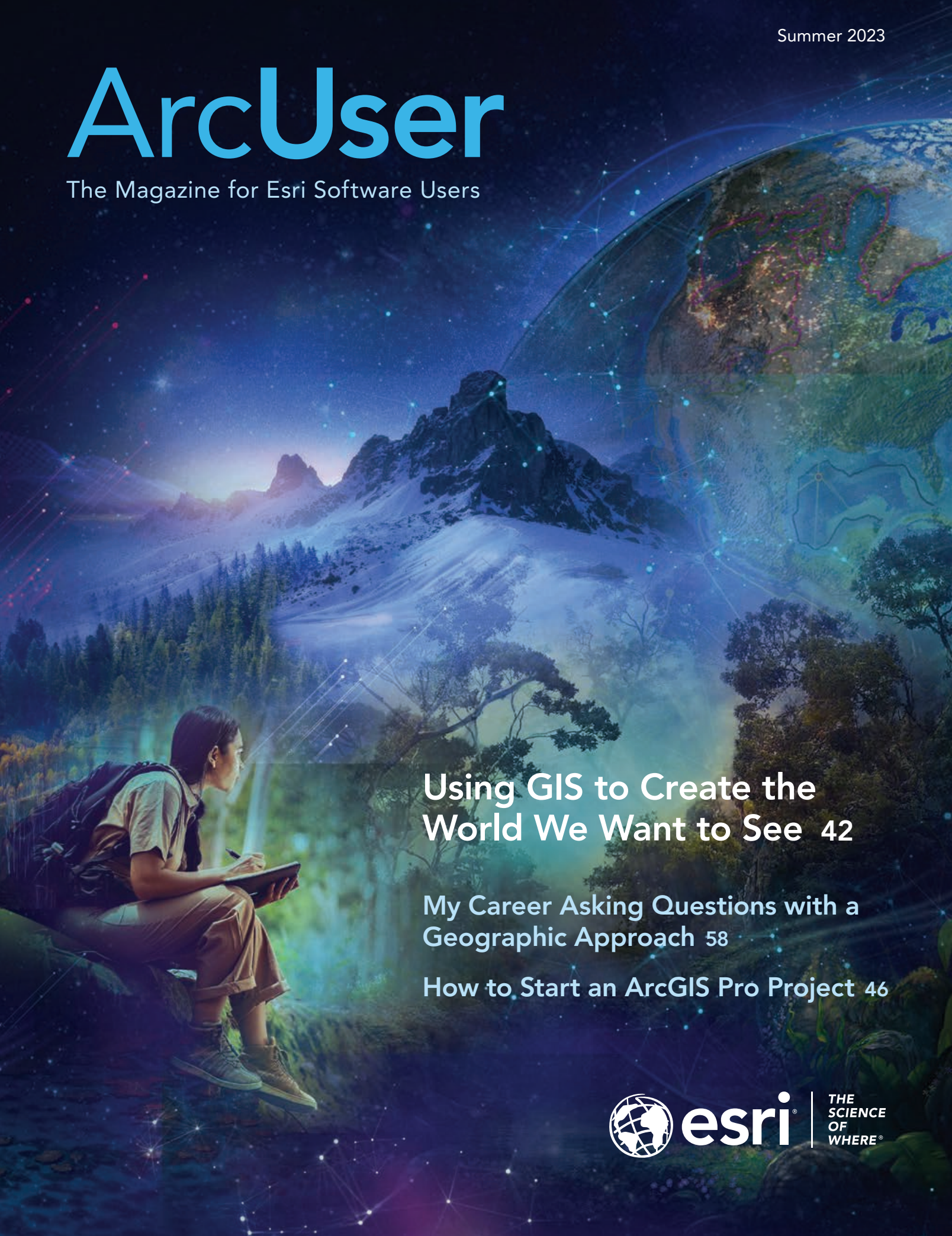
Summer 2023

ArcUser

The Magazine for Esri Software Users



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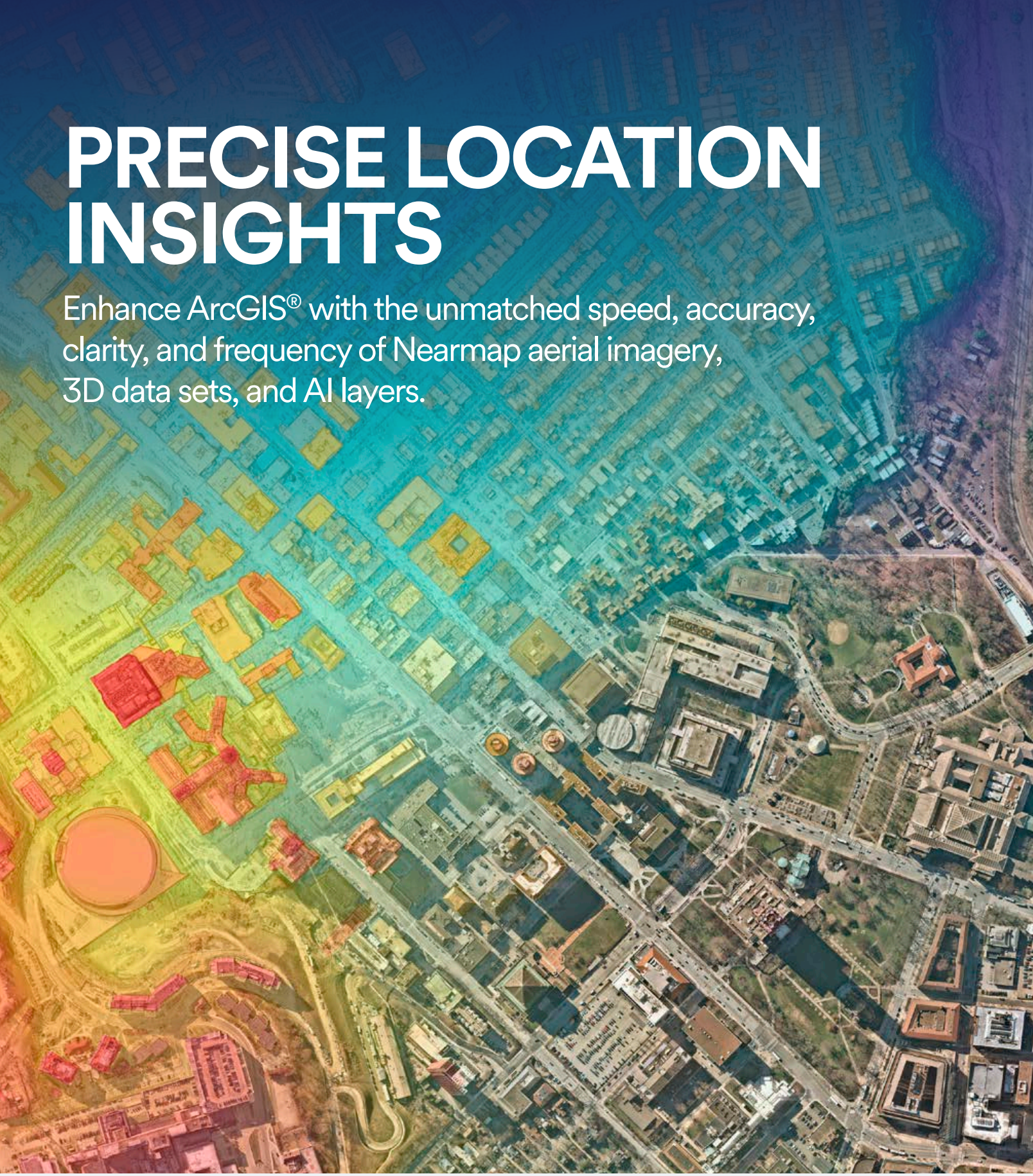

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Technology *and* Commitment for the World We Want

Environmental Systems Research Institute, Inc., was founded in 1969 by Jack and Laura Dangermond as a company that would build technology to preserve the environment by enabling more informed and holistic decision-making. Now known as Esri, the company has pioneered the application of the geographic approach to not only improve decisions but also streamline processes and enhance communication, thus helping public and private organizations save time and money.

Esri's original commitment to improving and preserving life on Earth remains. That commitment was reflected in the 2023 Esri User Conference theme, GIS—Creating the World You Want to See. The conference's Plenary Session showcased the work of 14 organizations that are using GIS to create a world that is more secure, prosperous, equitable, and sustainable. Several of those organizations are highlighted.

Lockheed Martin uses GIS to monitor and respond to the hundreds of thousands of events each year that may threaten the company's employees and assets.

Pacific Gas and Electric Company (PG&E), which provides electric and gas services to 16 million people, has expanded its use of GIS across the organization and improved the efficiency of its operations, access to information, and the productivity and safety of its employees.

Dr. Paulette Brown-Hinds was honored with a Making a Difference Award for her leadership in applying GIS to address the systemic inequalities that affect Black communities in California.

GIS lets Electrify America use a holistic approach to the siting of its ultrafast electric vehicle (EV) chargers. This approach considers customer needs, partner collaboration, financial realities, and environmental factors.

In concluding his discussion of the conference theme during the Plenary Session, Esri president Jack Dangermond stressed that creating the world we want to see will require more than technology. It will require the unique vision and talents of the GIS community.

Monica Pratt
ArcUser Editor

ArcUser

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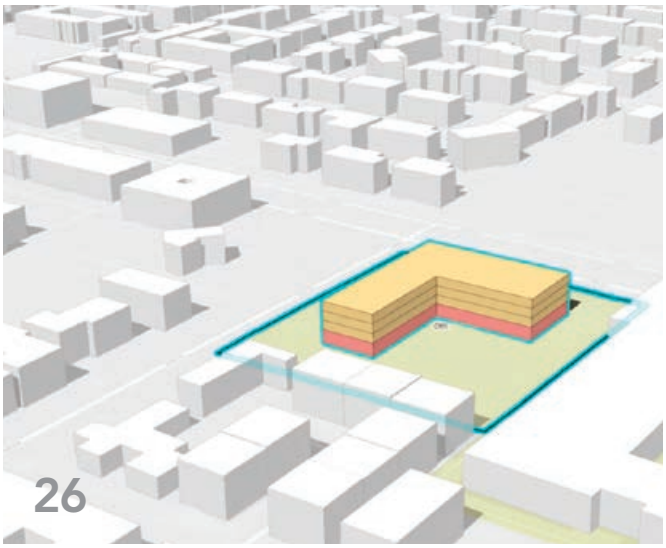

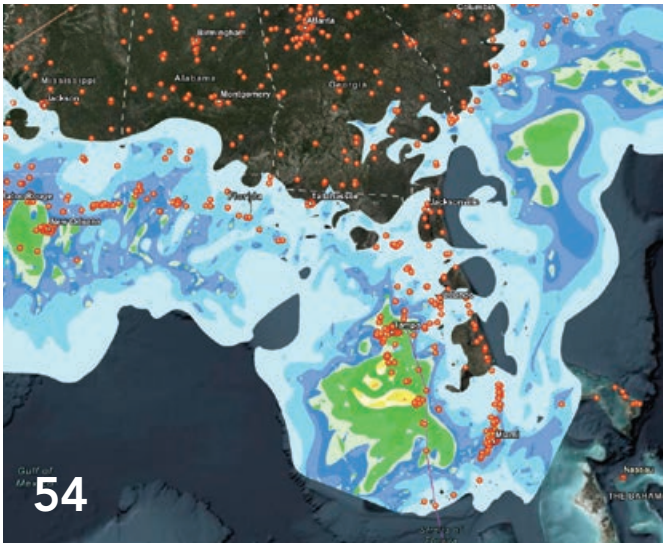

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Briefly Noted

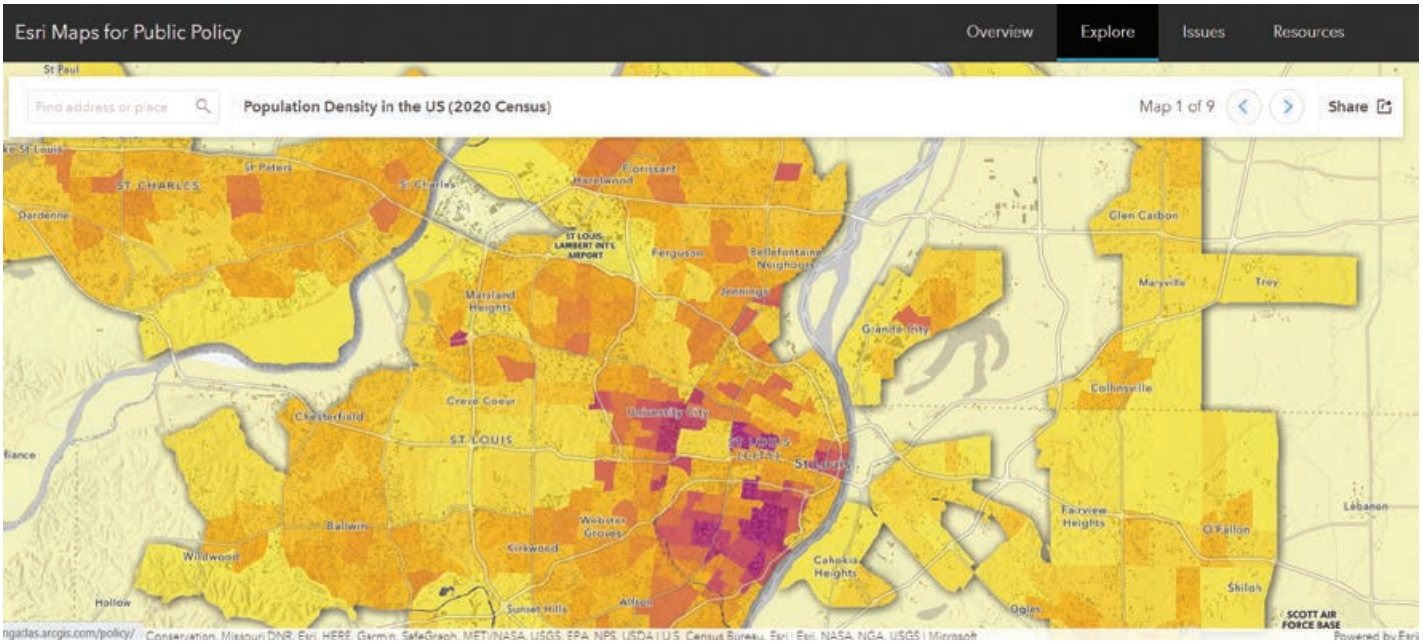
→ 2020 Census Demographics and Housing Characteristics Available in ArcGIS Living Atlas of the World

In the second quarter of 2023, the US Census Bureau released the 2020 Demographic and Housing Characteristics File (DHC), which contains 249 tables with nearly 10,000 attributes on topics such as population, age, sex, race and ethnicity, household type, occupancy, family type and more. The ArcGIS Living Atlas of the World policy maps team compiled the most popular tables into hosted feature layers in ArcGIS Online, organized by topic and geography.

The hosted feature layer provides total population counts as a nested layer containing nation, state, county, tract, and block group geographies. Five additional layers for total population provide legislative, place, metro, school, and tribal geographies. The total population is broken down by single race/ethnicity, male or female by age, urban and rural populations, dependent age groups, and relationship to householder. Tables have been joined to 2020 Census TIGER boundaries trimmed along coastlines, lakes, and major rivers to create cartographically pleasing maps of census data.

Essential metadata is built into the layers and can be accessed from within ArcGIS products. Since a differential privacy algorithm has been applied to this data to protect the privacy of respondents, the census bureau encourages data users to aggregate small populations and geographies to improve accuracy.

↓ Public policy maps using the 2020 Demographic and Housing Characteristics File (DHC) are available from the Esri Maps for Public Policy site (https://shorturl.at/mqxI0).



Esri Founders Receive Conservation Visionary Award

The International Land Conservation Network (ILCN) honored Esri founders Jack and Laura Dangermond with the Conservation Visionary Award at the 2023 Geodesign Summit. The award recognizes the Dangermonds' ongoing work toward understanding the connection between humans and the planet to help build a more sustainable world.

↑ Esri founders Jack and Laura Dangermond received the Conservation Visionary Award.

Collaboration Makes Advanced Spatial Analytics Available to Data Scientists

Analyzing data in a geographic context can uncover patterns, make predictions, and optimize workflows to create operational efficiencies. Esri has partnered with Databricks, the data and AI company, to provide users with advanced spatial analytics capabilities of ArcGIS software, made easily accessible in Databricks' big data platform, the Databricks Lakehouse Platform. This integration will allow data scientists to access the most comprehensive set of spatial analytics tools available natively within the Databricks environment.

ArcGIS Pro Add-On Provides Access to EarthCache Data

An ArcGIS Pro add-on enables ArcGIS users to access, manage, and distribute high-quality satellite imagery from SkyWatch's Earth observation platform, EarthCache. ArcGIS Pro users can publish to ArcGIS Online; create tiled basemaps from disparate georeferenced images; and customize how acquired data is saved, shared, and managed without maintaining commercial relationships with each data provider. Download this add-on at https://shorturl.at/ot578.

Boosting Geospatial Services for Rwanda's Social and Economic Development

In July 2023, the Rwanda Space Agency (RSA) and Esri signed a memorandum of understanding (MOU) to establish a collaborative partnership that will provide the foundation for promoting geospatial services to drive socioeconomic development in Rwanda. This agreement aligns with RSA's mission to harness space and GIS to foster sustainable and cross-sectoral development in Rwanda. In joining with Esri, RSA plans to leverage advanced geospatial technologies to address various developmental challenges and support a more prosperous future for Rwanda.

Matching COVID-19 Cases to Facilities: Lessons Learned

By Jonathan Gross and Darcy Phelan-Emrick

During the COVID-19 pandemic, the authors, who are epidemiologists at the Baltimore City Health Department, matched COVID-19 case and death data with lists of facilities most likely to be impacted by outbreaks. This information assisted the department with its response operations. Their article describes considerations for matching health data with facilities using ArcGIS tools.

The COVID-19 pandemic has disproportionately affected older adults, particularly those living in facilities such as nursing homes, and people residing in congregate living settings such as shelters and correctional facilities.

In Baltimore City, an estimated 28 percent of deaths from COVID-19 occurred in facilities for older adults and in congregate settings from March 2020 to March 2023. While cases within facilities represent a small percentage of all cases citywide, many of the deaths caused by COVID-19 occurred within facilities. Nursing homes had 19 percent of all deaths, followed by senior housing with 6 percent of deaths and assisted living facilities with 2 percent of deaths.

Within the first few days of the pandemic, Baltimore City Health Department epidemiologists created an internal map focusing on potential risk to older adults and facilities in Baltimore City. As the pandemic progressed, they matched COVID-19 case and death addresses with facility addresses.

Address matching could potentially identify more instances of deaths that occurred in facilities than the death certificate information that had been provided. Address matching reports were utilized daily by the contact tracing and outbreak investigation teams to guide their work.

When Interviews Can't Be Completed

Some COVID-19 case investigations and outbreak interviews cannot be completed for reasons ranging from lack of a phone number to an unresponsive subject.

However, address information is available for cases from COVID-19 test results. When a health-care provider orders a COVID-19 test, the patient's address must be entered in the test requisition form.

Information about a case's residential/facility address on the test requisition form can be used to glean information useful for operations. While some facility type and address matching could be completed using code, it was far more efficient to export case data and perform geographic matching using ArcGIS tools.

COVID-19 case data varies across jurisdictions. It may contain many types of location data including residence; test location; test organization; place of employment; places visited; place vaccinated; and travel, both domestic and international. In addition, there is also contact tracing data for these cases. These contacts may later become cases.

An Overview of the Process

Before beginning matching health data to facilities lists, determine the concerns of the people using this information. In this case, the consumers of the information were the assistant commissioner for clinical services, the Office of Acute Communicable Diseases, and the contact tracing team.

Identifying Which Facility Types to Track

At the Baltimore City Health Department, the epidemiologists decided to focus on licensed nonhospital health facilities and other high-risk settings for COVID-19. This list has grown and changed over time, but has included

- Nursing homes
- Assisted living facilities
- Adult medical day care centers
- Public housing (focusing on large facilities with older adults and disabled persons)
- Homelessness services programs
- Senior housing
- Correctional and juvenile justice facilities

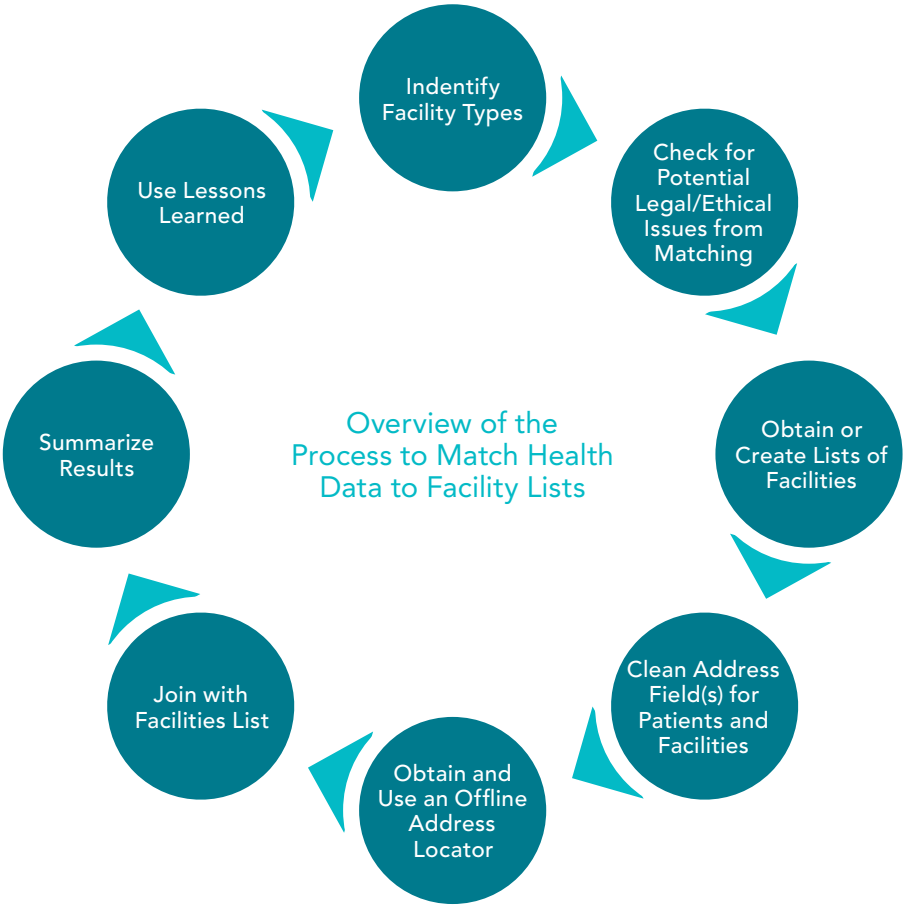
The epidemiologists discussed which facilities to track. They looked at laboratory records, talked to outbreak investigation staff, and contacted tracing staff. The facilities tracked varied over time as priorities changed or outbreaks among certain groups were detected.

