# ArcUser

The Magazine for Esri Software Users

## The 40th and First User Conference  30

esri | THE SCIENCE OF WHERE

# Contents <span>Summer 2020  Vol. 23  No. 3</span>



## Focus

## Special Section

## End Notes

# Interconnected on Many Levels

The GIS community came together for the Esri User Conference (Esri UC) this year, as it has for the last 40 years. However, the meeting space was virtual and not face-to-face. That change, necessitated by the coronavirus disease 2019 (COVID-19) pandemic, allowed an additional 70,000 people to attend the event—more than at any previous Esri UC.

"Interconnecting Our World," the theme for this year's Esri UC, turned out to be incredibly apt. The events of 2020 have made it glaringly, unavoidably apparent that interconnection is a fundamental characteristic of the world in which we live.

As the COVID-19 pandemic has demonstrated, interconnection exists across physical, economic, and societal levels. The virus has traveled to nearly every country, causing lockdowns and shutdowns that have not only affected local economies but disrupted the delicate and far-reaching web of global supply chains, causing effects that are felt half a world away. The stress to societies caused by these economic displacements have disproportionately impacted communities of color, revealing how social inequities are connected to long-standing and pervasive policies.

Fortunately, interconnection is also *how* GIS works and *why* it works. Geography is the framework that lets us see those connections and the context of problems. GIS is the technology that enables the use of a geographic framework to supply context and suss out relationships. It provides analysis tools for answering questions ranging from where is the best place to locate a new fire station to anticipating where ventilators will be needed if cases of COVID-19 surge.

To solve larger-scale problems, GIS is evolving into an even more interconnected and powerful system of systems. Building out this geospatial infrastructure will connect the worldwide community of GIS professionals so that they can bring to bear more resources on the challenges of an increasingly complex world.

As was seen in response to COVID-19, the actions of the GIS community matter. The response to the pandemic was celebrated throughout Esri UC. Jack Dangermond, Esri's president, characterized these efforts as "heroic work, no matter how you measure it."

The GIS community continues to take the lead in developing strategies for dealing with the monumental challenges the world faces. Interconnection is more important now than ever.

Monica Pratt
*ArcUser* Editor

**24**



**38**



**56**

# Departments

# Briefly Noted

## → Tools to Help with Racial Equity

The Esri Racial Equity microsite (www.esri.com/en-us/racial-equity/overview) shares resources for national, state, and local government organizations; nonprofits; and businesses so that they can use location intelligence to help address racial inequities. The site has tools and workflows to map and analyze inequities and engage communities. Resources include access to the Racial Equity GIS Hub (gis-for-racialequity.hub.arcgis.com), which provides data sources and relevant content. The site links to the Esri Disaster Response Program (DRP), which will support organizations responding to racial inequities.

## → ArcGIS Online Users Are Not Affected by Security and Privacy Issues

Microsoft announced a 17-year-old critical DNS server vulnerability (CVE-2020-1350) and provided a security patch. Fortunately, ArcGIS Online does not make use of Windows-based DNS servers and is therefore not vulnerable to this threat. However, Esri recommends that users update applicable DNS servers with the security patch released by Microsoft to protect users' on-premises or cloud-based deployments.

In July 2020, the Court of Justice of the European Union (EU) ruled that the protection provided by the EU-US Privacy Shield Framework was inadequate as a mechanism for complying with EU data protection requirements when transferring personal data from the European Union to the United States. Fortunately, through regional hosting—specifically, the EU region for ArcGIS Online—users can store their data in the EU. Esri utilizes a third party to assess the privacy adequacy of its operations.

## → Use Your Influence

If you aren't already a member of the ArcGIS Online Early Adopter Community (EAC) program, you should think about joining. As an EAC member, you will have a direct line of communication with the ArcGIS Online team and influence how the software is developed.

Members of EAC represent a wide range of experience levels, industries, and workflows from around the world. Members not only preview prerelease versions and documentation for ArcGIS Online, but they also have access to forums where they interact with other EAC members and Esri product teams. Sign up today at esri.com/en-us/early-adopter.

## → New Tool to Use Census Data to Fight Pandemic

Esri and the United Nations Population Fund (UNFPA) are collaborating on a new interactive tool that will provide public health workers, policy makers, and the general public with access to useful information on populations vulnerable to coronavirus disease 2019 (COVID-19). The UNFPA COVID-19 Population Vulnerability Dashboard will help target preparation and response efforts to help save lives. The dashboard highlights population vulnerabilities at the national and subnational levels, using data from the latest Integrated Public Use Microdata Series (IPUMS) census samples for 94 countries. Daily updates on COVID-19 cases and deaths are embedded in the dashboard.

## → Esri Named a Leader in Location Intelligence Platforms

The independent market research firm Forrester recognized Esri in T*he Forrester Wave: Location Intelligence Platforms, Q2 2020 Evaluation.* The report acknowledges Esri's leadership in location intelligence technology and highlights the company's long-term commitment to the development of a shared global geospatial infrastructure. The report noted, "The key strength of Esri's platform is its complete set of location intelligence ca-pabilities. It has depth and strength in multiple areas, including data management, data products, spatial visualization and analytics, and location intelligence execution." To learn more about Esri's ranking in *The Forrester Wave: Location Intelligence Platforms, Q2 2020 Evaluation*, visit go.esri.com/ForresterWave2020.

## → Deadline for HTTPS Only Requirement for ArcGIS Online Extended

Enforcement of HTTPS Only for ArcGIS Online has moved from September 15, 2020, to December 8, 2020, to ensure that all users have a six-month preparation period, as this important security update is likely to affect some ArcGIS software and custom solutions. Esri users need to act promptly to be ready for this change.

The ArcGIS platform uses the HTTPS protocol as a key component of its security for web and service API connections and includes connections between ArcGIS Online, ArcGIS Desktop, and ArcGIS Enterprise. HTTPS Only has been a default configuration setting in ArcGIS Online since September 2018. All new subscriptions since then cannot disable HTTPS. For ArcGIS Enterprise, HTTPS Only has been the default since version 10.7. With ArcGIS Enterprise, users have the option of turning this capability off if desired.

# Future Impacts of GeoAI on Mapping

By Steve Snow

*We are now living in an age where technology is the backbone of successful mapping organizations. By embracing technology, all parts of the workplace have become more productive.*

**Geospatial organizations** have continually improved production and analysis processes by introducing automation and new technologies. An exciting recent addition to automation has been the introduction of artificial intelligence (AI), deep learning (DL), and geographic artificial intelligence (GeoAI). These new technologies, when paired with human operators, are ushering in exciting capabilities that were previously considered possible only in science fiction.

The term *AI* was first introduced in 1955 by John McCarthy, a computer scientist and professor at Stanford University. The lack of the large and publicly available datasets required to train AI models and lack of computational power caused the field of AI to grow slowly. This started to change with the development and growth of the internet which made large amounts of data publicly available. Additionally, the advent of the graphics processing unit (GPU) has made possible affordable processing and accelerated the development and use of AI.

DL is a subset of AI that mainly uses neural networks that are very similar to the human brain. DL is being used in self-driving cars, speech recognition, robotics, image classification, and other areas that require quick decision \-making and pattern recognition.

## Why You Should Care

The most interesting development for mapping modernization has been GeoAI, the intersection of geospatial technology with AI and location.

Modernization is an ongoing process. The move from typewriters to computers—and now to GeoAI—didn't happen overnight. There is always a lag before adoption, and the hardest part of adapting to change is overcoming the fear of becoming irrelevant. The fear of being replaced often makes it hard for workers to recognize the opportunities that a new technology brings.

GeoAI provides new opportunities for workers to enhance their knowledge and understanding, making them more competitive in the workplace. By seizing these opportunities, workers can remove the risk of being left behind and advance their job skills. Remote sensing is one area in which this is taking place.

## GeoAI in National Mapping and Remote Sensing

It's important to note that mapping through earth observation is a difficult task. Earth observation spans multiple domains: air, land, and sea. One unifying technology is needed for mapping large geographic datasets in national domains. It requires a platform that is highly adaptable to support aviation, topographic mapping, and disaster response, as well as maritime charting of the ocean's bathymetry, water column, and littoral zones. Esri's ArcGIS platform utilizes GeoAI for object detection and classification from both point clouds and raster surfaces derived from remotely sensed data. Many international organizations, such as the International Civil Aviation Organization (ICAO), are bringing GeoAI into mainstream industries.

## About the Author

**Steve Snow** is an industry specialist for mapping, statistics, and imagery at Esri with more than 18 years of experience working in GIS, mapping, charting, and remote sensing. Prior to joining Esri, he was a commissioned engineer officer in the US Army. He was also a corps officer with the National Oceanic and Atmospheric Administration (NOAA), focusing on remote sensing, surveying, and charting for the US National Geodetic Survey Remote Sensing Division and NOAA Office of Marine and Aviation Services. A longtime GIS and remote-sensing professional, Snow focuses on applying remote-sensing capabilities to solve user mapping challenges with the ArcGIS platform.

**Trimble** | **esri** Partner Network Silver

Reality **Captured**

GIS **Empowered**

Intelligence **Delivered**

Geospatial.trimble.com/esri

# Studying Ancient Methods of Sustainable Development with GeoAI
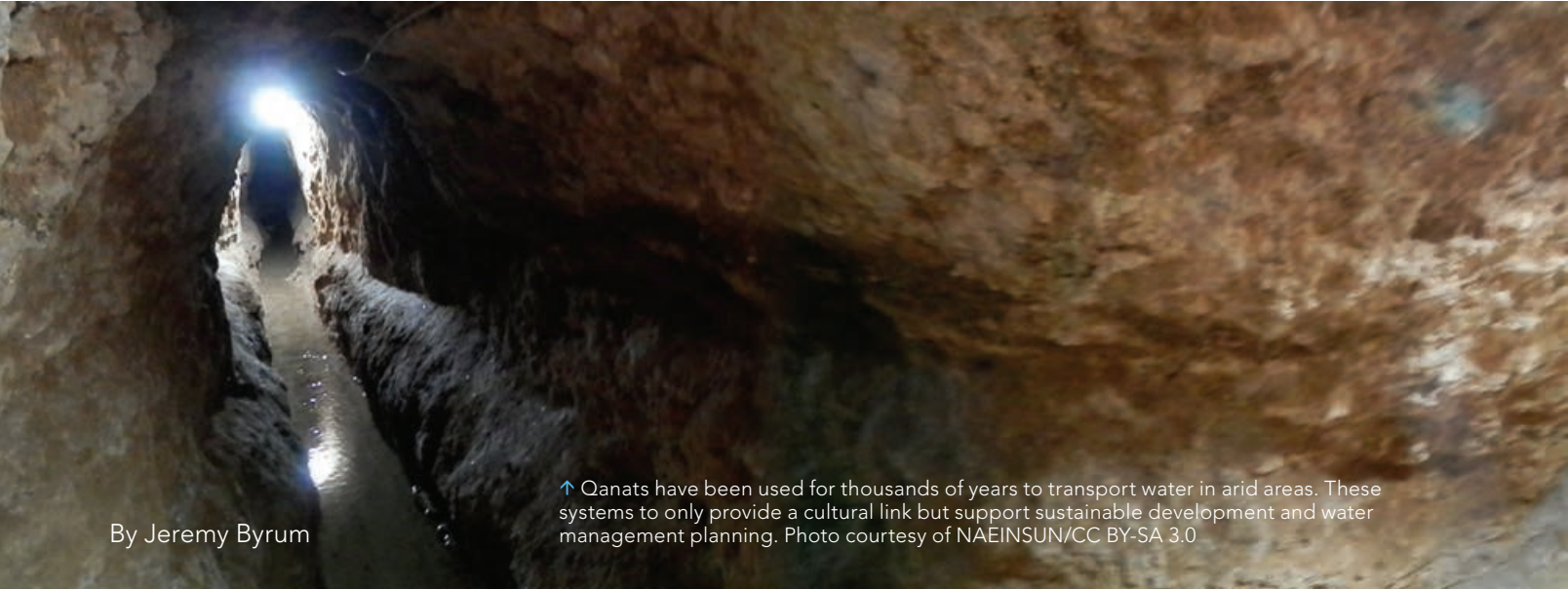


↑ Qanats have been used for thousands of years to transport water in arid areas. These systems to only provide a cultural link but support sustainable development and water management planning. Photo courtesy of NAEINSUN/CC BY-SA 3.0

By Jeremy Byrum

Sasa Arsic, a graduate student at Claremont Graduate University (CGU) in Claremont, California, used the deep learning capabilities in ArcGIS Pro to map ancient irrigation systems in the Middle East.

Called qanats, these systems are underground channels that have been used for thousands of years to transport water in arid areas with minimal loss from evaporation and without pumping. These systems not only provide a cultural link but support sustainable development and water management planning.

Arsic is enrolled in the Master of Science in Information Systems & Technology (MSIST) program. Originally from Switzerland, he is an entrepreneur who is interested in applying innovative technologies and has become a GIS enthusiast.

"I was pretty new to GIS when I first entered the program [at CGU], but I liked the work the faculty was doing, and I wanted to learn more," said Arsic.

His interest increased after a stint as an

intern at Esri during the summer of 2019. He worked as a UX/UI software engineer on the geoprocessing team, focusing on front-end development and enhancing the user experience and software UI dialogs for spatial analysis tools for the newest version

↓ The access shafts required to create and maintain qanats are dug by hand and intersect the underground water table. These shafts, visible from the surface, indicate where qanats are located. Diagram courtesy of Samuel Bailey/CC BY-SA 3.0



**Mother Well**
The main water source for the qanat

**Access Shaft**
Permits access to the qanat channel for construction and maintenance

**Qanat Channel**
The qanat's water-carrying channel

**Distribution**
A network of dams, gates and channels is used to distribute the water

Outlet

Irrigated Land

Alluvium

Bedrock

Water Table

← Access shafts, visible from the surface, indicate where qanats are located.

of ArcGIS Pro. Arsic knew he wanted to continue exploring the potential of the software in his own educational projects.

That led him to an independent study course, GeoAI: Data Science with ArcGIS and Drone-Based Imagery Collection, Cloud-Based Processing, and Analysis, with Brian Hilton. A clinical full professor in the university's Center for Information Systems & Technology (CISAT), Hilton is also the director of CGU's Advanced GIS Lab. *[He has applied GIS to many problems. See "Preserving Voter Rights with the Help of GIS" in the Summer 2019 issue of ArcUser to read about his collaboration with fellow faculty member Jean Schroedel.]*

While determining the course design, Arsic stumbled on a Learn ArcGIS lesson available from Esri at no cost called Use Deep Learning to Assess Palm Tree Health. Taking this course set the stage for pursuing a project he had heard about through the faculty grapevine.

## Applied Learning

University of Gothenburg, Sweden, geologist Rodney Stevens works with an international group of researchers on a project called Qanat GIS. The project studies qanats in the Middle East, particularly Afghanistan, to assess groundwater

resources available to people living in arid and semiarid regions. Accurate maps of active and inactive qanats are essential to supporting sustainable development and managing water sources in desert areas.

Since reliable maps are not available, Stevens asked for GIS help from his long-time friend Lorne Olfman, a professor and director of CISAT. Olfman passed that request on to Hilton and Arsic. Using knowledge he gained from his independent study course with Hilton, Arsic applied several deep learning models to satellite imagery to detect the location of qanats.

"It turns out that detecting palm trees is a lot like detecting qanats," Arsic said. In discussing the project with Hilton, they decided to use the same workflow Arsic had learned in the Learn ArcGIS lesson.

In ArcGIS Pro, satellite imagery of an area west of Kandahar, Afghanistan, showing access shafts was used by Arsic to manually identify their locations and generate samples and an Esri model definition (EMD) file that would be used to train a deep learning model. *[An EMD file is a metadata descriptor that contains information about the chip size of the samples and the deep learning framework used (e.g., CNTK or TensorFlow), and—most important—specifies the Python raster function (PRF), which lets the*

*model be integrated with the inferencing workflow in ArcGIS Pro. Several out-of-the-box PRF are supported. but a custom PRF can also be used.]*

## Training the Model

Access shafts are required to create and maintain qanats. These shafts, dug by hand, intersect the underground water table and are visible from the surface, indicating the locations of qanats.

Using ArcGIS Pro, Arsic was able to distinguish two categories of access shafts: active and damaged. Access shafts for active qanats have an easily discerned round shape and a clear, dark hole at the center, unlike the shafts for qanats that are damaged or filled with sediment.

In addition, the environment surrounding the qanats was categorized into two types. In the first category, qanats located in desert areas with little evidence of habitation appeared as simple colors in satellite imagery. In the second category, qanats located in more inhabited areas, surrounded by croplands, appeared more colorful and complex in satellite imagery.

More than 1,000 qanats were labeled using ArcGIS Pro and exported as 512 x 512-pixel image chips. *[Image chips are small blocks of imagery cut from the source image.]* Chips were processed in batches of six.

The analysis workflow used was the same one taught in the Learn ArcGIS lesson. The batches of processed imagery chips were used for training a deep learning model in Jupyter Notebook using the TensorFlow deep learning framework. Arsic trained his model using the SingleShotDetector (SSD) object detection algorithm available as a Python method in the arcgis.learn module.

The model was trained in 40 epochs. Between iterations, adjustments were made to improve each succeeding result. After each epoch, a graph displaying the current logs on training and validation showed whether the model was continuing to learn.

David Yu, a data scientist at Esri, provided advice on training the model. Yu, whose work on the Esri GeoAI team includes image classification and object detection, helped tweak the model after each iteration and

← Qanats located in desert areas with little evidence of habitation appeared as simple colors in satellite imagery. The training model produced better results when evaluating qanats located in these areas.

guide it in the right direction. Arsic learned a great deal from Yu, whom he found to be a great coach and mentor. Yu explained complex techniques in simple terms.

"Without him, I would have achieved poorer results. I am very grateful he put some time aside to help with the project," said Arsic.

After training the model, Yu saved it as an EMD file and then used the Detect Objects Using Deep Learning geoprocessing tool, available with the ArcGIS Image Analyst extension, to identify the qanats.

Arsic said they had expected the training model to produce better results when evaluating qanats located in simple backgrounds. Hilton and Arsic thought that more colorful imagery chips would likely confuse the training model and would take more time to provide good results.

Despite yielding a few false positives, the model produced promising results after running 40 epochs. Given its early stage of development—if the model keeps learning—Arsic expects additional training will produce better results. The resultant maps have the potential to indicate patterns of water transportation along valleys, the extent of qanat interconnectivity, and the height of groundwater elevations.

Arsic theorizes that well identification in areas with more colorful backgrounds can be improved by adding more noise to the training dataset so it can adapt to a different context using image augmentation techniques. In addition, other object detection networks, such as YOLO (You Only Look Once) or Few-Shot, might perform better.

## Sharing Project Results

Arsic presented his findings at the CalGIS 2020 conference in Long Beach, California. This annual event, sponsored by the Urban and Regional Information Systems Association (URISA), brings together speakers who present workshops and training on a wide range of information system topics. His entry received first place in the Best Student Poster competition, based on its originality, content clarity, visual presentation, and technical details.

"I took this opportunity to present my work to others, as it may help them with similar projects. I am very thankful to Professor Hilton and David [Yu] for their coaching and support, Esri for providing amazing software to all of us students, and

← Qanats located in more inhabited areas surrounded by croplands appeared more colorful and complex in satellite imagery. Well identification in these areas was more difficult but may be improved by adding more noise to the training dataset.



for my school sponsoring me to attend the conference." Asic was grateful not only for the award but for the opportunity to see other great projects.

## Future Work

In theory, qanat-based irrigation systems can be used in other regions affected by limited rainfall and water scarcity issues. For areas of Afghanistan and the Middle East, this project is merely the beginning of efforts to improve crop selection, ameliorate drought, and enhance other aspects of environmental sustainability. For now, Arsic is happy to start scratching the surface… or, perhaps, digging it up.

"These results are just the tip of the iceberg. There is so much more to do here in order to help water management in these arid regions," he said. "It's amazing to think that some of the qanats are still in use. I would love to visit these tunnels in person someday."

For more information about the GIS program at CGU, contact Nick Owchar, executive director of advancement communications, at nick.owchar@cgu.edu.

## About the Author

**Jeremy Byrum** is an advancement writer in the Office of Advancement at Claremont Graduate University.

# Adapting Voting Practices to Safeguard Elections

By Christopher Thomas

In modern elections, GIS is already common. Now, counties around the country are relying on GIS to adapt voting practices to the realities brought on by the coronavirus disease 2019 (COVID-19) pandemic. Election officials use GIS to analyze polling locations to avoid high-risk venues, increase physical distancing, and take measures that make voting safer for voters and poll workers. Frequently updated web maps can connect voters to polling places where mail-in ballots can be dropped off. GIS has already been used by election officials across the country to safeguard the election process.

**In March 2020,** the number of new COVID-19 cases ballooned from nearly zero to upwards of 25,000 every day. The pandemic's timing coincided with primary season in a major election year. States with primary elections across the country were faced with the same dilemma. It was clear that voting—which attracts large crowds to centralized locations—needed an emergency reassessment.

During the two weeks leading up to Arizona's Democratic presidential primary in March 2020, officials in Maricopa County, which includes most of the Phoenix metro area, were aware that a storm was coming. They quickly shifted to implement new protections for voters and poll workers. Adding to this challenge, protective gear and cleaning supplies that had been ordered had been diverted to California, leaving insufficient quantities to carry out recommended safety protocols.

The logistical challenges in Maricopa County were especially acute. Of the more than 3,000 counties in the United States, Maricopa ranks 4th for population and 15th for size. Only California's San Bernardino County has a comparably large combination of people and geographic area.

Furthermore, Arizona has emerged as a solidly "purple" battleground state. The ability of Maricopa County's voters to participate in free and fair elections during an historic pandemic carries consequences far beyond the Salt River Valley.

Although most Maricopa County voters take advantage of the state's robust mail-in ballot system, and the March election was only for the county's 800,000 registered Democrats, officials predicted that about 100,000 people would arrive at polling places to vote.

In addition, many traditional polling locations were no longer viable. Senior centers were closed because elderly people are severely at risk for coronavirus infections. Locations that were too cramped for adequate social distancing were also out. As the primary date approached, Maricopa officials engaged in an increasingly frantic attempt to close some locations and establish new ones.

In addition, state law required Maricopa to consolidate polling places so that the total was half the number typically used in a general election. This was a meticulous process that considered in-person voting trends, population centers, and input from community advocacy groups. In 2016, Maricopa had garnered unwanted national attention after miscalculations forced voters to endure long lines at the polls. Since then,
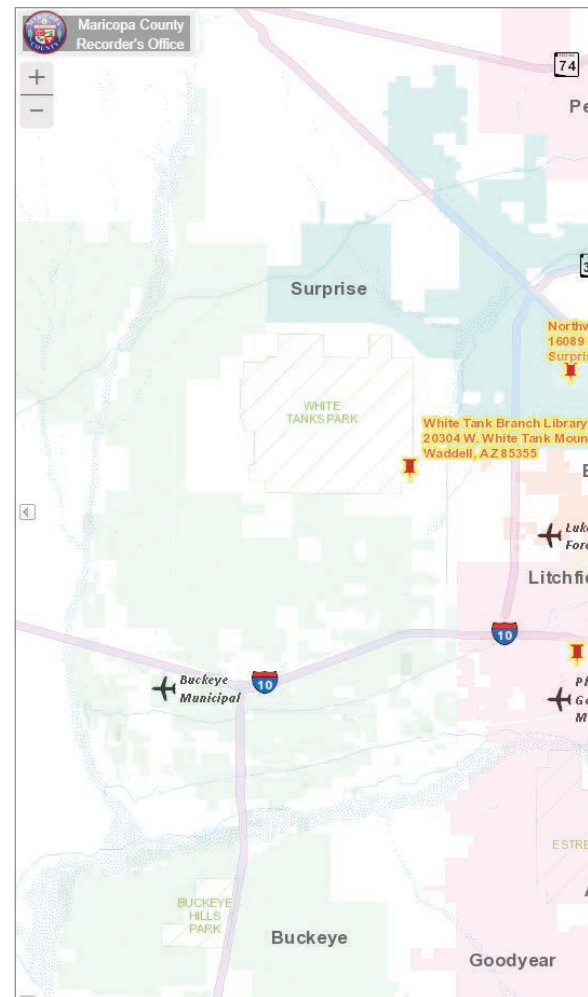
Maricopa election officials began using GIS maps to visualize the locations of likely voters and calculate travel times.

For the March election, Maricopa County leaders were able to retool the system of in-person voting by moving to a vote center model, which allows voters to choose from any of the county's polling locations.

The county's mapping tools stood ready for repurposing. GIS allowed election officials to ensure equal access throughout the county, while also reducing the risk of further closures at schools and senior living facilities.

The county started acquiring space in places like strip malls. "We can display them on the map, overlay them with heat maps *[showing each location's likely voters]*, and see where it made sense to put more locations," said Gary Bilotta, director of IT and GIS for Maricopa County.

