. Users can also share learning plans privately with specific individuals or publicly to the catalog, where the entire Esri Training community can easily find and enroll in them.

For organizations, learning plans are a valuable tool to increase awareness of GIS and ArcGIS capabilities, as well as to onboard new employees, prepare teams for upcoming projects, and support ongoing professional development. Educators also use learning plans to complement their curricula, build geospatial literacy, and help students acquire in-demand technical skills.

Ready to embark on a learning plan of your own? All you need is an Esri account and a desire to expand your skills. Visit esri.com/training/learning-plans to get started.

Certification

While Esri Technical Certifications never expire, old exams do get retired. On December 31, 2018, Esri will retire all version 10.3 exams. So if you are interested in achieving a 10.3 certification, be sure to schedule a test appointment before the end of the year.

Exciting changes are coming to the Esri Technical Certification Program in 2019. In addition to releasing new and updated exams, Esri will give certified individuals the opportunity to earn specialty certifications. Look for details and announcements in the coming months.

> "Esri Technical Certification is like most things in life: the more you put into them, the more you get out."
>
> So said Sandeep Burra, a senior GIS engineer at Openware Information Systems in Kuwait. He believes that his two Esri Technical Certifications have increased his credibility with colleagues and clients. Read Burra's story at go.esri.com/success-gallery.

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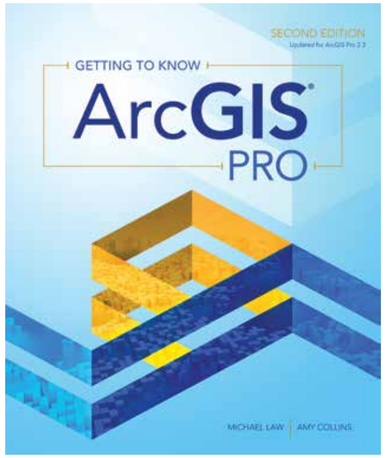
Esri Press

Getting to Know ArcGIS Pro, Second Edition

By Michael Law and Amy Collins

Another valuable addition to Esri's best-selling Getting to Know series, *Getting to Know ArcGIS Pro*, Second Edition, helps new and existing GIS users get started with ArcGIS Pro. Updated for ArcGIS Pro 2.3, the book teaches readers the basic functions and capabilities of ArcGIS Pro using practical, project-based workflows. Authors Michael Law and Amy Collins guide readers through how to solve problems by creating, querying, analyzing, visualizing, and presenting geospatial data in both 2D and 3D environments in ArcGIS Pro. By the end of the book, readers will understand how to solve problems with this essential component of the ArcGIS platform. January 2019, 480 pp. E-book ISBN: 9781589485389 and paperback ISBN: 9781589485372.



For more information on all Esri Press publications, visit **esri.com/esripress**.

GIS Day will officially be held November 14, 2018. This means GIS users and advocates are gearing up to host and attend events all over the world that show how geospatial technology makes a difference in business, government, education, conservation, and society in general.

How are some organizations celebrating?

- Esri chief scientist Dawn Wright will give the annual Borchert Lecture at the 2018 Spatial Forum on November 14 at the University of Minnesota, Minneapolis. Entitled "Swells, Soundings, and Sustainability in the Ocean," the lecture will focus on how the ocean has been mapped from ancient times to today and how modern mapping systems have become increasingly intelligent. The event, hosted by the university's Master of Geographic Information Science (MSGIS) program; the Geography, Environment and Society Department; and U-Spatial, is open to the public.
- The County of Los Angeles will present its eleventh annual GIS Day, billed as the largest GIS Day program on the West Coast, on November 14. Attendees will learn how county and city agencies use GIS for decision-making. The event will include a map gallery, lectures, demonstrations, and games—all designed to showcase how GIS is being used in government.
- The Montana Association of Geographic Information Professionals (MAGIP) will host the 2018 MAGIP GIS Day Web Map Contest on November 13 in Helena, Montana. MAGIP organizers say they will also host meetups throughout Montana to promote GIS.
- The School of Ocean Technology will present a program on ocean mapping and marine GIS at the Fisheries and Marine Institute of Memorial University of Newfoundland in Canada on November 14.
- The Geomatics Engineering Society (GES) at Kathmandu University in Nepal will host talks, panel discussions, and a project showcase by university students on November 13.
- Esri South Africa will give technology demonstrations with an emphasis on how ArcGIS supports machine learning, artificial intelligence, and the Internet of Things (IoT) at a GIS Day program in Johannesburg on November 14.

Find out about events near you—or register your own—at gisday.com.

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