Obtaining Lists of Facilities

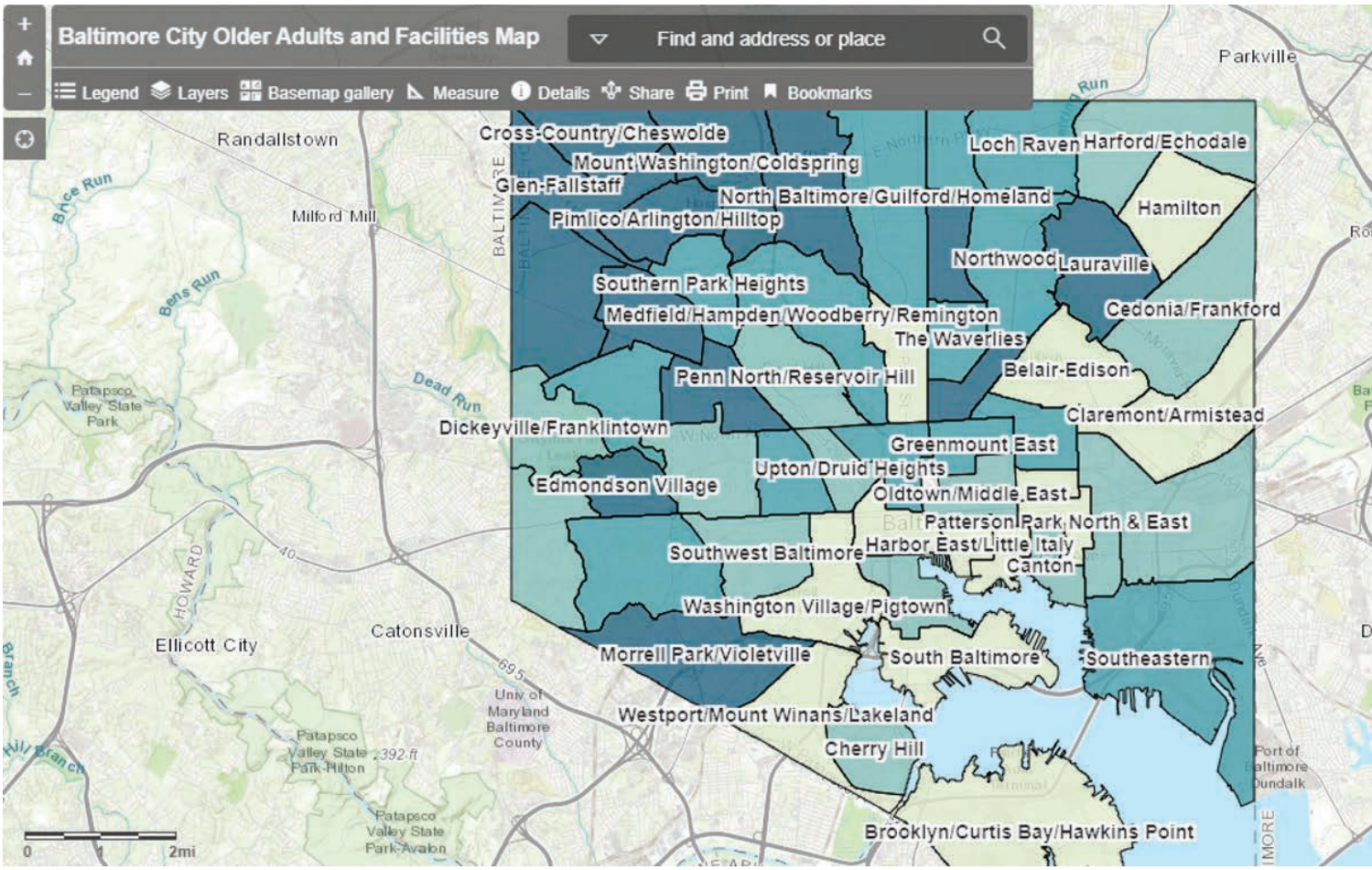
Obtaining up-to-date lists of medical facilities can be challenging. However, some state licensing boards maintain lists of licensed facilities. In Maryland, the Office of Health Care Quality maintains publicly available lists (https://shorturl.at/dilJQ). Some facilities may have a single address while others may have multiple addresses or address ranges. For example, colleges and universities were tracked using a list of locations with high frequencies of cases that included dormitories and student apartments.

Cleaning Address Fields

The COVID-19 address data was unstandardized because it came from multiple providers and included handwritten addresses.



Overview of the Process to Match Health Data to Facility Lists



↑ An interactive map was created using ArcGIS Online to highlight populations of older adults and people in facilities potentially at risk of COVID-19 during the first few days of the pandemic.

The first address field could sometimes contain the facility name or apartment, suite, unit, or floor number. These address fields can easily be cleaned up using a Python script in ArcGIS or a statistical program such as R or SAS.

Remember, when working with sensitive data, be sure to examine potential legal and ethical issues in advance. At Baltimore City Health Department, access to lists of cases matched with facilities was limited to outbreak staff and senior contact tracing staff.

Using an Offline Address Locator

With ArcGIS products, address locators and their reference data can be packed up by an organization and shared with other users, who can then unpack and use the locator. Having up-to-date location data is important as new communities are developed, populations move, large apartment complexes close, or those complexes are redeveloped.

Since many geocoding services are not approved for Protected Health Information (PHI), Baltimore City Health Department uses an offline address locator with locally stored reference data. *[PHI is individually identifiable health information such as a name, address, or medical record number.]* This allows large datasets to be geocoded on site.

The epidemiologists at the Baltimore City Health Department obtained a packaged locator with reference data from the Baltimore City GIS Office. If you do not have an address locator with reference data stored locally, consider contacting your state or local GIS office. Be sure to check the address locator properties to see where reference data is being pulled from.

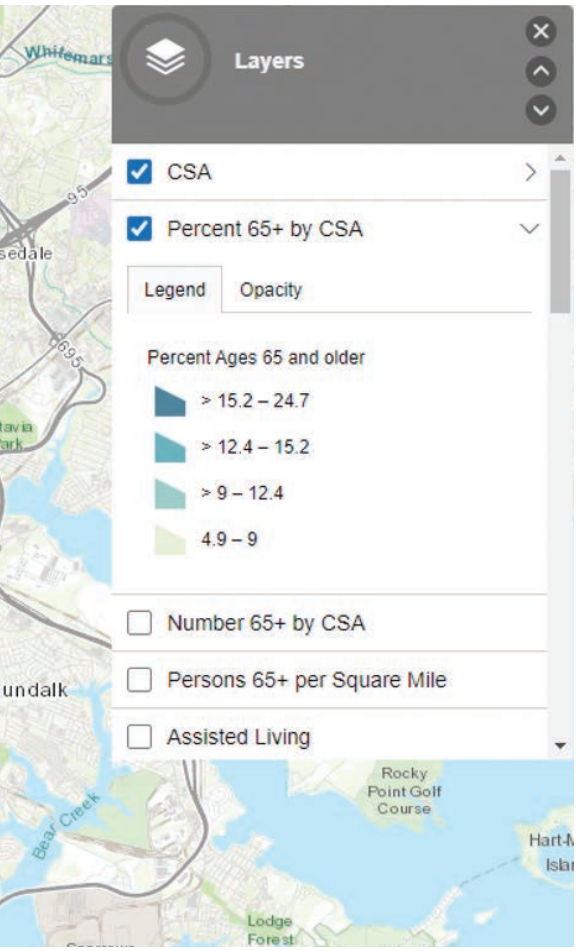
There are also a small number of geocoding services for PHI. These services require a Business Associates Agreement (BAA). *[A BAA is a legal agreement that outlines the responsibilities and obligations of a business associate (e.g., vendor) to handle PHI in a compliant and secure manner.]*

Joining Addresses with a Facilities List

Adding a join to match address fields between the cases and facilities list in ArcGIS Pro is easy. Factors to consider when creating a join between address fields and facilities include

- Whether you want to make a join permanent
- Whether some facilities may share the same address or are colocated on the facilities list
- Whether you want to keep all records or just matched records

Creating a list of the locations with the



most cases—a high frequency list—is important. In this case, the high frequency list consisted of locations or addresses with many COVID-19 cases. This list included both addresses that matched facility lists and addresses that did not match facility lists but still had many cases. For example, university student housing showed up clearly in the data. Real property data can help you better understand location types.

How to Summarize Results

Daily, Baltimore City Health Department epidemiologists produced a summary report of facilities with the number of cases and deaths. This report was sent to the outbreak investigation and contact tracing teams to facilitate their work. Case line lists by facility were also rapidly produced to allow investigators to compare against lists manually created as cases were reported by facilities.

Impact of Case and Facility Matching

Providing a daily summary report of COVID-19 cases and deaths gave health department staff a better starting point when investigating COVID-19 cases and outbreaks and performing contact tracing. These summaries helped avoid manually scrutinizing lengthy lists of unstandardized addresses. It also enabled epidemiologists to quickly identify patterns. As a result, it made Baltimore City Health Department's COVID-19 outbreak and contact tracing operations more efficient and effective. This was crucial, given the scale and complexity of the public health response to the pandemic.

Five Lessons Learned

Sometimes the end may just be the beginning. Lessons learned should be incorporated to improve processes over the long term. Matching health records with facilities lists can provide timely operational information. Facility matching has been expanded from cases to deaths and vaccination data. Matching can potentially shorten the time from laboratory test to outbreak detection, or at the very least allow contact tracing to begin sooner.

1. Providing matched lists of cases and facilities greatly aids outbreak investigation and contact tracing.
2. Simple cleaning of address fields can greatly improve the matching process during geocoding—making it faster and more accurate.
3. Facility staff can be matched to their work location, rather than their residential location.
4. Consider big data approaches when cleaning address fields. These could include breaking addresses into component parts and using fuzzy matching. Large organizations could consider paying for address cleaning.
5. Realize that address matching has limitations. Matching will almost always underestimate the burden of disease in facilities.

For more information, contact Jonathan Gross at jonathan.gross@baltimorecity.gov.

About the Authors

Jonathan Gross is an epidemiologist at the Baltimore City Health Department. Throughout the COVID-19 pandemic, he created maps and performed spatial analysis of COVID-19 cases, deaths, hospitalizations, and vaccinations. His background includes a master's degree in public health in epidemiology from the University of Michigan, Ann Arbor. He holds a certification in public health and a graduate certificate in geographic information systems from Johns Hopkins Advanced Academic Programs.

Darcy Phelan-Emrick is the chief epidemiologist at the Baltimore City Health Department. She leads the department's efforts to use existing data sources and new data collection tools to assess public health needs and inform policy development and assurance. She is a faculty member at the Johns Hopkins Bloomberg School of Public Health. Phelan-Emrick earned a doctorate in public health and a master's degree of health science in epidemiology at Johns Hopkins University.

Harnessing Geospatial Data for Informed Health-Care Planning

By Este Geraghty

In today's ever-changing health-care landscape, data-informed decision-making is vital for organizations to navigate complexities with confidence. Geospatial data, harnessed through GIS technology, provides a powerful foundation for strategic planning, operational efficiency, population health management, equity initiatives, and targeted marketing. This article explores how geospatial data underpins informed health-care planning, empowering organizations to purposefully align decisions with health system needs while also driving positive health outcomes.

Geospatial Data for Strategic Planning and Operations

Geospatial data serves as the backbone of strategic planning and operational efficiency in health care. By integrating various data streams, such as demographics, health metrics from electronic health records, public health data resources, and health-care facilities information, GIS enables organizations to gain a comprehensive understanding of their current situation and forecast potential changes.

This data-informed decision-making reduces uncertainty and guides critical determinations, such as facility siting, resource allocation, and the deployment or expansion of telehealth services. It can help organizations avoid costly errors by anticipating competition; identifying underperforming sites early; and monitoring unusual or inappropriate utilization patterns, such as overuse of hospital emergency services for preventable conditions like asthma exacerbation or hyperglycemia. Geospatial insights help organizations optimize service mix, align offerings with community needs, and facilitate sustainable growth strategies.

Geospatial Data for Population Health Management and Equity

Population health management is a critical application of geospatial data. GIS aids in stratifying risk across served populations, identifying high-risk communities, and guiding targeted interventions. Geospatial analysis enables health-care organizations to answer vital questions such as, Where are the high incidences of chronic diseases? Are certain populations facing barriers to accessing care? Where are there disparities in health outcomes and what are the root causes?

This insight helps organizations direct resources where they are most needed, improving health outcomes and reducing disparities. By incorporating historic redlining data and vulnerability indexes, geospatial analysis can unveil persistent structural inequities and inform modern multidimensional solutions.

Geospatial Data for Marketing and Communications

Geospatial data plays a crucial role in targeted marketing and effective communication with patients and communities. Demographic data, combined with lifestyle and behavior insights, allows organizations to tailor messaging, services, and care delivery to specific population segments. In addition, geospatial insights derived from attitudes, beliefs, and sentiments help organizations understand community preferences, urgent concerns, and engagement patterns. By leveraging geospatial data, health-care organizations can deliver personalized and impactful marketing campaigns that foster patient engagement and satisfaction.

Geospatial data is a transformative asset in health-care planning. It offers valuable insight for strategic decision-making, population health management, equity initiatives, and targeted marketing. By harnessing the power of GIS, organizations can align resources with health system needs, reduce disparities, and enhance health outcomes. Geospatial data enables health-care organizations to navigate complexities with precision and effectively deliver patient-centered care. Using GIS, organizations can make data-informed decisions that positively impact communities. Embracing geospatial insights as a foundational element of health-care planning empowers organizations to adapt, innovate, and drive meaningful change in the ever-evolving health-care landscape.

About the Author

Dr. Este Geraghty, the chief medical officer at Esri, leads strategy and messaging for the health and human services sector. With Esri since 2014, she leads business and solution development and has helped organizations around the world use location intelligence to meet a range of health challenges, including enhancing strategic planning and optimizing health-care access during the COVID-19 pandemic. She is a former deputy director of the Center for Health Statistics and Informatics with the California Department of Public Health and an associate professor of clinical internal medicine at the University of California at Davis. Geraghty holds advanced degrees in medicine, medical informatics, and public health and is also a board-certified public health (CPH) professional and a geographic information systems professional (GISP).

Geospatial Dataset	Strategic Planning and Operations You Can Answer
US Census Bureau and American Community Survey data on populations, population growth rate, Esri 5-year population estimates	Is my service area population growing or contracting? Should we expand or consolidate clinics and/or services?
Population demographic breakdowns by age and gender and community health needs assessments	Who makes up the population in my service area? Should we adjust our service mix now? In the future? Are new needs arising?
Human movement data on point of interest (POI) visitation	Where are health-related products and services being heavily used by the local community? Should we invest in new community partnerships?
Human movement data inside your facilities	Where are people congregating? What are the dwell times in key areas? Does this movement impact satisfaction, safety, or infection control?

Geospatial Dataset	Population Health Management and Equity Questions You Can Answer
Calculations of patients' access to care and their travel burden	Is my care network adequate? Who lives outside my service area? Do I need to recruit new providers or open new clinics, labs, or imaging centers? Are patients missing appointments because of higher travel burden? Do I need to provide rideshare or other transportation options?
Data on patients living outside the service area geographic routing calculation	Do I need to provide mobile health services or telehealth services? Would a hospital-at-home program work?
Population demographic breakdowns by race/ethnicity and social determinants of health	Is there is a difference in health outcomes that is based on population demographics and location? Are we providing culturally competent care?
Historic redline data and Social vulnerability data	Are there fewer health-promoting resources in formerly redlined neighborhoods? Are preventable hospitalizations higher in formerly redlined communities or those listed as socially vulnerable?

Geospatial Dataset	Marketing and Communications Questions You Can Answer
Attitudes about vaccination and vaccination rates	Are there areas with low vaccination rates? What are people's attitudes toward vaccination? Where do we need to improve vaccination education and confidence?
Sentiment/Satisfaction surveys	How do patients feel about our institution and the quality of services we provide? How do patients feel about health screening?
Belief surveys and preventive care screening rates	Where are screening rates high or low? What are patients' beliefs about the importance of screening and preventive measures?
Esri Tapestry Segmentation data	How can I understand a specific population within my service area to perform microtargeting campaigns? What are the population's core values? How do they get their information?

Revealing Opioid Diversion with ArcGIS AllSource

By Julia Smyth and Patrick O'Brien

According to the Centers for Disease Control and Prevention (CDC), since 2013 more than half a million Americans have died due to opioid overdoses. The illegal distribution of prescription drugs—opioid diversion—is a major contributing factor to this epidemic. To combat this, health-care workers or persons who are exploiting the healthcare system need to be identified.

This starts with looking at data associated with patients, the physicians who prescribe opioids, and pharmacies that distribute opioids. Health-care evaluators and auditors attempt to detect fraud by monitoring opioid distribution networks. They need to visualize the relationships between patients, physicians, and pharmacies to uncover patterns that are not easily discerned.

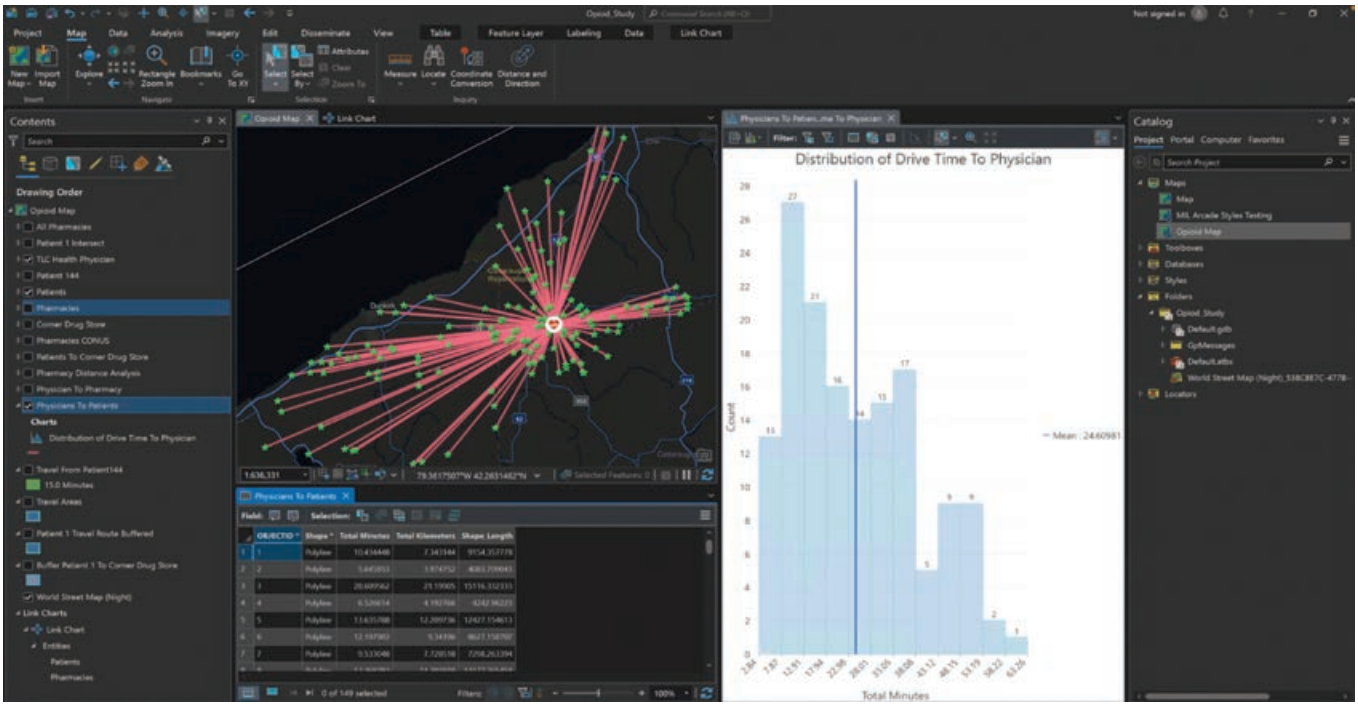
Combining data regarding patients, physicians, treatment centers, and opioid prescriptions can be overwhelming. It is difficult to track relationships without the right software. With limited resources to tackle this issue, auditors need to know where to best focus their efforts. They need to examine the networks formed by physicians, treatment centers, pharmacies, and patients through a geographic lens.

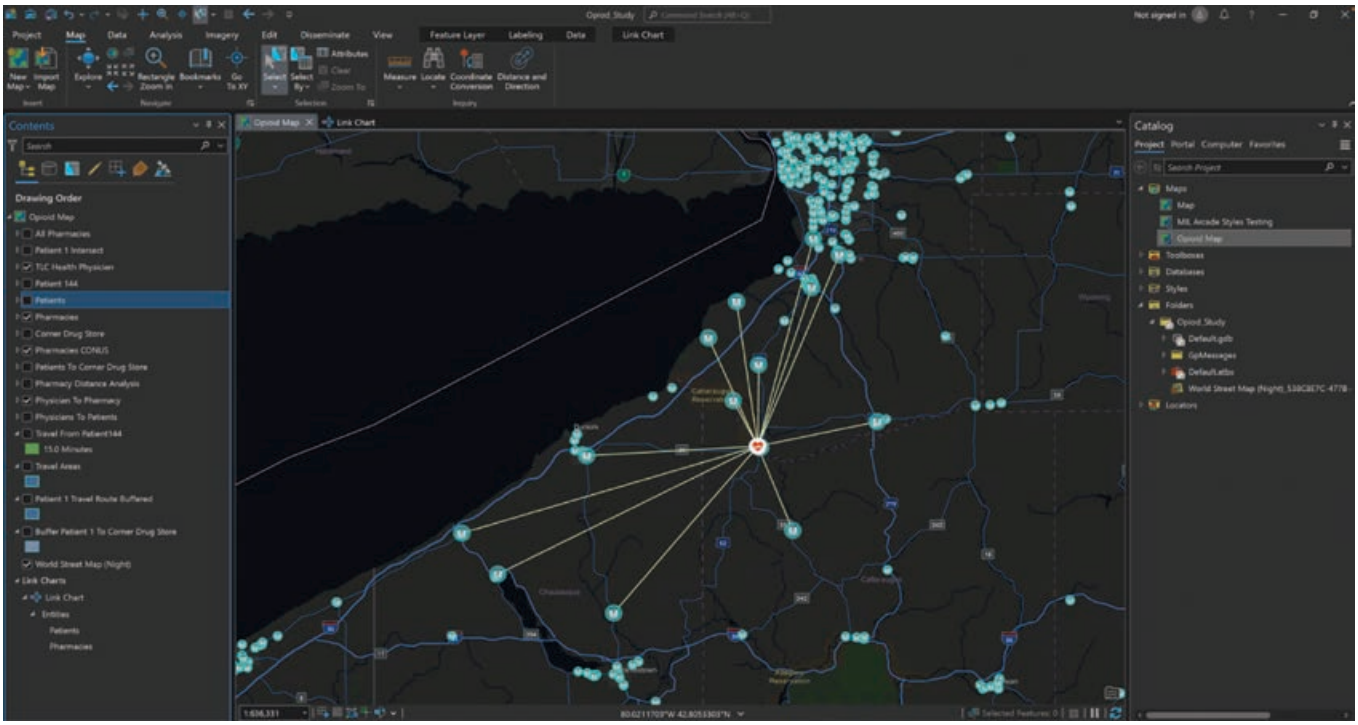
ArcGIS AllSource is powerful intelligence software that enables auditors to understand the irregularities in the spatial connections between the components of these networks. Auditors can analyze and visualize the data through multiple views, including maps, timelines, and charts—particularly link charts. These tools enable auditors to quickly identify outliers that can indicate possibly fraudulent activities.