"When we first created the map to figure out where to put polling places, we weren't
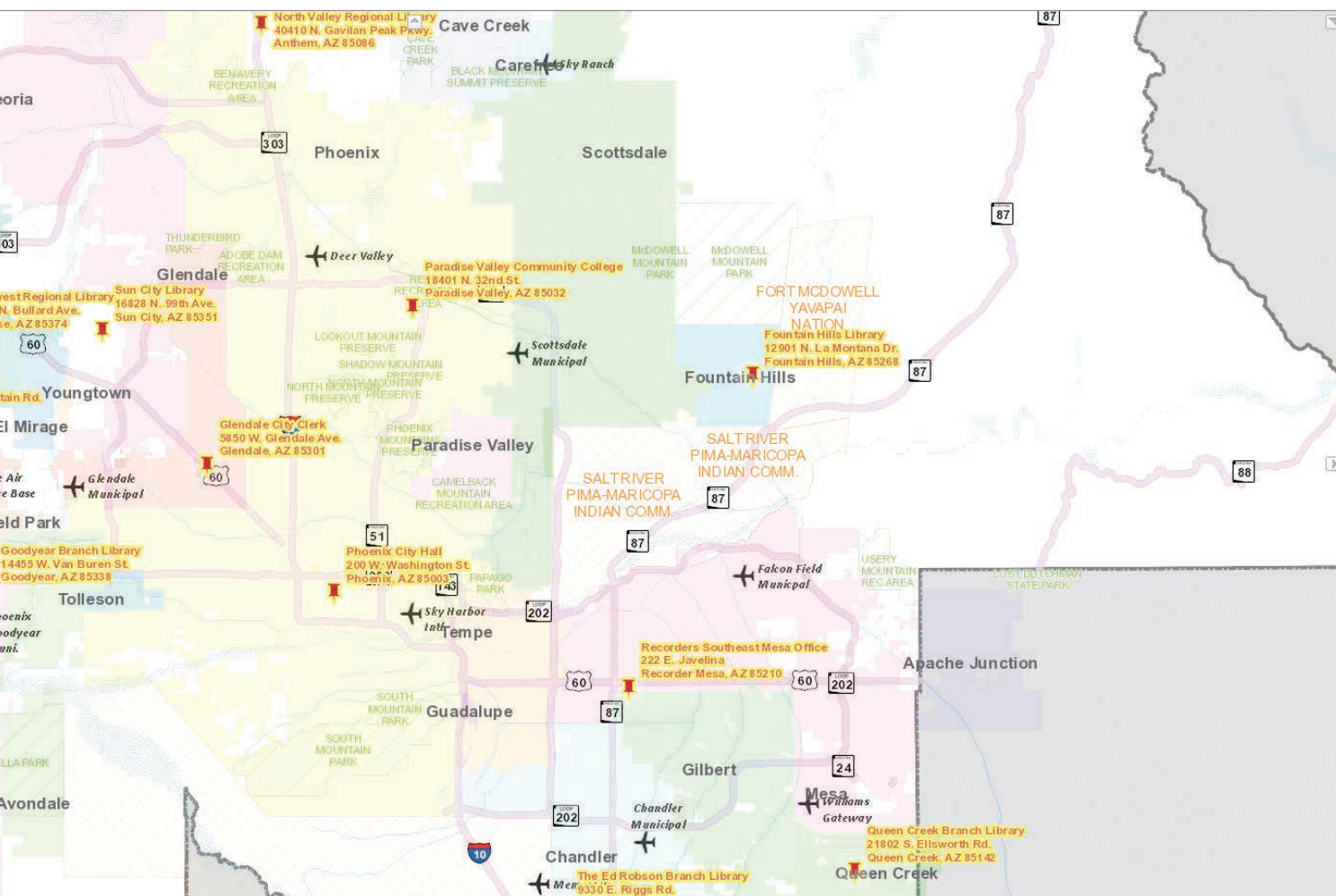
↑ The Maricopa County Recorder's Office provides an interactive map where registered voters can vote in person.

thinking specifically about using it for this, but it came in handy right when it needed to," said Bilotta.

### Innovative but Out of Sight

The most innovative uses of GIS for elections often occur on the back end and are never glimpsed by voters. As the act of voting has itself become more political, with battles erupting over the placement of polling stations in states such as Georgia, Wisconsin, and Kentucky, municipalities are using GIS tools to ensure fairness.

"When we select a polling location, it's not just, 'here's a good building,'" said Carly Koppes, clerk and recorder for Weld County in northern Colorado. "It's also 'here's a building, and here's how many potential voters could use it.' We integrate information on a map with overlays. We can even look and see how many people have used it in the past; and if it's low, we can

see if maybe it's because there isn't a lot of population density, or maybe it's because of transportation."

The process has helped Weld County find optimal locations for 16 ballot drop boxes for voters to use in lieu of polling stations, adding a layer of social distancing to the voting process.

### Encouraging New Ways to Vote

In Utah County, in central Utah, officials use GIS to promote a shift away from in-person voting. "Because of COVID-19, we're trying to get people to use mail-in ballots, instead of voting on Election Day," said Andrea Befus, a GIS analyst for the county. "So, we have a whole system that I built for tracking ballots from drop boxes."

During a period leading up to an election, voters are allowed to use the drop boxes, a process that Befus believes adds a layer of credibility for voters wary of sending their

ballot through the mail. A few times a day, officials check the boxes, using ArcGIS QuickCapture and ArcGIS Survey123 to register the time and leave documented proof of their location. When they return to the election office with ballots, they once again register the time and location.

"We're more accountable this way," she said. "If people worry that their ballot wasn't counted, we can say, 'Well, we were at this drop box at exactly this time; so if you dropped off your ballot, it was in there.'"

### About the Author

Christopher Thomas is the director of government markets at Esri and is a founding team member of the Industry Marketing Department. Prior to joining Esri in 1997, he was the first GIS coordinator for the City of Ontario, California. Thomas frequently writes articles on the use of GIS by government. Follow him on Twitter @GIS_Advocate.

# Find the Best Way to Organize Your Geospatial Talent

By Matthew Lewin

**Struggling to get the most out of your geospatial investment?**

**It could be the way your people are organized.**

**How to structure a team of geospatial professionals is a dilemma that comes up time and time again, regardless of the size or maturity of an organization's geospatial program.**

**Typically, the question** revolves around whether to centralize or decentralize. Should you group everyone who can spell *GIS* into a central team to get some consistency? Or should you leave departments to their own devices and let them grow and manage their own teams? Or should you do a bit of both, developing a hybrid model?

In some organizations, there's a strong philosophical tendency toward centralization. The desire for control compels these organizations to group people with common capabilities. For others, a culture of autonomy empowers managers to focus on their own interests. The drive toward speed, agility, and innovation motivates these organizations to build what they need, where they need it.

Each model has its advantages, but inevitably, over time, cracks emerge. A centralized team becomes overburdened with responsibility and is perceived as a bureaucratic bottleneck by the rest of the

organization. Every map, app, or dataset that is conceived of is provided by this one team—often to the dismay of the organization.

On the other hand, a decentralized organization can find itself facing widespread redundancy in roles, systems, and datasets and often struggles with collaboration. The phrases "that's our geodatabase" and "they work for me" are often heard in these organizations.

The swing back and forth between centralization and decentralization usually leads organizations to consider a hybrid approach. It's natural to want to have the best of both worlds: the control and oversight of centralization and the autonomy and agility of decentralization.

and decentralized. While it's rare to find an organization that implements its geospatial program exactly as defined by these models, it's useful to review some common patterns.

The key takeaway from these different models is that each serves a different purpose that closely reflects the goals and culture of the organization. This can't be overstated. When considering a reorganization, don't lose sight of what your organization will realistically accept.

Note the location or organizational home of the central group that is a feature of the Centralized, Hub-and-Spoke, Balanced, and Federated models. The home of this group depends on several strategic factors. In practice, a shared geospatial team typically reports to IT, reports to a specific business unit, or operates as a stand-alone corporate function. When a shared geospatial team operates as a stand-alone corporate function, it can be managed internally or outsourced.

## Defining Your Model

This list of organizational archetypes does not suggest that there are just five ways to organize a geospatial program. This list underlines that organizing talent is a balancing act.

To settle on a model that fits your organization, you're better served if you think about reorganization as a design process. This means following a structured and iterative process that starts with a base model and incrementally refines that model until the desired version emerges.

The approach suggested in this article was derived from one developed by Amy Kates and Jay R. Galbraith and explained in their book, *Designing Your Organization: Using the Star Model to Solve 5 Critical Design Challenges*.

### *Start with a decentralized model.*
Start at one end of the centralization spectrum or the other. It might be best to start with a decentralized model and work toward increasing centralization, rather than working in the opposite direction. A decentralized model prioritizes autonomy and freedom and puts decision-making in the hands of those closest to business challenges, so start with that as a baseline.

### *Identify functions that cannot be centralized.*
Certain systems, data, roles, and services must remain in the departments for legal, regulatory, privacy, risk, or security reasons. Identifying these components and acknowledging them as part of an organization's geospatial resources is important. However, centralizing them may not be possible. For example, city police services often require infrastructure, databases, and security credentials that must remain separate from the rest of city government.

### *Pull out functions that are noncore to the departments.*
Systems, data, or roles that are not essential to the mission of a department are candidates for relocation to the center. Often these functions exist on the business periphery or are supporting functions. Examples of these functions could include applications development, production mapping, application support, and geodatabase administration.

### *Move functions that would benefit from economies of scale.*
Many functions—while important to the work of the business—could be more efficiently delivered through a central, shared provider. Often these are functions that are not fully utilized by any one business area. Centralization, in this case, enables sharing the cost of expertise such as a pool of generalist location analytics professionals.

### *Identify the management and governance functions that should be owned centrally.*
Functions, like overall geospatial management and governance, are often better when centrally coordinated. These functions might include the development of corporate architectural standards, policies, and frameworks; solution rationalization criteria; and talent development plans.

### *Determine the need for integrative roles.*
You don't want to introduce new silos by creating a centralized function that is closed off from departments. That means you need to look at the roles and systems you centralized

---

The trick is figuring out what—specifically—should be centralized and what should be decentralized. This leads to several questions:

- How do we balance the competing forces of centralization and decentralization?
- How do we make sure the resulting model is a fit for our organization?
- Where in the organization should my new team reside?

## Common Organizational Models

Before looking at how to define your model, it's helpful to look at five organizational models: Centralized, Hub-and-Spoke, Balanced, Federated, and Decentralized. They fall on a spectrum between centralized

## Decentralized

**STRUCTURE:** Departments and business functions manage geospatial data, systems, and resources independently. No central coordinating team; departments coordinate among themselves as required.

**AUTHORITY:** There are often separate geospatial strategies.

**FAVORED BY:** Organizations with autonomy-based cultures and limited need for cross-departmental collaboration.

## Federated

**STRUCTURE:** A small central group serves as a coordinator among various departments. The primary focus on the central group, sometimes called a community of practice, is to develop standards and processes to facilitate collaboration and sharing.

**AUTHORITY:** Departments are primarily responsible for management of their own geospatial data, systems, and resources.

**FAVORED BY:** Organizations that value department-level independence but require a degree of collaboration and sharing in terms of data, systems, and skills.

## Balanced

**STRUCTURE:** A network of geospatial practitioners from various business units collaborate to collectively manage and deliver the geospatial function.

**AUTHORITY:** A common, central group of practitioners may serve as a center of excellence, defining common standards and processes as well as providing management and support of shared geospatial data and systems. Other practitioners are embedded within business units where they manage geospatial data, systems, and resources and enforce governance established by the community.

**FAVORED BY:** Organizations with highly collaborative cultures.
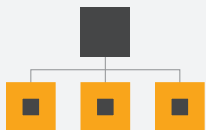
## Hub-and-Spoke

**STRUCTURE:** A central group is responsible for managing foundational datasets, systems, and overall governance of the geospatial environment.

**AUTHORITY:** Departments manage department-specific datasets and systems under strong guidance from the central team. Most support and administration roles reside in the central group, while discipline-specific analyst roles reside within the departments.

**FAVORED BY:** Organizations that value strong and central governance; want to benefit from the economies associated with shared data, systems, and resources; and recognize the need for department-specific roles that benefit from being closely aligned with the business.
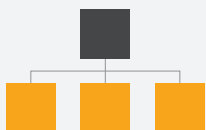
## Centralized

**STRUCTURE:** A central group serves the official owner of all geospatial data and systems.

**AUTHORITY:** Little, if any, data and systems reside outside the central team. Most geospatial professionals, including analysts, developers, architects, and map production specialists, reside in the central team. Support to other business areas is highly prescriptive and tightly controlled.

**FAVORED BY:** Highly regulated organizations with stringent system of record requirements and conservative culture.

and identify where there could be gaps in coordination or collaboration. Any of the gaps uncovered could be addressed by adding roles for relationship manager or business analyst that coordinate with the organization. This could also indicate a need for systems that support cross-departmental information sharing, collaboration, and innovation.

## Test Your Model for Fit

Once you've taken a first pass through the model selection process, you'll want to take a step back and conduct a sanity check by asking some probing questions:

- Is our centralized team now so big that it would be too unwieldy to support?
- Would the change imposed on the organization make this model impractical?
- Would senior management see this as being too risky?

If you answered yes to any of these questions, go back through your model and make practical adjustments. You are just using the organizational archetypes as a guide.

## Identifying the Home

Assuming you landed on some form of a centralized geospatial organization, you'll have one more very important decision to make: where should this organization be located? The answer will vary depending on your organization's business model, its strategic objectives, and its culture. There are several reporting structures that fit most geospatial teams: inside the IT department or as a department function, as a shared service, or as an outsourced function.

### Choosing IT as the Location

IT is a logical place to locate a central geospatial team, as the systems and data that are at the heart of geospatial capabilities are likely already supported by IT in some way. The IT function also supports a wide variety of business areas and needs. That said, the disadvantage of reporting to IT is that IT may already have a reputation for poor or slow service. This could rub off onto the geospatial team.

### Making It a Department Function

In some cases, embedding a central geospatial organization inside a department

other than IT is desirable. This can be true when a strong and effective central team is already in place in a department or where one department is the overwhelming user and beneficiary of geospatial systems and services. In this case, there's no sense in disrupting a good situation. However, it's important to regularly review this arrangement as demand for geospatial systems, data, or services in other areas changes.

### Making It a Shared Service

In a shared service model, the geospatial organization acts as a stand-alone service provider to the business. Among the benefits of this model is that the geospatial organization can serve areas of greatest demand if funding is in place and resources can be allocated effectively. The downside is that business areas that have funds or resources are often left on the sidelines.

### Using an External Provider

An outsourced geospatial function can be considered for some organizations. This model is highly dependent on the organization's culture and how amenable it is to external service providers. The benefits of this model include having flexibility in staffing, reducing operation costs, and being able to scale up and down quickly. On the downside, an external provider model can result in privacy and IP concerns, difficulty managing service quality, and concerns over cost control.
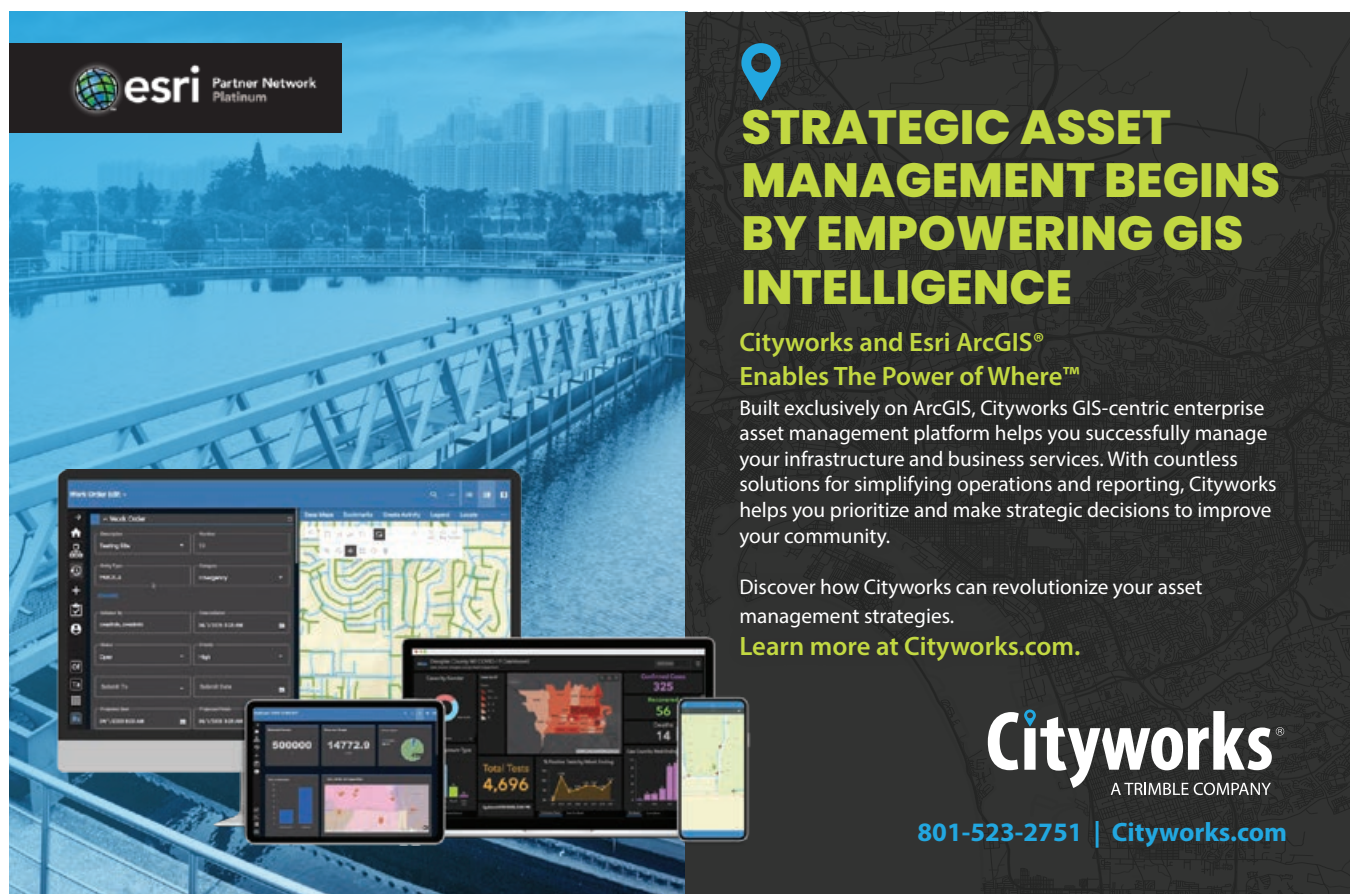
## No Model Is Perfect

No organizational model is going to be perfect. But the rapid evolution of the geospatial industry has made it imperative that managers look closely at how they deploy their geospatial talent. How you organize your people can have far-reaching implications in terms of employee productivity and

customer satisfaction. You may realize that your current model is no longer a fit and needs a refresh. By looking at alternative models and taking a structured approach to organization design, your organization will be better positioned to get the most out of its geospatial investment.

## About the Author

**Matthew Lewin** is the director of management consulting for Esri Canada. His efforts are focused on helping management teams optimize and transform their organizations through GIS and location-based strategies. As a seasoned consultant, Lewin provides organizations in the public and private sectors with practical strategies that enable GIS as an enterprise capability. His interests lie at the intersection of business and technology, and he thrives on helping organizations bridge the gap between the two to achieve their GIS ambitions. Contact Lewin at mlewin@esri.ca.

# IS YOUR WORKFORCE CHANGE READY?

By Suzanne Boden

**As government organizations** prepare to modernize mission-critical GIS systems and applications, the question many are asking is not where to start, but how to get to the finish line faster.

The finish line is not the system go-live date. The finish line is the date when the new system begins delivering its intended business value.

From the high-level organizational view, deploying new technology is not the primary goal. The primary goal is to leverage new technology to achieve defined business objectives. The key metrics for technology projects are speed and rate of user adoption. This means the workforce has a major impact on project success. However, a common reason projects fail to deliver the intended business value is a lack of attention to the needs of the people who are expected to use new systems and applications.

## The Impact of Technology-Driven Change on Staff

Recognizing the importance of user adoption when implementing the ArcGIS platform, Esri launched a people-focused change management consulting practice in 2017. Esri change management consultants apply the Prosci ADKAR Model for change, a model used successfully by many Fortune 100 companies.

According to research by Prosci, when organizations combine a people-focused change management plan with a technology project plan, they are up to six times more likely to achieve project success.

"Our focus is helping customers achieve their ArcGIS project goals by proactively preparing their workforce for change," said David Schneider, a Prosci-certified Esri change management consultant.

"Managers expect employees to quickly start using new apps that have been created for them, but a common scenario is that some employees are very comfortable with the familiar workflows that have been in place for years. Employees may actively resist change or simply take longer to adapt to the new environment than leaders expected."

Brian Collins, GIS manager in the Office of Information Technology at the Montana Department of Natural Resources & Conservation (DNRC), has been working with Esri consultant Michael Green to provide effective change management to employees impacted by a new ArcGIS Enterprise deployment. As the DNRC updates its ArcGIS 10.2 system to the latest version, legacy applications could no longer be supported. To help users adapt to the new environment, project sponsors understood they needed to prepare users for the impending changes.

"One of our keys to success is rooted in the relationships we've established with the hundreds of personnel we support. Taking a people-focused approach to change management
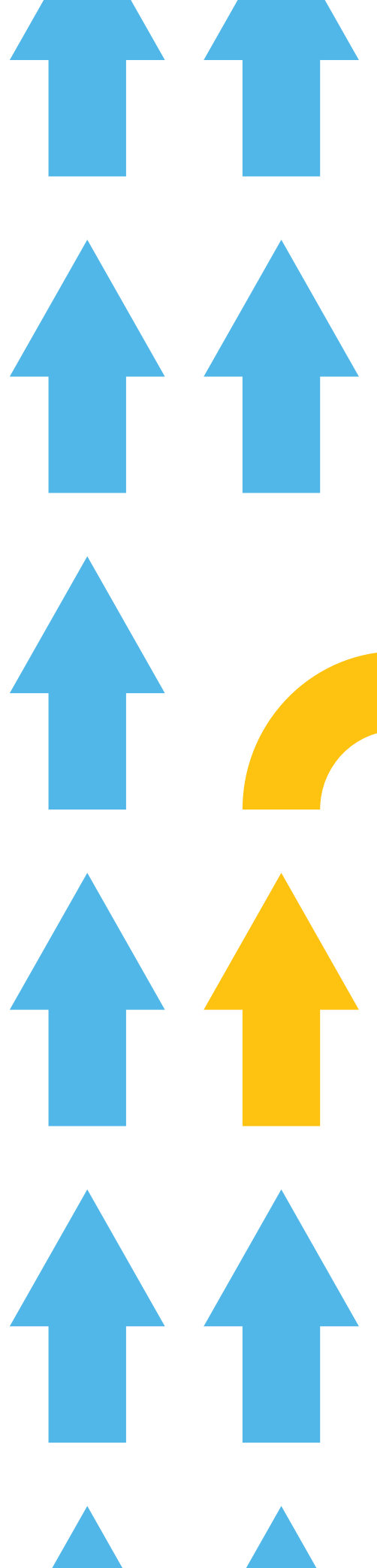
has presented us with an opportunity to significantly minimize resistance by methodically engaging with our end users throughout the process," said Collins.

According to Green, engaging users early and often with information about a planned change is a solid strategy to minimize resistance. That is why a detailed communications plan is an integral component of Esri change management plans.

## Smooth Transitions Aren't Automatic

Many state Departments of Transportation (DOTs) are modernizing their approach to field data collection. Leaders clearly recognize the business value of replacing paper-based workflows with devices running mobile applications such as ArcGIS Collector.

Schneider and Green have worked with several state DOTs. "Because smartphones and apps have become so engrained in our culture, there may be a perception that getting large groups of people to use apps in place of paper should be quick and easy," said Green.

"While the apps are easy to use, ensuring that impacted staff quickly adopt the new workflow requires preparation and planning. To facilitate a smooth rollout, the project team needs to have a plan in place to build awareness of the change and support the supervisors of frontline employees performing the data collection workflows."

Smooth transitions to digital workflows occur when impacted personnel understand the need for change, feel supported during the change, and have tools in place to successfully adapt to change.

Esri change management consultants are experts in helping organizations navigate the three phases of change: preparing for change, managing change, and reinforcing change. Through in-depth discussions with project sponsors and stakeholders, they develop a comprehensive plan to minimize change resistance, accelerate user adoption, and help organizations reach the finish line faster.

For more information on Esri change management consulting, contact your Esri account team or visit go.esri.com/change-mgmt.

## About the Author

**Suzanne Boden** is a marketing and communications specialist with Esri training services. She is passionate about sharing the real-life stories of individuals and organizations using GIS to improve business processes, enhance government services, and advance organizational goals. She writes about Esri technology, workforce development, and strategies to help organizations build geospatial literacy at an enterprise scale. Boden has a bachelor's degree in English literature from the University of Maryland, College Park.

# Open Up ArcGIS StoryMaps to Your Organization

The new Storyteller user type lets anyone in your organization create beautiful, inspiring, digital narratives using your organization's ArcGIS web maps and data for just $100 a year.

This user type lets content creators, marketers, public relations teams, writers, and anyone else in your organization use ArcGIS StoryMaps for an affordable price. Previously, this required either a Creator or a GIS Professional user type. The Storyteller user type makes ArcGIS StoryMaps stories more accessible to everyone in your organization, not just GIS users.

Staff with Storyteller user types can make ArcGIS StoryMaps stories that leverage the web maps, web scenes, apps, and other content created by others in your organization and shared on ArcGIS Online. With the builder in ArcGIS StoryMaps, they can add media blocks that add videos, photos, and text as part of a compelling and interactive narrative that's easy to publish and share. They can use free public content from the ArcGIS Living Atlas of the World. With express maps, they can quickly design interactive maps with points, pop-ups, and arrows. Stories made with the Storyteller user type can be shared publicly, shared only within your organization, or not shared at all.