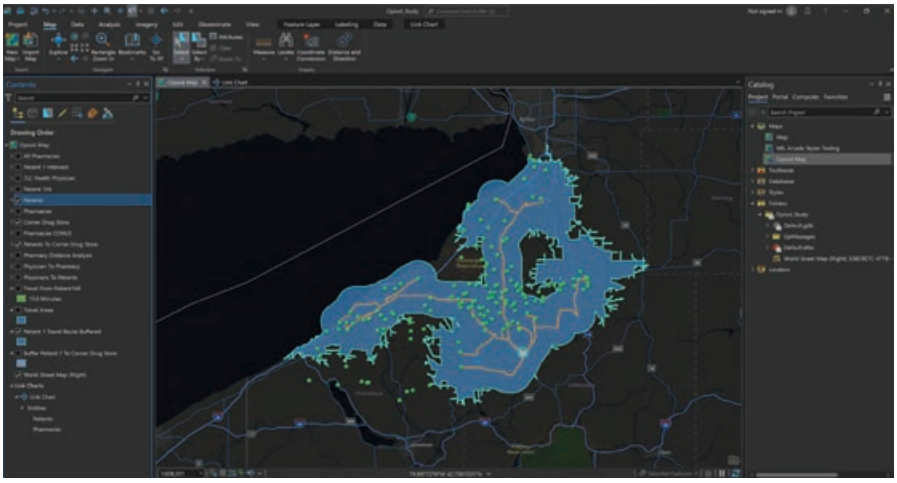
ArcGIS AllSource allows auditors to view locations of patient homes in relation to physicians and pharmacies. By interrogating the data, they can answer questions such as, How far are patients traveling to a specific doctor or pharmacy? How many pharmacies were closer to the patient than the one used? Answers to these and other questions can focus investigative efforts into illegal activities by physicians, treatment centers, and pharmacies.

In one interface, ArcGIS AllSource lets auditors connect disparate and large data sources so that potential bad actors can be more efficiently identified. The automation of AllSource workflows enables users to rapidly identify fraudulent behavior. Because workflows are captured, they can be shared with other cities, states, and agencies. Auditors can disseminate their findings to explain the analysis, display results, and support investigations.

↓ ArcGIS AllSource analyzes the distance between physicians and patients and identifies outliers.







↑ Analysis identified patients who drove extraordinarily far distances to fill a prescription at a specific pharmacy.

← Buffer analysis and drive-time analysis showed an average of eight other, more convenient pharmacies that were bypassed en route to this pharmacy.

In the following example, an auditor began by mapping a physician's office in western New York and each patient to whom he had prescribed opioids. By examining the distance between each patient's home and the physician's office, outliers were uncovered. These outliers were patients who drove abnormally long distances to see this doctor for a prescription.

The auditor also looked at the pharmacies that filled these opioid prescriptions. Geographic networks revealed where opioid prescriptions were most often picked up. One pharmacy was being used much more often than other pharmacies. Another distance analysis was performed on pharmacies and prescription holders. Ultimately, this revealed how far patients drove to this specific pharmacy. This analysis identified a pharmacy that had patients who drove remarkably long distances to fill prescriptions. A buffer and drive-time analysis showed an average of eight other, more convenient pharmacies that were bypassed on the way to this pharmacy.

ArcGIS AllSource analysis in this example helped reveal potential bad actors and facilitate investigation in a timely manner. Identifying potentially corrupt physicians and pharmacies gives law enforcement solid leads that can be acted on to make communities safer. ArcGIS AllSource helps investigative professionals make data actionable using seamless, straightforward, and organized searches.

About the Authors

Julia Smyth is an associate product marketing manager for ArcGIS Earth on the operational intelligence team at Esri. She creates digital content for numerous operational intelligence products.

Patrick O'Brien is a senior solution engineer on the public safety team at Esri. He primarily works in the United States federal law enforcement and national security arena. He is an ArcGIS technical expert who has extensive knowledge on incorporating GIS into workflows that support public safety. O'Brien obtained a bachelor's degree in geography from Salisbury University and a master's degree from the University of Maryland, College Park, in geospatial information science.

INTERACTIVE MAPS TELL THE STORY OF MODERN RISK MITIGATION IN FLORIDA

By Carrie Speranza

THE Federal Emergency Management Agency (FEMA) mandates that every US state create a five-year hazard mitigation plan that gives priority to community vulnerability and climate forecasts. Instead of producing a 500-page report, the Florida Division of Emergency Management (FDEM) is meeting this FEMA mandate in a new way by employing interactive maps to make the plan more user-friendly.

"We met with local jurisdictions, and they told us they didn't find the previous plan useful, which is a dagger to our heart for this huge five-year effort," said Kristin Lentz, the mitigation planning manager at FDEM.

To meet FEMA's directive by the August 2023 deadline, the FDEM team applied GIS analysis of hazards, climate, and social vulnerability. To make the plan more intuitive, Lentz worked with Dan Rydl, GIS manager at FDEM, to incorporate digital maps. They built the site using ArcGIS Hub to organize information and ArcGIS StoryMaps to provide narratives.

What was once a hefty PDF is now a website with data-rich maps and insightful narratives. FDEM will continue updating the site's open data and analytical guides for counties and municipalities.

Mitigation Projects through a Lens of Vulnerability

State hazard mitigation projects can include retrofitting critical facilities such as schools and hospitals to better withstand hazards such as high winds, flooding, and extreme heat. The work entails hardening infrastructure such as electrical and

telecommunications networks to uphold power and internet connections. Other hazard mitigation projects include increasing drainage and, in some cases, elevating homes in areas that experience repeat flooding to mitigate stormwater hazards.

After a major event, FDEM assesses the damage to determine how mitigation projects can reduce property loss and save people from harm.

"The loss avoidance reports help us with storytelling and getting buy-in for more projects," Lentz said. "In mitigation, projects utilize effective resilience techniques to improve future outcomes, which can be highlighted through these reports."

In a similar way, FDEM uses maps to show communities in need of more help and areas where hazard risks are highest. With more mapping, a more comprehensive picture of risk in Florida emerged. For instance, analysis of some natural hazards, such as extreme heat, revealed social vulnerability along the center of the state.

"We mapped risks and hazards and draped social vulnerability on top of that," Rydl said. "Almost everybody that looks at the hazard vulnerability map pauses and wants to talk about it because they understand hazard risk in a new way. Regardless of the hazard, it opens your eyes to the more challenged and impoverished areas. People assume that the coast is the most vulnerable, but that's not always the case."

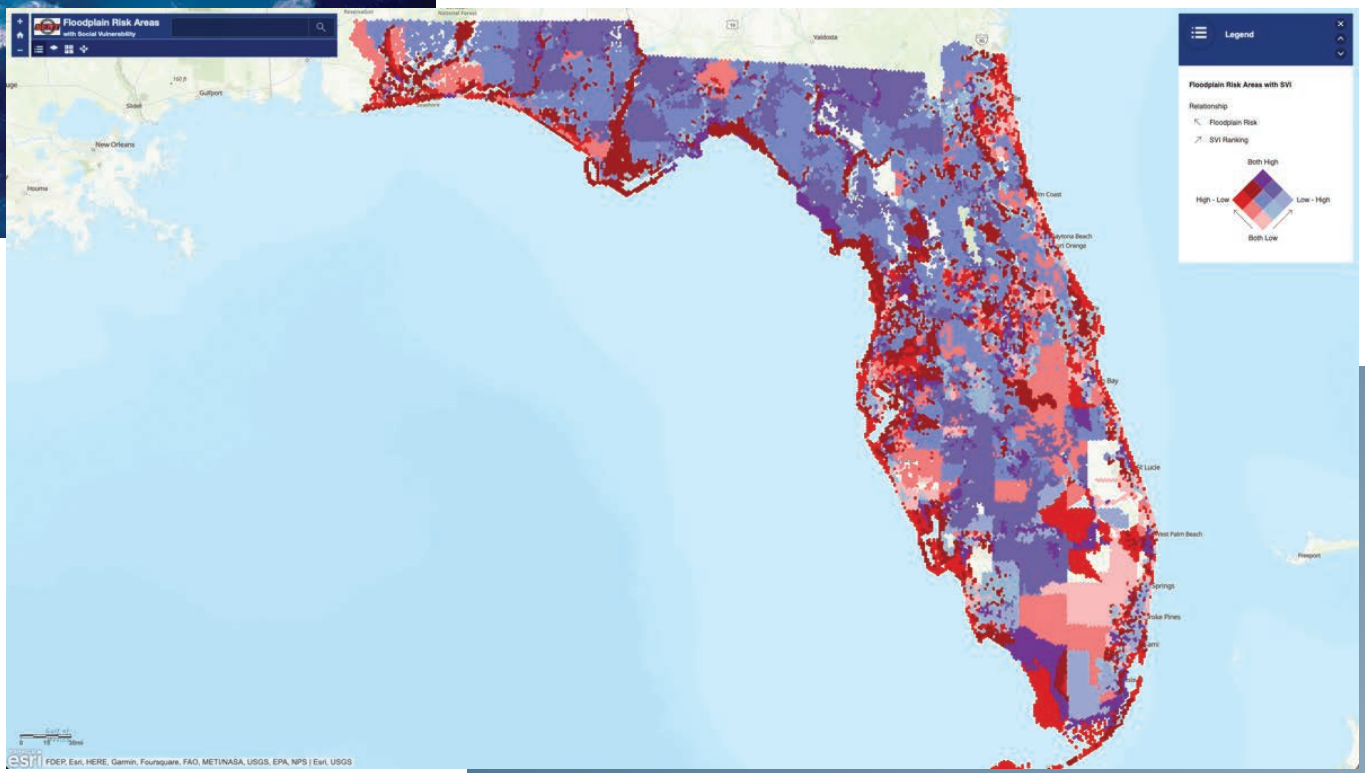
Forecasting and Collaboration Mark a Path Forward

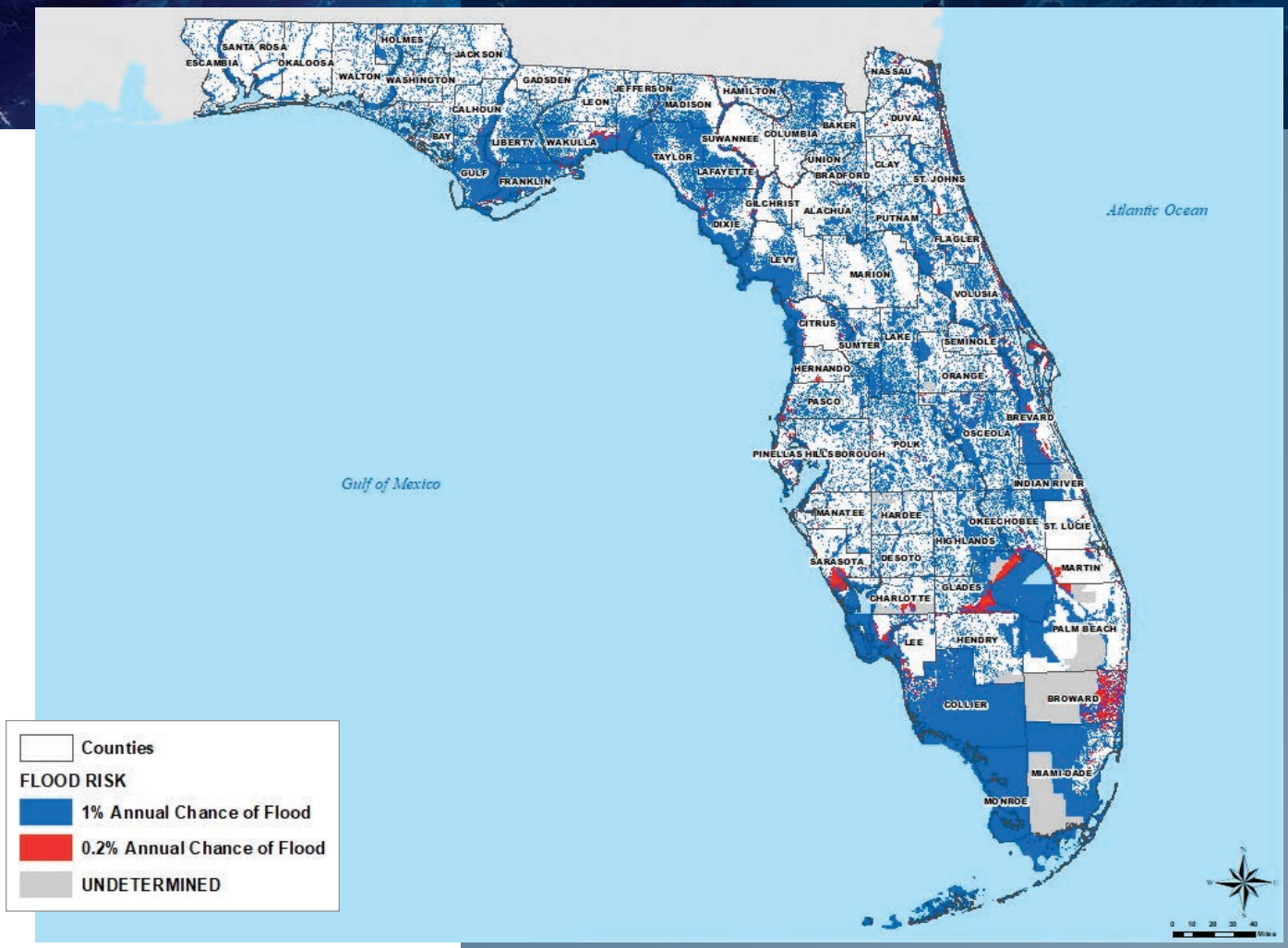
For the previous five-year plan, Rydl and the FDEM GIS team provided maps. For this plan, he taught Lentz and her mitigation planning team how to make maps. They met every week for two years. Rydl trained the team members on GIS basics, and they applied the technology to all FEMA's requirements.

Along the way, talent emerged on the combined GIS and planning teams. Some members were more comfortable making maps, others focused on narratives, and a few took on web development. "We picked up on that and built a really fun collaborative environment," Rydl said.

One area of focus was climate vulnerability. Florida currently feels increased impacts

↓ The bivariate risk map of Florida flood risk for the 2023 State Hazard Mitigation Plan relates the Social Vulnerability Index from the Centers for Disease Control and Prevention overlaid with hazard risk to reveal where help is needed most.





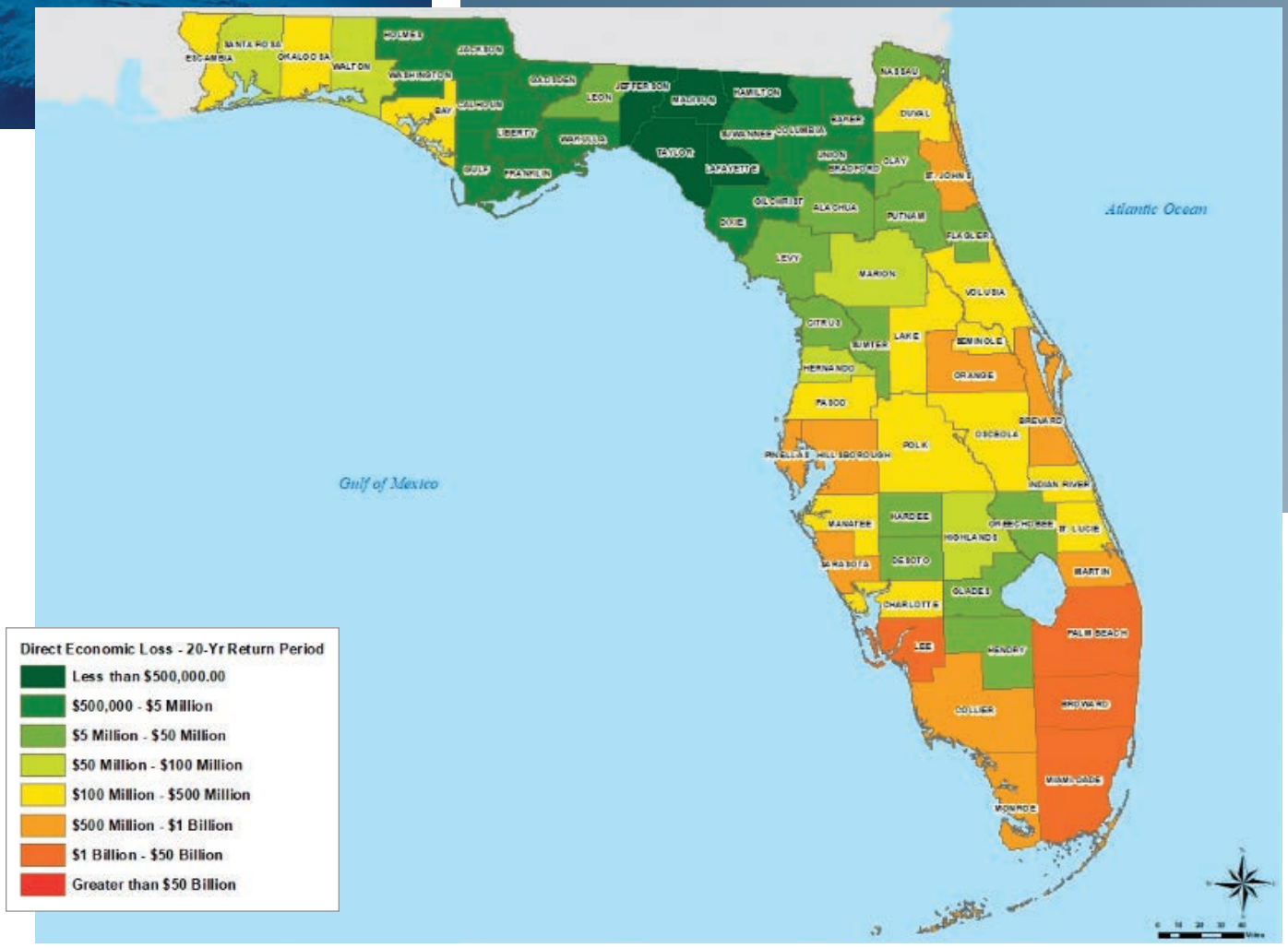
from more frequent and intense natural hazards. These hazards include wildfires, extreme heat, drought, storms, heavy precipitation, and sea level rise. The state has seen more natural disasters than most, particularly during hurricane season, which runs June 1 through November 30. For 2023, National Oceanic and Atmospheric Administration (NOAA) forecasters near normal activity for the first time in seven years. If that holds true, it will pause an upward trend as extreme hurricanes have been on the rise over the last six years.

Hurricane Ian, which devastated southwest Florida in September 2022, is a sobering example. It caused more than $112 billion in damages and more than 150 deaths. According to NOAA, it is the third-costliest hurricane in US history. Without the mitigation measures then in place, the damage could have been worse. Assessment of damage from hurricanes guides future mitigation.

↑ The flood risk map in the 2023 State Hazard Mitigation Plan corrects mapping errors made previously and shows FEMA special flood hazard areas.

↓ Florida experiences many natural disasters, particularly during hurricane season, which runs June 1 through November 30. This NOAA map shows historical hurricane tracks.

Historical Tropical Cyclone Tracks, Florida, 1916 to 2016



↑ Direct economic losses by county over the previous 20-year period.

While many states have considered climate forecasts in their hazard plans in the past, the FDEM team knows how tightly mitigation aligns with climate resilience.

"We've done the research to understand impacts, but I think we can improve on visualizing what future conditions will look like here in Florida," Lentz said.

Rydl is looking into risk forecast models to understand what's coming. Meanwhile, Lentz and her staff are on their way to becoming GIS experts. "I think the GIS team has become a little more mitigation-y, and I think mitigation got a little more GIS-y," Rydl said.

This year, the FDEM team is confident it's built a product that's more useful to the counties and municipalities that design mitigation projects.

"We created a tool that allows local jurisdictions to ask where dollars will best be spent," Lentz said. "They can look at how successful projects are, but also at where they haven't yet implemented mitigation."

About the Author

Carrie Speranza, director of emergency management solutions at Esri, is responsible for cross-cutting industry-wide strategic initiatives. Previously, she worked at the District of Columbia Homeland Security and Emergency Management Agency, where she served as deputy director. Currently, she is the vice chair of the FEMA National Advisory Council, where she has served as an administrator's appointee since 2019. Speranza is the second vice president of the International Association of Emergency Managers (IAEM) and was selected for the Top 40 Under 40 in 2021 by IAEM-USA Region 3. Speranza is a graduate of the National Emergency Management Executive Academy and is a certified emergency manager (CEM).

App Saves Time and Adds Flexibility and Transparency to Capital Funds Spending

By Daniel Shinnick

A capital improvement plan (CIP) is an important tool for organizations such as water districts and local governments when planning, managing, and coordinating the expenditure of capital funds. CIPs help maximize the return on investment (ROI) over an asset's life cycle. This article describes a solution that enabled a water district to more effectively manage its water mains by moving its CIP from a static report to an app.

The Dedham-Westwood Water District in southeastern Massachusetts is a private water supplier that provides water to two neighboring towns, Dedham and Westwood. The district manages 208 miles of water main serving more than 14,000 customers. Staying ahead of repair and maintenance is a constant challenge. Balancing budgets and schedules can become daunting.

To assist in prioritizing improvement and justifying capital expenditures, the district partners with Weston & Sampson, a company that provides interdisciplinary design, engineering, and environmental services for public and private entities, to produce and regularly update the district's CIP. This CIP is developed in three general stages—assembling data, evaluating conditions, and ranking assets—to produce a priority list of assets (PLA) that then help prioritize expenditures and maximize asset life cycle and ROI.

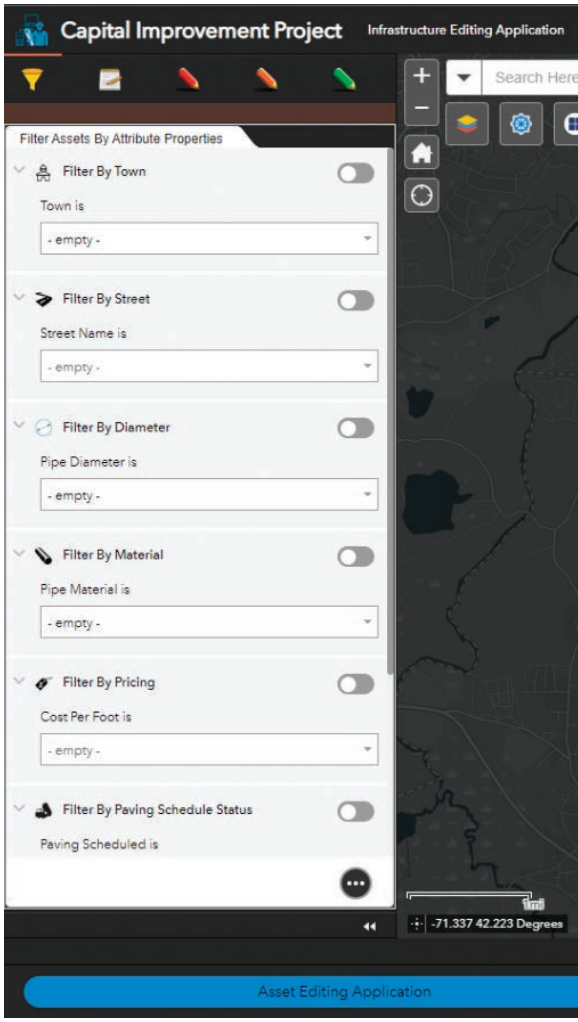
The CIP assesses a variety of asset variables that range from the condition and history of water mains to the paving schedule for Dedham and Westwood. The CIP is projected across multiple project time frames. Projects for the most important asset replacements are scheduled in the first year, with projects of less importance scheduled later. Projects can span 3 to 20 years.

Traditionally, the CIP takes the form of a static report. This means that if conditions change significantly, the plan's recommendations may not reflect its original intent. Also, assembling and evaluating all this data can take considerable time and is dependent on the condition and availability of resources. For example, a CIP that relies on the attributes within GIS will need to ensure that these attributes are fully and accurately populated. Because good data is required for good recommendations, significant effort is spent ensuring data quality. The process sometimes consumes 50 percent or more of the time spent on data assembly.

For these reasons, Weston & Sampson sought to provide a responsive solution that would proactively assemble as much of this data and categorization as possible and produce an up-to-date PLA so that the discussion of annual CIP efforts could start immediately. This solution is the CIP Viewer and PLA generator.

After migrating the district's data to ArcGIS Online, Weston & Sampson helped establish its CIP in the platform. Weston & Sampson took advantage of the configurable nature of ArcGIS Online platform components by embedding separate ArcGIS Web AppBuilder and ArcGIS Dashboards applications within an ArcGIS Experience Builder wrapper to produce an application that responds to dynamically changing inputs. These might be attributes of the water main feature service in ArcGIS Online (e.g., age or material) or an associated

↓ Asset Monitoring Page



feature service (e.g., main breaks) or direct user input such as paving schedules or costs.

Two centerpiece elements of the solution were the ability to integrate with the district's third-party asset management and work order software, and the primary algorithm used to facilitate the assembly and ranking of assets. The open-source REST end point architecture of services in ArcGIS Online lent itself to a seamless integration with the district's existing software.

Weston & Sampson worked with the district's existing software and established electronic forms in this platform that connected with and stored data in an ArcGIS Online hosted feature service. This made the history of breaks seamlessly available to the primary algorithm.

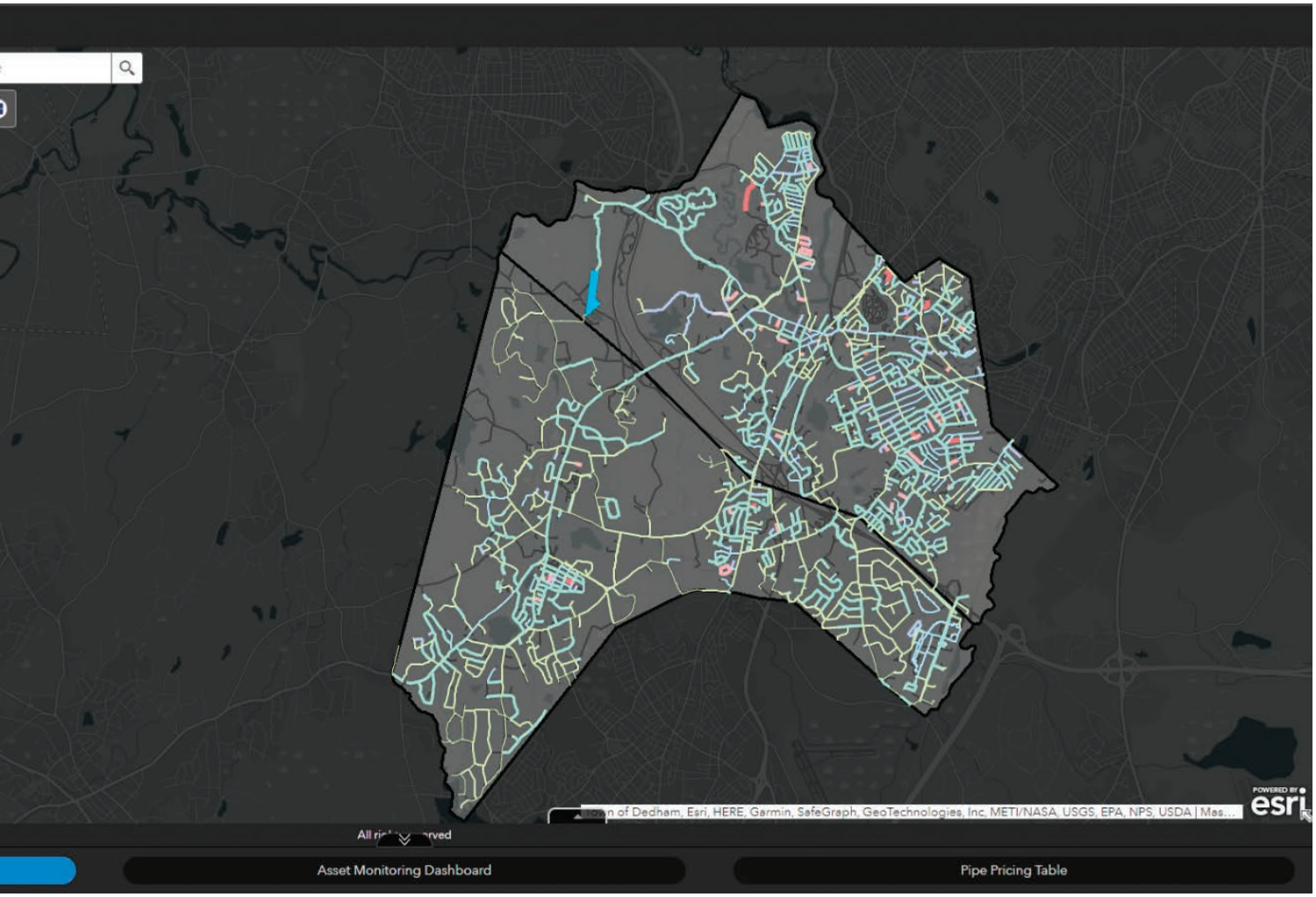
The primary algorithm for the development of the PLA is a customized script included in a scheduled ArcGIS Notebooks task on ArcGIS Online. The script periodically examines the input variables that are preserved as feature attributes and calculates priorities for each asset across the entire system based on a normalized score that is designed to be consistent with the approach developed as part of the original CIP.

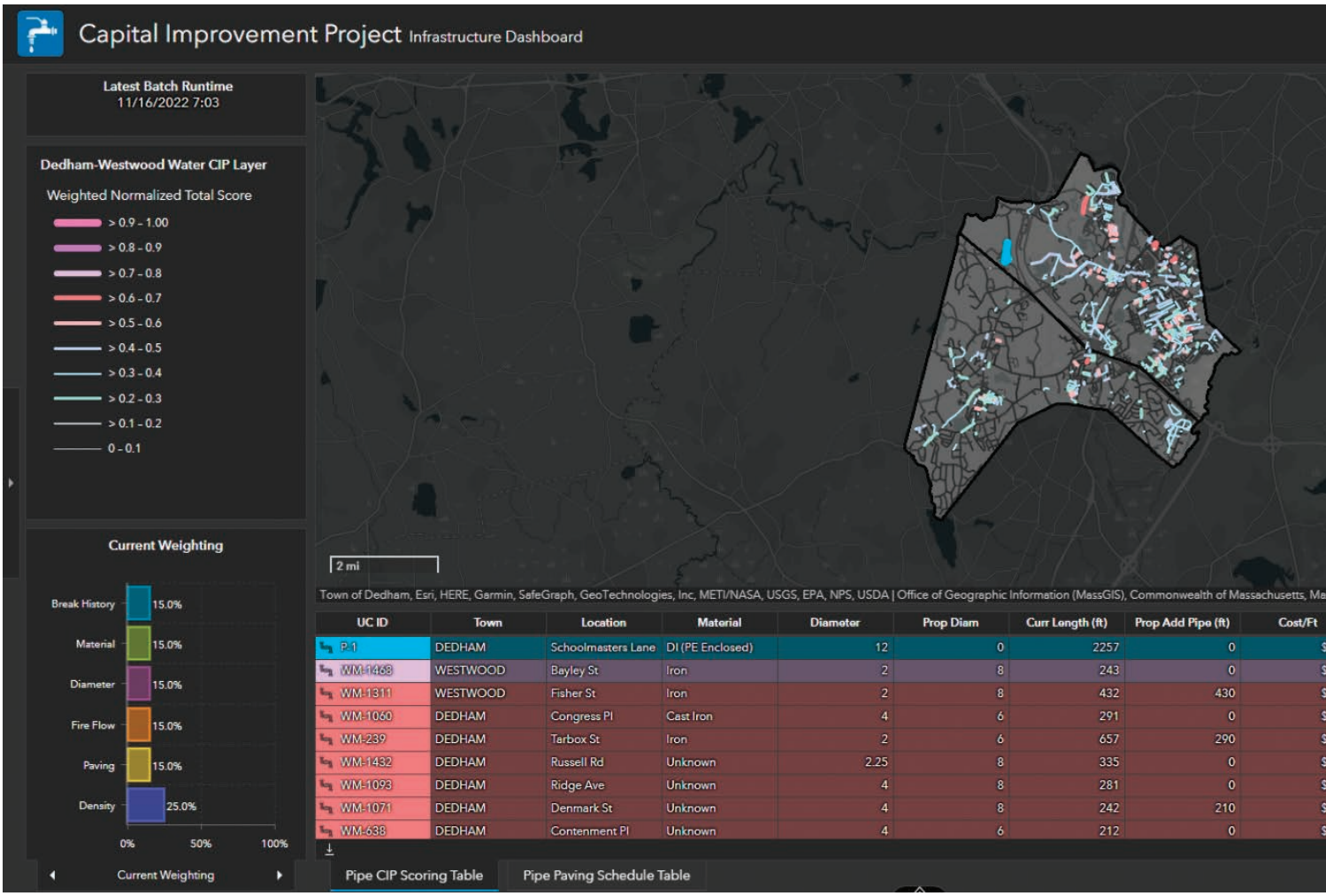
Assets are assessed based on their proximity to other assets, allowing them to be reprioritized based on the scores of those other assets and increasing the potential efficiency of any recommendations that result from prioritization.

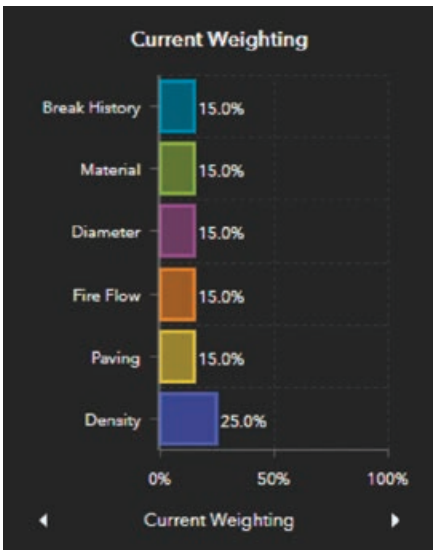
This allows the prioritization to be modified based on the condition of nearby assets and inserts a large measure of efficiency to a proposed list of assets. A summary dashboard portion of the application allows users a look at the prioritized list of assets and offers a set of filters to review conditions, including a budget filter that will take as input a budget number and display in an interactive map and table the list of assets of highest priority.

Weston & Sampson wanted to give district staff—and whoever is going to design the next CIP—a measure of control over the algorithm to affect how it was applied to each of the assets so that a custom fit could be developed for unique scenarios. The application is meant to facilitate quick assembly and ranking so that projects and allocation of funds/resources can proceed more readily.

The solution includes the ability to







↑ Weighting of factors is exposed in a graph widget for user review.

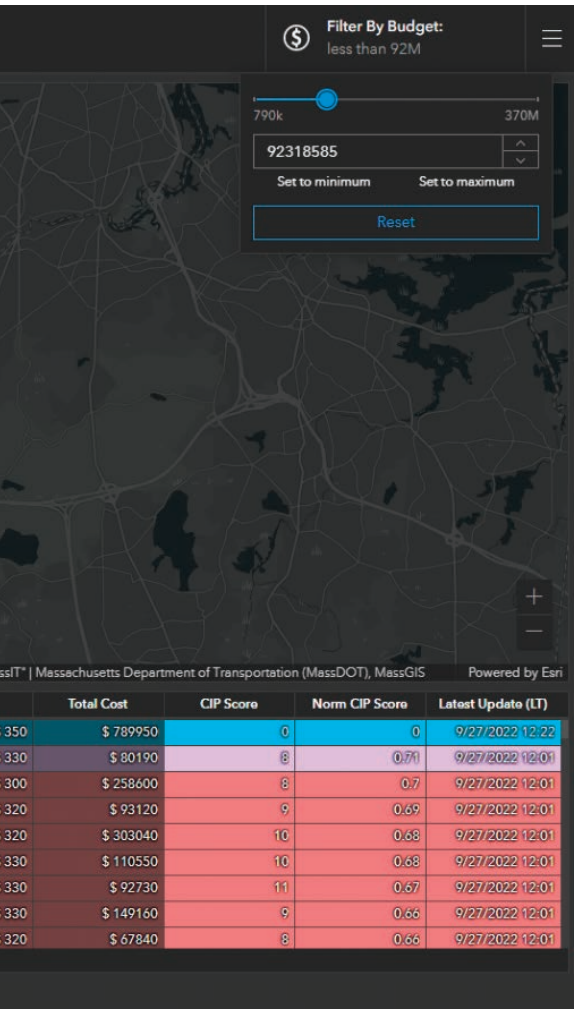
manipulate inputs globally or at the level of individual assets, allowing for tailored cost estimates. For example, a default cost per foot for the replacement of a given diameter of pipe can be assigned, but that cost can be overridden on individual assets if conditions such as additional permitting, difficult excavations, or response to an unanticipated quote or change order exist. In addition, weights (also manipulable at the asset level) can be applied to individual variables that will redistribute priorities based on whichever factors the district chooses to accentuate.

If the system needs to be expanded to accommodate new developments or subdivisions or establish looping scenarios for water quality concerns, users can establish new assets, such as pipes within the application that can be considered in a CIP. The algorithm establishes a separate set of asset pipes for evaluation without managing temporary features in the district's authoritative data.

Each variable affecting scoring is stored with the asset list so that users can see precisely which factors are influencing the score. This ensures transparency in the scoring process. The application allows users to tweak inputs and evaluate different sets of criteria and the effect on their budget and PLA.

A final list of assets is available for download as a Microsoft Excel spreadsheet for fine-tuning, sharing with a wider audience, or comparing different deployment patterns. In this way the tool provides stakeholders a window on the current state of all the district's assets as well as a way of evaluating the effectiveness of a variety of response scenarios. This means the tool is delivering a meaningful and justified place from which to start a discussion on expenditures.

This application provides a list of assets ripe for repair or replacement, but it does more as well. It simultaneously provides



← The Asset Editing Page includes a responsive budget filter.

justification for the consideration of these assets as a capital expense. This allows users to tailor their approach as their unique circumstances dictate. As this solution exists entirely in ArcGIS Online, it integrates directly with all other platform components such as the ArcGIS Field Maps solutions the district already uses, expanding the ROI of the GIS investment.

This project was completed in just under seven months over the spring and summer of 2022. Weston & Sampson is working with the district on full implementation and user training, ensuring that contributing components of the application are ingested as they become available, such as the identification of the paving schedules which are a primary driver for expense.

Savings will be most evident when creating a new CIP and the PLA is already established. This solution attempts to do all the front-end work up to and including the cost definitions on a rolling basis according to an existing, vetted approach, so users can get right to the work of defining projects, saving time and money.

The district is already seeing benefits. It has greater visibility into the spatial distribution of variables impacting its planned budgets. The solution will allow the district to take advantage of the existing static CIP while allowing it to remain purposefully flexible and responsive to developing needs. The next steps for this project will be further integration with the asset management software to include assessment of fire flow readings at hydrants during flushing events. As one of the critical variables impacting assessment, this is a perfect step toward better development of the PLA.

The flexibility of the ArcGIS system means that those inputs can be used directly by the script. The district may elect to expand the solution to manage other assets such as wells, tanks, and booster pump stations. Because these are all inventoried in the district's ArcGIS Online organization, facilitating the integration of those assets is relatively easy.

The Dedham-Westwood Water District is committed to providing its customers with the best service and best water possible. The CIP Viewer and PLA generator is a unique and innovative step toward assembling some of the most influential factors for managing the assets that help deliver on that commitment. Its flexible and convenient architecture opens opportunities to bolt on additional inputs and expand its scope while refining its recommendations. It is a tool that provides managers insight not only into the condition of their assets but also their organization's means to effectively minister to those assets. And because it does this actively, it is never out-of-date with current assessments, giving managers and stakeholders a window on their plan as it evolves.

About the Author

Daniel Shinnick, GISP, is the current GIS team leader at Weston & Sampson, a full-service environmental engineering firm headquartered in Reading, Massachusetts, with 18 offices serving the eastern United States. He has served as the head of GIS technology at Weston & Sampson since 2012 and leads a team of five full-time analysts supporting a GIS user base among 800 engineers. He graduated from Salem State University in 2003 with a bachelor's degree in cartography and GIS. In 2021, he received a master's degree in GIS from Penn State University. Shinnick has served as an adjunct professor at Endicott College in Beverly, Massachusetts, teaching GIS to undergraduate students, and he currently is a part-time teaching assistant at Penn State. He serves as the chairman on his local conservation commission and enjoys learning new things about how technologies work together to solve problems.

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Decades of Innovation by Orange County

At the 2023 Esri User Conference, Orange County, California, was one of a select group of outstanding organizations that gave presentations on their work during the Plenary Session. A user of Esri technology since the 1980s, the county has one of the most innovative local government GIS implementations.

The OC Survey is responsible for managing the county's GIS infrastructure, which makes it a little unusual in local government but has contributed to Orange County's unique success in implementing GIS. In 1991, OC Survey established a countywide GPS control network and passed a digital submission ordinance requiring all new subdivision maps to be submitted digitally and tied to this grid. Through early adoption of GIS, CAD, and GPS, Orange County has become a leader in surveying and mapping. In the 2000s, the county collaborated with the California Spatial Reference Center to create a real-time network.

ArcGIS is the foundation for the management of the county's parcel fabric and imagery, lidar, and digital assets, which are all tied to its accurate survey control and has enabled the creation of a digital twin. GIS has been adopted by nine departments and is used extensively by OC Public Works. The county monitors its capital improvement program using ArcGIS Dashboards. The infrastructure at John Wayne Airport—both indoor and outside—is managed with GIS. The Orange County Registrar of Voters uses GIS to make its management of voting both more efficient and secure and uses ArcGIS Dashboards to share election results. The county's GIS open data portal makes geospatial data and apps available to the public.

↓ Old and new methods for monitoring stockpile temperatures: (left) OC staff members used an analog probe to read and manually record temperatures and (right) a digital sensor attached to a Raspberry Pi unit, which automatically records the temperature and relays it in real-time.

↑ (left to right) Kevin Hills, county surveyor; Cameron Smith, GIS manager; and Marie Aquino, GIS specialist presented their work during the the Esri UC Plenary Session.

According to Orange County surveyor Kevin Hills, these innovative applications of GIS, which provide an exceptional level of services to the county's three million residents, are a product of the county's culture, which encourages its employees to be curious, engaged, and inspired. Orange County continually improves the efficiency of its services through expanding its use of GIS and incorporating some of the newest aspects of the technology.

This innovative approach was applied to the operations of Orange County Waste and Recycling. This OC Public Works agency operates three landfills that are among the largest in California. Together, these sites receive more than four million tons of solid waste annually.

Fires are a real concern for landfill managers. According to fire suppression systems company Fire Rover, at least 390 fires were reported at waste and recycling facilities in the United States and Canada in 2022. Monitoring and regulating waste stockpile temperatures is critical to safely maintaining these landfills and mitigating the risk of internal fires that could quickly spread.

Initially, OC Public Works equipped drones with thermal imaging infrared cameras to detect the surface temperature of stockpiles. When the surface of a stockpile reached a specific heat threshold,

↑ A 3D web scene showing stockpile sensors lets landfill staff retrieve real-time temperature data for each stockpile by clicking on the interactive map. Using ArcGIS Velocity, staff quickly set up the sensors to feed temperature data to maps.

a staff member was dispatched to manually record the internal temperature of the stockpile. This process helped landfill managers mitigate fire risk but lacked real-time awareness and a method for actively monitoring the stockpile's internal temperature.

The county was already pulling live data feeds from its fleet vehicles into GIS to proactively manage them and schedule preventative maintenance. County GIS staff realized that live feeds from sensors could be used to monitor waste stockpiles. To automatically record the internal temperature, sensors inserted into each stockpile were attached to Raspberry Pi units, low-cost, credit-card-size computers. Using ArcGIS Velocity, an add-on software as a service offering for ArcGIS Online, staff members fed sensor output data into a web map that showed real-time temperatures within each stockpile.

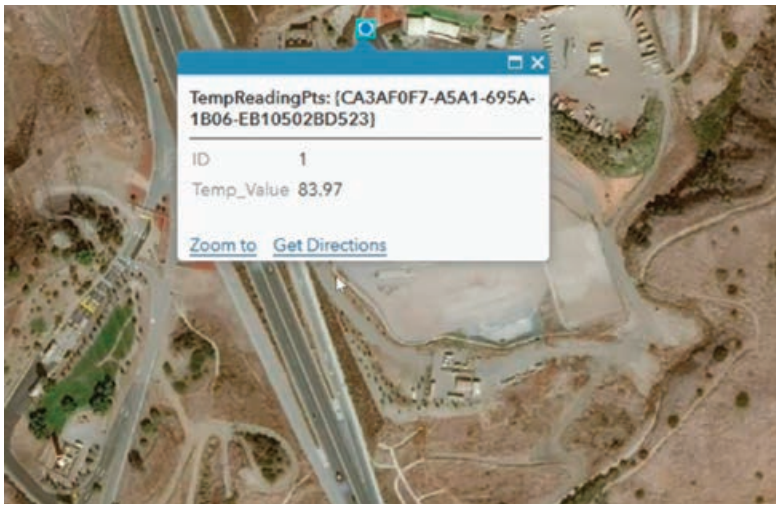
"For about $40 per device, we can deploy several sensors in different locations within a stockpile and collect precise insights 24/7," explained Cameron Smith, GIS manager at OC Public Works. "Outsourcing this to a vendor would've cost the county tens of thousands of dollars yearly."