The Storyteller user type leverages existing ArcGIS content, so someone in the organization must have a Creator or GIS Professional user type to create that content, since the Storyteller user type does not allow creation of content with ArcGIS Online or other ArcGIS apps or products. Also, the classic Esri Story Maps templates, such as Cascade, Map Tour, or Map Journal cannot be accessed with the Storyteller user type. The Storyteller user type is available now and can easily be added to an ArcGIS Online organizational account by visiting the ArcGIS StoryMaps pricing page (https://bit.ly/2UmJTAt).
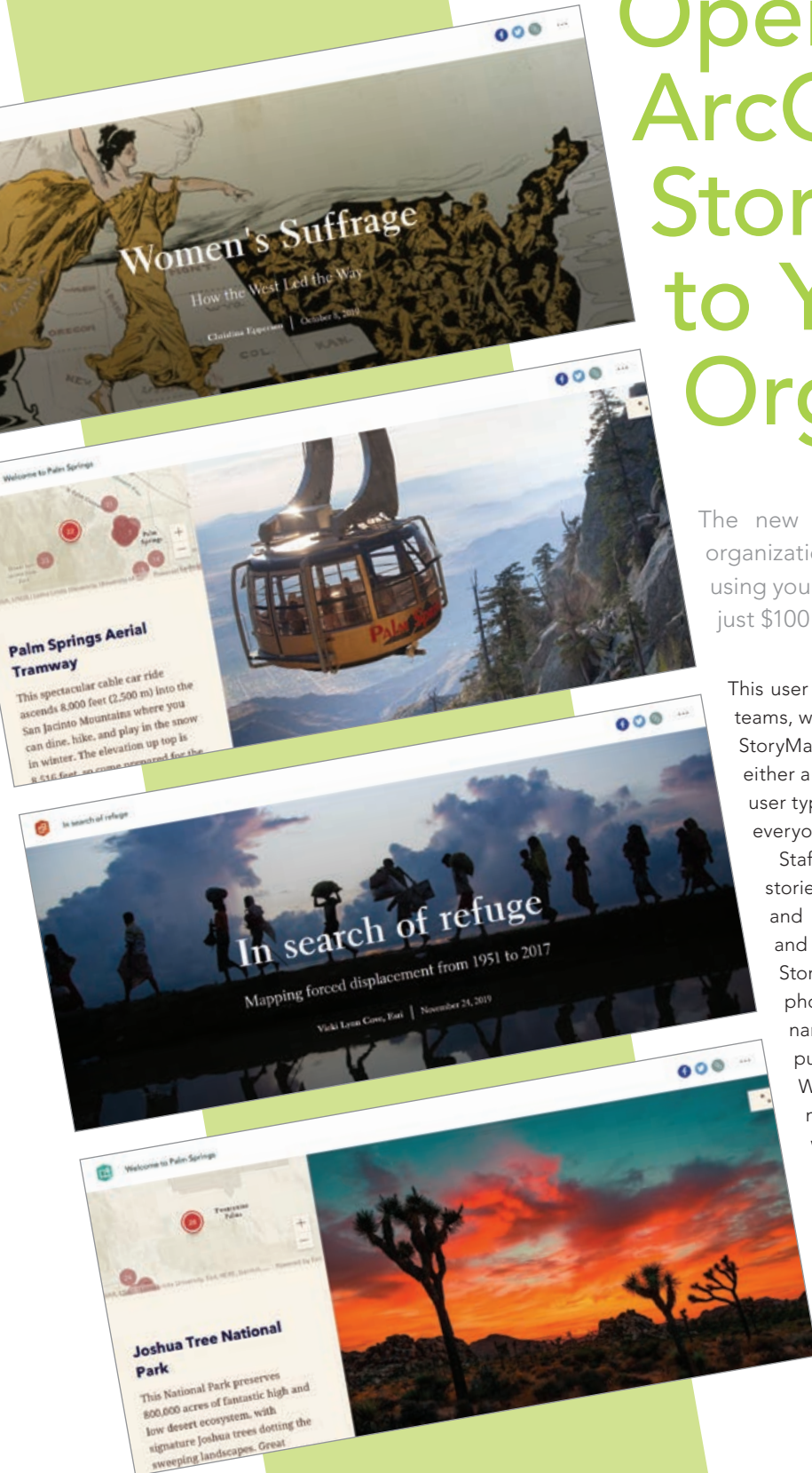
# Three Tips on Leadership

*Smarter Government: How to Govern for Results in the Information Age,* published by Esri Press, describes how Martin O'Malley, as mayor of Baltimore and later as governor of Maryland, instituted Stat systems, a series of performance measurement and management systems for policing, public works, education, business and economic development, health care, and the environment. Maps were a key component of these systems.

"This book is about leadership and management and the technology that makes more effective leadership possible," O'Malley said. "So it's my hope that as the years progress, the book will be of service to men and women working in city, county, state, and federal governments. Some of them might be frustrated at the leader at the so-called top who doesn't appreciate the value of these new technologies and the value of a new way of governing." He half jokes that it took him 23 years to write *Smarter Government.* The material for the book, which came from O'Malley's experiences, became more focused as he prepared to teach at colleges and universities around the country.

"One of my students at the University of Maryland raised his hand and said, 'All of the technology and all of that stuff is all great and everything, and I understand how we've never had it before, but it really doesn't amount to a hill of beans without leadership.' And I pointed at him and said, 'Congratulations. A-plus . . . you have learned the entire point of the course.'"

O'Malley has these three pieces of advice for anyone who's in a leadership role in a performance management environment, especially in government.

## 1  Start and Don't Stop

You have the convening authority and the convening power. Convene people regularly around the latest emerging truth. Focus on the big things that matter—the things that you are trying to achieve for your people.

Another part of *Start and don't stop,* is don't wait until it's perfect. Don't wait until all your trend lines are going in the right direction to be open and transparent. If you want to make annual progress, then fine, keep doing an annual budget. If you want to make progress that's really

impactful, get people together every two weeks. Instead of giving you 1 percent progress annually, they will give you 1 percent progress every two weeks. So, start and don't stop.

## 2  Lift Up the Leaders

Create a compelling scoreboard so that everybody in the organization knows that the soil conservation district or trash collection borough is the one that's the best led and the best run. That's what teachers call pedagogy—the ability to share and adopt best techniques.

## 3  Lead

Don't be afraid to declare public goals with public deadlines. If leaders don't make themselves vulnerable, the rest of the members of the organization won't extend themselves to make it happen.

# Use Blend Modes to Make Web Apps Stand Out

By Julie Powell

**Blend modes in ArcGIS** let you determine how the layers in a map affect each other so you can highlight a specific aspect of the data, produce an interesting effect on a layer, or make what seems like a new layer by blending two or more layers in a map.

However, these Adobe Photoshop-like effects create live, interactive maps rather than static images. Blend modes are available through the ArcGIS API for JavaScript and as an option when authoring maps in the new ArcGIS Online Map Viewer.

## What Are Blend Modes?

Blend modes have been used in photography and graphic design software for many years to restore, retouch, or create unique effects in images. In mapping, blend modes are used to blend layers together.

Unlike transparency—which can result in a washed-out top layer—blend modes can create a variety of vibrant and intriguing effects by blending a layer with one or more layers below it.

How a blended map looks is determined by three factors:

1. The map's appearance is affected by the layers that are being blended in the map. Any type of layer can be blended including imagery, vector basemaps, or thematic layers.
2. Layer order also affects the appearance of a blended map. The order determines how layers are blended.
3. Each mode involves a specific method for calculating or selecting between overlapping color values to produce the blended color value, so the mode chosen affects the map's appearance. Lightening blend modes produce lighter results than the overlapping layers. Darkening modes produce darker results. Compositing blend modes mask the contents of either the source or background layer.

Varying the kinds of layers used, their order, and the type of blend mode applied will create very different results. Any number of layers can be blended. Each individual layer can have its own blend mode, or if layers are part of a group layer, only the layers in the group will be blended together. The following examples describe the power of various blend modes—multiply, luminosity, saturation, hue, and compositing—and how they can be applied to layers.

## Multiply Blend Mode

A darkening mode called multiply, one of the most commonly used blend modes in Photoshop, happens to be very useful for mapping. It is a favorite among Esri's cartographers. It emphasizes the
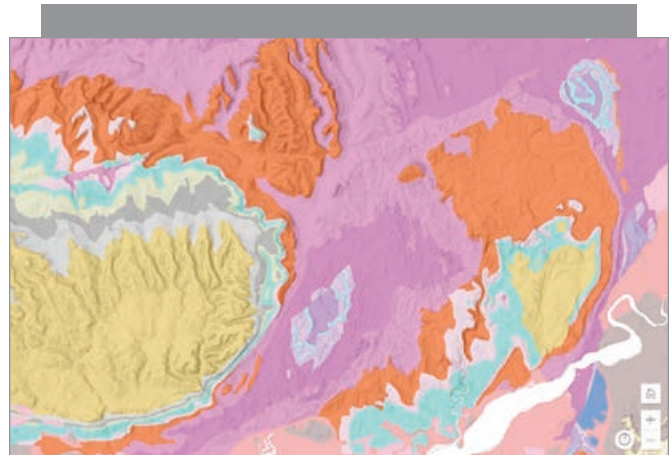
A
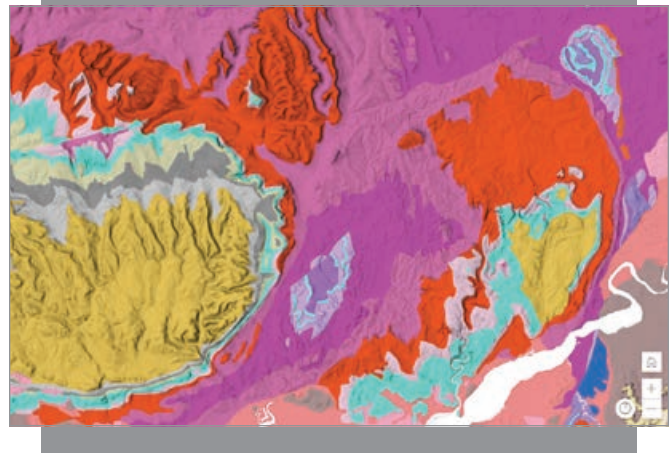
B

↑ The image on top uses a layer showing the mean land temperature with 50 percent transparency over a hillshade layer (A). The image on the bottom shows the same layers in the same order using the multiply blend mode. Blend mode maintains the vibrancy of the temperature colors, while the shaded relief is discernible (B).

darkest parts of overlapping layers by multiplying the colors of the top layer and the background layer. Multiply is often used to build contrast or accentuate an aspect of a map. For example, blend a hillshade map with a topographic map to have elevation show through the top layers. Multiply can also be used to blend thematic layers with a basemap.

A



## Saturation Blend Mode

Use a saturation blend mode to increase or decrease saturation in layers. Desaturate a basemap to make an operational layer stand out. Firefly cartography, a popular technique, is designed to be used with a neutral background and requires a desaturated basemap. The spatial context and texture of imagery contrast with the foreground thematic layers that are designed to capture the user's attention. With this mapping technique, the color of the

↓ This stunning 3D effect (A) is produced by using multiply to blend the World Topographic layer (B) with a hillshade layer (C) to make the elevation pop out of the map, giving it almost a 3D effect.

B



A



C



B



↑ A common use case for multiply blend mode is creating a physical map of the world that shows both boundaries and elevation (A). This map was constructed by blending each layer with all the layers underneath it.

C



## Luminosity Blend Mode

The luminosity blend mode uses the hue and saturation of any background layers and preserves the brightness of the top layer. You can blend two layers and produce seemingly new maps using existing content. Blend an imagery layer with a hillshade layer to create a basemap that looks nothing like imagery—it almost looks like a new layer.

A

imagery is mostly removed at the smallest global scales and then gradually reintroduced at the larger scales when the imagery's full detail is available. Some users prefer that the imagery remains desaturated so that the firefly symbols glow as brightly as they do when zoomed out. An easy way to achieve this effect is by blending a plain black vector basemap with the imagery using a saturation blend mode so the imagery doesn't compete as much with the firefly symbology.

↓ This glowing landscape (A) results from an imagery layer (B) that was blended with a hillshade layer (C) using luminosity.

A

B

B

C
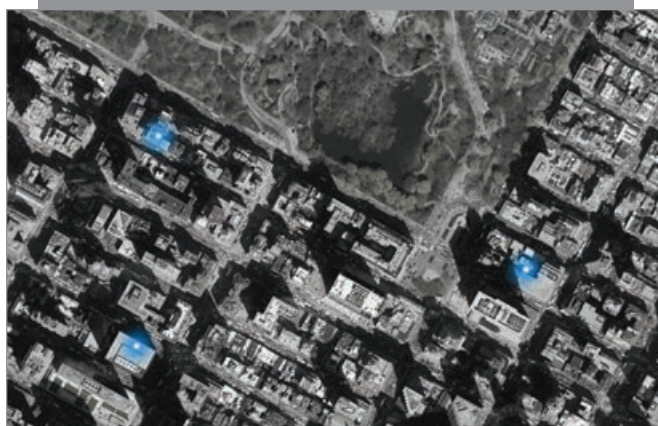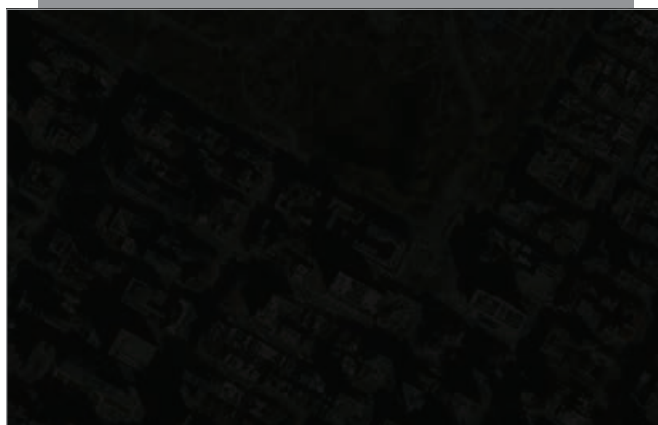
C

↑ To eliminate distractions and focus the map reader's attention on specific features (A), a blank black vector basemap (B) was displayed at 20 percent transparency using saturation blend mode over a World Imagery layer (C).

## Hue Blend Mode

The hue blend mode maintains the color of the top layer while blending the luminosity and saturation of the layers below it. This can be useful if you want to change the color of the map but maintain the tones and saturation of the original layer.

A

B

C

country, region, or area of interest, put the clip boundary layer on top of the layer to be masked and give it a destination atop blend.

Compositing blend modes can also blend two related layers that have different geographies—or even different layer types— to highlight specific aspects of the data in one of the layers as it relates to the other.

## Experiment with Blend Modes in the Map Viewer

The new Map Viewer in ArcGIS Online (and eventually in ArcGIS Enterprise) exposes blend modes in the layer properties and is a great environment to try out different modes to see how layers interact, and to experiment with layer ordering. The ArcGIS Living Atlas of the World is a great resource for finding layers to use for experimenting with blend modes because layer blending properties can be saved as part of the web map.

## Using Blend Modes in the ArcGIS API for JavaScript

It is easy for developers to apply blend modes to layers in apps. The code is easy, so developers can spend more time unleashing their creativity by playing with different blend modes on different layers. There are two ways to apply blend modes. Simply load an ArcGIS Online Map Viewer web map created using a blend mode. Developers can make changes to the layers in the map, including blending, once the map is loaded. They can programmatically set the blendMode property on the layer to the desired blend mode, as shown in Listing 1.

```
const layer = new FeatureLayer({
  url: "url",
  blendMode: "multiply"
});
```

↑ Listing 1: Setting the blend mode programmatically

↓ Bird migration path blended with the World Imagery basemap (B) using the destination-in mode focuses only on the imagery that is below the path and excludes the rest of the imagery basemap, showing the bird's eye-view. (A).

↑ This purple-tinted map (A) was obtained by displaying a blue-colored polygon (B) blended using the hue mode over the World Topographic basemap (C).

## Compositing Blend Modes

Compositing blend modes are used to mask the contents of either the source or background layer. Destination modes can be used to mask the contents of a top layer using the contents of a background layer. Source modes can be used to mask the contents of a background layer using the contents of a top layer.

These are useful for cutting out parts of the top layer or parts of the background layer. To create a map that only contains a specific

A

B

Since a blend mode can be accessed via code, developers can use it dynamically. For example, developers can let the end user play with a few effects on the map by having code update the blend property on the fly. A blend mode can also be applied to the result of a query, geoprocessing task, or any other operation by putting it on its own layer for blending. Blending works on individual color values and is independent of geometries.

This article has provided just a taste of the ways blend modes can be used. Layer blending in ArcGIS is an exciting new capability for developers, cartographers, and other mapmakers that will reveal many new and intriguing opportunities for web mapping such as inspiring the re-creation of static maps as web mapping apps.

## About the Author

Julie Powell is a technical product manager at Esri. Her primary focus is the ArcGIS API for JavaScript. She has more than 17 years of experience working with software development, delivering solutions for both enterprise and consumer markets. Powell has worked on a wide range of projects and consulting endeavors, including serving as a technical lead for web mapping solutions for strategic customers. She interfaces with a wide user community to maintain awareness of and insight into GIS community needs while contributing feedback to development teams to help ensure that users can be successful in building state-of-the-art, purposeful solutions using ArcGIS software.

↓ A 2010 population density layer was queried by age and gender to select residents in neighborhoods that intersected a buffer. To make the features inside the buffer pop, the buffer graphic was placed in its own graphics layer. A color-burn blend mode was applied to create a more saturated effect on the features inside the buffer, since the color-burned buffer cleanly cuts through any features that extend beyond the buffer.
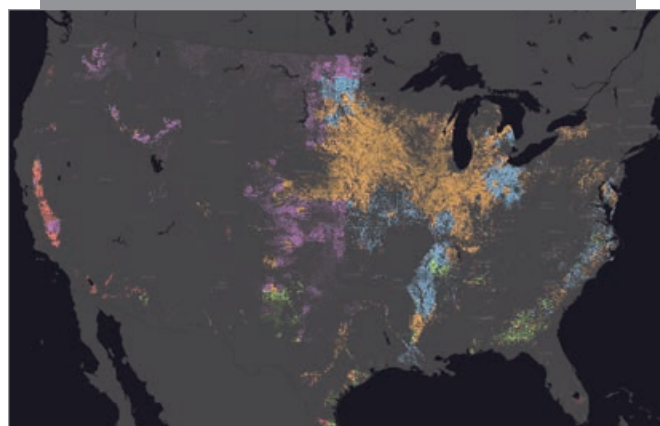




A
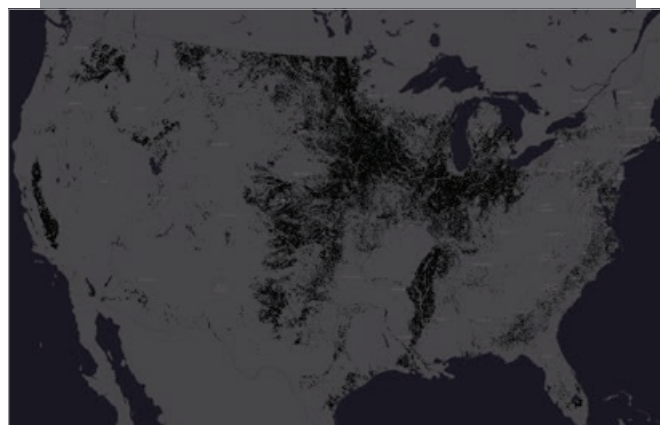
B
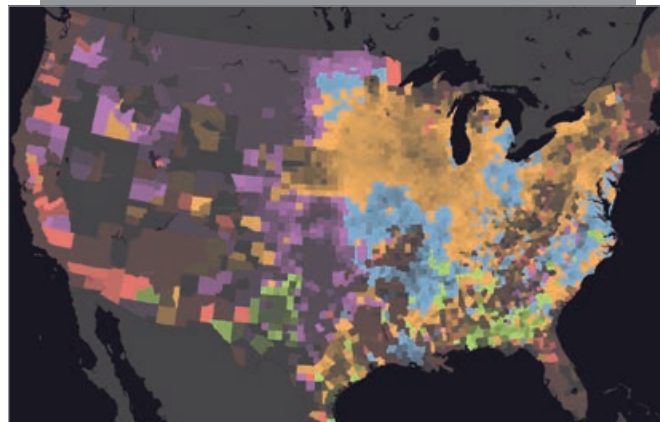
C

↑ A layer showing the predominant crops for each county in the United States (C) was blended with a land-cover imagery service using data from the National Land Cover Database (NLCD) (B) to display the predominant crops only in the areas where land is cultivated (A).

# EASILY PROCESS AND ANALYZE SAR DATA

Get the benefit of SAR analytics
across the ArcGIS® platform

**For more information visit www.L3HarrisGeospatial.com/SARscape**

L3HARRIS™

FAST. FORWARD.

# THE 40TH AND FIRST
## *USER CONFERENCE*

By Monica Pratt

*THE 40TH ANNUAL* Esri User Conference (UC) took place July 13–16, 2020—not in San Diego in front of 18,000 users—but online with more than 88,000 registered attendees from 180 countries. The first virtual Esri UC—held in response to the coronavirus disease 2019 (COVID-19) pandemic—was an event that preserved many of the most valuable aspects of the conference and expanded its benefits to people around the world that might not have the opportunity to attend the face-to-face event.

Beginning with the first Esri UC, which was held at a Montessori school adjacent to the Esri campus and attended by just 11 users, this event has always been about connecting, inspiring, sharing, and celebrating the GIS community. The Plenary Session, livestreamed this year to more than 97,000 people in three sessions over three days, gave many more people than ever the opportunity of learning about the most recent developments in GIS.

The achievements of Esri's users were celebrated in the major awards handed out during the first day. The Making a Difference Award went to the team from the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU) for its COVID-19 Dashboard built using ArcGIS Dashboards. Esri president Jack Dangermond said that they "woke up the world to seeing the context of the pandemic and helped us begin to understand it and its impact on the world." Ensheng Dong, a graduate student, and Lauren Gardner, professor and codirector of CSSE, were singled out for their work in developing the dashboard with technical assistance from the Johns Hopkins Applied Physics Laboratory and Esri. Learn more about the outstanding work of JHU in responding to COVID-19 by reading "Creating the Dashboard for the Pandemic," in this issue of *ArcUser*.

The Enterprise Award went to two organizations this year. The Louisiana Department of Transportation & Development received it for the complete enterprise GIS it implemented for its highway department. The project, headed by Brad D. Doucet, director of Enterprise Support Services, has outfitted every fieldworker with GIS technology.

The second Enterprise Award recipient was Enel Green Power North America (EGP), recognized for its enterprise implementation led by Keith Aubin, chapter leader of Geographic Information Platform at EGP and his team. EGP was selected in part for its pioneering work in renewables, which includes wind, hydroelectric, solar, and geothermal power from plants in the United States, Canada, and Mexico.

The President's Award, which Dangermond alone selects, went to the Regional Municipality of York (York Region) in Ontario, Canada. See the accompanying article, "Geospatial Infrastructure at Its Best," to learn more about York Region.

More than 175 organizations around the world won Special Achievement in GIS (SAG) Awards and were acknowledged during the Plenary Session. These organizations, representing less than one percent of the Esri user community, received this award in acknowledgment of their outstanding work, which exemplifies best practices in GIS.

Some trademarked Esri UC events had online incarnations. The Map Gallery, a perennial favorite of attendees, became a virtual showcase of 658 maps on a wide variety of topics and interests, ranging from social justice to Star Wars. A virtual format let many more people to participate in the 5K Run/Walk. In the virtual version, participants from 82 countries used ArcGIS QuickCapture to document nearly 3,400 runs logged during the Esri UC week that added up to 16,634 kilometers. The route of each run was mapped onto a globe for online viewing.

Another staple of the Esri UC Plenary Session, Dangermond's cavalcade of user maps showing the hundreds of ways that people all over the world are using GIS to address the world's challenges was part of the online experience. Esri received a record number of map submissions for this presentation, and a great many highlighted the outstanding work done in response to the COVID-19 pandemic.

Dangermond noted that some of this work was extraordinary. He said, "Be proud, because we're proud of you. GIS has never been more important than it is today. Your work on COVID-19 has been incredible. It is saving lives, transitioning economies, and making the world safer. So much of the COVID work was done not as part of your job description. You stood up these sites and did

the investigative work and supported people. It was heroic work, no matter how you measure it."

After highlighting the work of users, Esri staff gave a series of presentations on the new work Esri has done since the last Esri UC. This section included presentations on the ArcGIS Pro Suitability Modeler, ArcGIS Notebooks, additional 3D capabilities, and the introduction of voxels as a data format. Demonstrations showed the continued extension of the ArcGIS platform to people who are not GIS specialists with geoenabled systems such as ArcGIS Urban, ArcGIS Indoors, and ArcGIS Mission.

## MEETING GLOBAL GOALS WITH GEOGRAPHIC KNOWLEDGE

Jeffrey Sachs joined the Plenary Session live from his home to share his vision for changing "the direction of the planet." An economist by training, Sachs is the president of the United Nations (UN) Sustainable Development Solutions Network, a UN Sustainable Development Goals (SDG) advocate, and director of the Center for Sustainable Development at Columbia University.

He noted that the Earth's population of 8 billion needs "safe water, good food, and a healthful environment." However climate change, pollution, and the destruction of biodiversity that blocks the achievement of these goals and are causing stresses that are pulling the world's economy apart at an ever-increasing rate.

Sachs is committed to furthering the 17 UN SDGs as an effective way to combine economics with social justice to meet basic human rights in an environmentally sustainable way. To that end, he helped found the Sustainable Development Solutions Network, which is an organization of scientists, thought leaders, and knowledge institutions around the world. He sees the GIS community as fundamentally important to achieving the SDGs because the skills it brings are essential to devising solutions.

Sachs announced the launch of the SDGs Today site (SDGsToday.org), which provides reliable, high-quality, and timely data for informed decision-making on environmental issues.

## THE NEED FOR A NEW GENERATION OF SPATIAL THINKERS

Vicki Phillips, executive vice president and chief education officer for the National Geographic Society joined Jack Dangermond to discuss the vital role of geography and spatial thinking play in educating the next generation to meet the many challenges the world faces now and invent a sustainable future.

Esri and the National Geographic Society are partnering to

develop a generation of spatial natives that Dangermond termed GeoGen. "Geography is a science well-suited to solving the problems of the 21st century," he said. "We want to give young people a much more modern view of what geography is all about."

Dangermond emphasized the need for a geospatially literate society that can use design thinking and spatial problem solving to better understand the world. As the COVID-19 pandemic has so emphatically demonstrated, linking science and rational thinking to real-world action is vital.

## THOUGHTS FOR THE FUTURE

For Esri staff, Esri UC is always a much-anticipated opportunity to directly connect with users. This interaction is energizing and uplifting. The insights and reactions of users help inform work at Esri throughout the rest of the year. As Dirk Goter, director of product management/marketing, often observes, "Users are our greatest asset."

Although the online platform was designed to help make those connections, staff members have said how this year they missed opportunities to share a meal or a serendipitous chat while strolling through the San Diego Convention Center on the way to a session. Dangermond echoed the thoughts of staff members in his hope that—in the near future—it will be possible to again meet face-to-face.

Despite the unrest and uncertainty of this moment, during this virtual Esri UC, the GIS community came together, as it has for the last 40 years, to share knowledge, catch up with old friends and meet new ones, validate the value of GIS work, and affirm the critical that role GIS professionals will continue playing in the future.

# UC 2020

**LIVE FROM ESRI**

# Geospatial Infrastructure at Its Best

**At the 2020** Esri User Conference, the work of the Regional Municipality of York (York Region), was honored for its pioneering work in creating a shared geospatial infrastructure that epitomizes the conference theme of Connecting Our World. York Region is the first Canadian organization to win the President's Award.