Staff members can also push alerts to managers and landfill personnel when internal temperatures have passed a certain threshold. Sensors improve worker safety by replacing manual temperature probe readings with automatically recorded and reported data and eliminating potential fire hazards. In addition to real-time awareness of stockpile conditions, a dataset of temperature readings can be accumulated and analyzed to look for trends and patterns. Methane and moisture sensors can also be integrated to improve landfill management.

Although the county was already working with regulators to ensure that landfills operate in full compliance with all federal, state, and local codes and regulations, this technology will keep the community and personnel safer and help save county employee hours and taxpayer dollars. Orange County continues expanding its use of GIS to streamline processes, save money, and improve decision-making.

Watch Orange County's Esri User Conference Plenary Sessions presentation at https://shorturl.at/bqrS2.

↓ Real-time temperature data fed to an interactive map by ArcGIS Velocity can be queried.



How GIS Mitigates the Impact of Vacant Office Space

By Keith Cooke

One of the most damaging and lasting economic impacts of the COVID-19 pandemic has been the increase of unused and vacated office space. This has been almost exclusively driven by the immediate need for remote work, followed by the slow (some would say glacial) pace of return to work in the office.

A *Wall Street Journal* article in January 2023 noted that the number of remote work listings were beginning to rapidly dwindle. Regardless, the slow return to the office has caused economic downturns in areas that have a domino effect for local businesses, further hindering economic development efforts. This phenomenon has been called the doom spiral or urban doom loop.

What Is the Doom Spiral?

If employees aren't in the office, there is less foot traffic around neighboring businesses, such as restaurants, stores, and other service providers. CBRE, considered by many as a global leader in commercial real estate services, conducted a study of this effect and noted a nearly 60 percent reduction in average foot traffic in business districts during the first two years of the pandemic. Less foot traffic leads to lower spending. Think of the lack of lunchtime and after-work visits to nearby restaurants and bars. Lower spending invariably leads to local business closures and downsizing.

This excessive supply of unused and vacant office space puts considerable pressure on the local commercial real estate market. An April 13, 2023, an article in Investopedia states, "Across the US, office vacancy rates averaged 16.9 percent at the end of the first quarter, up from the 12.4 percent average vacancy rate in the first quarter of 2020." The doom spiral takes hold from here.

If the office space is vacant, it leads to declines in the value of commercial real estate. This affects the owners and investors, as well as the banks that are holding the loans for these properties. This can lead to loan defaults, which leads to reduced property tax revenue, which leads to reduction in municipal services and, ultimately, economic stagnation.

How Can Cities Reverse This Trend?

The simple fix for this is for employers to require a return to office work. Currently, that's a slow process, primarily because labor shortages give some people demanding remote work some temporary leverage.

But planners and city leaders must be more proactive and long-range with their strategies. Dealing with vacant office space provides an opportunity to rethink land use in urban areas. In other words, if companies are not going to make full use of allocated space, how can cities promote changes in uses that meet the changing needs of its residents?

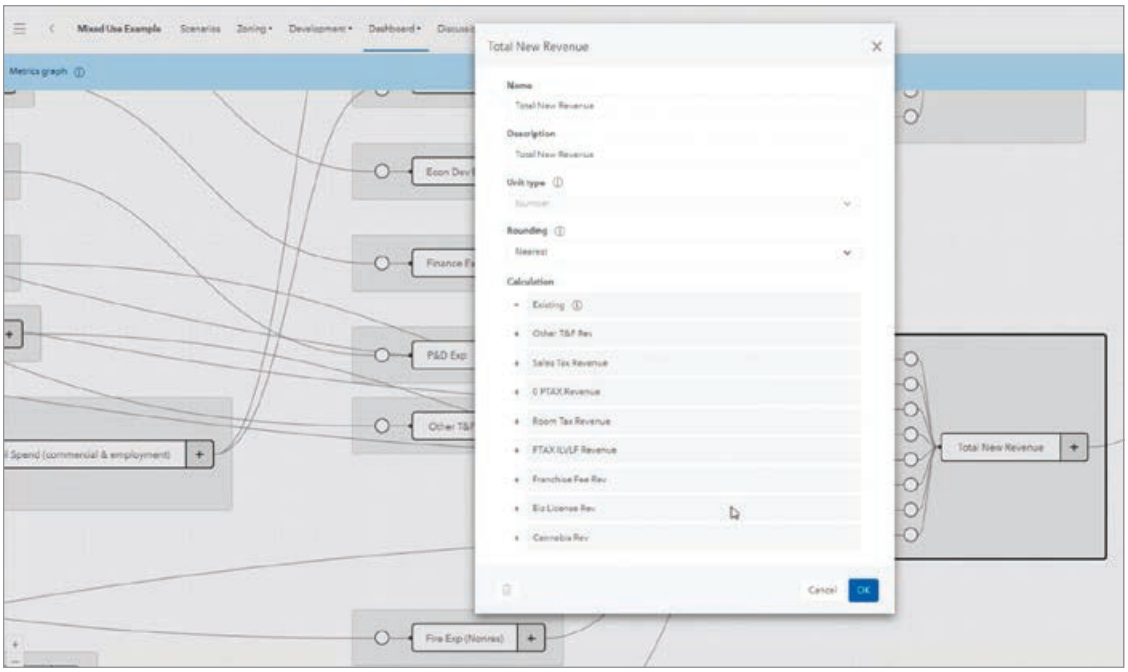
As stated many times in this space, the need for housing has not slowed nationally. Planners can look to vacant offices as space that can be repurposed for affordable housing. Buildings that are currently single purpose for commercial or office use can be rezoned to mixed-use developments. This supports the concepts of economic mobility, whereby residents are within walking distance (or have reasonable transit access) to jobs, services, health care, education, and so forth.

Another option is to redefine the permitted types of commercial or office space that could be used. Instead of traditional office space, using the vacated areas for collaborative (or shared) workspaces or a small business incubator might be viable. If this concept sounds vaguely like a type of zoning reform, that's because it is exactly that. It is altering the zoning ordinance of a city to meet the modern needs of its residents. This kind of effort requires a geographic approach to planning.

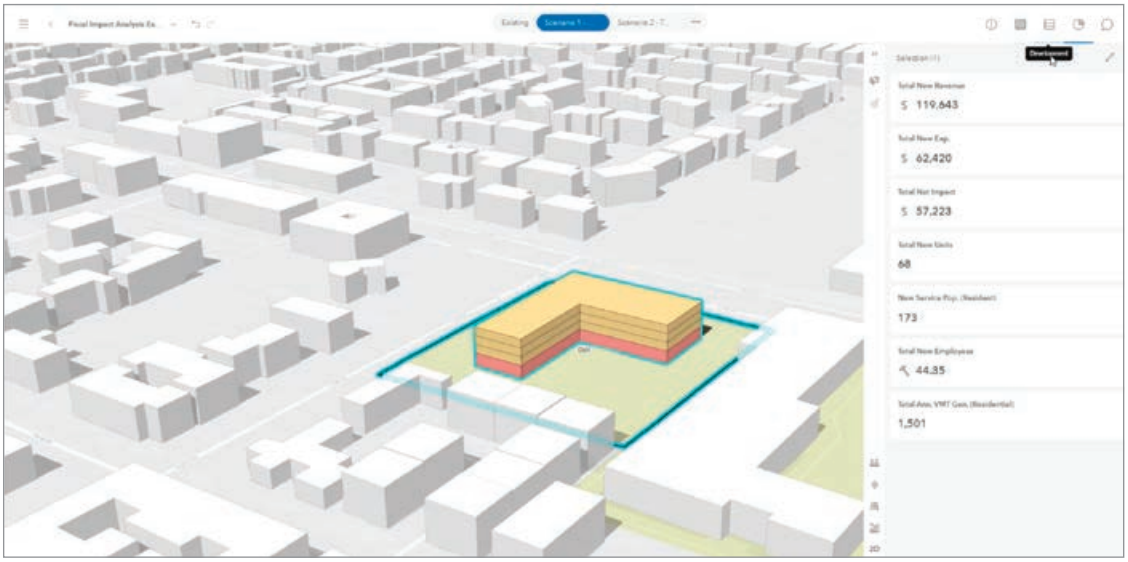
GIS to the Rescue

I've highlighted five facets of the geographic approach to planning. All apply to efforts to reverse the doom spiral of vacated office and commercial space.

1. Understanding neighborhood characteristics—Where are demands for housing? Where is vacant office space and what are the demographics in the area? Would changes to the land use in these spaces address affordable housing and economic mobility issues? ArcGIS Community Analyst can help answer these questions.
2. Deriving business intelligence from permitting—Where are we seeing the most demand for residential growth? What trends and patterns can we see over time that might identify a vacant office building as a viable (or nonviable) choice for repurposing? Where are the more disadvantaged locations that could benefit the most from impactful changes like this? This information can be derived using ArcGIS Insights.
3. Generating sustainable policies—What is a reasonable amount of office/commercial space that we could repurpose for viable uses? Would economic incentives be helpful in attracting a business incubator or a developer to design a mixed-use development in the space? What would be the impact on tax revenue in the area? Policy maps available from ArcGIS Living Atlas of the World help in evaluating the impacts of policies.
4. Supporting civic inclusion—This kind of long-range planning cannot occur successfully in a vacuum. What do local residents think about these potential changes? What opportunities do developers see for this vacant space? ArcGIS Hub can facilitate civic engagement.
5. Empowering scenario planning and design—What would a redesigned building look like if it were changed to higher-density housing? What would be the fiscal impact of ensuring that 10, 20,



← ArcGIS Urban is used to create customized metrics to analyze the impact of a development. In this instance, the model is measuring the tax revenue impact of a repurposed and redesigned building.



← ArcGIS Urban is then used to visualize and analyze changes of the office space to a mixed-use (residential and commercial) space. Note the calculated metrics for the development to the right.

or 30 percent of the housing is designated as affordable? What if the property is changed to mixed use? What are the potential new developments that could occur around this project? ArcGIS Urban enables digital transformation of city and regional planning.

These are all questions that ArcGIS can answer. Location is at the core of all things related to planning. ArcGIS provides the platform for a timely data-driven approach to sustainable economic development, rather than one that is anecdotal. It helps establish buy-in from city leaders, planners, developers, and the public for ways to repurpose unused space to meet the needs of a community.

ArcGIS Urban is used to create customized metrics to analyze the impact of a development. In this example, the model is measuring the tax revenue impact of a repurposed and redesigned building. Then ArcGIS Urban is used to visualize and analyze the changes of the office space to a mixed-use (residential and commercial) space.

The economic doom spiral is a reality for many cities, large and small. But more and more cities are looking to ArcGIS to counter this trend and design sustainable, thriving, and equitable projects and neighborhoods.

About the Author

Keith Cooke is the global industry manager for community development at Esri. A graduate of Auburn University, he has been a GIS professional since 1994 and has worked for planning and community development agencies at the regional and municipal levels in Alabama and North Carolina. Prior to this role, he was an Esri account executive for 15 years who worked with more than 100 local governments.

How to Communicate the Business Value of Your Tech Innovation

By Matthew Lewin

One of the most common questions I get as a technology strategist is, How do we communicate the value of a new solution or promising technology…especially to executives who don't necessarily "get" technology?

The question usually comes from a frustrated manager or salesperson who has tried—and largely failed—to secure a budget for a significant technology investment because the (seemingly) irresistible force of a tech-centered sales pitch met the immovable object of the executive team's results-obsessed mindset.

Selling technology on its capabilities as opposed to its business value are two very different things. The manager's attempts to woo the executive audience with features and functions had undeniably fallen flat. In some cases, executives became downright angry, leading to incredulous responses such as, "You want us to invest how much? For this!?"

While I sympathize with these folks, the fact is they usually have themselves to blame. They're guilty of breaking the golden rule of persuasive communication—speak to your audience's interests. In this case, they failed to address the key question every executive team asks when evaluating a proposal: What is the business value of this technology?

I want to address this issue by looking at a simple and structured way of communicating the business value of technology.

Dual Factors

When an executive team asks what the business value of this technology is, they're really asking, How does this technology benefit their stakeholders, and how does it contribute to their business strategy?

The first question relates to value creation—specifically, stakeholder value and the ability of the technology to generate positive returns for the individuals and groups that have an interest in the organization. This can include financial benefits—delivered primarily to the organization's owners and shareholders—and non-financial benefits impacting anyone who intersects with the organization, including customers, employees, partners, and society as a whole.

The second question is about strategic contribution. This refers to the degree to which a technology strengthens the organization's competitive position. To be clear, this is different from value creation. With strategic contribution, we're focused on where and how an organization uniquely competes. Technologies that provide a competitive advantage or underpin an organization's strategic priorities have a high degree of strategic contribution and are prized by executive teams.

The key is to avoid looking at value creation and strategic contribution in isolation and consider them in combination, as a matched pair. Unfortunately, too many proposals focus on one or the other. They either fixate on the stakeholder benefits and ignore the strategic contribution—leaving executives wondering how it helps their long-term mission—or they focus on specific strategic priorities and fail to mention anything about how stakeholders will benefit.

In some cases, a one-sided approach might work. It depends on your audience. But in my experience, you're better off covering your assets—and the best proposals do just that. Let's look at value creation and strategic contribution in turn. We'll start with the value side.

Value Creation

For convenience, I separate value creation into two groups: financial and nonfinancial. I do this mainly so that nonfinancial value isn't ignored. In practice, questions like, "How much money will we save?" tend to dominate executive sessions, and I want to make sure we consider benefits other than the economic ones.

Financial Value

On the financial side, I look at three value drivers: revenue growth, operational efficiency, and business resiliency—in other words, how money is made, saved, and protected. Your job is to explain how your innovation contributes to these drivers and, if possible, quantify the contribution.

For example, let's say you've developed a way to use non-fungible tokens (NFTs) to automatically mint any corporate communication so that the source of the communication can be instantly verified—virtually eliminating the risk of tampering as well as providing greater confidence in the origin and receipt of any communication. The financial value of such an innovation could be tremendous, but we need to get specific when explaining its value. We need to describe how and where value is created across each economic driver. Here are a few examples:

Revenue—NFTs could reduce customer churn and the revenue lost from customers who are dissatisfied over suspect or lost communications.

Operational efficiency—NFTs could reduce costly follow-up and tracing efforts required in the event of tampering.

Business resiliency—Faster and more verifiable communications tracing enabled by NFTs could protect the company brand (and revenue) in the event of a communications hack.

Breaking it down like this is much better than simply saying it provides financial value. In fact, to make an even stronger case, you should try to quantify the contribution. This takes work and data, but numbers have a significant impact. In some cases, you might be able to get away with a purely qualitative (no numbers) description of financial value, but in my experience, providing even a ballpark estimate makes your case much stronger.

Nonfinancial Value

With nonfinancial value, we're focused on how the technology benefits stakeholders other than the organization's financial beneficiaries. This includes customers, employees, partners, suppliers, communities, and even society as a whole. We want to make it clear how these groups benefit from your proposed tech innovation. Continuing with the NFT example used previously, these are nonfinancial benefits.

Employees—NFTs could increase employee job satisfaction by reducing the number of irate customers calling customer service.

Partners and Suppliers—NFTs could increase confidence in the chain of custody because materials and products are automatically signed and verified as they move across the supply chain

These aren't direct financial benefits (although they could indirectly benefit the bottom line) but they're just as important to highlight. They show how the whole stakeholder ecosystem is affected.

Like financial benefits, quantifying nonfinancial benefits makes an even stronger case. A statement like "20 percent fewer irate customers" is better than simply "fewer irate customers"—so make it measurable. Focusing on the tangible benefits delivered to all stakeholders—not just the owners and shareholders—demonstrates that your innovation has organization-wide value.

Strategic Contribution

If you've sold the executive team on the value of your innovation, you're halfway there. Well done! However, you can't stop here. Value creation is a necessary but often insufficient component of your sales pitch. You need to address the strategic contribution.

Most likely, the executive team is considering many different investment options, and yours is just one of them. And more than likely, all these investments claim to provide some level of value. You need to differentiate your sales pitch from the rest. The best way is to show how it helps the organization from a strategic perspective.

I call this *strategic contribution*, and—similar to value creation—I separate it into two categories: competitive advantage and strategic priorities.

Competitive Advantage

A primary concern of an executive team is how to establish or grow a competitive advantage. This refers to the factors that allow a company to produce its goods or services better or more efficiently than its competitors. And the more sustainable the advantage, the better.

A concept I like for understanding sustainable competitive advantage is economic moats. As described in "Profit Is Less About Good Management than You Think" by José Antonio Marco-Izquierdo in the *Harvard Business Review*, "an economic moat is a structural, durable competitive advantage" that protects market share by creating barriers to competitors.

Moats generally come in two flavors: revenue moats and cost moats. Revenue moats protect the top line and include things like brand perception, switching costs, and network effects. A loyalty program is one example as it creates switching costs for customers considering leaving the program (i.e., you lose your points).

A cost moat creates favorable cost conditions and is associated with things like superior processes, favorable location, and scale. Walmart built a deep cost moat by managing inventories across its network of stores, allowing the company to limit stock in a given store and share management expenses across the network.

Returning to the previous NFT example, let's say you work for a food processing company. Verifying the safe handling of food as it passes from the grower to the processor to the distributor to the end retailer is critical to running a sustainable business. Mishandling could result in lengthy and costly contact tracing and a major hit to the company's reputation. Companies that excel in this regard have a distinct advantage in minimizing the cost of contact tracing and protecting their brand.

Your NFT innovation is promising in both regards. It lowers the cost of tracing efforts since the blockchain that underpins the NFT is automatically and almost instantly traceable. It also speeds up the response time in the event of a contamination, preventing a large outbreak and the ensuing public relations fallout. It could be a significant source of competitive advantage.

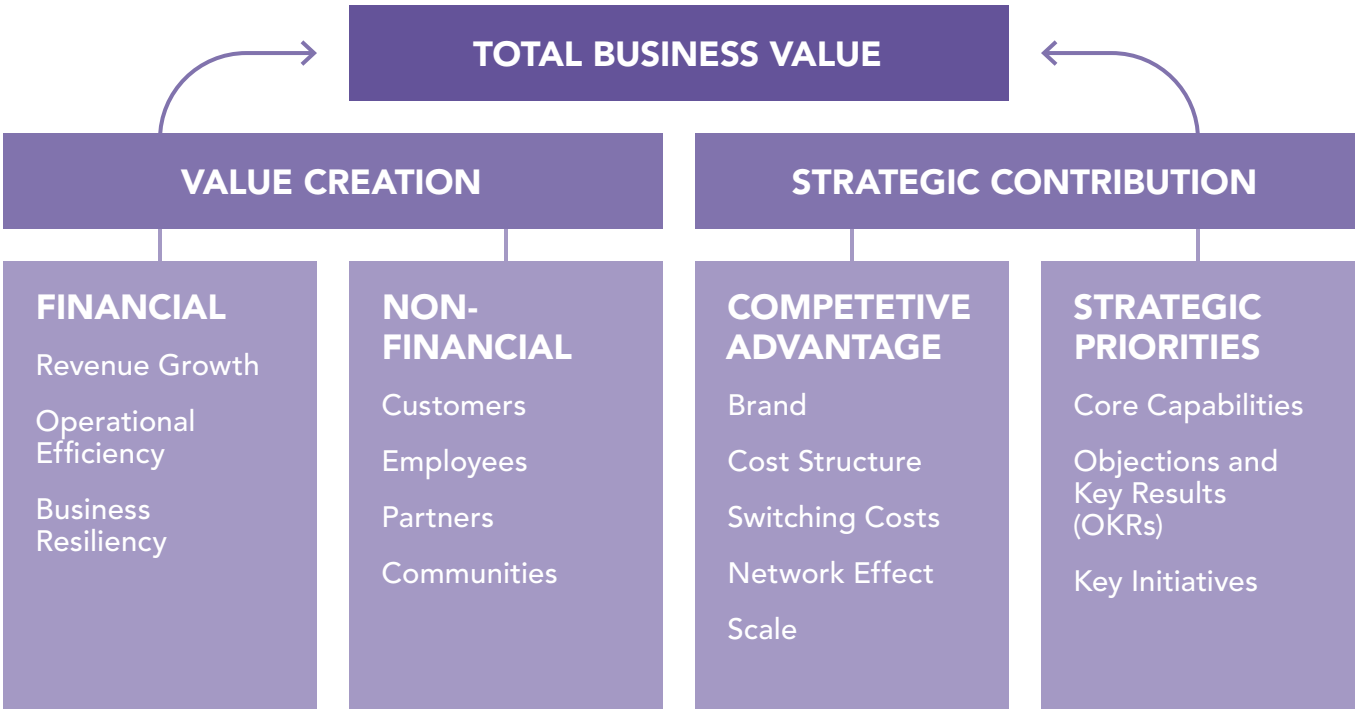
Strategic Priorities

The other side of strategic contribution relates to how the technology supports the business's strategic priorities. With competitive advantage, we were focused on general strategy or how your technology helps build economic moats. With strategic priorities, we're focused on unique aspects of your organization's strategy and business model.

Core capabilities—These are the combinations of people, processes, and technology that support a core function of the business.

Objectives and key results (OKRs)—OKRs summarize the organization's stated goals and desired outcomes.

Key initiatives—These are the high-impact, high-profile projects or programs that are essential to the organization's business strategy.



↑ The total business value of a technology investment depends on the degree to which it creates stakeholder value and contributes to business strategy. (Chart by Matt Lewin)

As before, your job is to articulate how your proposed technology impacts these strategic priorities. In the food processing company example, the organization might have a high-profile public relations initiative to showcase the safe and reliable handling of food across the supply chain. The company might also have a stated objective to achieve industry leadership in food safety. Your NFT innovation has a role to play in both. The key in this section is to make explicit the link between your proposed technology and the organization's stated priorities—priorities that the executive team likely had a direct hand in creating.

Tips and Guidance

The total business value of a technology will largely determine if the leadership team is on board with your idea. Individuals might have their own bias toward value creation or strategic contribution, but your best play is to focus on both sides of the equation.

Do that, and you can comfortably say you've communicated the true business value of your tech innovation. The following are some additional tips and guidance to sell your technology.

If you've successfully communicated the value, the next obvious question is, How much does it cost? You'll need a price at the ready as the focus shifts toward affordability and return on investment (ROI). This is really a discussion about opportunity cost—that is, is this investment more worthwhile than other investments? Assuming the price tag isn't completely out of the question, focus your cost comparison against other investments considered by the leadership team. Highlight the total business value as it relates to the alternatives.

If you've convinced your audience of the business value and the cost, the last question will be about risk. How difficult will this be to implement? How will it impact our people's day-to-day work? Be transparent about the risks and the change impact. Have a risk strategy ready. Identify the major risks or success barriers and describe your mitigation plans. Show that you've anticipated these problems and have a plan to address them should they arise. This can make all the difference in the world in getting your proposal across the finish line.

You can use the total business value approach for a specific solution, but you can also use it for a whole portfolio of solutions or a set of projects. You can even use it to position an entire technology strategy. Value creation and strategic contribution are concepts that are relevant at many scales.

Communicating business value isn't always easy, but it can be easier with a bit of structure. Use the accompanying chart to verify whether your proposal highlights both the value creation capabilities and the strategic contribution of your innovation. If it focuses on just one, think about how to incorporate the other dimension. Everyone wins in the process.

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 businesses through GIS and location-based strategies. As a seasoned consultant, Lewin has provided organizations in the public and private sectors with practical strategies that enable GIS as an enterprise business capability. His interests lie at the intersection of business and technology. He thrives on helping organizations bridge the gap between the two to achieve their most challenging GIS ambitions.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Accessibility and Arcade: Working in Color

By Taylor McNeil

With the November 2022 release of ArcGIS Online, a new ArcGIS Arcade editor was introduced to the platform. This editor provides a variety of improvements to help users author their expressions quickly and efficiently. Since then, Esri has been exploring ways to enhance the experience of users leveraging Arcade in their work. With the June 2023 release of ArcGIS Online, a new accessible color palette for syntax highlighting has been added to the editor in Map Viewer.

Color Vision Deficiency	Description
Deuteranomaly	Difficulty seeing green
Deuteranopia	Unable to perceive green
Protanomaly	Difficulty seeing red
Protanopia	Unable to perceive red
Tritanomaly	Difficulty seeing blue and yellow
Tritanopia	Unable to perceive blue and yellow

↑ Table 1

Color in Code

Using color to provide context is a common practice in design, and syntax highlighting is no exception. Syntax highlighting, otherwise known as code colorization, is a method used to help quickly differentiate elements within a script. It can help authors troubleshoot issues in their script while simultaneously improving code readability.

Color Vision Deficiencies

A color vision deficiency–colloquially referred to as color blindness–is an inability for an individual to distinguish certain shades or colors. The type and severity of color vision deficiency can vary greatly between individuals. Table 1 contains a brief overview of the various types of color vision deficiencies.

Accessibility in ArcGIS Online

Accessibility is the practice of developing and producing content that is usable for all individuals, regardless of their physical or cognitive capabilities. Esri is committed to ensuring its products are accessible, and ArcGIS Online is no exception.

To achieve this objective, Esri leverages the Web Content Accessibility Guidelines (WCAG 2.0) (https://www.w3.org/TR/WCAG20/), an internationally recognized set of standards used for developing accessible web content and software. The new color palette used to highlight syntax in the Arcade editor was designed to be compliant with WCAG 2.0 special criterion 1.4.3. This criterion specifies that the contrast ratio between foreground and background elements must be at least 4.5:1. This ensures that text is still legible for individuals with moderately low vision or other color vision deficiencies.

A Brief History of Color in Arcade

If you've used the Arcade editor before, you'll know that syntax highlighting isn't new. All versions of the editor have leveraged color to varying degrees to differentiate syntax elements. In the initial release of the editor, minimal highlighting was used to signify text and numbers.

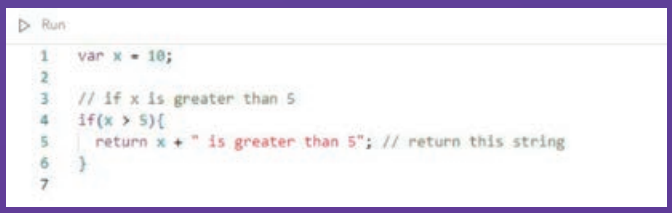
Within the new editor, these colors were expanded to include other syntax elements such as keywords and comments. While this was a huge enhancement from the previous version, there was some overlap in the colors used for different elements and, therefore, room for improvement. The editor's new color palette has been designed to fulfill two objectives:

1. Better differentiate syntax elements within an Arcade expression
2. Ensure the element contrast is compliant with WCAG 2.0 1.4.3 standards, both for individuals with typical color vision and with those with color vision deficiencies.

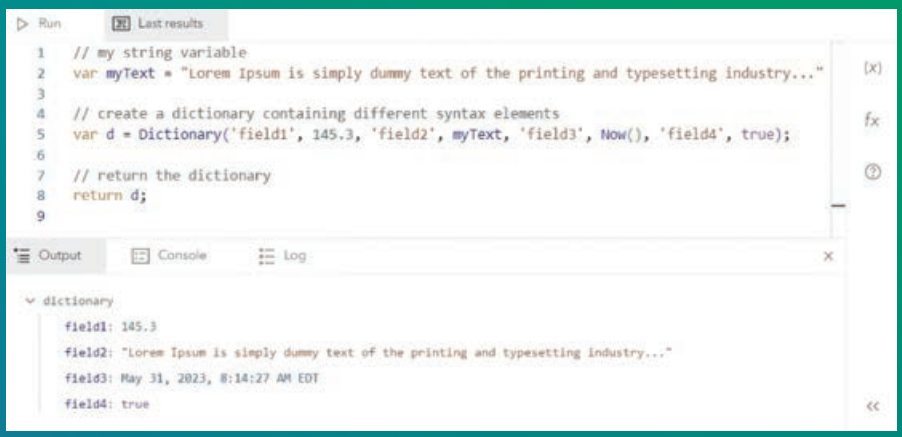
Out with the Old, In with the New (Colors)

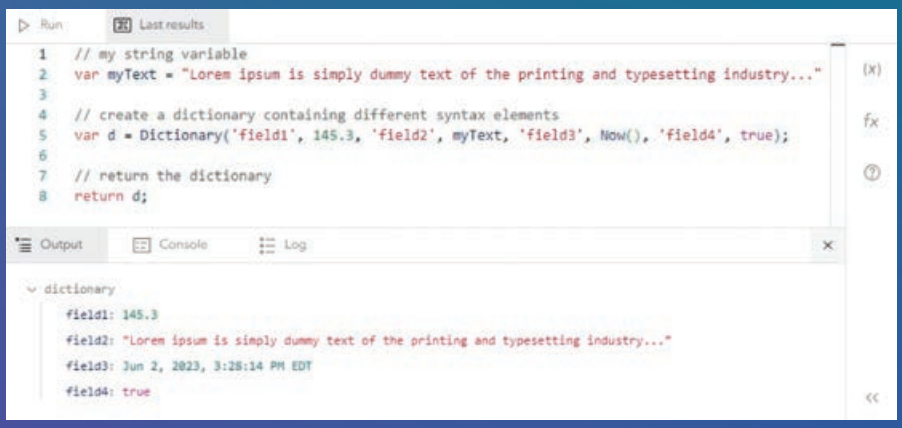
If you've already seen the new syntax colors, you might have noticed there are some similarities between the old and new color palettes. While the hue and saturation of many of the element colors have changed, Esri tried to maintain consistency where possible. For example, text is still red, and numbers are still green.

The new colors and the respective



→ The only syntax highlighting present in the original Arcade editor was applied to text and numbers.





↖ The new syntax highlighting color palette for the Arcade editor in Map Viewer was made available in June 2023.

← The new syntax colors are shown with a deuteranomaly visual emulation applied.

↙ The new syntax colors shown with a tritanomaly visual emulation applied.

↓ Table 2

Element	Color
Comments	Gray
Boolean literals and nulls	Purple
Dates	Light blue
Functions, constants, and variables	Dark blue
Numbers	Green
Text	Red

elements they're assigned to in the editor are listed in Table 2. Right now, you'll be able to see these new colors in use anywhere in Map Viewer that leverages the Arcade editor (e.g., styles, labels, pop-ups, and forms).

Ensuring that color isn't the only way information is conveyed is an important tenet of accessible web design. The color palette we've implemented for highlighting syntax in the editor has been tested to ensure it meets WCAG 2.0 contrast standards for all types of color vision deficiencies.

While syntax color certainly isn't the only method for conveying context in the editor, Esri wants to ensure that the contrast of text is sufficient for all individuals working with Arcade expressions in ArcGIS Online.

Conclusion

If you haven't already had the chance, try out our new syntax colors. Aside from Map Viewer, they're also available in the ArcGIS Arcade playground (developers.arcgis.com/arcade/playground/).

Esri is also hoping to leverage these syntax colors in other areas where Arcade is used in ArcGIS. Finally, a WCAG 2.0 compliant color palette for a dark version of the editor is being developed. For more information on enhancements to the Arcade editor, read these blog posts, "Introducing the new Arcade Editor in ArcGIS Online" (https://tinyurl.com/yt6sz2sh) and "Discover the powerful new features of the Arcade Editor" (https://tinyurl.com/4zrhf72r).

About the Author

Taylor McNeil is a product engineer on Esri's ArcGIS Online team who is based in Ottawa, Ontario. She received a bachelor's degree in biology and a master's degree in applied geomatics. When she's not at work, she can be found taking care of her houseplants, reading copious amounts of fiction, and exploring local thrift stores.

Build Accessible Web Apps

By Kitty Hurley and Jessica McCall

Web accessibility techniques remove the barriers in web apps that can prevent people from fully experiencing content and supports the inclusion of individuals with disabilities.

Creating fully accessible web solutions can be a complex process because the way individuals interact with the web can vary greatly. However, the Web Content Accessibility Guidelines (WCAG) (https://rebrand.ly/9xb6c1w) is a guide for improving accessibility on the web. WCAG is an internationally recognized coding standard that was developed to meet the varying needs of individuals, organizations, and government agencies when implementing web accessibility. Its success criterion provides standards for developers of web and mobile content when publishing web content or apps.

Building Accessibility into Web Maps

The accessible components in ArcGIS Maps SDK for JavaScript (JavaScript Maps SDK) and Calcite Design System demonstrate Esri's commitment to accessibility. These components provide the building blocks to design an accessible UI. This article includes some ways accessible and inclusive apps can be built with JavaScript Maps SDK and Calcite.

Improve Color Contrast

Color contrast is key for individuals who have low vision, macular degeneration due to age, color vision deficiency (color blindness), or other vision-related impairments.

Being aware of the contrast of colors or specific combinations of colors is a key aspect when creating an accessible web app. WCAG Success Criterion 1.4.3: Contrast (Minimum) aims for a 4.5 to 1 ratio when visually presenting text and images.

Color contrast can be enhanced with Calcite's web components to support WCAG Success Criterion 1.4.3: Contrast (Minimum), or level AA. *[WCAG has three levels of conformance: A is minimum, AA is midrange and widely accessible, and AAA is the most optimal accessibility rating.]* You can also add support for WCAG Success Criterion 1.4.6: Contrast (Enhanced), or level AAA, by updating the CSS variable of calcite-ui-danger. It provides a contrast ratio greater than 7 to 1, when the background color is white or #FFF.

Using High-Contrast Mode

High-contrast modes increase the contrast of elements, making it easier to read text and distinguish individual elements. When these modes are enabled for an operating system (OS), colors are forced, visual elements are simplified, and browser-specific values are selected from a set of system colors that ensures consistent contrast. High-contrast mode supports individuals who have low vision or who are unable to distinguish shapes or details in objects.

Add Contrast to Maps

There are several ways you can improve the contrast of maps to showcase solutions to a wider audience while supporting the success criterion. One method is to toggle between high-contrast basemaps. Switch between high-contrast light and dark basemaps using the BasemapToggle widget. To do this, add high-contrast basemaps as objects, as shown in Listing 1.

Next, set the map's basemap property to the light basemap, as shown in Listing 2. Then add the BasemapToggle widget with the nextBasemap set to the dark basemap, as shown in Listing 3.

You can also toggle the JavaScript Maps SDK theme for additional contrast on the controls. For instance, when the high-contrast

```
const highContrastLightBasemap = new Basemap({
  portalItem: {
    id: "084291b0ecad4588b8c8853898d72445"
  },
  title: "High contrast light theme",
  id: "high-contrast-light"
});

const highContrastDarkBasemap = new Basemap({
  portalItem: {
    id: "3e23478909194c54992eaaee78b5f754"
  },
  title: "High contrast dark theme",
  id: "high-contrast-dark"
});
```

↑ Listing 1

```
const map = new Map({
  basemap: highContrastLightBasemap
});
```

↑ Listing 2

```
const baseToggleWidget = new BasemapToggle({
  view: view,
  nextBasemap: highContrastDarkBasemap,
  container: baseToggleDiv
});
```

↑ Listing 3

```
const baseToggleDiv = document.getElementById("baseToggleDiv");

baseToggleDiv.addEventListener("click", () => {
  const lightTheme = document.getElementById("darkTheme");
  const darkTheme = document.getElementById("lightTheme");
  lightTheme.toggleAttribute("disabled");
  darkTheme.toggleAttribute("disabled");
});
```

↑ Listing 4

light basemap is active, the JavaScript Maps SDK theme is dark, as shown in Listing 4.

Customize Graphics by Basemap Theme

To style graphics added to the map with an appropriate color contrast ratio for the basemap, first obtain the basemap background color using getBasemapBackground and getBasemapColor and use that value.

Use reactiveUtils to watch when the basemap's background theme color changes from light to dark, or vice versa. An AbortController signal can be used to communicate, or abort a request in the document object model (DOM) when the view is no longer updating. Once the view has finished updating, use getBackgroundColorTheme to update the graphic's symbol color, based on the light or dark value. See Listing 5.

Navigating through Content

Focus attributes are important to accessibility because they help show people where they are on the screen and provide context for navigating through the screen as well as supporting better keyboard navigation. Setting focus attributes to underline, highlight, or place a shape around an active element ensures users can navigate sequentially through content when using a keyboard to meet WCAG Success Criterion 2.4.3: Focus Order. When using the open method for a pop-up, employ the shouldFocus option to shift focus to the pop-up when it is opened, as shown in Listing 6.

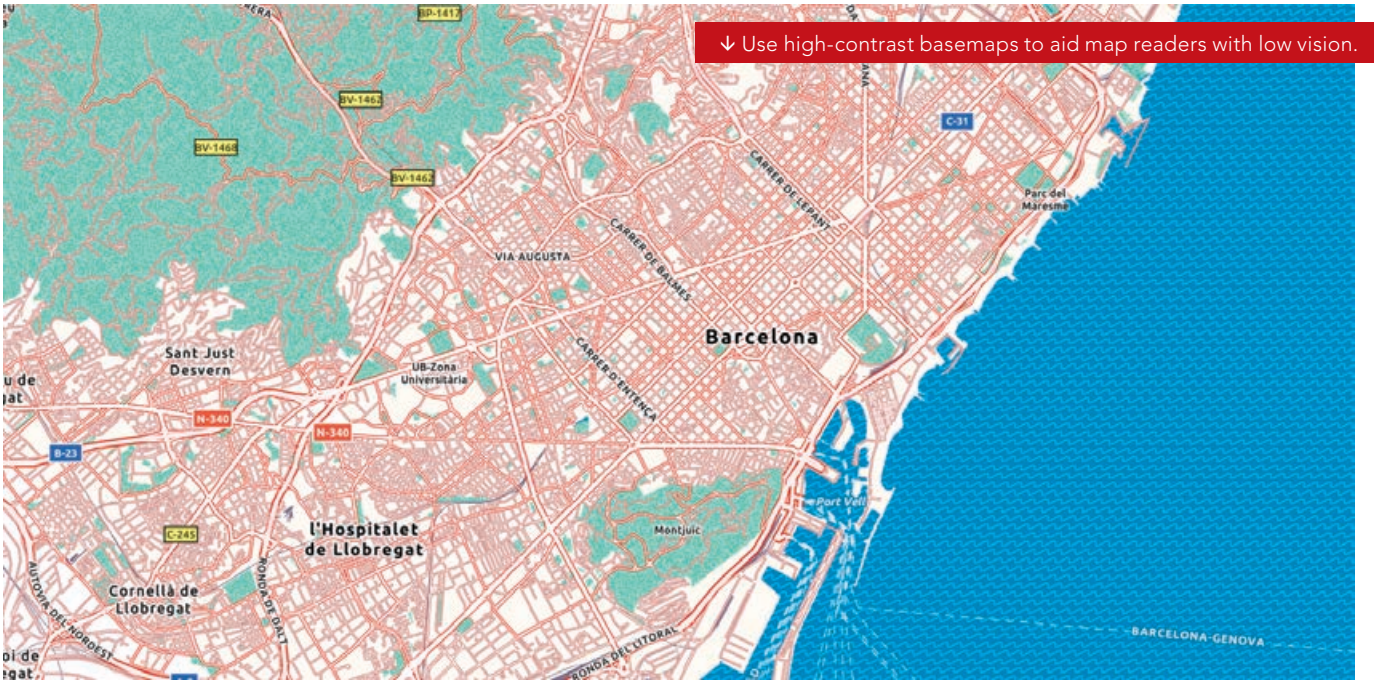
Search Widget Focus

Shift focus between the search widget and the search results pop-up with reactiveUtils. Upon closing the results pop-up, focus will shift back to the search widget so users can navigate sequentially while searching the map's content.

When the pop-up is visible, set focus to the pop-up from the search widget using the search-complete event. First, create a promise with the reactiveUtils whenOnce() method and an AbortController signal when the pop-up is visible. Once visible, shift focus to the pop-up. A second promise waits for the pop-up to no longer be visible so that the focus will be set back to the search widget, as shown in Listing 6.

Animations

People who suffer from disorders of the vestibular system (which affects balance) or who have suffered traumatic brain injury can experience headaches, nausea, seizures, or other symptoms that are triggered by animations. Those users may consider choosing OS and browser settings to reduce animations and other interactive elements. WCAG Success Criterion 2.3.3: Animation from



↓ Use high-contrast basemaps to aid map readers with low vision.

```
const basemapHandle = reactiveUtils.watch(
  () => view.map.basemap,
  () => onBasemapChange(),
  { initial: true }
);

// Remove watch handle when view is destroyed
view.addHandles(basemapHandle);

async function onBasemapChange() {
  abortController?.abort();
  const { signal } = (abortController = new AbortController());

  await reactiveUtils.whenOnce(() => !view.updating, signal);

  // getBackgroundColor is also available
  const backgroundTheme = await colorUtils.getBackgroundColorTheme(view);
  const color = backgroundTheme === "light" ? lightColor : darkColor;

  locate.graphic.symbol.color = color;
  if (hasLocation) {
    // We already have a graphic. Let's recreate
    view.graphics.removeAll();
    locate.locate();
  }
}
```

↑ Listing 5

```
search.on("search-complete", () => onSearchComplete());

let abortController = null;

async function onSearchComplete() {
  abortController?.abort();
  const { signal } = (abortController = new AbortController());

  // When the popup is visible set focus on it.
  await reactiveUtils.whenOnce(() => view.popup.visible, signal);
  view.popup.focus();

  // And when the popup is closed move the focus back to the search widget.
  await reactiveUtils.whenOnce(() => !view.popup.visible, signal);
  search.focus();
}
```

↑ Listing 6

Interaction recommends allowing users to disable interactions unless animation is essential for conveying information.

Calcite minimizes animation when system animations are turned off or reduced. When animations are enabled, animations are executed in Calcite's loader component.

With JavaScript Maps SDK, animation on the map can be reduced when animations are not shown or reduced with prefers-reduced-motion. When animations are enabled, some of the map's functions—such as zooming to a feature—include basemap tile animations. When animations are turned off or reduced, a function can be added to reduce map animations. Add the goToOverride function to the pop-up's goTo method, as shown in Listing 7.

Explore Further

This article summarizes Building Accessible Web Apps with ArcGIS Maps SDK for JavaScript and Calcite Design System, a session presented at the 2023 Esri Developer Summit in Palm Springs, California.

The code and full demonstrations are available on GitHub (https://github.com/kellyhutchins/DevSummit2023-A11y). Subscribe to the Accessibility Community (community.esri.com/t5/accessibility/ct-p/accessibility) on Esri Community.

Some Final Thoughts

Esri supports the successful implementation of accessible mapping apps. Accessibility should not be an afterthought. It is more efficient for developers and designers to include accessibility rather than reworking published apps. Accessibility should be a part of the development process throughout the app design and development workflow so that anyone can access web maps.

About the Authors

Kitty Hurley is passionate about web map accessibility and bringing the web and maps to wider audiences. She is a senior product engineer with Calcite Design System at Esri. Outside work, Hurley enjoys exploring Minnesota's wilderness and wants to visit every major league baseball stadium in America.

Jessica McCall, the senior accessibility project manager for the Esri accessibility team, manages strategic planning and project management activities. Along with members of her team, she gathers and supports customer requirements for accessibility. Prior to joining Esri, she worked for a consulting firm as a project and operations manager supporting utility data migration and data integration projects between GIS and CAD-based software.

```
view.popup.goToOverride = goToOverride;

function goToOverride (view, goToParams) {
  const mediaQuery = window.matchMedia("(prefers-reduced-motion: reduce)");
  if (mediaQuery.matches) {
    goToParams.options = {
      ...goToParams.options,
      ...{
        animate: false,
      },
    };
  }
  return view.goTo(goToParams.target, goToParams.options);
}
```

↑ Listing 7

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TAKING RESPONSIBILITY FOR OUR FUTURE

Esri president Jack Dangermond greeted the audience for the Plenary Session of the 2023 Esri User Conference (Esri UC) with, "You're just an amazing group of people." The conference was held July 10–14 in San Diego, California.

> "Creating the world that you want to see, I think, is going to require GIS, this geographic approach."

Esri UC started 43 years ago as a meeting of just 11 of Esri software users. The reason for that first meeting and all subsequent ones has been the same: for users and Esri staff to get to know each other better. In the intervening years, the event has grown enormously. In 2023, Esri UC had more than 18,000 in-person and 10,000 virtual attendees from 130 countries. Over more than four decades, the conference has provided an opportunity for Esri's users and staff to share, learn, celebrate, and grow closer as a community.

In his opening address, Dangermond highlighted a select group of maps from the thousands that were submitted by users for this year's conference. Reviewing these submissions led Dangermond to conclude, "You are working on just about every issue we are facing."

After this overview of the challenges that users are addressing with GIS, Dangermond moved on to this year's conference theme, GIS—Creating the World You Want to See. He asked the audience to think of a few words or phrases that would describe the kind of world they wanted to see. Following a few minutes of silence, he shared phrases that captured his vision for the future: healthy, prosperous, equitable, peaceful, secure, sustainable, and in balance with nature.

He noted that achievements in science, technology, and culture have led to the overwhelming success of humans as a species and the exponential growth of the human population, which is threatening the viability of the planet.