In presenting the award, Esri president Jack Dangermond characterized the work of the municipality. "It's really geospatial infrastructure at its best," he said. Using Esri technology, York Region built a data cooperative that shares data, scripts, code, apps, workflows, and training among its constituent organizations.

John Houweling, director of the Data, Analytics and Visualization Services Branch at York Region, accepted the award via video during this entirely virtual user conference. "What a wonderful acknowledgment of our incredibly talented team working together with our partners. We are connecting our world here in York Region," he said. "We're

doing this through a culture of collaboration that encourages sharing, breaks down silos, and puts our collective data to work."

York Region is located north of Toronto, the provincial capital of Ontario. It encompasses nine fast-growing cities and towns—the City of Markham, City of Vaughan, City of Richmond Hill, Town of Newmarket, Town of Aurora, Town of Georgina, Town of Whitchurch-Stouffville, Town of East Gwillimbury, and Township of King as well as two district school boards and two conservation authorities. With 1.2 million residents, the region is one of Canada's largest municipalities.

Although the region is being honored for a current project, the York Data Co-op, York Region has long recognized the value of GIS for improving government. In 1996, it formed the YorkInfo Partnership to help all its constituent entities benefit by collectively investing in GIS technology, data, and the people who apply both to improve government processes and services.

According to Houweling, "Enabling data access and sharing has been our core direction for years. Building trust in the data adds confidence in decision-making and

ultimately results in more effective services. The York Data Co-op takes this further by enabling partners to share apps and tools. This increases collaboration in common business areas."

The sharing aspect of York Data Co-op has been especially important for smaller municipalities that lacked the resources to support the adoption of spatial technologies. The Data Co-op provides a virtual Marketplace in which partners can locate digital assets using a familiar online shopping experience. GIS has been adopted by all service areas in the region and supports governance, housing, transportation, environmental protection, land use, forestry, economic development, public health, and water and wastewater management.

This effort was guided by a vision that would connect the various partners' GIS implementations, allowing access to digital assets to be controlled by those partners. This led to the adoption of a truly federated model—a system of systems—in which no partner is the central owner or distributor of assets. Sharing can occur between any partner, using Esri technology to facilitate collaboration.

↓ Partner data can be pulled into a variety of apps such as this ArcGIS StoryMaps story that promotes the region's rental market.

This federated platform for sharing was built using ArcGIS Enterprise portal and ArcGIS Online, Esri's cloud-based data sharing, mapping, and analysis service, which gave partners a low-cost entry point to quickly and easily develop solutions.

"The ArcGIS Online development environment is so straightforward that we've literally been working things out on a whiteboard in the morning and then looking at a prototype online that afternoon," said Brendan Coles, GIS project specialist for York Region. "Everyone gets excited when they see how quickly we can make things real."

The York Region Open Data portal and the Marketplace were built using ArcGIS Hub. Partners publish the digital assets that they wish to share by registering them with the York Data Co-op. These assets aren't physically copied into a central server. They remain behind each partner's firewall, where they are maintained so that assets are always current. The assets needed for a specific use are easy to locate because they are grouped based on function rather than asset owner. A defined legal and governance framework controls the use of YorkInfo Partnership resources.

Not only does this structure greatly enhance opportunities for collaboration but it improves accuracy while saving time and eliminating the costs associated with maintaining redundant assets. Users never have to wrestle with determining which of many versions from many sources is the most current and authoritative.

The York Data Co-op provides a common infrastructure for delivering services, whether within cities, towns, and districts or across the region. This is enormously useful in situations that require municipalities to jointly manage operations such as water and wastewater management.

Access to the most authoritative data also promotes data-based decisions by ensuring accuracy and currency. This system provides one window into all the data and a single source of truth. Each asset—whether it is a dataset, script, app, or workflow—is documented with metadata identifying its source, extent, timeliness, and other information so that it can be used knowledgeably by other partners.

Providing the Marketplace has another powerful benefit. Partners can incorporate the work already done by others, rather than replicating it, then build on that work to accomplish more. This support improves productivity and scalability for municipal GIS departments, whether those they are single-person shops or departments with many staff members.

This is especially valuable for smaller partners that have more limited resources that may lack the internal capabilities to develop these assets. This also makes deploying new apps more doable and less risky and enables larger cooperative activities between partners, such as using common data models.

Partner data can be pulled into a variety of apps via APIs or into ArcGIS StoryMaps, used in ArcGIS Online maps and analyses, or pulled into work on the desktop using ArcGIS Pro. This approach supports the operations of individual municipalities by letting them choose how they use technology so that it works with, rather than disrupts, existing business processes.

This enables innovation, not for innovation's sake, but to improve processes and services that benefit residents of York Region. This includes a federated Open Data portal that provides York Region businesses and residents with access to government data. Although not all partners' open data has been connected yet, eventually any data shared by partners will be accessible and usable.

YorkInfo Partnership will continue to grow. There are plans for incorporating other municipal service providers, additional levels of government, and organizations in the private sector, although that will require some legal and governance changes.

"The data sharing that they've undertaken lays down a solid foundation for leveraging new technology. Because this works well in such a diverse environment as York Region, it will encourage others to follow their path. It becomes a lighthouse for other municipalities," said Alex Miller, president of Esri Canada.

# How to Change the Way We Talk about Climate Change

By Monica Pratt

**Although addressing** the online audience remotely from Lubbock, Texas, Katharine Hayhoe, the 2020 Esri Science Symposium keynote speaker, was anything but remote. In her dynamic and interactive presentation, "The First Step to Tackling Climate Change," Hayhoe took on the seemingly intractable problem of building

consensus and taking meaningful action to lessen human impacts on the environment and curb climate change.

Her presentation was part of the fifth annual—and first virtual—Science Symposium, held on July 16, 2020. The coronavirus disease 2019 (COVID-19) pandemic caused the symposium to

rapidly morph into an online event. In previous years, the symposium not only highlighted scientific work enabled by GIS technology but provided an opportunity for the scientific subset of the Esri user community to network.

While face-to-face interactions were sacrificed this year for safety's sake, the event

↑ Hayhoe advocates talking about climate change in a way that engages people and encourages positive, immediate action.

became more broadly accessible. The nearly 1,200 (virtual) attendees this year was more than doubled attendance the previous year. The event attests to Esri's commitment to supporting the science done by its users and staff and the science that underpins its products. Esri staff are actively involved in research and in organizations that support science as well as publishing books on the scientific applications of GIS, such as the recently released *GIS for Science*, Volume 2.

← Dr. Katharine Hayhoe
Photo courtesy of Artie Limmer/Texas Tech University.

## Examining What Is Needed

Dubbed "the Climate Explainer" by the *New York Times*, Hayhoe is an atmospheric scientist who is a professor in the Department of Political Science, and a director of the Climate Center at Texas Tech University. She is also a United Nations Champion of the Earth. She holds a bachelor's degree in physics and astronomy from the University of Toronto and a master's degree and a doctorate in atmospheric science from the University of Illinois, Urbana-Champaign. A prolific author of more than 125 peer-reviewed papers, abstracts, and other publications, she is also a frequent speaker on climate change and its impacts,

effective communication, and faith.

In a compelling hour-long presentation, Hayhoe used insights gleaned from cognitive neuroscience and maps showing the distribution of public opinion on climate change in the United States to explore the approaches that have been used and why they haven't worked. The event drew a diverse audience that came from industry, academia, nonprofits, consulting, and other sectors. She immediately included the online audience with interactive polls that captured their reactions and displayed them in maps, charts, and word clouds.

Hayhoe noted that when people are asked to take action on climate change,

↑ Hayhoe encouraged audience participation through polls. Responses were visualized in maps, charts, and word clouds. This word cloud was generated in response to the statement "I care about climate change because it affects…".

they most often think of what they can do as individuals. These actions can include installing smart thermostats, using LED lightbulbs, and practicing recycling. While she acknowledged that these are all positive things, they fall far short of what is necessary.

For example, the use of LED lightbulbs has cut $CO_2$ by 570 million tons each year. This sounds impressive until it is placed in context. Since the annual $CO_2$ output is 33,000 million tons, using LED lightbulbs accounts for only slightly more than 1.7 percent of emissions. "We need more," she said.

Given the scope of the problem, the *more* required for affecting a solution is policy change. However, the current and projected states of global temperature increase, as visualized by the Climate Action Tracker, show that the goal of limiting temperature increases to no more than 2 degrees Celsius—as stipulated by the 2015 Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC)—will not be met by the majority of signatories to the pact.

## When More Isn't Better

The nearly universal reaction to this lack of action is to conclude that people don't understand enough science. The response to this perceived lack is to pummel climate change naysayers with studies and data that show the dire trajectory for the planet in the belief that explaining the facts is enough to change minds.

However, scientific evidence of climate change has been well-known since the 1820s and is well documented. A simple search on climate change in Google Scholar reveals more than 2.6 million studies. Numerous national climate assessments—running into the thousands of pages—have been published. As Hayhoe noted, "We have plenty of science demonstrating the reality of climate change driven by human actions."

The objection she most commonly hears from climate change skeptics is that "it's been warmer before." She uses paleoclimate data to counter that argument and points out that, while temperatures have been higher, they have never been this high in human history.

The disastrous effect of climate change is brought home to people every day in news headlines that describe epic wildfires, instances of sea level rise, and extreme weather events.

## What Will It Take?

The science is available and compelling, the consequences can be observed firsthand, and the stakes couldn't be higher. If individual action isn't the answer and a deluge of doomsday scientific data won't motivate policy change, what will it take to make people act and—act rapidly?

To answer this crucial question, Hayhoe produced a visualization by the *New York Times* of Pew Research Center data collected in 2020 on the issues on which Republicans and Democrats are most

department of Experimental Psychology at University College London. Sharot's research shows that the brain is programmed to get a kick out of new information, but it will only accept that information if it harmonizes with existing beliefs, a phenomenon popularly known as confirmation bias.

Like most animals, people actively pursue rewarding activities but withdraw from situations that cause fear and anxiety and become inactive. Continuing to shovel an ever-increasing number of scary facts about the consequences of climate change will not only fail to change minds but will harden preconceptions. In short, the effort to scare people into action appears futile despite the fact that emphasizing global doom has overwhelmingly been the most widely employed strategy.

When Hayhoe asked attendees to name what they thought was the most convincing scientific fact that would spur climate action, increases in extreme weather conditions topped the list, followed by the melting ice in the Arctic and rising sea levels. Although these facts all make a strong case for concern about climate change, they are often perceived as distant in time and space and therefore not compelling.

## Talk That Inspires Hope and Action

How can this vicious cycle be broken? Hayhoe's answer: talk about climate change but in a way that engages people, helps them appreciate the immediacy of the problem, and encourages positive action.

Instead of using images of polar bears trapped on shrinking ice floes, make people realize that climate change is something that will harm them personally. She urged using examples of the increasingly common local flooding and fires events that necessitate changing zoning laws and enhancing public safety response.

Hayhoe also recommended localizing and scaling data that is readily available from the ArcGIS Living Atlas of the World to quantify these impacts in terms of people and dollars. This same approach can be used to show where improvements

have been made—such as the increase in the use of renewable energy sources—to demonstrate beneficial practices that are gaining traction.

Instead of using data to bludgeon people who are dismissive of climate change, Hayhoe advocates employing insightful methods of connecting with people by talking about how and why addressing climate change is important to them—right now—and inspiring them to action by sharing what can be done to improve the situation. This will create a positive feedback loop that will lead to action.

## About the Author

**Monica Pratt** is the founding and current editor of *ArcUser* magazine, the executive editor of *ArcNews* magazine, the editor of *Esri Globe*, and the head of the publications team at Esri. She has been writing on technology topics, specializing in GIS, for more than 25 years. Before joining Esri in 1997, she worked for newspapers and in the financial industry.

divided. It was presented in descending order, and climate change tops the list as the most politically polarized topic in the United States. But this situation is also true in other countries.

Using a series of thematic maps produced by the Yale Program on Climate Change Communication, Hayhoe explored this phenomenon further. These maps show by county and congressional district that for most questions related to climate change, party affiliation is the single most decisive factor influencing the type of response.

However, the maps also showed something else. While most people of either political affiliation acknowledged the reality of climate change, they don't think it will affect them, they think they can't do anything about it anyway, and they never talk about it.

Hayhoe posits that the answer to this perplexing situation is not found in climate science but in the science of the human mind. She pointed to the work of Tali Sharot, a professor of cognitive neuroscience in the

# Effectively Present Information about Race/Ethnicity (or Any Group)

By Diana Lavery

## Organizations worldwide are working to eliminate inequities, and mapping is a big part of that work.
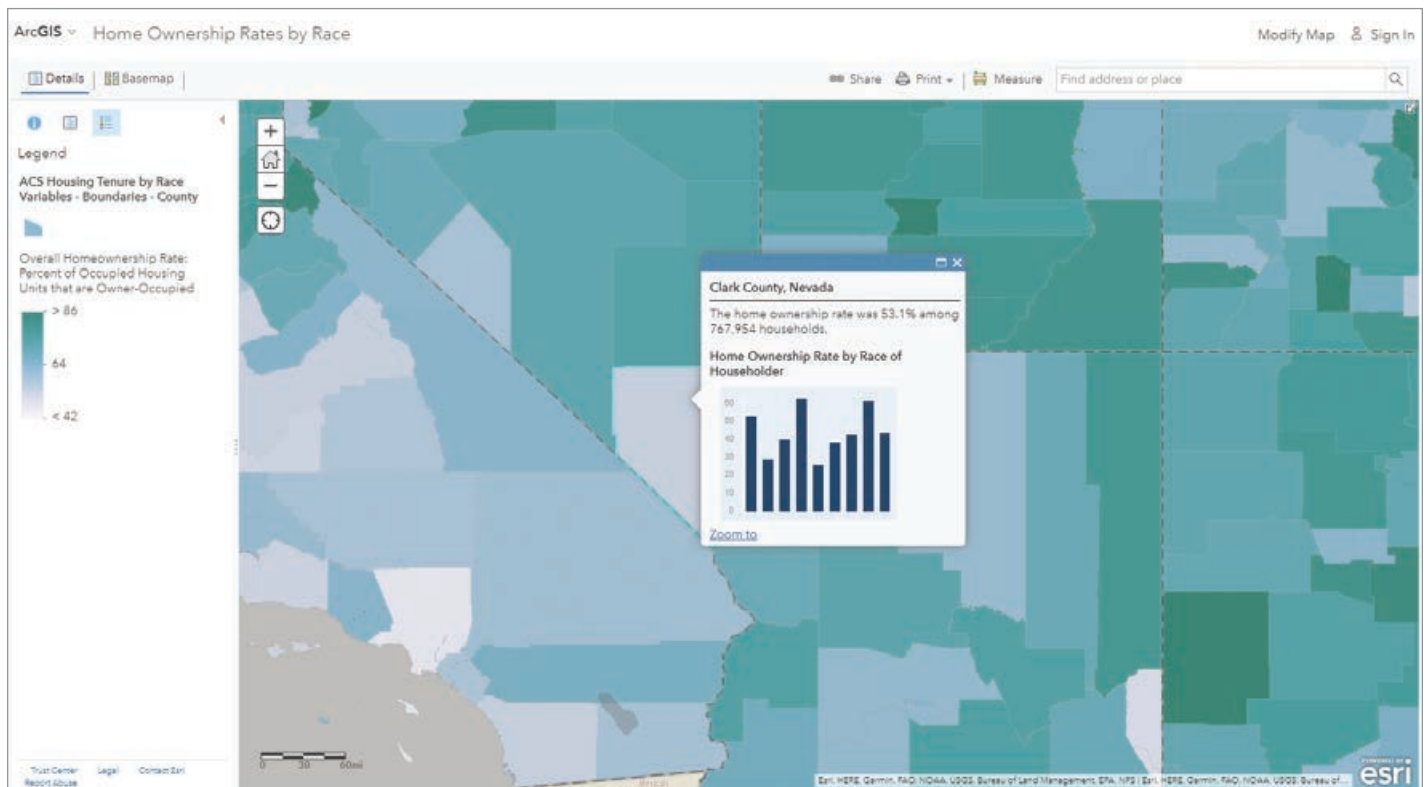
This article describes some mapping techniques that show how to work with health or economic data and address the differences by characteristics, such as occupation, age group, or race/ethnicity, without making a separate map for each group. Instead, you can present breakdowns of this data in a single map.

This minimizes work for you. It also helps your audience more easily digest the information by preventing users from being overwhelmed by multiple maps. Here are a few techniques for incorporating and presenting breakdowns by different groups:

- Configuring the pop-up to show breakdowns
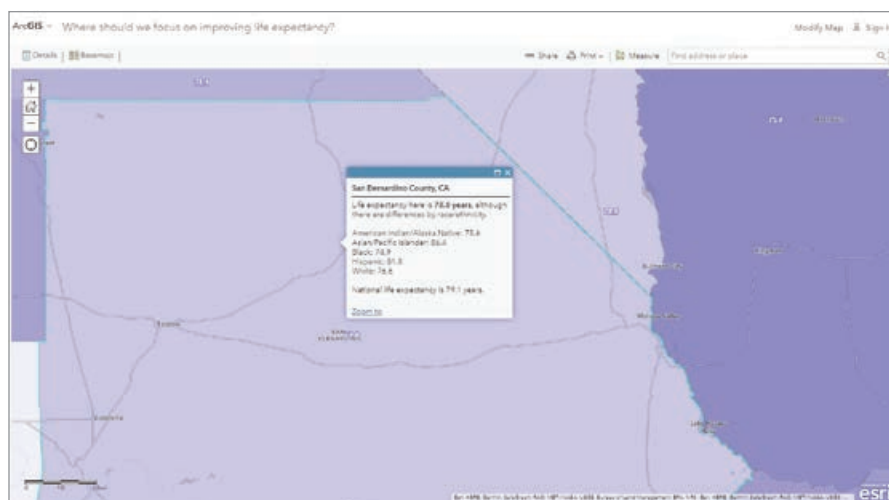- Using different mapping styles
- Labeling the map to indicate breakdowns

These techniques result in fewer but more informative maps that can help identify opportunities to address inequalities.

↓ Adding a column chart to a pop-up can break out data. Each column in this chart presents a racial/ethnic group. The data for each group is accessed by hovering over each column.

A



## Presenting Breakdowns in Pop-Ups

Configure the pop-up to show a custom attribute display by adding media and using ArcGIS Arcade expressions. The sky is the limit for crafting a pop-up that conveys breakdowns by an aspect of the overall attributes being mapped such as race/ethnicity. Pop-ups can use a simple chart or list to do this.

**Display a simple chart.** Map the overall attribute of interest, such as homeownership, and then present different categories of that attribute in the pop-up, using a column chart. A column chart is just one type of chart you might want to use. The *ArcGIS Blog* post "Pop-ups: adding charts" provides an overview of the different chart options available.

**Display a brief list.** Create a text-based display of the differences by using a short list in the pop-up. This option doesn't require the map reader to hover over the chart.

## Mapping Styles to Display Differences

Mapping the differences with the Above-and-Below theme, predominance mapping, and dot density mapping are all styles that can be effective for breaking down data.

**Map the difference itself with above-and-below mapping.** This works well when there are only two groups of interest such as men and women or owners and renters or veterans and nonveterans. One approach is to calculate x–y, and then use the Above-and-Below theme centered at zero.

B
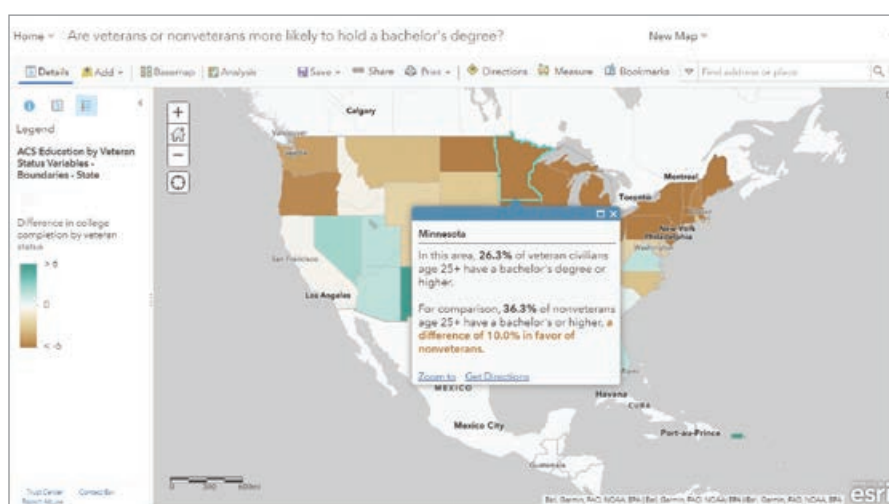
Difference in college completion by veteran status (Color Style)

```
$feature["B21003_calc_pctVetGEBAE"]-$feature["B21003_calc_pctNvetGEBAE"]
```

This helps illuminate the magnitude of the difference between the two groups. In the lighter areas, the difference isn't so great, but in the darker areas, it is. To achieve this, open the Change Style panel and select the attribute for the difference itself, then choose the Above-and-Below theme.

Another approach is to map the difference as a percentage. When mapping differences, make sure you are comparing "apples to apples" as much as possible. For example, when mapping women's earnings as a percentage of men's earnings, take into account the fact that women are more likely than men to work part-time, so limit the data considered to reflect only full-time

C

workers to accurately portray the wage gap between these two groups.

**Map the most frequent group with predominance mapping.** A predominance map considers multiple attributes in the data and displays the most common or highest value. Predominance mapping is a great choice when there are more than two groups, as in the case when mapping the race/ethnicity, educational attainment, or occupations of a population. This technique can also be used when there are only two categories.

**Show concentrated and mixed areas with dot density mapping.** The new Map Viewer allows dot density mapping and takes predominance mapping even further by showing both concentrated and mixed areas through blending. Dot density works when you want to display multiple count or integer values inside a polygon. Areas that display a mix of two or more colors reflect a more mixed community.

**Use labels to present breakdowns.** Improvements in labeling in Map Viewer Beta can be used to highlight data breakdowns. Labels work well when the extent is zoomed in to an area. By setting labels to turn on when someone viewing the map zooms in to an area, you can convey breakdowns of the data.

## These Maps Are Just the Start

Creating these types of maps is often only the first step in a much larger project for implementing and strengthening intervention programs. Differences will most likely be greater in some areas than in others, which will help in allocating scarce resources. Identifying where underrepresented

groups have had better outcomes than other groups is also valuable information.

Maps that show breakdowns by race/ethnicity often provide information that is valuable in decision-support discussions—discussions that GIS analysts are well-positioned to contribute to.

All the maps in this article and others can be found at Esri Maps for Public Policy (https://bit.ly/2Vnrxiy). Contribute to the conversation in the GIS for Equity & Social Justice space on GeoNet.

## About the Author

**Diana Lavery** loves working with data. She has more than a decade of experience as a practitioner of demography, sociology, economics, policy analysis, and GIS—making her a true social science quantoid. Lavery holds a bachelor's degree in quantitative economics and a master's degree in applied demography. She has been with Esri as a product engineer on the ArcGIS Living Atlas of the World and policy maps teams since 2017. She enjoys strong coffee and clean datasets, usually simultaneously.
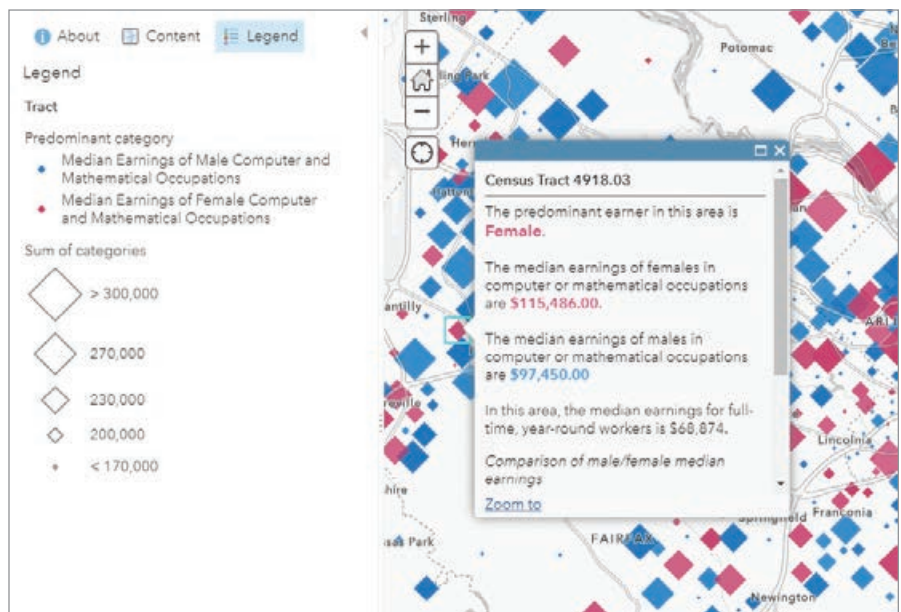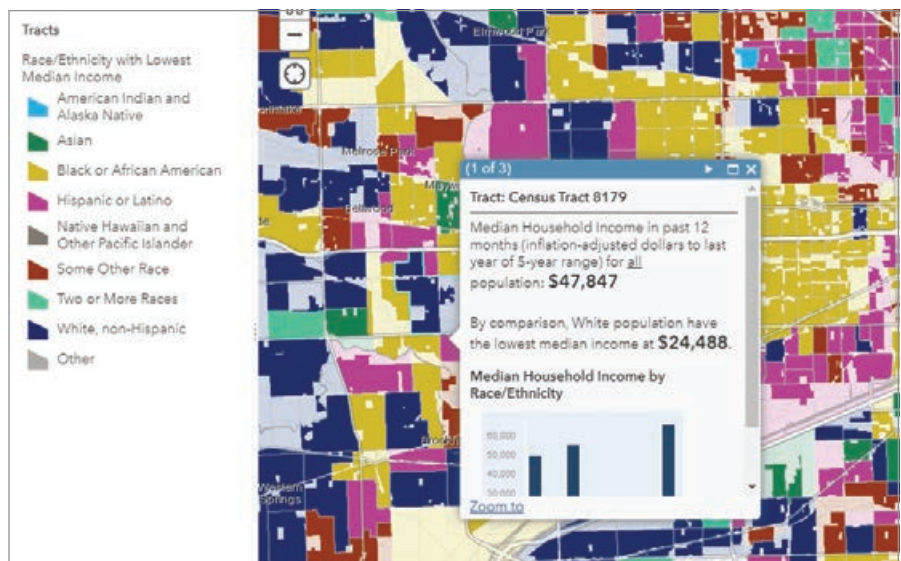




↗ Predominance mapping used to compare groups imapping more than two groups, as in the case when mapping the race/ethnicity, educational attainment, or occupations of a population.

↘ Predominance mapping can also be used when comparing two groups with regard to a characteristic such as pay.

**Legend**

ACS Race and Hispanic Origin Variables - Boundaries - Tract

1 Dot = 9

- Non-Hispanic White Population
- Hispanic or Latino Population
- Black or African American Population
- Asian Population
- American Indian and Alaska Native Population
- Two or More Races Population
- Native Hawaiian and Other Pacific Islander Population
- Some Other Race Population

**Census Tract 4822.01**

The predominant race in this area is
**Asian**

Non-Hispanic White: 119
Hispanic or Latino: 760
Black or African American: 1
Asian: 3,081
American Indian and Alaska Native: 0
Two or more races: 45
Native Hawaiian and Other Pacific Islander: 0
Some other race: 0

🔍 Zoom to

↑ Dot density mapping takes predominance mapping further by showing concentrated and mixed areas to display multiple count or integer values.

# Give Your Maps an Edge
## *with Vignettes*

By Aileen Buckley

Vignettes are a handy and versatile tool that can be used to emphasize or de-emphasize features. They can subtly communicate the ambiguity of a boundary or add professional polish to a map.

**Let's start** by answering the question, What is a vignette? In cartography, a vignette is a symbol—applied most often to a line feature or the outline of a polygon—to give the impression that the feature fades gradually into the background. You can do this in several ways.

## Figure-Ground

Vignettes can be used to enhance an areal feature of importance by drawing attention to it. This can be done by fading the background color surrounding it to the white of a page or computer screen or by fading the background to semitransparency that allows the background to be seen faintly outside the main map area containing the feature.

Used in this way, vignettes promote the cartographic design principle of figure-ground by separating the map image in the foreground from a seemingly amorphous background. This is critical in helping the map reader understand which geographic area to focus on.

## De-emphasized Lines or Outlines

Vignettes can also be used to create a line or polygon outline symbol that has less visual prominence than it would if

↗ This vignette fades to white and helps visually promote the extent of Crater Lake National Park, Oregon.

↘ This vignette fades to semitransparency, another way to show the extent of Crater Lake National Park, Oregon.
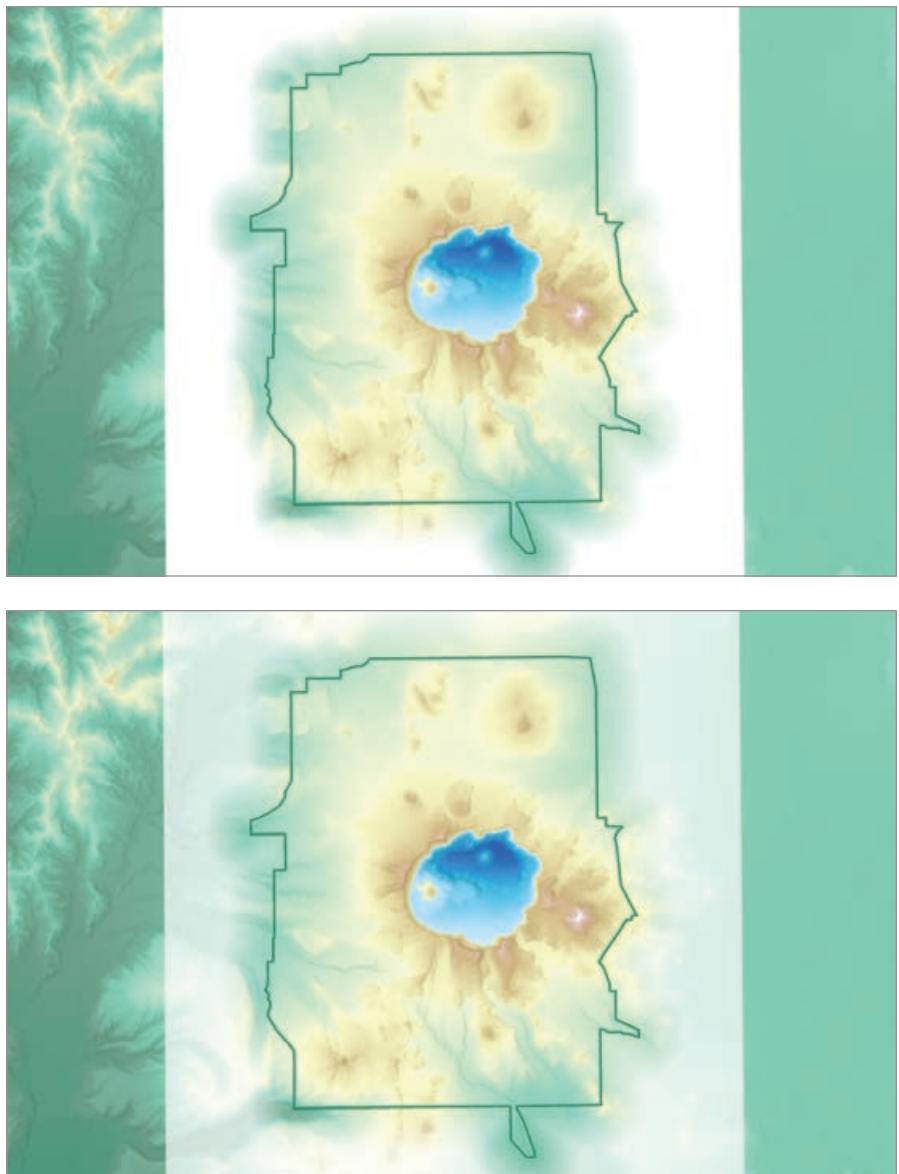
↖ Buffalo tints are used in this map to subtly distinguish the states and territories of Australia.



← The gray wolf's range along coastlines is known, so vignette edges are shown with a darker color. But because the extent of the gray wolf's range in the middle of the continent is less certain, that is communicated with a symbol that has no clear centerline.



↙ A vignette can be used to symbolize the impermanent nature of features that move over time, such as the ever-changing extent of the Aral Sea.

represented as a solid line. You may have seen this effect in atlases to symbolize world countries or the states and provinces within countries. Borders between administrative areas can be seen clearly, though they do not command the attention of the map reader as the most important feature on the map. This use of a vignette is called a buffalo tint.

This vignette technique is especially helpful when many line features on the map compete for the map reader's attention. Graded colors separate areas into distinguishable entities, but the lines between the areas do not command visual prominence. This is important for reference and atlas maps that include many types of line features (e.g., boundaries, roads, rivers).

## Indeterminate Boundaries

Vignettes are a useful way to show the extent of features with no sharp boundaries, such as animal ranges, soil units, and ecotones (i.e., the transition areas between two adjacent ecological communities). Using a symbol that does not have a sharp edge helps convey the uncertain nature of the feature's extent. For example, because the gray wolf's range along coastlines is known, those vignette edges are shown with a darker color. Because the extent of the gray wolf's range in the middle of the continent is less certain, darker vignette colors are not used.

This use of vignettes is also helpful for showing extents that vary over time, such as polar sea ice, a moving oil spill, or the historic extent of the Aral Sea. Using a vignette helps convey the impermanent nature of the extent of these features.

## Subtle Visual Distinction

Vignettes are often used to subtly enhance the interface between two different types

of features. A vignette used to enhance the land-water interface is often called a coastal or shoreline vignette. The areas closest to the shoreline or coastline are shown with a white color that suggests the white water of breaking waves along beaches. White areas fade into blue areas that gradually become darker as the distance from the shoreline increases, giving the impression of deeper water.

The resultant cartographic effect has the added benefit of providing the illusion of an added dimension to an otherwise flat map. Other types of symbols can be used in coastal or shoreline vignettes, including stipple patterns, broken line patterns, and lines parallel to shore.

## Is It a Vignette or Feathering?

While cartographers called this effect a vignette, graphic artists would use the term *feathering*. In graphic arts, a vignette is a reduction of an image's brightness or saturation toward the periphery compared to the image center. The word *vignette*, from the same root as *vine*, originally referred to a decorative border in a book. This border could be used to frame the map page by appearing as a dark edge that fades transparently toward the interior of the map area, thus drawing attention to the center of the page. Esri cartographer John Nelson, describes this effect in an *ArcGIS Blog* post,

↓ A vignette can be used to emphasize landforms (A), coasts (B), or both (C).



A



B

← This portion of a 1905 US Geological Survey topographic map of Portland, Oregon, creates a vignette with parallel lines that highlight the water areas along the shoreline of the Columbia River. Lines nearer to shore are closer together, simulating the real-world phenomenon of waves getting closer together as they approach the shore. It is not only cartographically effective, but beautiful.

Nonetheless, the acceptance by cartographers of the term *vignette* has resulted in its standard usage within the profession.

## About the Author

**Aileen Buckley** is a research cartographer at Esri and has been making maps for over 30 years. She holds a doctorate in geography from Oregon State University, taught cartography while on the faculty at the University of Oregon, and is currently an adjunct professor at the University of Redlands. Buckley is a past president of the Cartography and Geographic Information Society and is the current the chair of the AutoCarto conference committee. In addition to publishing and lecturing widely on topics of map design and GIS for mapping, she is an author of the *Atlas of Oregon* and coauthor of *Map Use* (sixth, seventh, and eighth editions) and a regular contributor to Esri's *ArcWatch* and *ArcUser*.

"Steal These Vignettes, Please," and illustrates it. *[Go to Nelson's post to download an assortment of textured vignette ArcGIS Pro styles and start using them right away.]*

The more appropriate graphic arts term to describe the effect of smoothing or blurring the edges of a feature would be feathering. The softened edge gradually fades until it becomes transparent, using a technique similar to one used for retouching photographs that employs fine feathers.

# Many Possibilities for Policy Maps from Living Atlas Data

By Diana Lavery

Today, services, web maps, and open data in the cloud put data at your fingertips.

But there's much, much more to it.

Using online layers enables anyone to explore and create additional maps directly from these layers, with no download required. Working with these layers is exciting because this data can potentially answer so many questions.

ArcGIS Living Atlas of the World contains high-quality layers to help you get started making the maps you need to fuel your information products. This instant access to useful layers enables frictionless new ways to explore and map more effectively. For example, each of the American Community Survey (ACS) layers in Living Atlas can be used by thousands of ArcGIS users who want to make specific maps that answer their unique questions. A single layer can often power many maps.

Labor Force Participation by Age, which uses ACS data, is a new topic Esri has added to ArcGIS Living Atlas. Each age group is broken down into:

- Everyone who worked in the past 12 months
- Those who worked full-time, year-round in the past 12 months
- Those who worked less than full-time, year-round in the past 12 months
- Everyone who did not work in the past 12 months

This one layer can be the source for several policy maps on labor force dynamics. The maps referenced in this article will give you a taste of some ways you can configure maps to fit your specific needs. Using a whole range of functionality within ArcGIS Online, I made four policy maps from the layers for this one topic. Each map answers a different question that illuminates multiple aspects of this topic.

## Where Are People Aged 65 Years and Over Who Are Still Working?

The map in Figure 1 (arcg.is/yeWO50) combines the boundary and centroid versions of the ACS Labor Force Participation by Age variables data, using the symbology from both to get a textured look that communicates percentages and counts. While age 65 is

↓ Figure 1: This map (arcg.is/yeWO50) combines the boundary and centroid versions of the ACS Labor Force Participation by Age variables data.
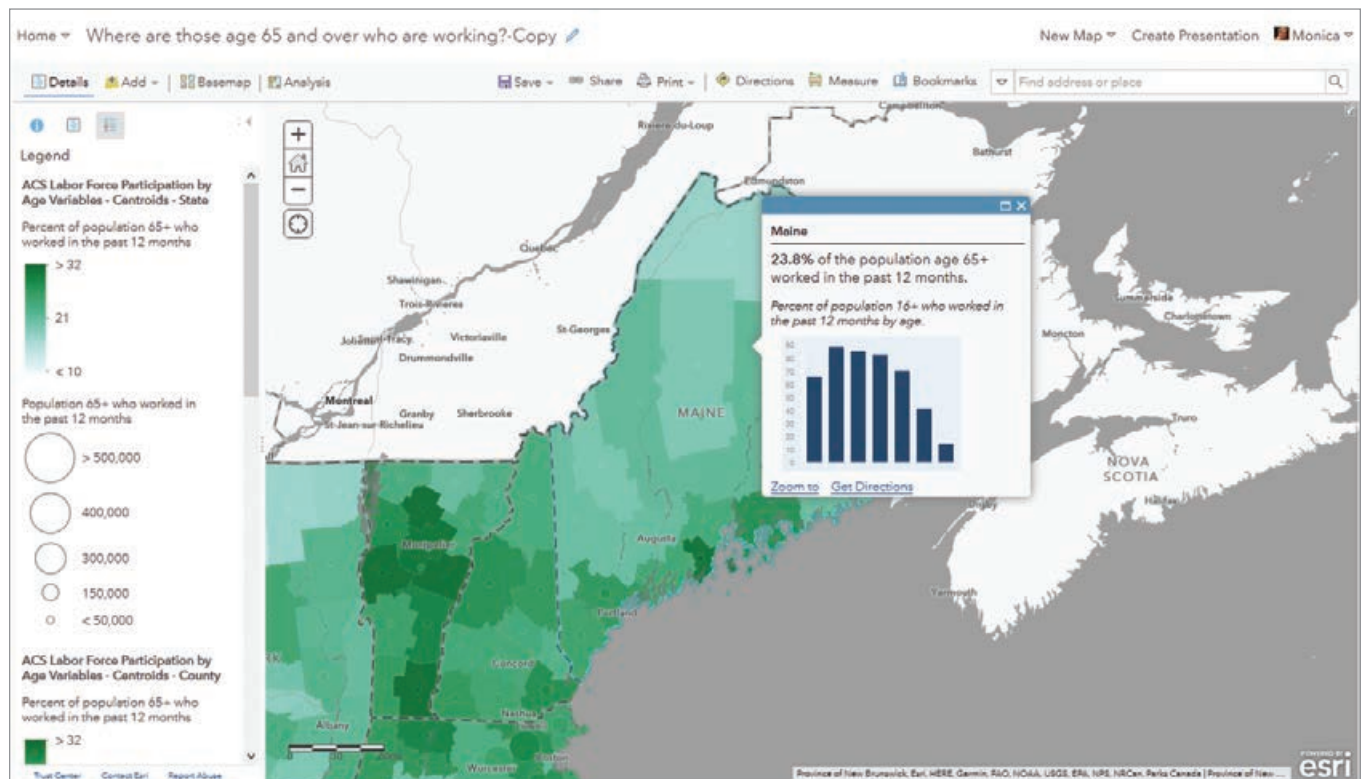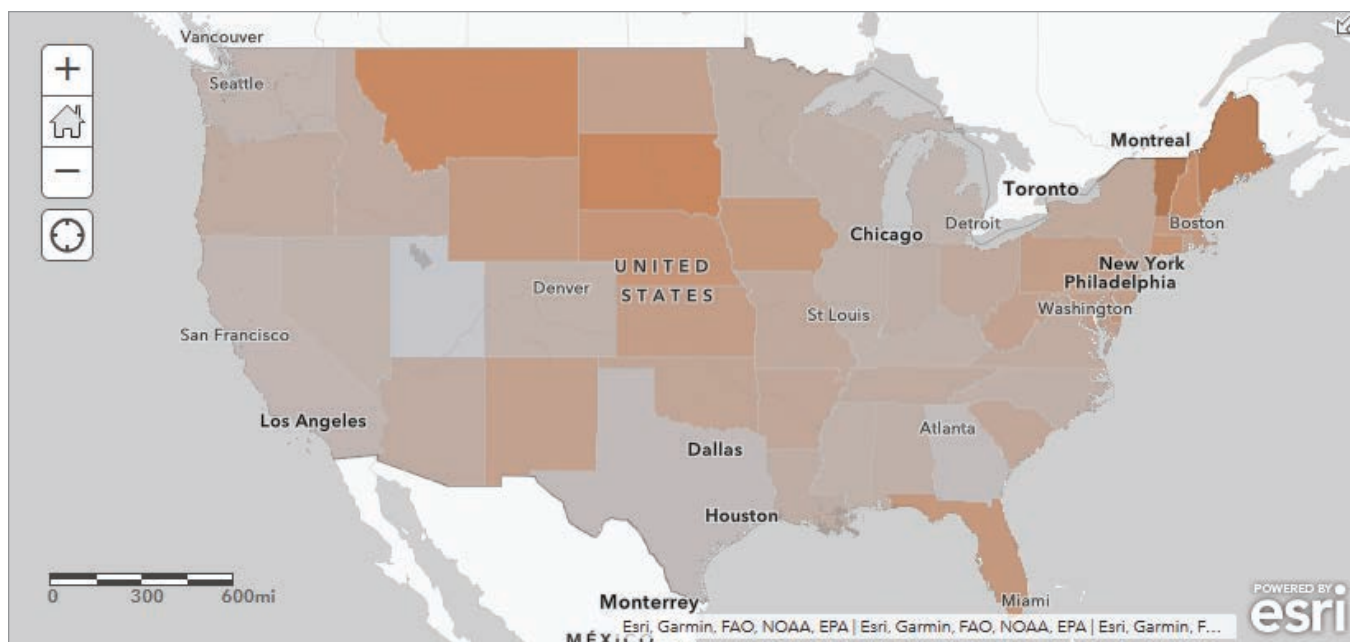
commonly thought of as retirement age, many people aged 65 and over still work for a variety of reasons. For example, the map in Figure 1 shows that 23.8 percent of Maine's population who are aged 65 years and over are still working.

## How Many Workers Are Aged 65 Years and Over and Likely to Retire Soon?

Let's change the question slightly and ask, What share of the working population is aged 65 years and over? View this multiscale map, illustrated in Figure 2 (arcg.is/1Hf8Hn). The Social Security Administration tracks this measure, as the ratio of workers to retirees has been falling over the past few decades due to an aging population. Some communities are feeling this effect more than others and are even experiencing a shortage of workers. Maine, for example, has a high percentage of its current workers that are aged 65 years and over. Figure 2 uses ArcGIS Arcade to map a value that is slightly different from the value in the previous map.

A good policy map makes locations in need of intervention clear. One simple way to do this is to use a color ramp that really emphasizes the areas with high values through a gray-to-color ramp, such as this gray-to-orange ramp map in Figure 2.

As a starting place, these color ramps only give the darkest color to values one standard deviation above the average of the data values. You can easily adjust this by dragging the handles, entering in your own breakpoints, and even inverting the color ramp as appropriate. Using a gray-to-color ramp helps de-emphasize places with lower values by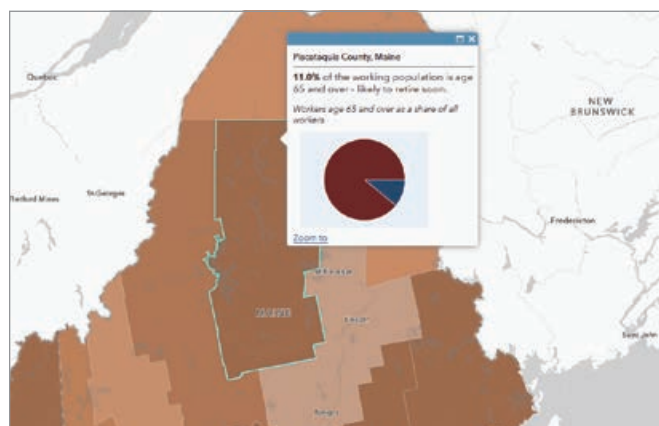 symbolizing them with a color that is closer to the color of the basemap. Maine and other states with older working populations really stand out on this map.

By symbolizing each level of geography, as shown in Figure 3, someone viewing this map can drill down into the county and tract levels to see exactly where Maine will have a shortage of workers soon.



↑↑ Figure 2: A good policy map makes locations in need of intervention clear. This map does that by using a gray-to-orange color ramp that really emphasizes the areas with high values.

↑ Figure 3: Some communities are feeling the effect of an aging population more than others. Maine has a high percentage of its current workers that are aged 65 years and over.

## Where Are Teens Working Full-Time, Year-Round?

When looking at the pipeline of future workers, an obvious group to map is youth. Many communities are interested in building the capacity of their youth population in terms of workforce training. Knowing where to target these efforts helps them allocate scarce resources. One subgroup to consider targeting could be teens who are currently working full-time.

The map in Figure 4 (arcg.is/18y9zb) uses pop-ups to provide additional context for counties and tracts by displaying the percentage of working teens in that county or tract in relation to the percentage of teens working statewide. For example, the percentage of working teens in Hardin County is above the percentage of working teens statewide, but it is below the percentage of working teens in Chambers County.
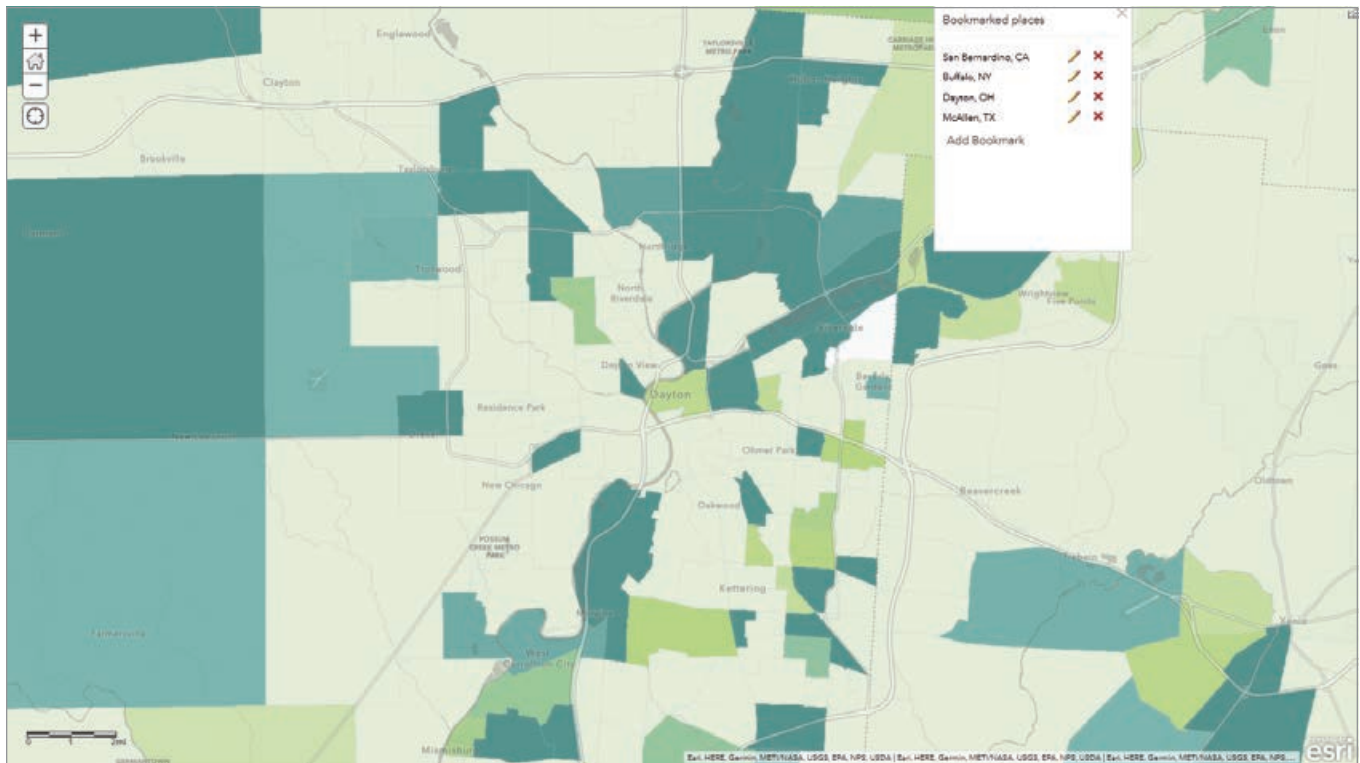
↑ Figure 4: The state percentage of working teens is being calculated on the fly, using an ArcGIS Arcade statement containing a FeatureSet function that calls to the state-level layer in this map.

The state's percentage is being calculated on the fly, using an Arcade statement containing a FeatureSet function that calls to the state-level layer in this map, as shown in Listing 1.

```
Listing 1
//get the state's fips code from the first 2 digits of the
county's and tract's fips code
var state_fips = left($feature.GEOID,2)

//connect to state-level layer in the map
/* ACS Labor Force Participation by Age Variables -
Boundaries - State */
var state_data = FeatureSetById($map,
"ACS_Labor_Force_Participation_by_Age_Boundaries_8020")

var match_key = "GEOID = @state_fips"

var state_match = first(filter(state_data,match_key))

var state_rate = round(100*(state_match.B23027_004E/state_
match.B23027_002E),1)
//return state_rate

var pop_up_text = when(
    (100*$feature["B23027_004E"]/$feature["B23027_002E"])>;
state_rate, "above",
    (100*$feature["B23027_004E"]/$feature["B23027_002E"])<;
state_rate, "below",
```

```
    "no different from"
    )

return pop_up_text + " the state average for " +
$feature['State'] + " of " + state_rate
```

This map also uses bookmarks to guide the viewer to other areas of interest for this topic.

## In What Age Group Does Part-Time Work Predominate?

This final example in Figure 5 (arcg.is/Tu9Lv) maps the predominant age groups working part-time, as well as the count of part-time workers, and depicts them by size. This map uses the centroids version of the layer, rather than the boundaries version.

Many people work part-time over the course of their careers. People who voluntarily work less than full-time include students, parents with young children, people with other family commitments, and seniors who work bridge jobs to ease into retirement. Some may want to work full-time but can only get part-time hours. Others may have seasonally worked full-time hours, but not year-round.

This map uses a more advanced mapping style than the simple high-to-low ramps that the other three use. Predominance maps are great for showing which group in a category is most common. Sequential predominance is useful when those categories have a natural order and the category is symbolized with a sequential color ramp.