"It's my sense we are living a little recklessly…we're living beyond our means," said Dangermond. "This just simply isn't sustainable." However, despite imminent threats to our future, he believes humans still have a choice and they can and will create a sustainable future.

"We're going to have to take collective responsibility for imagining and designing and creating solutions and implementing them everywhere. We need to move quickly. There's no time for fooling around," he cautioned. Dangermond believes that GIS professionals "have and will have an enormous role to play in creating the future of our planet. You and your work are essential for creating a sustainable future."

This is because sustainability starts with geography. The geographic approach is the key to holistically solving problems and is the foundation for positive action. GIS, the technology for implementing the geographic approach, is advancing

rapidly. It is making information pervasively available and expanding the capability for action. The work of organizations using GIS is becoming interconnected into a geospatial infrastructure of distributed servers—a system of systems.

Dangermond supplied a few examples of organizations that are employing this approach to tackle ambitious programs. The United Nations is using a system of systems approach for managing the information needed to realize its Sustainable Development Goals (SDGs), which seek to protect the planet and improve the lives of its people. The US Geological Survey adopted this approach for conservation planning to achieve 30x30, the conservation goal of protecting 30 percent of the planet's land and water by 2030. The International Geodesign Consortium relies on GIS for creating a global plan that is based on sustainability goals. GIS underpins the efforts of each of these organizations and is providing the tools to create a better future.

After acknowledging how the GIS profession is expanding and becoming more impactful, he observed, "Yet it's still not enough. The challenges that I described are really a big bunch of challenges. On the other hand, I think you're up to it."

That deep belief in the ability and commitment of the GIS community is Dangermond's thesis for this conference. GIS professionals will have an important role to play in creating a sustainable world.

"Creating the world that you want to see, I think, is going to require GIS, this geographic approach. And most importantly, it's going to require you going all in, doing the work, mobilizing, understanding, calling forth the best of you. This is going to be very important."

"You and your work are essential for creating a sustainable future."

→ Esri president Jack Dangermond challenged GIS professionals to commit to creating a sustainable world.

THE NEW BLUE ECONOMY & PREDICTABILITY

In his keynote address to the 2023 Esri User Conference, Dr. Richard W. Spinrad introduced event attendees to the New Blue Economy.

Spinrad, Under Secretary of Commerce for Oceans and Atmosphere and National Oceanic and Atmospheric Administration (NOAA) administrator, described the New Blue Economy, which is based on knowledge rather than the extraction of materials from the ocean. This approach emphasizes the transformation of NOAA's massive data stores into information that addresses the world's environmental and economic challenges.

"The New Blue Economy is the concept of taking data and translating it into usable decision support. The New Blue Economy—what Jack *[Dangermond]* calls Ocean GIS—is the future that is both environmentally sustainable and supportive of economic development," said Spinrad.

He described data collection as the "heart and soul" of this new paradigm. The massive volume of data NOAA collects is the foundation of the New Blue Economy. Plentiful, current, and diverse data is required to build reliable information products that support policy, operational, and designation decisions and clarify uncertainty.

"The reason we can build this Blue Economy is because not only do we have so much more data…but we also have this diversity of data and this explosion of ways in which we are collecting data," said Spinrad. This is giving NOAA "an opportunity to build a whole new world around predictability."

↓ Keynote speaker Dr. Richard W. Spinrad appealed to the GIS community to build out the New Blue Economy, which is "what we need to create the oceans we want for the world we want."

In addition to the collection of physical data, such as water temperature, salinity, and depth, captured from research vessels and sensors, NOAA has new and expanded data acquisition methods. Much larger amounts of satellite data are now acquired and used. In recent years, the rise of commercially available geospatial data has opened up new opportunities for NOAA to purchase an array of datasets. NOAA is also collecting an extraordinary new kind of data: environmental DNA (eDNA), which is DNA that is collected from samples of soil, snow, air, or—in this case—seawater that provide a record of the interaction of organisms with their environment. Satellites are also providing a new type of data by using GPS reflectance to characterize the surface of the ocean and determine such things as the height of waves and the size of tides.

As Spinrad noted, "We've got this

incredible ability to collect varieties of data, volumes of data, and do amazing things with it."

But while it had greatly expanded its data sources, NOAA realized that it needed to collect data a little differently. Spinrad characterized this shift by saying, "You need global data to answer local problems." He explained that this required taking seemingly unrelated types of data and combining them to understand complex systems. "That sounds like GIS to me."

At that point in his address, Spinrad introduced Dr. Mimi Diorio, a geoscientist at NOAA National Marine Protected Areas Center. Diorio demonstrated how ArcGIS Pro and its machine learning capabilities can model NOAA data to analyze how climate change is modifying ocean conditions and predict how these conditions will modify snow crab ranges in the future. Spatial models can guide future species management and enhance the security of both food and jobs.

"It's data-driven decision-making that puts the 'new' in the New Blue Economy," said Diorio. "GIS gives us the tools to translate and transform our data and make it matter."

She provided additional examples that showed how the 20 terabytes of data NOAA captures every day can be put to work. She noted how the data from 19,000 Argo buoys has "transformed our understanding of the ocean, particularly in the deeper areas. Data from buoys, satellites, and other sensors combine to create an integrated observational system that drives complex global models." For example, the output of NOAA models can predict when and where harmful algal blooms will occur.

ArcGIS visualization capabilities help meet one of the biggest challenges of the ocean: it's three-dimensional. Tools in ArcGIS Pro, such as voxels, help better visualize 3D data and understand how a variable like nitrate changes its concentration depending on water depth.

The NOAA GeoPlatform, which provides geospatial data, maps, and analytics using ArcGIS Online, contains 100,000 unique datasets. The agency is working to provide these datasets as web services in ArcGIS Living Atlas of the World. Diorio called these resources "the foundation of environmental intelligence."

But more than data is required, according to Diorio, who appealed to the audience at the conclusion of her portion of the presentation. "All this rich data only gets us so far. We need you, the global GIS community, to work your magic, apply your local knowledge, your passion, your perspective, your talent, and your expertise. Help us transform this data into action."

As he picked up the theme of the critical role of GIS in the Blue Economy, Spinrad outlined the diverse factors that must be considered when siting offshore wind turbines in a way that won't adversely affect highly endangered marine species, such as the North Atlantic right whale. He noted that diverse data must be considered holistically to answer questions such as, "How do we ensure that while building out this renewable energy source we are also preserving the right whale? How are we going to know that the wind will be there in 30 years?" The New Blue Economy is all about prediction and understanding the environment in a way that builds a body of environmental intelligence to inform decisions.

Commercial interests must be balanced with conservation concerns to achieve the goal of preserving 30 percent of the planet's water as well as its land by 2030, Spinrad emphasized. The New Blue Economy enables decision-making that supports marine conservation. NOAA is using GIS to evaluate the uniqueness of areas and incorporate indigenous knowledge in its process of locating six national marine sanctuaries.

The development of prediction systems for the New Blue Economy relies not only on data, models, and information products, but also on people and partnerships. This work requires transdisciplinary people who work cooperatively. Spinrad said he believed that Esri was able to stand up the Climate Mapping for Resilience and Adaptation (CMRA) portal so rapidly because NOAA and Esri had a 35-year working relationship.

Echoing Diorio's earlier appeal to the GIS community, Spinrad made a similar appeal to GIS experts, entrepreneurs, and data wizards to build out the New Blue Economy, which is "what we need to create the oceans we want for the world we want." He concluded with a quote from oceanographer and ocean defender Sylvia Earle: "It's now time to go make waves."

↓ NOAA geoscientist Dr. Mimi Diorio demonstrated how ArcGIS Pro and its machine learning capabilities can model NOAA data to analyze how climate change is modifying ocean conditions.

USING GIS TO CREATE THE WORLD WE WANT TO SEE

The Esri User Conference (Esri UC) has always been all about the work of organizations that use GIS to improve the world, whether it is providing residents with better government services, more effectively responding to disasters, or preserving the environment.

Celebrating and sharing the outstanding work of users was a central part of the Plenary Session held on July 10 at the 2023 conference. Presentations of special awards were made to those organizations receiving the Making a Difference Award, the Enterprise GIS Award, and the President's Award.

This year, there were two recipients of the two Making a Difference Awards, and both helped people see the world more clearly and completely. The Netherlands' Cadastre, Land Registry and Mapping Agency—known as Kadaster—was honored for its work producing tactile maps that let people with impaired vision gain a greater understanding of the world around them. Kadaster was aided in this work by Esri Nederland, local accessibility organizations, and academics from around the world.

The second Making a Difference Award was presented to Dr. Paulette Brown-Hinds, founder of Voice Media Ventures and Mapping Black California, for her leadership in advancing the use of mapping, visualization, and spatial analysis to work collaboratively to address systemic inequities affecting Black communities in California. She leads the Mapping Black California project, and her team developed the Racism as Public Health Crisis dashboard.

↓ An enterprise implementation of GIS has transformed the way PG&E works and makes sure "everyone and everything is always safe."

Pacific Gas and Electric Company (PG&E) was recognized with the Enterprise GIS Award for its transformational implementation of GIS across one of the largest combined natural gas and electric energy companies in the United States. PG&E has an ongoing commitment to evolving its GIS to meet both business and customer needs and ensure the safety of its operations.

The NYPD—Information Technology Bureau (NYPD-ITB) received the President's Award for implementing an enterprise GIS that has digitally transformed its operations and streamlined and modernized its workflows to better serve the city's 7.9 million residents and 50 million annual visitors. NYPD-ITB's GIS includes systems of engagement and insight as well as systems of record and analysis.

Organizations whose outstanding work was recognized this year with a Special Achievement in GIS (SAG) Award were acknowledged during the Plenary Session. At a separate ceremony during Esri UC, 230 organizations from around

the world—representing just 1/120 of a percent of Esri users—received this award. See https://shorturl.at/coDZ4 to learn more about these organizations.

Following the awards ceremony, the exemplary work of special guest organizations was shared in a series of presentations. Summaries of these presentations are listed below.

3D Mapping Builds Resilience and Engagement

The GIS team for the City of Cambridge, Massachusetts, has been a leader in using 3D GIS for more than a decade to manage this densely populated, heavily built-out city. Cambridge GIS manager Jeff Amero; Cambridge GIS web technology specialist Katie Grillo; and William (Bill) P. Witts Jr., manager, facility information systems at the Massachusetts Institute of Technology (MIT), shared their work, which leverages reality mapping, digital submissions, and advanced spatial analytics. The city uses GIS tools to build engagement with the community and manage the city's urban forest of 30,000 trees as part of its climate resiliency efforts. The city has collaborated with Harvard University and MIT to build the city's 3D system of record and use it for spatial analysis. Buildings cover about 28 percent of Cambridge, so the GIS team uses 3D to analyze roof types and locations to find the optimum buildings to convert to cool roofs. MIT uses 3D modeling of the area surrounding the campus to provide context for its campus projects.

Intelligently Building the EV Charging Infrastructure

Brandy Mathie, director of site acquisition and portfolio management, and Julie Wagner, location strategy manager, described the holistic approach Electrify America uses to build out its network of ultrafast electric vehicle (EV) chargers. GIS plays a significant role in the selection of sites for the company's more than 3,500 EV chargers, which are backed by 100 percent renewable energy. Electrify America is spending $2 billion to build its EV charging infrastructure and educate people so they can confidently adopt an EV lifestyle, which will actively contribute to carbon emissions reduction. With the largest open, ultrafast charging network in the United States, Electrify America considers economic, social, and environmental factors to find the best location for its charging stations. Site Selection Explorer, an application the company uses to site chargers, runs what-if scenarios that identify alternative locations in an area based on strategic, financial, and real estate factors and supports collaboration with power providers.

Shaping Cities and Minds with Urban Design

Creating resilient cities requires learning from the past and adapting to the future. Bruno Moser, the head of urban design at the global multidisciplinary design and architecture studio Foster + Partners (F+P), described how the firm is using GIS to design an entirely new 24-square-mile city in Kuwait. South Sabah Al-Ahmad will have 280,000 residents, feature an extensive open space network, and have a multilayered public transport system that promotes sustainability.

"At Foster's, we build geography right into our design process. We need to understand the patterns and relationships, the forces that shape our cities, so that we can take informed decisions when we design new projects," said Moser. Mateo Neira, an associate data scientist at F+P, demonstrated how ArcGIS CityEngine was used to optimize street network connectivity, reduce the total amount of road space by 10 percent, and provide more public space for residents. This design helps create a more livable and sustainable city that considers the region's climate and responds to the unique challenges of the site. This design was exported and enhanced with the Unreal Engine tool to produce an immersive, photorealistic, and animated model of the city.

Proactive Threat Management

With more than 120,000 employees, in more than 350 facilities, located in more than 40 countries, Lockheed Martin has a pressing "duty of care," according to Amanda Haas, the company's security systems senior manager. To meet this responsibility, the American aerospace, arms, defense, information security, and technology corporation developed its Global Emergency Operations Center (GEOC) as a 24/7/365 solution to monitor threats.

↑ Lockheed Martin uses GIS to proactively ensure the safety of its 120,000 employees worldwide.

Hundreds of thousands of events each year can threaten Lockheed Martin's employees and assets.

Using ArcGIS, watch officers monitor global incidents, detect threats, analyze the impacts of incidents and threats, and prioritize immediate action if required. GEOC lets Lockheed Martin ensure the safety and security of its employees anywhere, anytime. Wellness checks are quickly conducted on employees who may be affected, even outside of work hours. GEOC lets the company stay ahead of these events and ensure the safety of its employees.

The Explorer Mindset and the Geographic Approach

Using the geographic approach is central to driving a change in the world, according to Dr. Deborah R. Grayson, chief education officer at the National Geographic Society. That is why the National Geographic Society and Esri developed the next iteration of National Geographic MapMaker to promote geographic inquiry, exploration,

and storytelling. National Geographic Society collaborates with Esri on several educational initiatives that inspire learners to think like an explorer so they can advance real-world change.

Transforming and Expanding Operations Safely

The evolution of geospatial, mission-critical enterprise systems has transformed how PG&E operates and helps meet its commitment that "everyone and everything is always safe." PG&E, one of the oldest and largest utilities in the United States, provides electric and gas service to 16 million people across 70,000 square miles in California.

Since completing the transition from paper-based processes to fully digital spatial-based workflows about a decade ago, PG&E has continued modernizing its systems, workflows, and data processes by taking advantage of the company's foundational GIS investments and deploying an enterprise GIS. The company uses GIS for mobile applications, visualizations, analytics, and sharing tools that have improved safety, situational awareness, data integrity, access to information, and staff productivity and collaboration.

PG&E developed an innovative system of record. This remote sensing data platform provides access to more than 50 million images, point clouds, and videos that can now be viewed in 3D locational context. This has allowed PG&E to increase the efficiency of substation inspections by 150 percent using its Substation Inspection tool.

Automated and accurate field data collection in ArcGIS Field Maps helps the gas operations team collect multiple features in a single process and plays a critical role in responding to real-time events.

PG&E's Hazard Awareness and Warning Center (HAWC) web application provides situational awareness by pulling together real-time feeds from weather, live cameras, current outages, and PG&E truck locations to respond to critical events. PG&E keeps partner agencies informed of power shutoffs through the Public Safety Power Shutoff (PSPS) portal and the public-facing Outage Center that provides outage information to customers.

"We are very proud of our work on behalf of the GIS department and everyone at PG&E; we'll continue to maintain our stand: Everyone and everything is always safe," said Hamilton Erridge, PG&E principal remote sensing data platform program manager.

New Medical Facility Built with a Sustainable Future in Mind

PCL Construction is pushing the boundaries of traditional construction approaches, elevating efficiency, precision, and accuracy of construction as it works with Providence Health to design and build a new C$1.7 billion, state-of-the-art, two-million square foot medical facility in Vancouver, British Columbia, Canada. PCL uses GIS to deliver this project on time and on budget. Providence Health's goal is to build a sustainable, 100-year facility. The construction of the new St. Paul's Hospital uses drones as part of its site mapping and GIS to coordinate construction activities and make data-driven decisions. Forward-thinking requirements and processes for the digital handoff of project design, construction, and commissioning information allow PCL Construction and Providence Health to incorporate requirements for indoor GIS before the floors are built and provide the foundation for a digital twin by including digital project handover requirements at the outset of the project.

Responding to Crises Around the World

The Conflict Observatory, created by the US Department of State Bureau of Conflict and Stabilization Operations (CSO), uses the latest scientific methodologies and brings together government officials, private industry, and academia to ensure technology works for democracy. As a team of teams, the Conflict Observatory program includes nearly 70 subject matter and technical experts across organizations and research institutions including the Yale Humanitarian Research Lab, the Smithsonian Cultural Rescue Initiative, PlanetScape Ai, Esri Partner Quiet Professionals, and Esri. These teams document war crimes and other atrocities using commercial satellite imagery and other sources.

Begun in the early days of the Russian invasion of Ukraine in 2022, the program leverages satellite imagery, social media, and other commercially and publicly available data collection technologies to document possible atrocities. The Conflict Observatory can be deployed anywhere in the world. In February 2023, the team released a report on the forced relocation of thousands of Ukrainian children to at least 43 sites across Russia, which resulted in the issuance of arrest warrants by the International Criminal Court. The same platform and geospatial data feeds

↓ Geospatial data feeds are used by the Conflict Observatory to document conflict activities in Ukraine and Sudan.

have been expanded to document conflict activities impacting civilians in Sudan and assist ongoing humanitarian operations.

Local Government on the Move

Orange County, California, manages one of the most modern and innovative GIS implementations in the United States. GIS has become a vital component of mapping and data management for the county, which has experienced significant growth in the last 25 years. Orange County uses ArcGIS as a foundation for its parcel fabric, imagery, lidar, and digital infrastructure, which are all built on the county's accurate survey control. The OC Survey GIS team developed a self-service map submission application using ArcGIS API for JavaScript and Autodesk Platform Services that surveyors can use to complete a digital check of their maps. This application streamlines the county review process, provides real-time validation, and reduces costs. In addition to robust survey control and parcel fabric, GIS applications manage both outdoor and indoor facilities at John Wayne Airport and provide a wealth of services that support sustainable and resilient workflows across nine departments.

(See also an accompanying article in this issue, "Decades of Innovation by Orange County.")

The More I Click, the More I Learn

Three sixth grade students from Foulks Ranch Elementary School in Elk Grove demonstrated how they are using the National Geographic MapMaker to interactively explore the world around them. Liam Moen, Cadence Calvillo, and Gavin Sutherland used GIS 2D and 3D visualization tools and data from ArcGIS Living Atlas of the World to better understand the demographics of communities and where and when extreme weather events, such as hurricanes and cyclones, have occurred.

The Source of Life: Exploring the Okavango Delta's Watersheds

Dr. Steve Boyes, one of the 2023 Esri UC keynote speakers, has dedicated his life to preserving Africa's wilderness areas and the species that depend on them. The South African native, who is a conservationist, National Geographic Explorer, and TED Senior Fellow, has been founding and running conservation organizations for more than a decade.

↑ Dr. Steve Boyes uses ArcGIS to conduct detailed, repeatable ecological surveys as part of the National Geographic Okavango Wilderness Project.

In 2015, Boyes launched what has become the National Geographic Okavango Wilderness Project to help establish community-based systems to protect this area based on detailed, repeatable ecological surveys and long-term environmental monitoring systems. To help local governments preserve long-term resilience to climate change impacts, Boyes and his research team are working on establishing detailed early 21st century hydrologic and ecological baselines.

The current work protecting the Angolan Highlands Water Tower (AHWT) was the subject of Boyes's keynote address. AHWT is a highland area that stores large quantities of freshwater that flows downhill and is the water source for the world's largest transboundary conservation area and two-thirds of Africa's remaining elephants. Boyes's team has undertaken arduous large-scale ground truth surveys and expeditions, and in the process, they have discovered new species; taken environmental DNA (eDNA) samples; deployed permanent hydrologic and meteorologic monitoring stations; monitored wildlife populations using camera traps; and mapped birds, wildlife, and human activity observed along the team's multimonth river transects. The team employs ArcGIS Survey123 for expert data capture and shares its findings via EarthViews, a custom GIS solution that generates 360-degree virtual maps.

The goal of the Okavango Wilderness Project is to demonstrate the interconnectedness of the entire region through integrating data collected via sensor and field apps and visualizing that data using GIS. Project research has identified more than 143 new species and gained a better understanding of the region's physical geography. To create a sustainable future for the region requires understanding the unique culture of its people. Boyes and his team are working with area communities to rebuild a sense of pride and ownership of the landscape that has been made dangerous by conflict.

Watch presentations from the Esri UC Plenary Session in their entirety at esri.com/en-us/about/events/uc/plenary.

How to Start an ArcGIS Pro Project

By Kevin Priestley

ArcGIS Pro is a toolbox, and inside this toolbox is an almost limitless set of tools. Just as a carpenter's tools are designed to work with and manipulate wood, the material we work with in ArcGIS Pro is data. We can alter the appearance of data using symbology, visibility ranges, definition queries, labeling, masking, and other operations. We can alter data itself using geoprocessing and editing tools.

Because we can do so much with and to data as GIS users, one common mistake we make is to throw all the data we can find into a map. I have done this as many times as anyone. That's when the first thing I do is find and download as much data as I possibly can when I start a project.

At that point, I step back and wonder, what am I making?

It would be as if a carpenter went to the hardware store and bought a bunch of mismatching fasteners, wood that had been cut to random lengths, and some glue.

Instead, the carpenter first needs to answer the following questions:

- What is being made?
- Who is it being made for?
- Why is it being made?
- How will it be made?

Focusing Our GIS Projects

To focus our GIS projects most effectively, I argue that we need to rough out a project before we start to work on it. We need to identify what we want to make, who we are making it for, how we do and do not want it to be used, and any constraints on how our product works. We can focus our GIS efforts using these five project considerations: vision, budget, scope, time, and audience.

Vision

When making something, a carpenter may have all the tools but needs an idea and should be able to answer these three questions in a single sentence:

- What do I want to make?
- What can I do with it?
- Why do I want to make it?

For example, an answer might be, I want to make a table so that I can eat a family meal more comfortably.

As GIS users, we can apply the same questions to rough out GIS projects. Answers might be, "I want to make a web map that shows car crashes so I can design safer streets," or, "I want to make a database that stores parcel information for my organization to use," or, "I want a printed map of potential locations to open a new business."

When we answer these questions concretely, we narrow the number of tools we need for the project. We reduce the number of potential products we will make. We simplify the search for data.

Budget

In a perfect world, we could make whatever we wanted, whenever we wanted it, and cost would be no object. In this world, our

projects and products face constraints—budgetary constraints being chief among them.

And if we put nonfinancial resources under the umbrella of budget, we can also start to picture the technical, infrastructural, or staffing constraints on a project as well. To understand project constraints, we need to answer the following questions:

- Do we need to buy things such as server space, new computers, software, add-ins, or licenses?
- Do we have adequate staffing to create and maintain the project?
- Do we need to provide training on new technologies or workflows?
- Can we afford to do all these things?
- Alternatively, can we only afford to do some of these things?