These four maps are just a few of the many maps that could be made from this layer. Some other maps could answer questions such as:

- Where are those 70 years of age and over who are working full-time, year-round (likely out of necessity)?
- What is the teen employment rate?
- What percentage of workers worked part-time last year?
- Where are people aged 25 to 64 years—the peak-working-age population—not working?

The best part about these maps is that, since they are powered by ACS layers in the Living Atlas, they will be refreshed every year when the US Census Bureau releases the new ACS data. Just check your map and make any adjustments to symbology based on the new values. No more building maps from scratch each year!

Labor Force Participation by Age is just one of many ACS topics in the Living Atlas. Each of the 39 topics can answer all kinds of policy questions. There are dozens of other ACS layers to explore in the Living Atlas. For example, the boundaries and centroids layers on Health Insurance Coverage Variables could answer questions such as:

- Where are the uninsured?

- What is the most predominant type of health insurance coverage for children?
- Where do people have Medicaid/other means-tested public coverage?

Let enhanced metadata help you while you are mapping. If you are unsure what any field means, simply click the information button (*i* in a circle) to the right of the long field description in the Map Viewer.

## What Policy Maps Will You Make from ACS Layers?

Map the whole nation or apply a filter to the layers and make a custom map about your community. There are so many possibilities for policy maps from ACS layers. They can vary based on the questions you address, the way you style your map, or the configurable app or ArcGIS StoryMaps story you pick.

To get inspiration, browse the *American Community Survey Atlas* gallery (bit.ly/3bsapyy), peruse the Learn ArcGIS lessons on policy mapping and take advantage of the resources on the Esri Maps for Public Policy site (bit.ly/3bhNfe6). What opportunities to intervene and strengthen your community will your maps highlight?

↓ Figure 5: This map employs sequential predominance to map a category that has a natural order. It is symbolized with a sequential color.
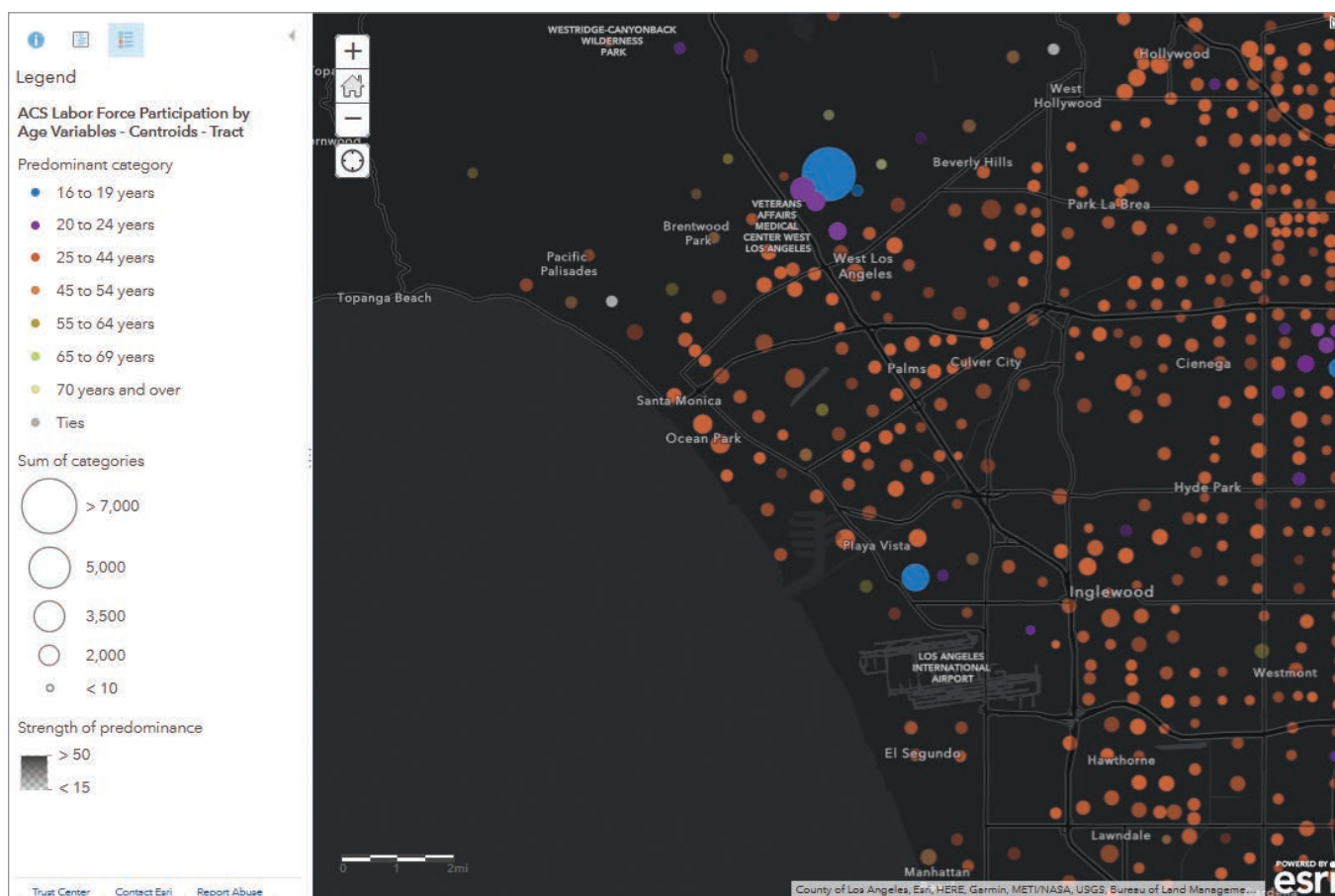
# Coordinate Systems:
# *What's the Difference?*

By Heather Smith

**Knowledge of coordinate systems** is fundamental for GIS specialists, but there are so many confusing terms. In this article, I explain some topics that have confused me at one time or another when working with coordinate systems. Hopefully, these explanations will help clear things up for you by helping you understand the difference between the following terms:

- A GCS and a PCS
- A datum and a geographic coordinate system
- A projection and a projected coordinate system
- WKT and WKID
- The Define Projection tool and the Project tool
- Projection on the fly and geographic transformations
- A spatial reference and a coordinate system

## What's the Difference between a GCS and a PCS?

A geographic coordinate system (GCS) is a reference framework that defines the locations of features on a model of the earth. It's shaped like a globe, so its spherical. Its units are angular and are usually degrees.

A projected coordinate system (PCS) is flat. It contains a GCS, but it converts that GCS into a flat surface, using math (the projection algorithm) and other parameters. Its units are linear, most commonly meters.

To learn more, see my *ArcGIS Blog* post "Geographic vs. Projected Coordinate Systems" (bit.ly/30h2tgf).

↓ A GCS defines exactly where data will be drawn on earth's surface. A PCS defines how data will be drawn on a flat map.



## What's the Difference between a Datum and a Geographic Coordinate System?

A datum is one parameter in a GCS. It is the part of the GCS that determines which model (spheroid) is used to represent the earth's surface and where it is positioned relative to the surface. Since the earth's surface is not perfectly smooth or round, there are many different datums designed for different parts of the world.

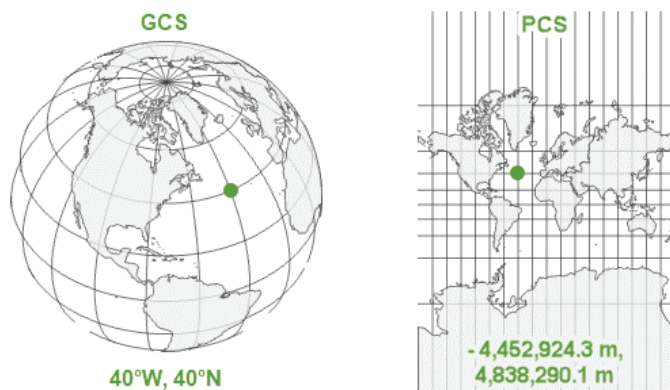A GCS is the full definition of how coordinate values are tied to real locations on the earth. In addition to a datum, a GCS includes a prime meridian that specifies the location of 0° longitude and an angular unit, which is often degrees.

The datum includes a spheroid, which is defined by its semi-major axis, semiminor axis, and inverse flattening values.

## What's the Difference between a Projection and a Projected Coordinate System?

A projection is one parameter in a PCS. The projection is the mathematical algorithm that defines how to present the round earth on a flat map. All the supported map projections available in ArcGIS are listed in the ArcGIS Pro online help (bit.ly/2XGaytr).

A PCS is the full definition of how a specific round earth model is projected onto a flat map. In addition to a projection, a PCS includes a geographic coordinate system that defines the earth model; a unit (often meters); and a set of parameter values, such as false easting, central meridian, or standard parallel, that vary depending on the projection. These values can be used to center the PCS on different parts of the world.

As its name implies, a PCS is a coordinate system. A projection is not a coordinate system; it's an algorithm that is used to create a PCS.

## What's the Difference between WKT and WKID?

Well-known text (WKT) and well-known ID (WKID) both provide ways of identifying coordinate systems, so you can exactly specify parameters.

WKT is a string that defines all necessary parameters of a coordinate system. If you save the projection file (.prj) for any coordinate system and open it in a text editor, you will see its WKT.

A WKID is a unique number assigned to a coordinate system. You can find the WKID in the Coordinate Systems Details window by right-clicking the layer in the ArcGIS Pro Contents pane and choosing Properties > Source > Spatial Reference. Once you know this number, it's a handy way to search for the coordinate system later.

The authority for each WKID number will be either Esri or
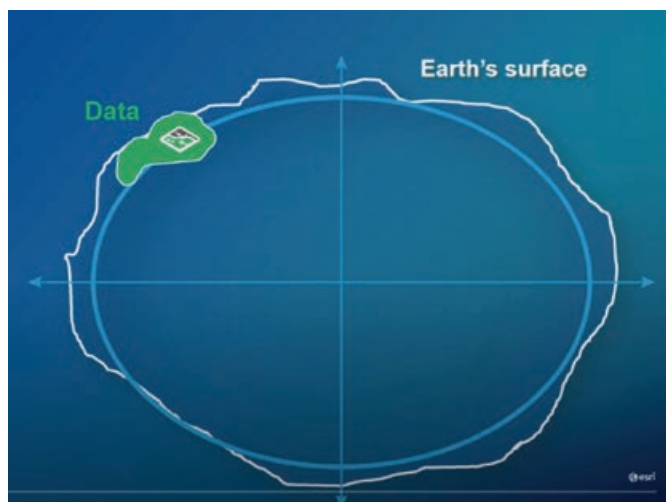
↑ The earth's surface is not perfectly smooth or round. A spheroid, defined by its semimajor axis, semiminor axis, and inverse flattening values, is part of the datum that provides a reference system or an approximation of the earth's surface against which positional measurements are made for computing locations.

EPSG, which indicates the European Petroleum Survey Group, a now-defunct organization that was absorbed by the Geomatics Committee of the International Association of Oil and Gas Producers in 2005. The numbers from these sources don't overlap, so there's no need to worry about which authority defined the WKID.

## What's the Difference between the Define Projection tool and the Project tool?

The Define Projection tool is used mainly when data has an unknown coordinate system. It reassigns the coordinate system information in the metadata. It won't change the actual coordinate values.

The Project tool converts all coordinates from one coordinate system to another by unprojecting the data into geographic co-ordinates (latitude and longitude). It transforms the geographic coordinates of the original projection into the new geographic coordinate system, then it projects these geographic coordinates into the new projected coordinate system. It also updates the metadata information.

## What's the Difference between Projection on the Fly and Geographic Transformation?

Geographic transformations are one part of the projection-on-the-fly process. Projection on the fly is what ArcGIS does to resolve conflicts when your data is in a different coordinate system than your map's. If you didn't have projection on the fly, you wouldn't be able to draw the data without first converting it to the same coordinate system used by the map.

Whenever projection on the fly includes converting between geographic coordinate systems, the process will include geographic transformations. These are calculations that convert coordinates from one GCS to another. They are sometimes referred to as datum transformations.

You can choose which transformation to use. If your data uses

a different GCS than your map, and you don't use a geographic transformation, the data will be drawn in the wrong place.

To learn more, see my *ArcGIS Blog*, "Projection on the fly and geographic transformations" at bit.ly/2BuSf1p.

## What's the Difference between a Spatial Reference and a Coordinate System?

There isn't one. At least not in Esri products. The terms are used interchangeably. To learn more about all these terms and concepts, watch the "Introducing Coordinate Systems and Map Projections" on YouTube at https://bit.ly/30a6Fyp.

## Acknowledgments

## About the Author

**Heather Smith** is a cartographer and artist who mixes both practices to express and understand landscapes. She works as a product engineer at Esri, where she writes and edits lessons for the Learn ArcGIS website. View more of her work at www.heathergabrielsmith.ca.

↓ Well-known text (WKT) is a text string that defines all necessary parameters of a coordinate system.

↓↓ The spatial reference properties for each layer provide information about the projected coordinate system and geographic coordinate system used.

```
PROJCS["NAD_1983_2011_UTM_Zone_16N",GEOGCS
["GCS_NAD_1983_2011",DATUM["D_NAD_1983_2011",SPHEROID
["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT
["Degree",0.0174532925199433]],PROJECTION
["Transverse_Mercator"],PARAMETER
["False_Easting",500000.0],PARAMETER
["False_Northing",0.0],PARAMETER["Central_Meridian",-
87.0],PARAMETER["Scale_Factor",0.9996],PARAMETER
["Latitude_Of_Origin",0.0],UNIT["Meter",1.0],AUTHORITY["EPSG",6345]
```
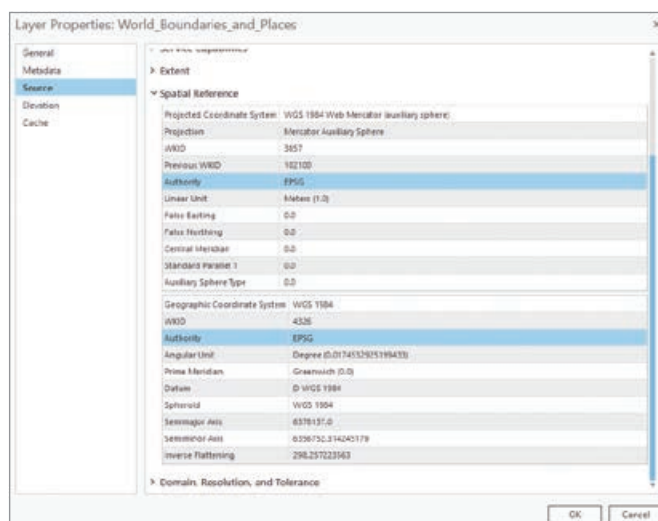
# Mapping with Population-Weighted Centroids

By Thomas Dilts

**In this age of COVID-19** and the 24-hour news cycle, many of us look at maps daily. Maps provide opportunities to uncover patterns that cannot be easily understood from tables or big blocks of text alone. They allow us to see hot spots and by watching the change in maps over many days or weeks, we can begin to see dynamic patterns emerge.

Often, these are graduated symbol maps that show some quantitative measure for a political boundary unit, such as a county (for most of the United States) or parish (in Louisiana) or borough (in Alaska). For COVID-19 maps, that measure can be the number of new cases or deaths. The symbol size is proportionate to the magnitude of the measure. These maps have been featured heavily in the news since COVID-19 began its nearly exponential increase.

There is one aspect of graduated symbol maps that has not received much scrutiny but is readily apparent to the careful observer. In the United States, populated areas of a county are not usually located near the geographic center of that county. Consequently, symbols can appear misplaced on the map.

This mismatch between the geometric center and the population center is most apparent in the western states, which typically have large, sparsely populated counties. For example, in San Bernardino County, California, the geometric center of the county is located about 8 miles north of Ludlow, an unincorporated community of 40 people in the Mojave Desert. In contrast, the largest city in the county, San Bernardino, is 80 miles away from Ludlow, in the southwest corner of the county.

Population-weighted centroids are one alternative to geometric centroids. The author of this article created population-weighted centroids for each county/parish/borough in the United States to determine whether population-weighted centroids represent these administrative units in a more realistic manner than geometric centroids.

↘ The difference between geometric and population-weighted county centroids varies widely across the United States. Larger differences typically occur in the western states, where the counties are larger and—except in cities—population is sparse.



Difference between geometric and population centroids

Population density
people per sq km
43,330

0
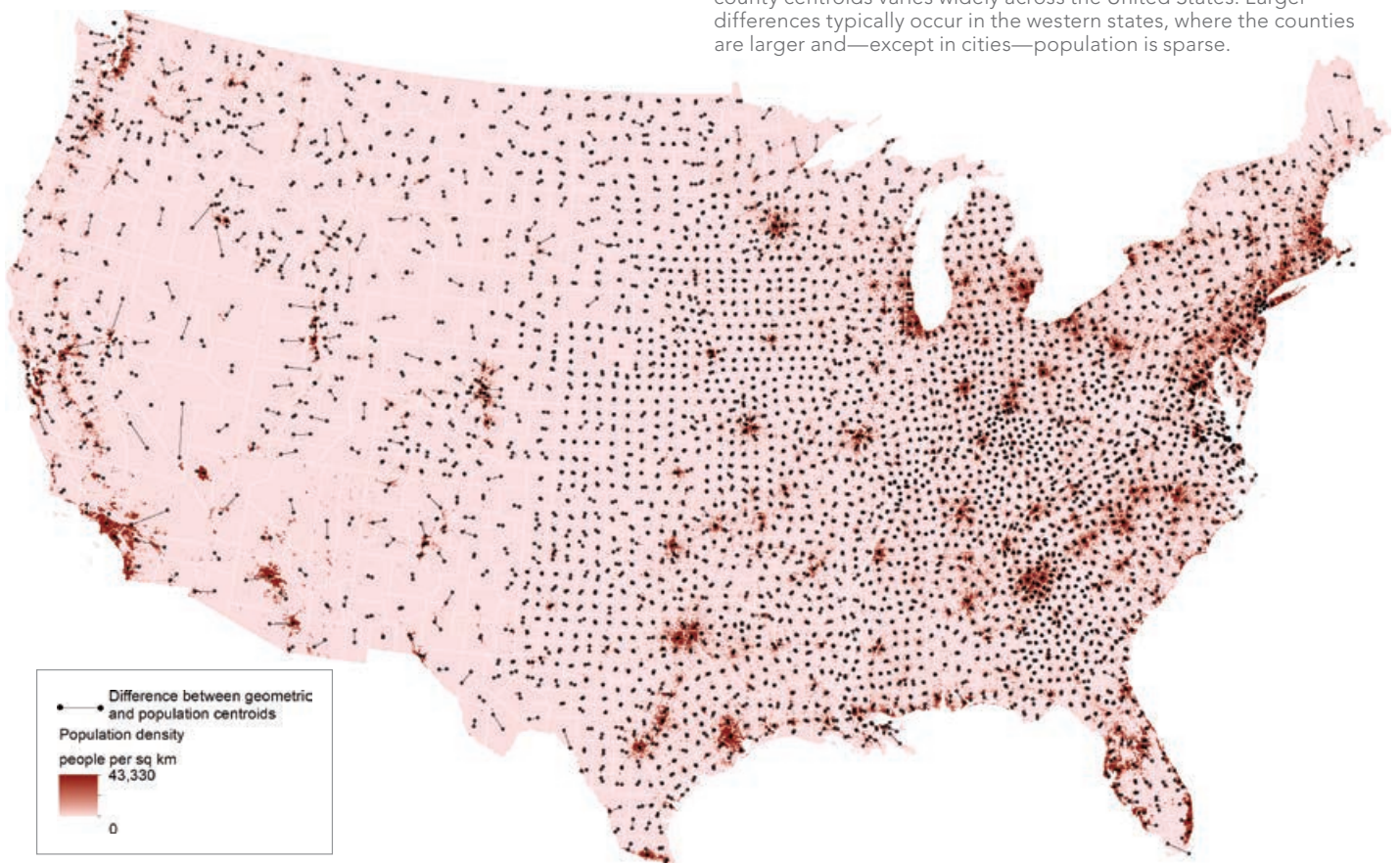
These centroids can be created using the Mean Center tool in the Spatial Statistics toolbox for ArcGIS Pro with the Gridded Population of the World (GPW) version 4 data from the Center for International Earth Science Information Network (CIESIN) at Columbia University. The GPW version 4 data was combined with US Census TIGER county shapefiles in a custom model in ArcGIS ModelBuilder.

*[GPW is a raster data product developed to provide a spatially disaggregated population service. It is a free and open-source, census-based global population grid that was first published in 1995. GPW was initially produced by Waldo Tobler, Uwe Deichmann, Jon Gottsegen, and Kelly Maloy as a tool for interdisciplinary study.]*

The maps the author produced show large discrepancies between population-weighted and geometric centroids. Large counties in the western United States and Alaska have centroids in quite different places. Although county size is one of the primary reasons why the geometric and population-weighed centroids differed, climatic and population factors also played a strong role.

In the arid portions of the western US, settlement was constrained by lack of water, and cities tend to be highly clustered. Furthermore, many cities, such as Las Vegas, Nevada, and Phoenix, Arizona, are among the largest in the West yet are surrounded by vast expanses of federally owned open land. At 146 miles, the Yukon-Kuskokwim Census Area in Alaska was the administrative unit with the biggest difference between the location of its geometric and population-weighted centroids; while in the contiguous 48 states, Nye County, Nevada, had the greatest difference—112 miles.

In this era of COVID-19, when we see many graduated symbol maps, thinking critically about the geometry underlying the placement of those symbols is worthwhile. Using population-weighted rather than traditional geometric centroids can result in maps with symbol placement that better reflects the underlying population characteristics of a place.

For more information, contact Thomas Dilts at tdilts@unr.edu.

## Resources

Erin Doxsey-Whitfield, Kytt MacManus, Susana B. Adamo, Linda Pistolesi, John Squires, Olena Borkovska, and Sandra R. Baptista (2015). "Taking Advantage of the Improved Availability of Census Data: A First Look at the Gridded Population of the World, Version 4." *Papers in Applied Geography*, 1(3), 226–234.

All data and the model used to build these maps are available for download at nevada.box.com/s/021w6ur4ji8ut9of37lpcr6y3iz5278o.

## About the Author

**Thomas Dilts** is a research scientist in the Department of Natural Resources at the University of Nevada, Reno. He holds bachelor's and master's degrees in geography and has been employed in the GIS field for more than 15 years.



↓ The difference between geometric and population-weighted centroids is interpolated and depicted as a hot spot map.
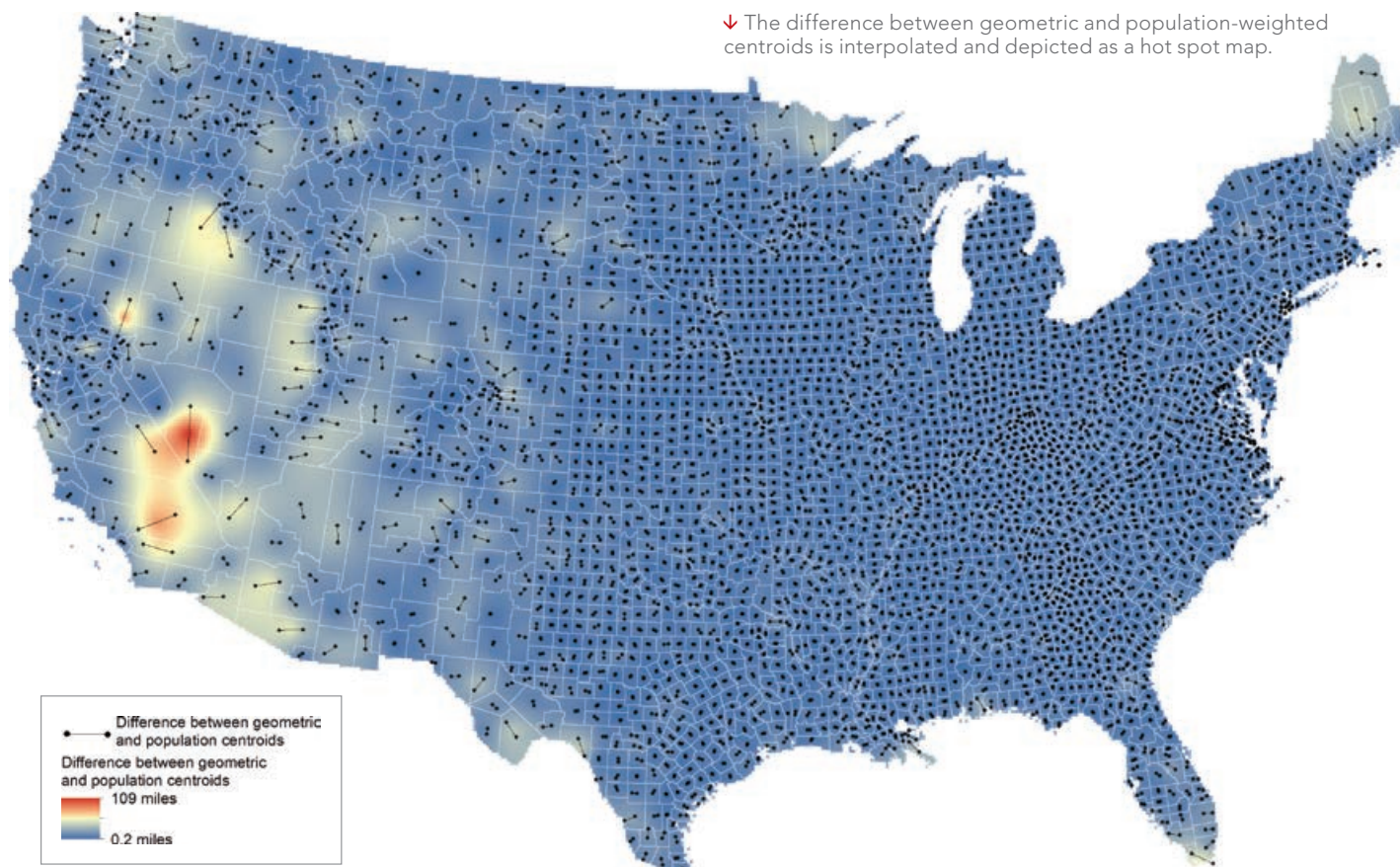
# Make Any Living Atlas Basemap Your Own

By Bern Szukalski

**A basemap provides** the geographic context for the content you want to display on a map.

When you create a new map using ArcGIS Online, you can choose which basemap you want from the basemap gallery. The basemap gallery is a collection of maps used throughout an organization and set by the organization's administrator. The administrator can choose to use the Esri default basemaps or create a custom basemap gallery.

No matter what your basemap gallery contains, you can select your own basemap from among any of those available in ArcGIS Living Atlas of the World, using these simple steps:

1. Go to the ArcGIS Living Atlas of the World website (livingatlas.arcgis.com/en) and sign in.
2. Click the Browse tab.
3. Click Basemaps and choose one or more of the categories.
4. Browse to find a basemap you like. Click the title or thumbnail to open the item page to learn more about it, then open the map in Map Viewer. Or click the options icon (…) and open the map directly in Map Viewer.
5. Once you have opened the map, it will be shown as the basemap in the Contents pane. Since you've already signed in, all you need to do is add your operational layers, then save it as a new map.

## About the Author

Bern Szukalski is a tech evangelist and product strategist at Esri, who focuses on ways to broaden access to geographic information and help users succeed with the ArcGIS platform. On a good day, he is making a map; on a great day, he is on one.
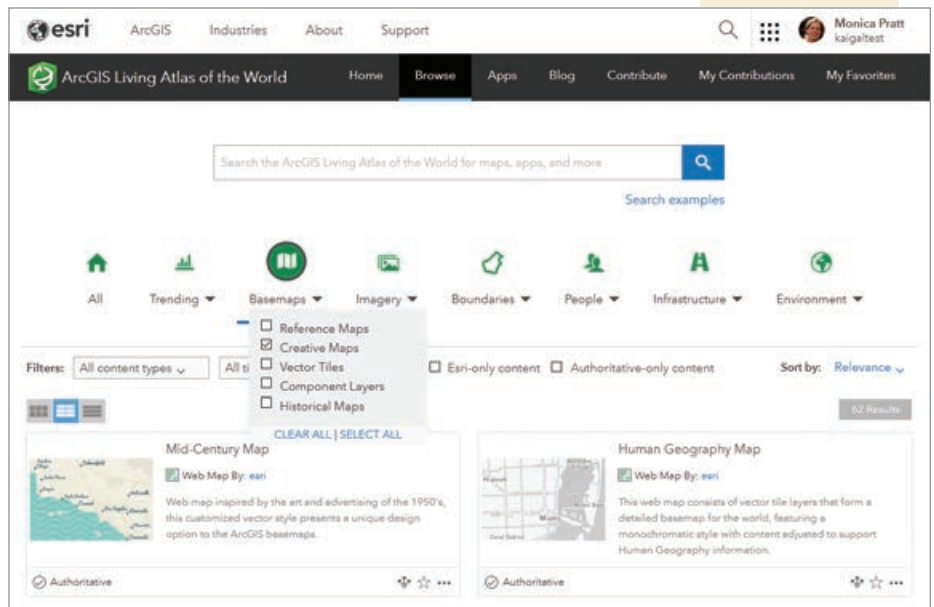


↑ Log in to the ArcGIS Living Atlas of the World website, click the Browse tab, and use the check boxes to filter basemaps.
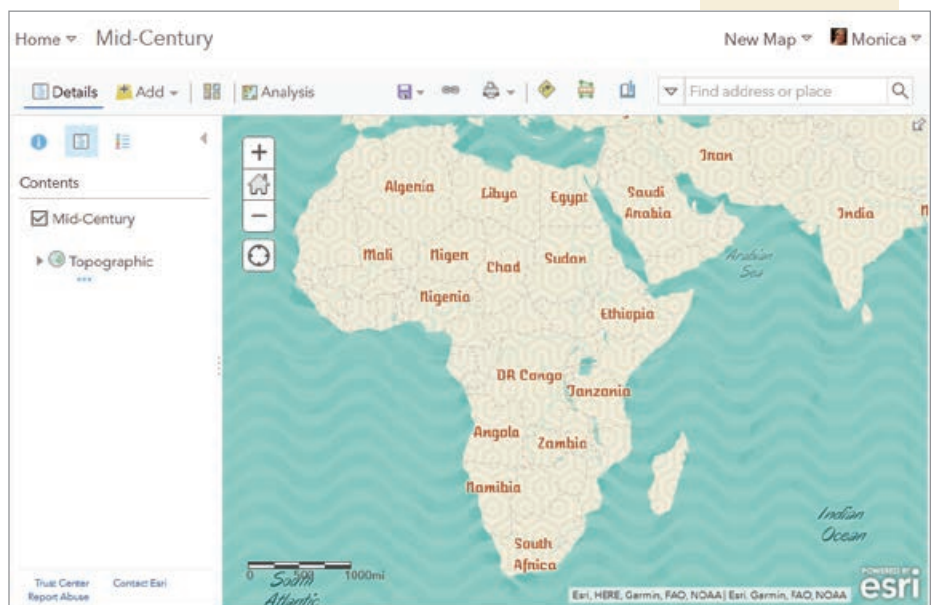


↑ Once you have selected basemap, add operational layers and save as a new map.

# Advanced Python Scripting for ArcGIS Pro

By Paul A. Zandbergen

*Advanced Python Scripting for ArcGIS Pro,* builds on the lessons taught in *Python Scripting for ArcGIS Pro*, also by Zandbergen, and takes your scripting skills to the next level. Enhance your productivity and capabilities and those of your organization by creating and sharing script tools; managing Python packages and environments; working with Jupyter Notebook; and using the Python site package, ArcPy, and the ArcGIS API for Python to automate processes and perform geographic data analysis, data conversion, and data management. The book's format reinforces learning with chapter summaries that include key terms and review questions. Exercises and the related datasets are available online.

Zandbergen is a professor in the GIS program at Vancouver Island University. He teaches courses on GIS, spatial analysis and modeling, spatial statistics, and programming. Esri Press, 2020; 290 pp., print edition ISBN: 9781589486188, e-book ISBN: 9781589486195.
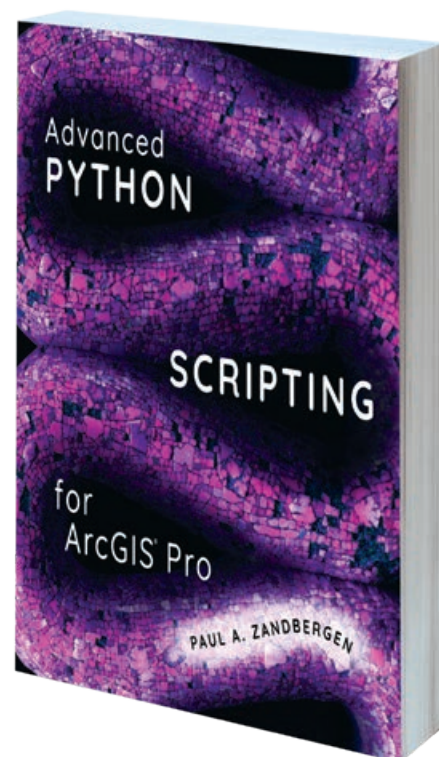
# Getting to Know Web GIS, Fourth Edition

By Pinde Fu and Dr. Jie Chang

This fourth edition of *Getting to Know Web GIS* helps readers understand and apply Web GIS to create compelling, useful, and fun Web GIS apps. It builds on the previous three editions and features information on the latest advances in Esri's Web GIS platform on both the cloud server side and the client side. This book covers the ArcGIS field apps, builder apps, and dashboards. Additional knowledge is provided on artificial intelligence generally, and more specifically on machine learning and deep learning, as well as augmented reality (AR), virtual reality (VR), and the Internet of Things (IoT) in the context of Web GIS. It contains information on online spatial analysis, image services, and 3D web scenes. Learn best practices for Web GIS and how to use ArcGIS Notebooks and the ArcGIS API for JavaScript.

This text is appropriate for classroom lab work and on-the-job training for GIS students, instructors, GIS analysts, managers, web developers, and other professionals. This book combines a discussion of principles and hands-on, step-by-step exercises; answers to common questions; an independent assignment to test new skills; and additional resources.

Author Pinde Fu leads the ArcGIS platform engineering team at Esri Professional Services and teaches at universities including Harvard Extension School. His specialties include web and mobile GIS technologies and applications in various industries. Several of his projects have won special achievement awards. Fu is the lead author of *Web GIS: Principles and Applications* and the Getting to Know Web GIS series. Coauthor Dr. Jie Chang (author of chapter 9) is a product engineer for the ArcGIS 3D Analyst team. His specialties include 3D, imagery, spatial analysis, and databases. He received his doctorate from the University of Texas, Dallas. Esri Press, 2020, 490 pp., ISBN: 9781589485921.

# Creating the Dashboard for the Pandemic

By Greg Milner



↑ Graduate student Ensheng Dong was a driving force behind the creation of the iconic Johns Hopkins COVID-19 Dashboard.

Ensheng Dong, a doctoral student from Johns Hopkins University, created the iconic dashboard visualization the world uses to gauge the spread of the coronavirus disease 2019 (COVID-19) pandemic.

Less than a month into 2020, Dong heard that a new viral contagion, COVID-19, had begun to spread in Wuhan, the capital of China's Hubei Province. Dong, a student living in Baltimore, Maryland, was thousands of miles away from the outbreak's epicenter, but he had studied epidemics and knew how fast they can spread.

Taiyuan, the capital of Shanxi Province, has more than four million inhabitants and it is Dong's hometown. Although it is 600 miles from Wuhan—the same distance that separates New York City and Detroit—Dong felt concerned for his family's safety.

On January 20, the first case of COVID-19 in the United States was confirmed in Washington State. Suddenly, the virus—for

At the 2020 Esri User Conference, the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University won the Making a Difference Award for creating the Johns Hopkins COVID-19 Dashboard.

Dong—seemed that much closer.

The following day, Dong met with his faculty adviser, Dr. Lauren Gardner, an engineering professor and the codirector of the Johns Hopkins Center for Systems Science and Engineering. They discussed the emerging epidemic and decided it was worth a closer look. Gardner suggested that Dong use GIS to construct an online dashboard to monitor unfolding events because he has a strong GIS background.

After completing his undergraduate work in China, Dong earned a master's degree in geography and statistics at the University of Idaho. While interning at the Idaho Department of Health and Welfare, he helped the agency use GIS to collect health-related data.

When Dong first contacted Gardner about the possibility of pursuing a PhD at Johns Hopkins, she was particularly intrigued by his facility with GIS, a skill Dong had honed during an internship at Esri. He arrived on campus at Johns Hopkins a few months before his program was to start, to assist in a study Gardner was coauthoring on measles vulnerability in the US.

"I immediately jumped into the project and helped her visualize measles risk in a dashboard," he said. Media outlets, including the New York Times and CNN, featured Dong's handiwork, a prelude to work that would soon focus on a much larger health crisis.

At Johns Hopkins, Dong studies systems engineering, which is a modernized approach to civil engineering for the complex, interconnected world.

"The emphasis is on civilization engineering," Dong said. "It's basically about the interaction of people with the built environment." For Dong, the discipline allows him to explore ways to combine the objectivity of numeric data with the subjectivity of data visualization.

## The Data Problem

Dong knew ArcGIS Dashboards was an ideal way to display data about the pandemic and provide a geographic visualization of the outbreak. A dashboard is typically oriented around a map, with accompanying charts, graphs, or other visuals to contextualize map imagery.

But a dashboard requires data. Soon after his meeting with Gardner, Dong

## "For a month, I barely slept—five hours a day or less."

—Ensheng Dong

↑ Taiyuan, Dong's home city, is the capital and largest city of Shanxi Province.

gathered the data he needed to launch the Johns Hopkins COVID-19 Dashboard. For the rest of January, he worked mostly by himself, driven by a desire to map the outbreak on Taiyuan, his home city.

"Ensheng and I were basically the two that started the dashboard, but he was really the mastermind behind it," Gardner said in an interview for an Esri podcast about the dashboard. "He's a total whiz with Esri technology and dashboard development."

As cases began to multiply around the world, Dong struggled to keep up. He scoured the internet for reliable data, often consulting BNO News, a Dutch website that publishes COVID-19 data from several nations in tabular format. In addition to gathering data, Dong had to synchronize it, accounting for the different methods governments used for classifying cases as confirmed or recovering.

Twice a day, he would update the dashboard. "For a month, I barely slept—five hours a day or less," he said.

One reason the work was so labor-intensive was that Dong was inputting all the data manually. A team of volunteers was assembled from Johns Hopkins to help update and maintain the site. In February, Esri's Living Atlas of the World team helped Dong and his team with data scraping, automating the process of importing the data.

## Cartography Communicates

Soon after Dong began to amass data, he had to confront questions about how to present it. To emphasize the alarming nature of the pandemic, Dong chose to display bright red dots over a stark, black background. The larger the dot, the greater the number of COVID-19 cases in that region.

But behind each red dot lurks a plethora of choices. A major decision involved how to break down the data for presentation.

As Dong's team adapted the map to provide worldwide data by state and province—and, in some countries, such as the United States, by county—these choices multiplied. The county-level perspective means the United States is blanketed in red dots, while other countries may have one large red dot and a lot of blank space.

"As we get down to the state level, for large countries like Russia, we can spread out that one large dot, so you'll see more distributed dots that aren't as large," Dong said. "That's a tricky thing for geographers—what's the best size for the dot?"

A map like this needs to inform and empower people to take action, but it also runs the danger of making people lose hope so that they see no way out of the crisis.

"We're constantly adjusting the dot," Dong said. "We added a few other maps besides the cumulative and confirmed cases, such as active cases, to clearly communicate the data we were collecting and sharing. If more people in your country are recovering, you refer to that map. The dots are smaller, and you feel better."
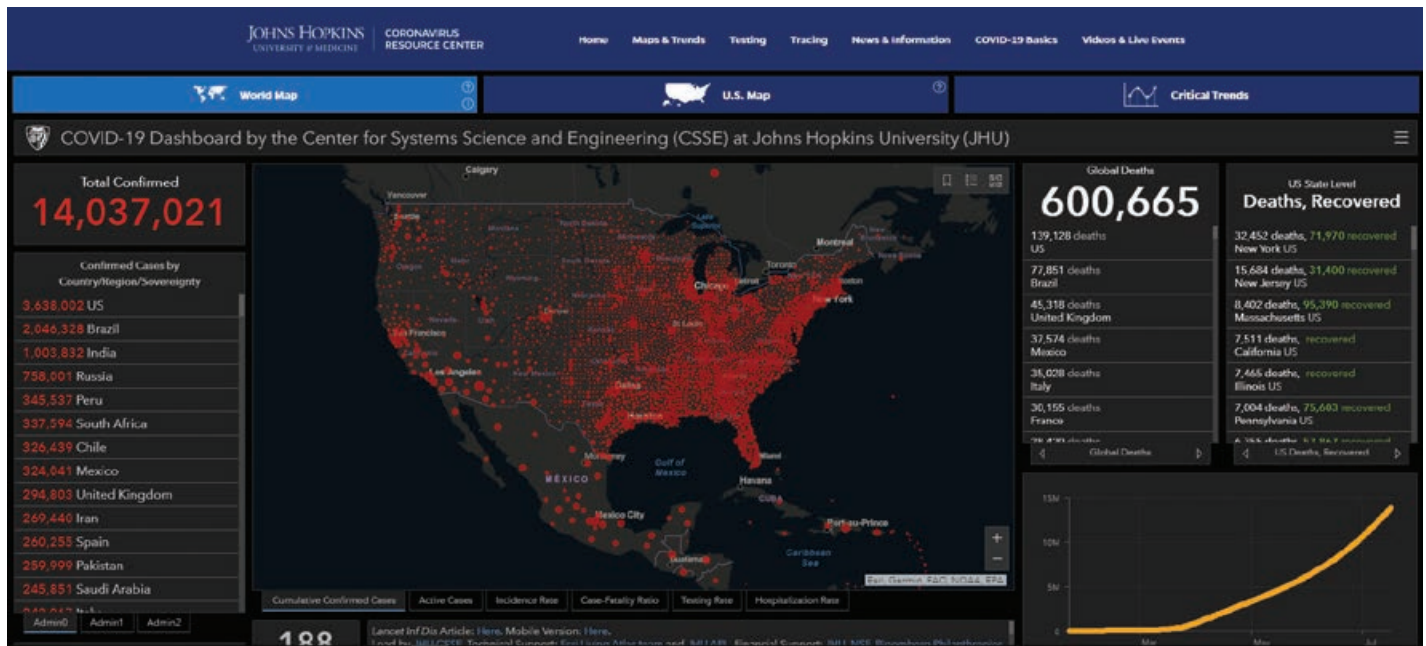
## Directing Increasing Traffic

Increases in dashboard visitor traffic indicated the disease's progress. "We had at least three crashes," he said. "Each time, it was because of a surge of cases in new locations. I remember that at the end of February, as Italy and other European countries had more cases, we could see that a lot of Italians were jumping on the site to see what was going on."

By mid-March, around the time the World Health Organization officially classified COVID-19 as a pandemic, Dong's team was able to automate updates from all US counties.

As the world took notice, Dong and his team were driven to provide up-to-date and authoritative data. What began as an attempt to monitor the outbreak in China has evolved into one of the world's most trusted sources of information on the pandemic.

"I think we're now getting somewhere between 3 and 4.5 billion requests a day," Gardner said. "And they're coming from everywhere. Most of it is just individuals clicking around on the dashboard, but there are definitely lots of requests for the data that we make available, which other groups are pulling data directly into their own internal dashboards and using for policy making."

With the data gathering mostly automated, Dong can step back a bit from the site and begin to study the epidemic itself, using mobility models as the basis for his doctoral dissertation. But with his adopted



← Street barricades, like this one in Shenzhen, China, delineate quarantine areas.

← The interactive Johns Hopkins COVID-19 Dashboard has received billions of requests per day.

country now the pandemic epicenter, he still keeps an eye on the map.

"Initially, dots were mainly located in China and East Asia, and I worried about my family," he said. "Right now, my hometown has zero new cases, but today there is a large dot near where I live in the US."

## The Data Tells Stories

As the COVID-19 pandemic spread around the world, the Johns Hopkins COVID-19 Dashboard expanded its scope. What began as a modest effort by graduate student Dong to map the disease in China has become a multilayered resource that includes supplementary graphics and expert analyses.

With the epicenter now firmly established in the United States, the most significant addition to the Johns Hopkins Dashboard is an embedded United States map. This part of the project was the brainchild of

Beth Blauer, the executive director of the Centers for Civic Impact, a Johns Hopkins organization that works with local governments to use data to address problems. Blauer was one of the key architects of CitiStat, a program launched by Martin O'Malley during his tenure as Baltimore's mayor to gather data as part of a smarter government approach. Blauer also ran a similar statewide program after O'Malley was elected governor of Maryland.

When Dong first launched the dashboard, COVID-19 was the story. Blauer recognized that as the pandemic touched the lives of millions of people, there was a story within the story. Actually, there were many stories especially in a country like the United States, which has stark extremes of socioeconomic inequality. Data associated with the pandemic could reveal the uneven nature of its impact.

The US map, which went live in April, displays county data relating to hospital capacity; health insurance availability; and demographic breakdowns, including statistics

relating to age, ethnicity, and unemployment. The map, which also includes comparisons with statewide data, has proved to be a powerful illustrator of the inequities associated with COVID-19 and the disproportionate vulnerability of communities of color.

The overall effect of the US map is a reminder that behind all those red dots are lives in peril. In an interview quoted in the *Washington Post*, Gardner said, "When you actually start looking at the affected populations, it becomes so much more human."

## About the Author

**Greg Milner** is a writer in the strategic content group at Esri, where he tells stories about how location intelligence is transforming our world and how we perceive it. A former magazine editor and political speechwriter, he is the author of the books *Perfecting Sound Forever: An Aural History of Recorded Music* (a finalist for the National Book Critics Circle Award) and *Pinpoint: How GPS Is Changing Technology, Culture, and Our Minds.*

# Introducing Business School Students to Location Analytics

## An Interview with Joseph J. Kerski

By Jim Baumann

**While many aspects** of business are directly related to location analytics, such as site selection and supply chain management, business schools have only recently become aware of the benefits of including courses on location analytics in master of business administration (MBA) and master of science in supply chain management (MS SCM) programs. In the following interview, Dr. Joseph J. Kerski, geographer, educator, GIS professional (GISP), and education manager at Esri, shares his thoughts on implementing location analytics into the course curricula of these programs.

**Baumann:** What is the current state of offering location analytics-related classes in the MBA and MS SCM course curricula?

**Kerski:** Because in business, it is "location, location, location" that matters, and because location analytics tools and geospatial data are increasingly used in business workplaces, university faculty are increasingly using location analytics principles and applications in their business courses and programs. Universities are seeing that as societal and educational needs change, geotechnologies coupled with spatial thinking in their teaching and research are key ways that universities can remain relevant and innovative.

**Baumann:** How do students enrolled in MBA and MS SCM programs benefit from learning location analytics?

**Kerski:** Students who are rigorously using location analytics in their courses develop skills in critical thinking and spatial thinking. GIS has always been a thinker's tool for solving problems from a local to a global scale. Using location analytics fosters media fluency and the opportunity to work with a large volume and variety of data. The story maps *[Esri Story Map Apps and now ArcGIS StoryMaps stories]* and other web mapping applications that they create for presentations foster oral and digital communication skills. These skills and perspectives enable students to be key decision-makers when they graduate.

In addition, having location analytics on students' tool belts helps them stand out among the thousands of business students graduating each year with skills that are in demand in the workplace. The fact that much of Esri location analytics has evolved into a cloud-based platform that is capable of being accessed anytime, anywhere, on any device, lowers the technology barriers in education.

**Baumann:** What are some of the challenges in introducing location analytics into these curricula?

**Kerski:** Like all large organizations, educational institutions—such as community colleges and universities—contain a diverse set of people, programs, and goals. They need to see a positive return on investment for any set of tools and approaches before widely adopting them. Furthermore, the rapid advance of location analytics tools and the spatial data behind the tools make it a challenge to determine how and which course activities should be included.

Using any professional tool presents a double challenge to faculty. Faculty must at least be comfortable enough with the tools to use them in their courses. They must understand how to effectively teach with them. Location analytics is part of a system—a geographic information system—that contains many interlocking components. Deciding which of the components to use in teaching and in what manner to do so takes effort.

However, teaching with inquiry-driven approaches and tools yields many benefits in student learning that instructors are increasingly valuing. In addition, when students learn with location analytics, they become much more marketable, no matter which aspects of business they choose to pursue.

**Baumann:** Please describe how you advised Dr. Bill Ritchie at James Madison University on a supply chain management course he was teaching.

**Kerski:** Dr. William Ritchie, associate professor of management, has been using location analytics in the university's supply chain management program for the past three years. Most recently, with the disruption caused by COVID-19, he created and taught a five-week supply chain course—entirely online—entitled Introduction to Supply Chain Management. This course used location analytics as its primary framework, asking the students to investigate such spatial problems as the COVID-19 impact on hospital certification visits and staffing shortages in distribution centers. It also included activities, such as mapping the distribution of Starbucks restaurants and tracking maritime vessels, using ArcGIS Online tools and remotely sensed data.

**Baumann:** How did the students respond to the class?

**Kerski:** The students overwhelmingly commented that the hands-on ArcGIS Online tools…were very engaging. After each supply chain management tenets was explained, students could immediately apply what they learned by working with real data in real scenarios, at multiple scales, ranging from local to regional to global. As the tools used were part of ArcGIS Online, and the data was accessed as online data services, this approach meshed perfectly with conducting the course using an online learning management system (LMS)—in this case, Canvas [an LMS from Instructure].

**Baumann:** Please describe the program that Esri and Texas Christian University are developing.

**Kerski:** Location analytics has long been integral to Texas Christian University's GIS courses. In the introductory course, lab assignments give students experience using GIS in thematic areas such as demographic analysis, market research, and urban environmental change. In another course, Urban and Business Applications of GIS, students gain experience applying GIS to solve real-world urban and business problems.

Topics for the graduate school program being developed include demographic analysis, remote sensing of urban areas, network analysis, 3D urban modeling, spatial statistics, temporal analysis, geodemographic classification, market area analysis, and Web GIS services. Students will also complete a semester-long group project that applies GIS to assist an organization or business in the area where the school is located.

Recently, Esri supported Texas Christian University's Neeley Center for Supply Chain Innovation's Graduate Supply Chain Case Competition [held Febrary 20–23, 2020]. The case competition, sponsored by Chick-fil-A, addressed the challenges of supporting high supply chain growth in seven western states. Utilizing demographics, consumer behaviors, and natural seasonality, each team of students was tasked with expanding distribution networks to meet customer demand for Chick-fil-A products. Teams were also provided with GIS software from Esri.

Esri was recently selected as an industry partner for the University of California, San Diego, Rady School of Management, Master of Science in Business Analytics [program], student capstone project. In the project and program, students used [ArcGIS] Business Analyst Web App, R [programming language], ArcGIS Online, and other tools to propose the most commercially viable use for a parcel outside of Redlands, California. Their proposal included descriptive, predictive, and prescriptive elements. Students approached the problem from a data science perspective, creating a set of Esri Story Maps apps to present their results.

Included in a new program at the University of Redlands is a spatial business initiative with Esri. Esri has also been honored to be advising the Location Analytics for Business courses at the W.P. Carey School of Business at Arizona State University. This course is included in an 18-credit-hour applied business data analytics certificate, providing rigorous exposure to predictive analytics and modeling, big data techniques, and visualization.

**Baumann:** Is there anything else that you would like to add?

**Kerski:** All of us at Esri are deeply committed to the value of GIS throughout society, including all disciplines and all levels of education. We want to be considered as a trusted partner that universities can count on to assist them as they chart a course through the educational waters ahead.

For more information, and to connect to the GIS education community, start with the Education space on GeoNet.

### About the Author

**Jim Baumann** is a longtime employee at Esri. He has written articles on GIS technology and the computer graphics industry for more than 30 years.

# Turning a Challenge
## *into an Opportunity*

By Monica Pratt

During spring break in 2020, Gregory Brunner, an adjunct professor at Saint Louis University (SLU), quickly transformed a course he was teaching from a traditional classroom format into a remotely taught interactive experience with the help of ArcGIS Notebooks.

**The sudden escalation** of the COVID-19 pandemic led to the abrupt suspension of classes on campus, giving Brunner just a week to convert the course from an in-person lab to a remote course that could be effectively taught via Zoom.

Brunner, who is also a data science team lead at Esri, became an adjunct professor in spring 2017 and has taught a variety of programming courses related to geospatial technologies, ranging from introductory to advanced levels.

When Brunner had to reformat his Introduction to Programming for GIS and Remote Sensing course, he decided to revise his curriculum at the same time. He coordinated the topics in his course so they would complement those covered in the introductory GIS course taught at the university. This reorganization led him to include exercises that made use of additional Python packages such as pandas and NumPy.

He had been using ArcGIS Pro and Jupyter Notebook in his lab course. While



Temperature at Depth of 4

In [18]: selected_4

Out[18]:

Temperature at Depth of 150

In [21]: selected_150

Out[21]:

Temperature at Depth of 1250

```
In [47]: plt.figure(figsize=(8,4), dpi= 96, facecolor='w', edgecolor='k')
         for j in range(4):
             plt.plot(temperatures[0][js[j]],depths[:len(temperatures[0][js[j]])])
         plt.xlabel("Temperature (C)");
         plt.ylabel("Depth (meters)");
         plt.title('Temperature Profile at x: -21.005859, y: -1.193764');
         plt.legend(dts)
Out[47]: <matplotlib.legend.Legend at 0x24c1af06e10>
```



← Brunner used ArcGIS Notebooks to employ an inquiry-based approach to teaching how ocean temperature varies with location, depth, and time of year. He showed students how to extract ocean temperature profiles from a multidimensional image service hosted in ArcGIS Online.

↑ Notebooks made it simple to incorporate popular scientific Python packages, such as Matplotlib and Seaborn, into the students' workflow to visualize data.

he was busy making sure his students were set up with ArcGIS Pro and Jupyter Notebook on their own computers, he noticed that ArcGIS Notebooks had just appeared as an option in the university's ArcGIS Online subscription. Initially, Brunner decided it might be a good way to share lecture notes, but he soon discovered ArcGIS Notebooks could enhance his teaching methods in many more ways.

### Integrating Jupyter

Jupyter Notebook is an open-source web application for creating and sharing documents containing live code, equations, visualizations, and narrative text. Although it supports interactive computing for numerous programming languages, Jupyter Notebook has been used alongside with ArcGIS Pro and with ArcGIS API for Python for several years to to make the vast ecosystem of Python libraries,

especially those related to data science, readily available.

With the release of ArcGIS Pro 2.5, Jupyter Notebook is integrated with ArcGIS Pro in ArcGIS Notebooks, Esri's Jupyter Notebook environment. A notebook can be created, edited, saved, and shared as part of an ArcGIS Pro project, and it is available at any license level with no additional cost, installer, license, or app required.

Within ArcGIS Online, ArcGIS Notebooks is a software-as-a-service (SaaS) offering that can make standard analysis tools available through the ArcGIS API for Python as well as access more than 1,400 geoprocessing tools via ArcPy. ArcGIS Python libraries can be combined with hundreds of open-source Python libraries and used to solve complex analytical problems.

With ArcGIS Enterprise, ArcGIS Notebooks is a server licensing role available at version 10.7 or later. ArcGIS Notebooks makes GIS, programming, and data science tools available in an interactive framework that automates processes, documents workflows, and enhances learning.

### Course Reset after Spring Break

When his course resumed, Brunner not only delivered lecture notes using ArcGIS Notebooks but also decided to use them to supply homework. Soon he was also encouraging his students—with a five-point bonus—to use ArcGIS Notebooks for their final projects.

As he eased students into using ArcGIS Notebooks, he found it was popular because students didn't have to download anything—they simply accessed the notebook containing the homework from ArcGIS Online and ran through the problems. He described each problem and assigned the points possible using Markdown (explanatory text added to a Jupyter Notebook). In answering questions, students found, manipulated, and visualized data in the notebook and Brunner could see how they arrived at their answers. Notebooks also gave his students lots of flexibility for creatively finding solutions.

ArcGIS Notebooks benefited Brunner because, as he said, "it let me be proactive in working with students." He could follow each student's progress and see when they last worked on a problem. It

provided feedback that would let him see which topics were giving students problems. He could also gauge how far along each student was on a project and provide suggestions and guidance.

As a bonus, he could turn a notebook into a slideshow, an immersive way to explain the content, which also allowed him to drill down into the notebook to provide examples using ArcGIS Online content.

Brunner organized materials in ArcGIS Online so that they were easy for students to locate. He made a folder for course notebooks and applied a naming convention for individual notebooks that used the week in the course, the lecture number, and the lecture topic. He created two ArcGIS Online groups to manage access to course notebooks. One group was for lectures and homework solutions, and the other was dedicated to student projects.

Using notebooks made it very simple for Brunner to employ an inquiry-based approach to teaching. For example, in a lesson on how to interact with image services, he began by asking how ocean temperature varies based on location, depth, and time of year. To answer that question, he showed students how to extract ocean temperature profiles from a multi-dimensional image service that is hosted in ArcGIS Online. Using a notebook, he walked students through all the steps and logic behind this process in a clear and well-documented fashion. It was also simple to incorporate popular scientific Python packages, such as Matplotlib and Seaborn, into the students' workflow.

## The Benefits of Teaching with Notebooks

Brunner summed up in one sentence why he likes using ArcGIS Notebooks: "The notebooks just work." He doesn't have to worry about keeping passwords straight or installing all the right Python packages or making sure that all students have the same software and data. Students just log in and connect—no updating or troubleshooting local software. Notebooks can be created simply from an interface choice. The focus is on learning content, not tech support.

Sharing is a lot easier. In ArcGIS Online
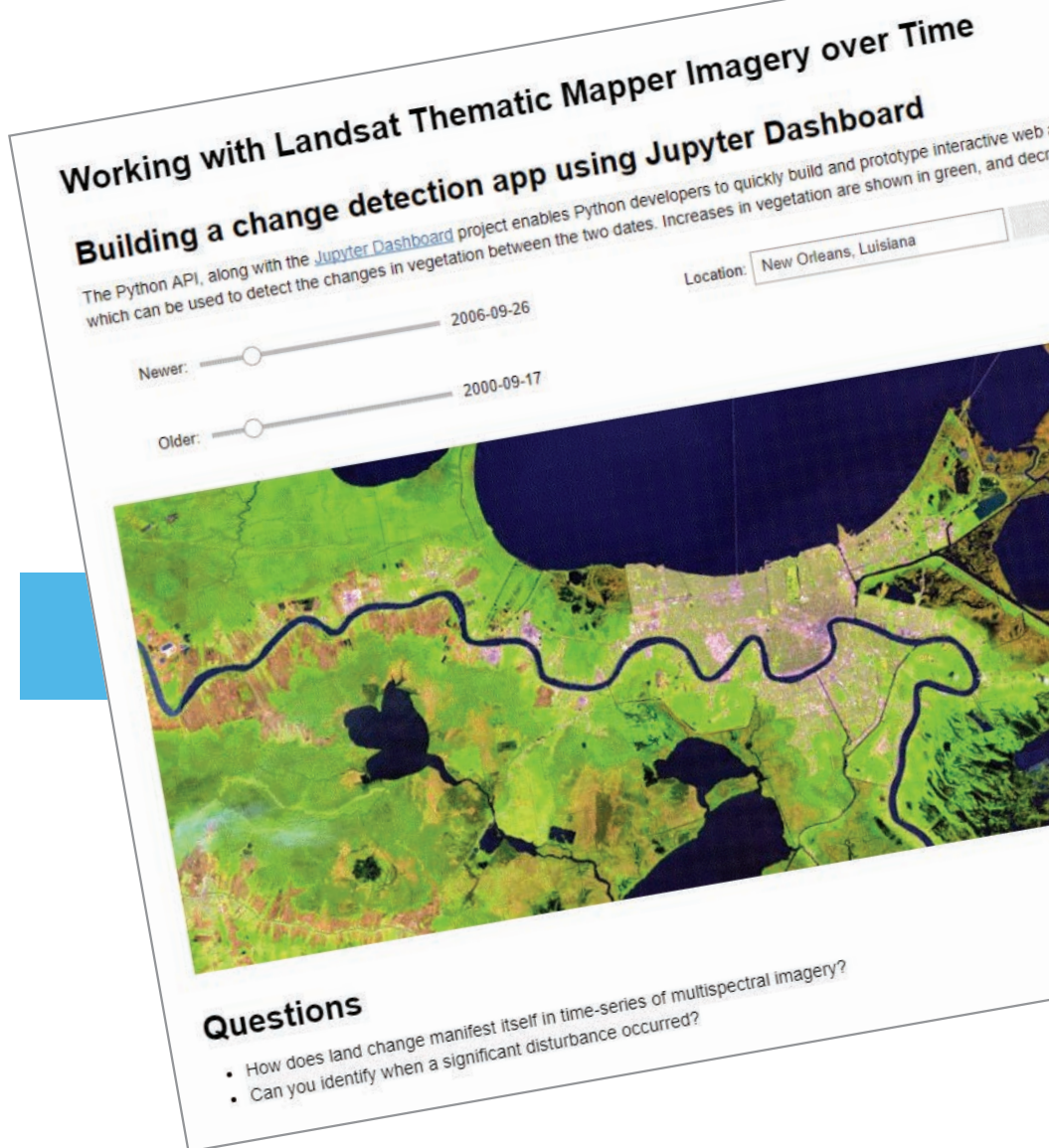


↑ Student assignments explored the use of imagery services and the ArcGIS API for Python for acquiring and modeling spatiotemporal scientific data.

and ArcGIS Enterprise, notebooks can be shared as content items that are easy to find, are described, and are easily accessed without downloading. In ArcGIS Pro, notebooks are saved with the project, so notebooks are shared by sharing projects.

## Easy Access to Technology Tools

Readily available to educators, ArcGIS Notebooks is included in the Esri Higher Education Institutional Agreement. Any university that has this agreement, already has access to ArcGIS Notebooks.

With ArcGIS Pro 2.5 and later, no additional license is required because ArcGIS Notebooks is part of the core product. For ArcGIS Online, the standard version of ArcGIS Notebooks is included with the organizational account. Simply create a custom role that includes privileges for working with ArcGIS Notebooks and apply that role to students. In addition to the standard option, there are two additional premium options for ArcGIS Notebooks that allow access to ArcPy modules and the GPU-enabled notebooks. For ArcGIS Enterprise, ArcGIS Notebooks is part of the server role for implementations of 10.7 or later. It requires Docker images, available from My Esri.

As course materials are updated, not only is the data updated but workflows in the notebooks can be easily revised. Notebooks can be shared as reproducible research, used as lessons across disciplines and research areas, and used to enlist citizen scientists to help make their

This sample illustrates one such app...
...eases are shown in magenta.

✔ Go    ✔ Detect changes
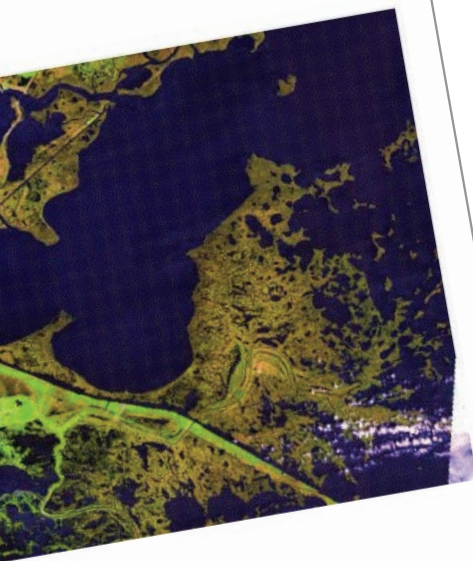
contributions more valuable.

ArcGIS Notebooks expands learning opportunities because it lets students take work with them after they complete a course. Notebooks also enlarge the tools, methods, and materials available to instructors, who can integrate open science tools and experiences and use ArcGIS spatial analysis tools. Lessons can incorporate arcgis.learn, the deep learning module from the ArcGIS API for Python, as well as the machine learning capabilities available from within ArcGIS or from open source Python packages.

Educators can build lessons with access to a wealth of current data from the ArcGIS Living Atlas of the World and work with all types of data: imagery, multidimensional, tabular, unstructured data, vector, 3D, real-time data, big data, lidar, time series data, and full-motion video.

## Take Advantage of Opportunities

Brunner urges educators to use technology and reimagine their courses and take advantage of the new tools and free content available from Esri and the Esri repository on GitHub, which contains many sample notebooks. "ArcGIS Notebooks [is] a great way to involve your students and enhance their learning by improving how students learn programming and strengthen their GIS analytical skills," said Brunner.

## About the Author

Monica Pratt is the founding and current editor of *ArcUser* magazine, the executive editor of *ArcNews* magazine, the editor of *Esri Globe,* and head of the publications team at Esri. She has been writing on technology topics, specializing in GIS, for more than 25 years. Before joining Esri in 1997, she worked for newspapers and in the financial industry.

# Before Construction Starts, GIS Makes a Virtual Tour Possible

By Jim Baumann

A civil engineering firm used the advanced GIS capabilities in ArcGIS to create a virtual reality tour to more effectively preview a proposed construction project. The project will be part of a high-density, mixed-use development in Austin, Texas.

With a population of nearly one million, Austin, Texas, was ranked third in POLICOM's 2020 economic strength rankings for metropolitan areas in the United States. Often referred to as Austin's second downtown, The Domain contains office, retail, and residential properties occupying 303 acres in the northwest section of the city. Commercial tenants include Amazon and Facebook, and shoppers can visit Louis Vuitton, Tiffany & Co., and other retail establishments.

The Domain's location was originally developed by IBM as a campus for its administration and manufacturing operations but was sold in the 1990s. The initial phase of The Domain project was completed in 2007. Stonelake Capital Partners, one of the four companies that own and operate The Domain, is now redeveloping an existing 33-acre site and constructing eight high-rise commercial and residential buildings.

## Evaluating Building Designs

After a building has been designed, it must be visualized so that the architectural designers and project investors can evaluate the design prior to construction. This can be done in various ways.

Scaled design models of buildings, provided in various 3D file formats, can be created and distributed for review. These highly detailed models can be easily viewed in design programs but lack locational context for the proposed construction.

Full-scale mock-ups can be created and precisely positioned at their proposed locations on the construction site. Also, large-scale, mounted renderings of the proposed buildings are sometimes created and positioned at the construction site.

In the past, positioning large-scale renderings was a method used at The Domain. Those involved in the construction or financing of the project drove around the site to get a firsthand view of how the proposed development would look in relation to existing buildings and the site.

However, models and renderings don't provide much more than a static view of the proposed construction. Another disadvantage of using either mock-ups or large illustrations is that the

↑ The 3D model of proposed construction created by Pape-Dawson Engineers showed the project in the context of the existing buildings and the site.

construction site must be physically visited. This can be inconvenient because it may require traveling long distances to the site and depend on favorable weather.

## Creating the Immersive Experience

Pape-Dawson Engineers, a Texas firm that uses GIS, was selected for the civil development of the property. The firm solicited building designs from a number of architectural firms. Daniel Chantlos,

who was a GIS analyst at Pape-Dawson Engineers prior to his position as a solution engineer for architecture, engineering, and construction (AEC) at Esri, worked on The Domain project.

"Since the proposed project and existing development around it are very complex, standard renderings and presentation boards were not the appropriate tool to allow the audience to properly visualize the new redevelopment plan," said Chantlos. "In addition, the number of renderings that would have been required to

↑ After autogenerating the streets and buildings in ArcGIS CityEngine, trees, streetlights, people, and cars were added to make it look like a cityscape.



↑ Because investors didn't have to travel to the construction site in Texas, the decision-making process was sped up, and the immersive model was also used as a tool for preleasing one of the proposed buildings.

adequately depict the project would have been unmanageable and even increase the total cost of the project."

Instead, he saw a way to skip the physical rendering stage by creating a dynamic, three-dimensional virtual reality tour of the properties to be constructed at The Domain using ArcGIS. Chantlos used ArcGIS CityEngine, advanced 3D design software; ArcGIS Online; and the ArcGIS 360 VR app with an Oculus Go headset.

Creating the tour required several steps. From the architectural firms, Chantlos received models of each proposed building in a 3D file format. From the commercial land development team at Pape-Dawson Engineers, he obtained street network data in CAD format.

After importing the building and street networks data into ArcGIS CityEngine, the streets were autogenerated. Chantlos added trees, streetlights, people, and cars to make it look like a cityscape. Still in CityEngine, he extracted aerial imagery of the construction site from the Esri World Imagery dataset to import footprints of the existing buildings and determine where the new buildings will be constructed.

The final design was exported as a 360 VR Experience (3VR file) from CityEngine and shared on ArcGIS Online. Chantlos accessed the 3VR file on an Oculus Go headset using the ArcGIS 360 VR app to view the completed virtual reality scene.

"The architects used a variety of 3D software in their design work for this project, which included Revit, InfraWorks, and SketchUp, so it was beneficial that CityEngine can import a number of different 3D file formats," said Chantlos. Because different 3D software was used to create the building designs, each file had to be manipulated in some way in CityEngine by manually rescaling each model proportionally. Often 3D designs do not contain coordinate system information, so he had to manually place each 3D building in its proper location on the construction site.

Because this was the first time Chantlos had created a fully immersive virtual reality experience, he had to learn how to use CityEngine. It was a rewarding experience for Chantlos, who said, "All parties were very happy with the final result."

## Expediting Construction and Leasing

The planned redevelopment project was easily viewed as a virtual reality scene by the potential investors from locations throughout the United States with their Oculus Go headsets. Because the investors didn't have to travel to the actual construction site in Austin, Texas, Pape-Dawson Engineers was able to speed up the decision-making process. This immersive experience was also used as a tool for preleasing one of the proposed buildings.

## About the Author

**Jim Baumann** is a longtime employee at Esri. He has written articles on GIS technology and the computer graphics industry for more than 30 years.

## Esri Corporate Headquarters

**380 New York Street**
**Redlands, CA 92373-8100** USA
T 909 793 2853
F 909 793 5953
info@esri.com
esri.com

**Esri Store**
esri.com/store

**Esri Customer Service**
Toll Free
T 888 377 4575
F 909 307 3082
service@esri.com
esri.com/customerservice

**Esri Developer Network**
developers.arcgis.com

**Esri Technical Support**
T 888 377 4575
F 909 792 0960
support@esri.com
esri.com/support

**Product Information**
ArcGIS Resources
resources.arcgis.com

**Esri Desktop Order Center**
**and Software Information**
T 800 447 9778 (USA only)
F 909 307 3049
info@esri.com

## Esri US Regional Offices

**Boston**
Middleton, MA
T 978 777 4543
F 978 777 8476

**Charlotte**
Charlotte, NC
T 704 541 9810
F 704 541 7620

**Denver**
Broomfield, CO
T 303 449 7779
F 303 449 8830

**Minneapolis**
St. Paul, MN
T 651 454 0600
F 651 454 0705

**Olympia**
Olympia, WA
T 360 754 4727
F 360 943 6910

**Philadelphia**
Chesterbrook, PA
T 610 644 3374
F 610 644 3379

**Redlands**
Redlands, CA
T 909 793 2853  x1906
F 909 307 3025

**San Antonio**
San Antonio, TX
T 210 499 1044
F 210 499 4112

**St. Louis**
St. Charles, MO
T 636 949 6620
F 636 949 6735

**Washington, DC**
Vienna, VA
T 703 506 9515
F 703 506 9514

For additional information
about Esri US regional offices,
please visit esri.com/usa.

## Esri Distributors Worldwide

**Esri Australia Pty. Ltd.**
esriaustralia.com.au

**Esri BeLux N.V.**
esribelux.com

**Esri Bilgi Sistemleri**
**Muhendislik ve Egitim, Ltd.**
esriturkey.com.tr

**Esri Bulgaria Ltd.**
esribulgaria.com

**Esri Canada Limited**
esri.ca

**Esri Chile S.A.**
esri.cl

**Esri China (Hong Kong) Limited**
esrichina.hk

**Esri CIS Limited**
esri-cis.ru

**Esri Colombia SAS**
esri.co

**Esri Deutschland GmbH**
esri.de

**Esri Eastern Africa Limited**
esriea.co.ke

**Esri España Soluciones**
**Geospaciales SL**
esri.es

**Esri Finland Oy**
esri.fi

**Esri France S.A.**
esrifrance.fr

**Esri India Technologies, Ltd.**
www.esriindia.com

**Esri Italia Sp.A.**
www.esriitalia.it

**Esri Japan Corporation**
esrij.com

**Esri Korea, Inc.**
esrikr.com

**Esri Lebanon sal**
esrilebanon.com

**Esri Muscat Co LLC**
esrimuscat.com

**Esri Nederland B.V.**
esri.nl

**Esri Northeast Africa**
www.esrinea.com

**Esri Panama, S.A.**
esri.pa

**Esri Polska sp. z o.o.**
esri.pl

**Esri Portugal—Sistemas e**
**Informação Geográfica, S.A.**
esri-portugal.pt

**Esri Romania S.R.L.**
esriro.ro

**Esri South Africa (Pty) Ltd.**
esri-southafrica.com

**Esri Southern Africa**
www.esri-southernafrica.com

**Esri South Asia Pte. Ltd.**
www.esrisa.com

**Esri Sverige AB**
esri.se

**Esri (Thailand) Co. Ltd.**
esrith.com

**Esri (UK) Ltd.**
esriuk.com

**Esri Ukraine Ltd.**
esri.ua

**GeoScene Information Technology**
**Co Ltd.**
www.geoscene.cn

**Grupo Esri de Venezuela, C.A.**
esriven.com

Esri also has distributors in other
countries around the world. For
more information, contact Esri.
T 909 793 2853  x1235
F 909 307 3070

@esri.com, 3D Analyst, ACORN, Address Coder, ADF, AML, ArcAtlas, ArcCAD, ArcCatalog, ArcCOGO, ArcData, ArcDoc, ArcEdit, ArcEditor, ArcEurope, ArcExplorer, ArcExpress, ArcGIS, arcgis.com, ArcGlobe, ArcGrid, ArcIMS, ARC/INFO, ArcInfo, ArcInfo Librarian, ArcLessons, ArcLocation, ArcLogistics, ArcMap, ArcNetwork, *ArcNews*, ArcObjects, ArcOpen, ArcPad, ArcPlot, ArcPress, ArcPy, ArcQuest, ArcReader, ArcScan, ArcScene, ArcSchool, ArcScripts, ArcSDE, ArcSdl, ArcSketch, ArcStorm, ArcSurvey, ArcTIN, ArcToolbox, ArcTools, ArcUSA, *ArcUser*, ArcView, ArcVoyager, *ArcWatch*, ArcWeb, ArcWorld, ArcXML, Atlas GIS, AtlasWare, Avenue, BAO, Business Analyst, Business Analyst Online, BusinessMAP, CityEngine, Community, Community Analyst, CommunityInfo, Community Maps, Companion, Database Integrator, DBI Kit, Drone2Map, EDN, Esri, esri.com, Esri—Team GIS, Esri—*The GIS Company*, Esri—The GIS People, Esri—The GIS Software Leader, Excalibur, FormEdit, GeoCollector, GeoEnrichment, GeoEvent, Geographic Design System, Geography Matters, Geography Network, geographynetwork.com, Geoloqi, GeoPlanner, Geoportal, Geotrigger, GIS by Esri, gis.com, GISData Server, GIS Day, gisday.com, GIS for Everyone, Indoors, Insights, JTX, MapIT, Maplex, MapObjects, MapStudio, ModelBuilder, MOLE, MPS—Atlas, Ortho Maker, PLTS, Rent-a-Tech, SDE, See What Others Can't, SML, Sourcebook·America, SpatiaLABS, Spatial Analyst, Spatial Database Engine, StoryMaps, Story Maps Basic, Story Maps Cascade, Story Maps Crowdsource, Story Maps Journal, Story Maps Series, Story Maps Shortlist, Story Maps Swipe and Spyglass, Story Maps Tour, StreetMap, Tapestry, the ARC/INFO logo, the ArcGIS Explorer logo, the ArcGIS logo, the ArcPad logo, the Esri globe logo, the Esri Press logo, The Geographic Advantage, The Geographic Approach, the GIS Day logo, the MapIT logo, The Science of Where, The World's Leading Desktop GIS, *Water Writes*, and Your Personal Geographic Information System are trademarks, service marks, or registered marks of Esri in the United States, the European Community, or certain other jurisdictions.

Other companies and products or services mentioned herein may be trademarks, service marks, or other registered marks of their respective mark owners.
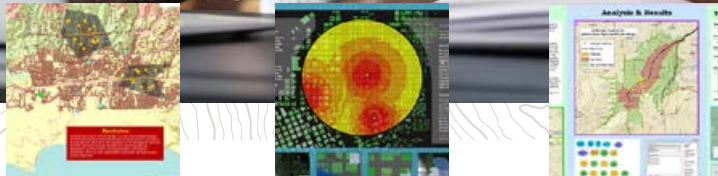
# MASTER THE BUSINESS OF WHERE

## DEVELOP SKILLS NEEDED TO ADAPT QUICKLY IN A CHANGING MARKETPLACE

The University of Redlands is a private, nonprofit university located in Redlands, California—close neighbors and partners with geospatial leader, Esri.

All Redlands academic programs enable access to Esri technology, training, people, events, and internships, including classes taught by Esri employees.

## Business Location Analytics Certificate

Master the business of "where" with a graduate certificate that focuses on using GIS to achieve business success. Learn how leading organizations deploy location analytics to gain customer insights, expand the business, manage risk, and design effective spatial business strategies. Develop technical skills in location analytics and spatial storytelling that can improve business decision-making and positively impact society.

### Online only

**3 courses**

**10 credits**

**20 weeks**

## MBA – Location Analytics Concentration

Use the power of location intelligence to lead 21st century businesses and organizations. The MBA with a location analytics concentration equips you to unlock the potential of spatial data, solve real-world problems, and gain a competitive advantage in today's business world.

### Online + On campus

**12 courses**

**48 credits**

**18-24 months**

Learn more
**spatial.redlands.edu**

UNIVERSITY OF
Redlands
SCHOOL OF BUSINESS

175892  G1169778



# Welcome to the
# Esri® Store

## Shopping for ArcGIS® products has never been easier.

Find what you need and discover new products, digitally delivered within minutes. Enjoy a 30-day money back guarantee, and secure transactions with data encryption.

**esri.com/store**

**esri**® | THE SCIENCE OF WHERE®