If someone asks a carpenter to build a table, two of the first questions the carpenter will ask are What kind of table do you want? and How much are you willing to spend? In other words, the carpenter is asking, What is your vision? and What is your budget?

Scope

To put it simply, scope defines the stuff we care about and the stuff we don't care about. In defining the scope of a project, we start to identify how we can achieve our vision within constraints.

For example, once a vision and a budget are set, the carpenter and the customer will start to define how large the table should be, how it should look, what kind of wood should be used, and other details. Within

← Just as a carpenter needs to understand project requirements before starting to build a table, GIS users also need to understand requirements before starting on a project. (Photo by Ryno Marais on Unsplash)

↓ Deadlines are probably top of mind when you think of time in relation to a project, but work in GIS also involves the relationship of a project to time.

↑ The audience for a project may be a large group or a small one, perhaps even a single person.

that scope, the carpenter can meet the customer's expectations and find opportunities to add specific embellishments to the table.

In GIS, we can narrow down the set of materials we work with when we define a geographic area of interest, identify data providers we want to use, and outline the workflows or processes we will use to realize our vision. From there, we can create beautiful maps, apps, dashboards, hubs, and other information products. We are not here to investigate everything, because doing that often gets in the way of the one thing we want to make.

Time

When do you need your table?, the carpenter might ask the customer. Deadlines are probably top of mind when you think of time in relation to a project. We live in a fast-paced world in which information is constantly updated, so delayed project deliveries might mean making decisions with imperfect or outdated information. But beyond deadlines, work in GIS also involves what I would call the temporality of a project: the relationship of our project to time.

On one hand, incorporating temporal components in a project adds considerable depth and richness for product end users. On the other, temporality adds an immense amount of complexity for GIS users and organizations.

Let us use a simple, concrete example. We just came to an agreement about the vision, budget, and scope of a new project we want to initiate. We want to create a public web map of population density in New York City. We can only afford to use public data available from the US Census Bureau. We want to make this information available as soon as possible. To accomplish this goal, we could use ArcGIS Pro or ArcGIS Online to access decennial census data. If a population density field does not exist, we will have to add and calculate a field to generate the necessary attributes. Then we can symbolize and share our data.

But if we want to know how population density in New York City has changed since 2000, we must ask and answer all kinds of additional questions because space and data that describes it change over time, too. Census boundaries change. Data

definitions and categories change.

We will likely need to expand the scope of our project in such cases. Not only will we need to perform extra processes and workflows to our data, but we will have to spend more time understanding the variegated terrain of the data.

Common temporal questions we might ask of our project include

- How did data categories, definitions, and boundaries change?
- What processes or workflows will we use to resolve temporal differences in our data (e.g., apportionment)?
- When working with economic data, how do we adjust for inflation?
- Does it make sense to generalize data or resample rasters to make temporal comparisons easier?

Audience

Unlike the carpenter, whose audience is self-selected and specific, we often create GIS products with an amorphous understanding of audience. We tend to think of an intended audience or a group of people we think would be interested in our product.

Sometimes the audience is the public, a small group of stakeholders, or subject matter experts. Sometimes the audience is composed of members within our organization. Each potential audience has different ways of interacting with the products we create. Each has a different level of familiarity with maps and GIS concepts such as spatial statistics or raster analysis. To identify the audience for your GIS project, answer the following questions:

- Who is the audience?
- How will they use this product?
- What story will this product help us tell?

Considering our intended audience will help us decide how much specificity or level of detail we must incorporate into our project; select the kinds of technologies through which to make our product available; and determine accessibility requirements, symbology, design details, narratives, and other considerations.

I encourage you to document and record your project considerations before you go out and download every dataset you can find. That way, you can assess whether an unforeseen spatial relationship or a specialized web app meets your overarching vision. Although it will take more time up front, you can save yourself a lot of headaches down the line.

On the other hand, if you make these considerations too rigid, you may not be able to meet expectations, and you cannot pick the project up from an earlier moment. You get stuck and waste resources.

To get unstuck, I suggest using these project considerations as guideposts. Check in with yourself or your team regularly. Make sure your vision still makes sense. Make sure the scope is still correct. Make sure you can create what you want for the audience who needs to see it.

In other words, measure twice, cut once.

About the Author

Kevin Priestley is an instructor at Esri. He has a background in urban and regional planning and holds a master's degree in city/urban, community, and regional planning from the Humphrey School of Public Affairs and a bachelor's degree in international/global studies from Macalester College.

↓ Braille keyboards help make technology accessible.

Using Alternative Text for Equitable Storytelling

By Lara Winegar

According to the World Health Organization (WHO), roughly 16 percent of people will—at some point—experience significant challenges or disabilities that impede navigating the world or accessing online content. This article shares examples of how to structure alternative text for complex media used to create stories so that the experience is not just accessible but also an equitable and inclusive one.

Accessibility as a Standard

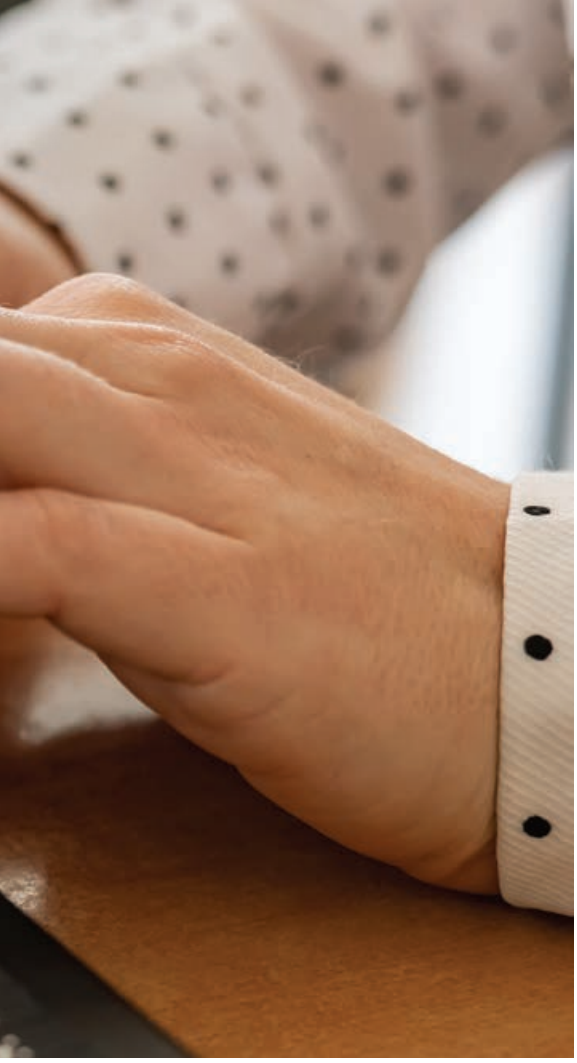
When we think of accessibility, we may think of the ramps accompanying stairways or the sidewalk curb cuts that are standard in most public spaces. In terms of the internet, accessibility means providing a product or service that can be used by everyone—ideally with a similar level of ease. Like well-designed stairway ramps, easily accessible content can benefit everyone.

The ArcGIS StoryMaps builder includes integrated accessibility tools that allow you to create stories that meet the Web Content Accessibility Guidelines (WCAG) (https://www.w3.org/TR/WCAG20/), which are technical standards developed by the World Wide Web Consortium (W3C). ArcGIS StoryMaps has an in-app contrast checker that will help ensure your text is visible against the background of a story. This makes creating an attractive and accessible custom theme for your story much easier.

ArcGIS StoryMaps is fully compliant with Section 508 of the Rehabilitation Act of 1973, which ensures people with disabilities have equal access to government information. Esri's development team maintains standards that integrate the latest design options that allow audiences who use assistive devices such as screen readers to have an accessible experience. To learn more, see Esri's accessibility resources at https://tinyurl.com/2rsx57t6.

Alternative Text as a Standard

Alternative text, also called alt text, is a standard feature of many websites. It is



useful when media is not displayed because of bandwidth limitations, slow internet speeds, or broken links. Screen readers and other assistive technologies also look for alt text to describe media.

Within the ArcGIS StoryMaps builder, you can add alt text to all media by entering it via the options panel (the gear icon) for media such as images, embedded web content, videos, maps, and scenes. (See this video https://tinyurl.com/2wedvz42 to learn how to add alt text in a story.)

Tip: Write and edit alt text in a text program first, and then paste it into the ArcGIS StoryMaps builder.

The goal is to write alt text for media, maps, or graphics as succinctly as possible. A rule of thumb is to keep alt text to 125 characters or less and skip ending punctuation. While that usually works for simple photos, a 125-character limit may not provide a fully equitable experience when it comes to maps or complex graphics. When brevity conflicts with providing your audience with a more equitable experience, you may want to consider other options.

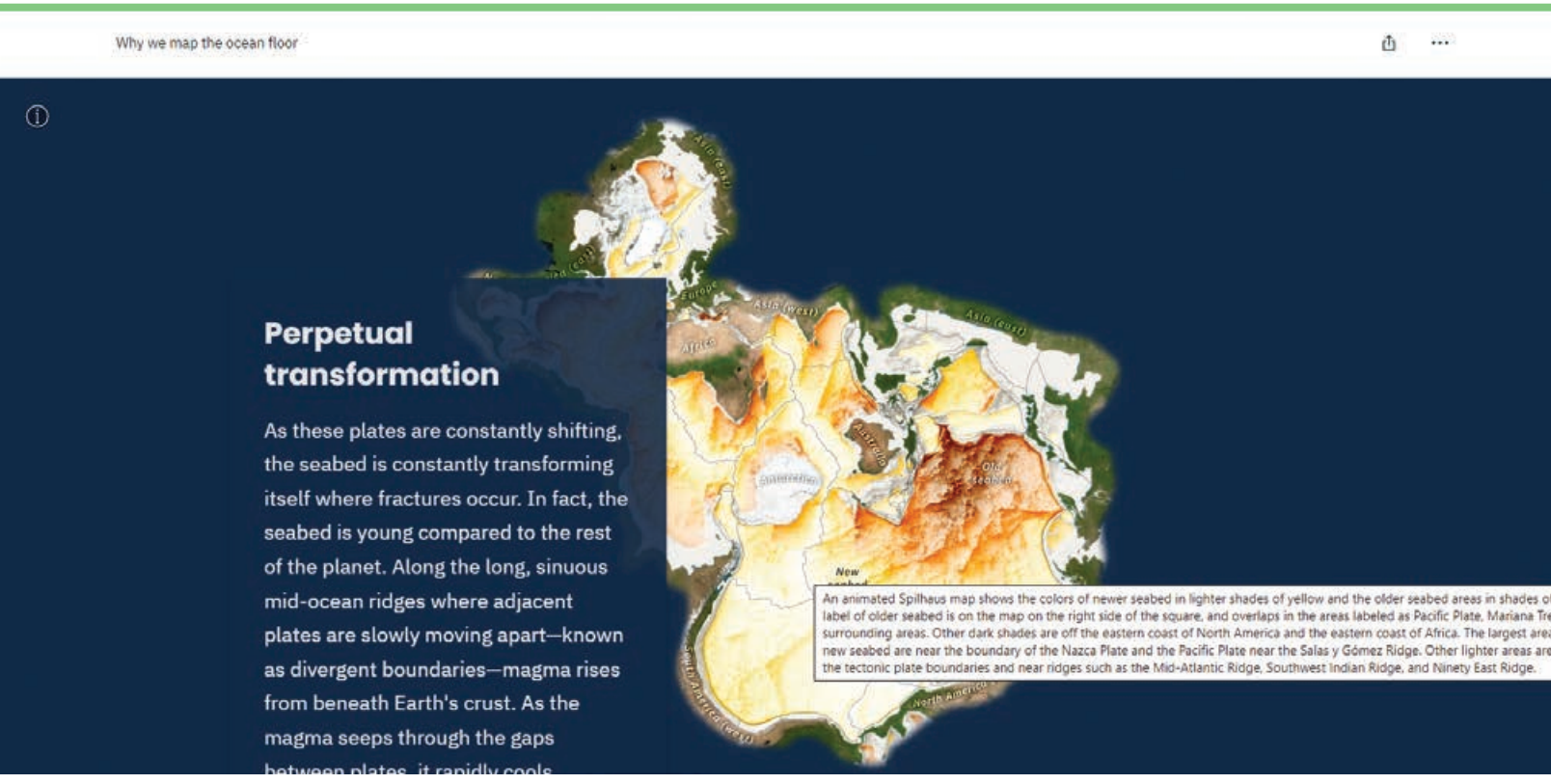
Options for Creating Equitable Experiences

The first possibility is simply to break that 125-character barrier. One example of this is the fantastic alt text for NASA's Webb telescope photos posted on Twitter that made headlines over the summer of 2022. The positive reaction these descriptions received confirmed that many audience members appreciate an equitable experience, even if it's a little wordier.

Another option is to explain your media more within the story's running text. However, it might not be possible to efficiently provide ample information in the copy to say what a graphic or map communicates. Sometimes adding extra text can be the antithesis of why you created a map or graphic in the first place—to illustrate, simplify, or efficiently explain a concept.

For complex maps and graphics, one

↓ The alt text descriptions for NASA's Webb telescope images posted on Twitter exceed the 125-character limit but have received a very positive reaction.



more possible solution is to narrate those parts of your story with audio files that explain your maps and ensure that your story will be understood by your entire audience.

Some organizations encourage providing a spreadsheet of data along with a map when it's practical for the map context (e.g., locations of medical facility addresses). However, a spreadsheet is not always an ideal solution, especially when working with large datasets.

An Animated Example

In "Why we map the ocean floor" (https://tinyurl.com/yeysvcyh), ArcGIS StoryMaps team cartographer Cooper Thomas created several animated maps—some of the most visually striking maps I've ever seen.

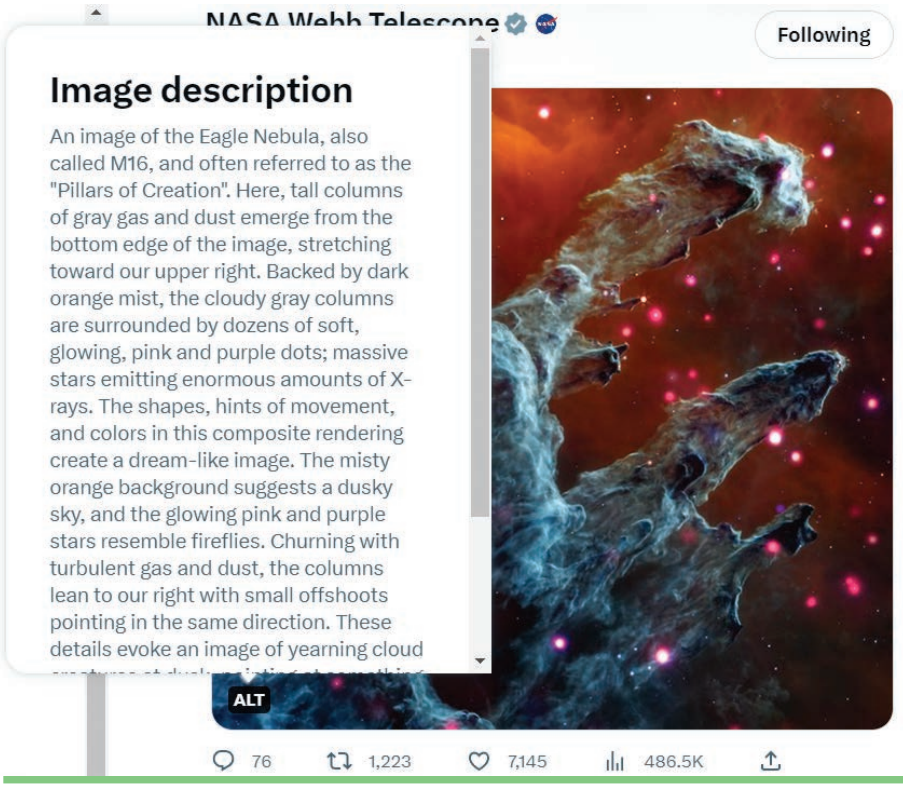
These maps—as complex as they are beautiful—use the Spilhaus projection. This projection shows the ocean as one continuous body of water with the land areas occupying the edges of the map. It was the perfect projection for the story content. The Spilhaus projection is atypical for even the biggest map fan. It comes across as abstract when compared with more familiar projections such as a Mercator or Winkel Tripel projection.

After the story's introduction, the first Spilhaus map acts as a base for several maps that follow. When adding new layers of human-made infrastructure, the details made the animations even more complex. Content developers on the ArcGIS StoryMaps team had to pause and ask, How do we create an equitable experience for those who are unable to actually see these maps?

The solution was to establish patterns in the structure of the alt text so the audience would know what to expect and could more easily process the description.

The steps in the process used to establish these patterns were

1. Plan the alt text by building on the map legend information, such as values or color, and the order that they are shown in the legend to help structure the descriptions.
2. Start the description by stating an overview sentence of the map's purpose.
3. Establish the pattern for describing the map, such as a grid system or a clockwise pattern and include other major points of reference to create context and reduce the length of descriptions.
4. Share a description of the content noting if patterns exist, but not necessarily stating a conclusion.



↑ The ArcGIS StoryMaps team structured the alt text so that the information presented in the animation would be accessible to those with limited vision.

The first map in the Spilhaus series—without the other layers—is used as a base. It includes major physical features that are used as points of reference for other layers. For the alt text, we started by explaining that the map was a world map and that it was a nonstandard map projection. We continued by describing the shape and appearance of the projection, and then used a grid system to describe the map's features, going counterclockwise from the top. We also noted in the alt text that the following layers were based on the initial description, and we would not include the full description of the basemap after that.

After establishing this pattern in the first map, the team decided to describe only the patterns and pertinent information for the following layers. This allowed alt text descriptions that were shorter for ensuing layers in the series.

Establishing a predictable pattern, much like other broader storytelling strategies, helps create context and a setting that helps your audience understand and process the information more efficiently. Similar alt text strategies have been used for other stories such as "Justice deferred" (https://tinyurl.com/437b9p38) and "(Farm) Animal Planet" (https://tinyurl.com/4t4tf8mh). All stories in ArcGIS StoryMaps produced by the editorial team include alt text.

What Do You Think?

The ArcGIS StoryMaps team encourages all content creators and storytellers to share their thoughts on strategies for making complex graphics and maps accessible to members of the GIS community who use assistive devices. Share your solutions or suggestions for accessible story creation in ArcGIS StoryMaps Community (https://tinyurl.com/3a28khbs).

The team members who devised these strategies for alt text want to hear your feature suggestions for the ArcGIS StoryMaps builder. You can add your feedback to the form available in the ArcGIS StoryMaps builder under the help menu.

About the Author

Lara Winegar is a content creator and product engineer on the Esri ArcGIS StoryMaps team.

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Manage Layers More Efficiently in ArcGIS Pro with Catalog Layers

By Greg Lehner and Tanu Hoque

Geographic data comes in all shapes and sizes. Finding the data you need for your project is one thing, but keeping track of it inside a project with dozens of maps and hundreds of layers can be difficult.

You can filter what you don't need to see from the Contents pane, but maps are a visual experience. Sometimes you just don't want to see a layer and you don't want to keep having to make manual adjustments. What's not currently drawing in the view still takes up space in the Contents pane and uses system resources.

To solve this dilemma, ArcGIS Pro 3.1 introduces catalog layers—a new layer type. Catalog layers may be useful for those who work with ArcGIS Pro maps or scenes that contain a large amount of data. This article shares an example of how catalog layers can be used.

It's called a catalog layer because its purpose is to help you organize, or catalog, your datasets. A catalog dataset is created and stored in a geodatabase and establishes item references with the data it includes. The item references point to various data sources—from local or network file shares, or your Enterprise portal.

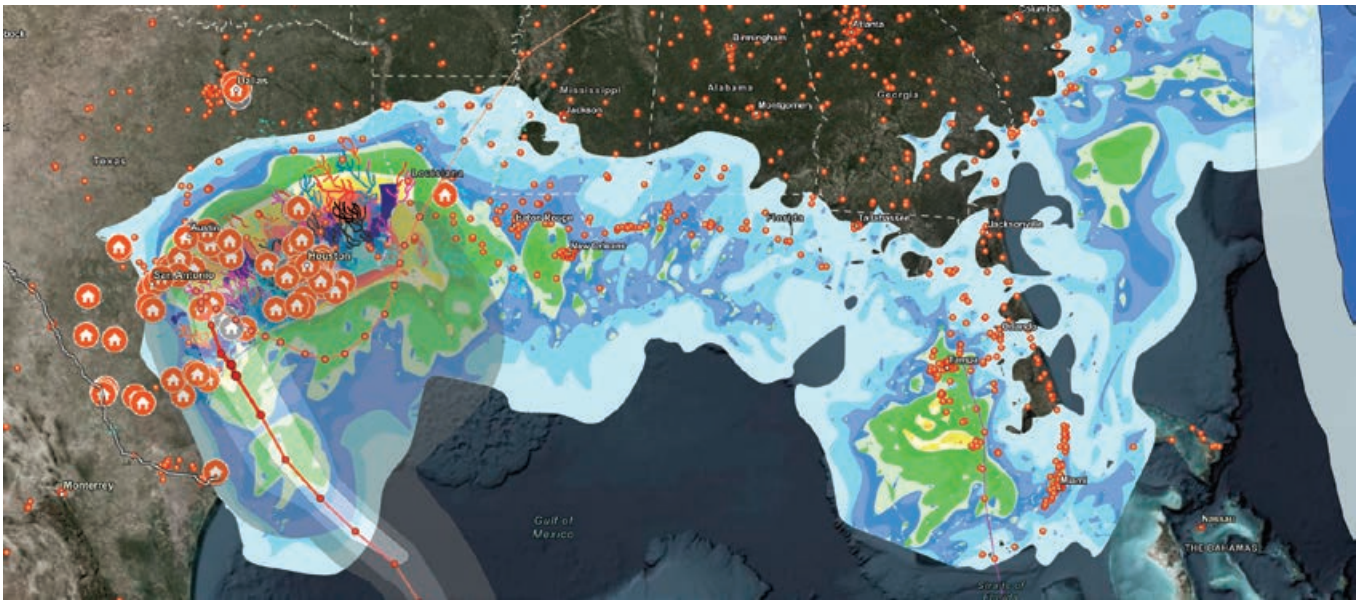
With catalog layers, data management tasks are minimal. You're not breaking existing data connections or duplicating anything. Think of it this way: the catalog dataset is a file cabinet. Each item reference to a dataset, feature class, or service is a file in the cabinet. You'll frequently pull out the files you want to see, and the ones you don't need right now are put in the back of the cabinet—but they are still in the cabinet. This analogy can simplify your understanding of what is going on behind the scenes.

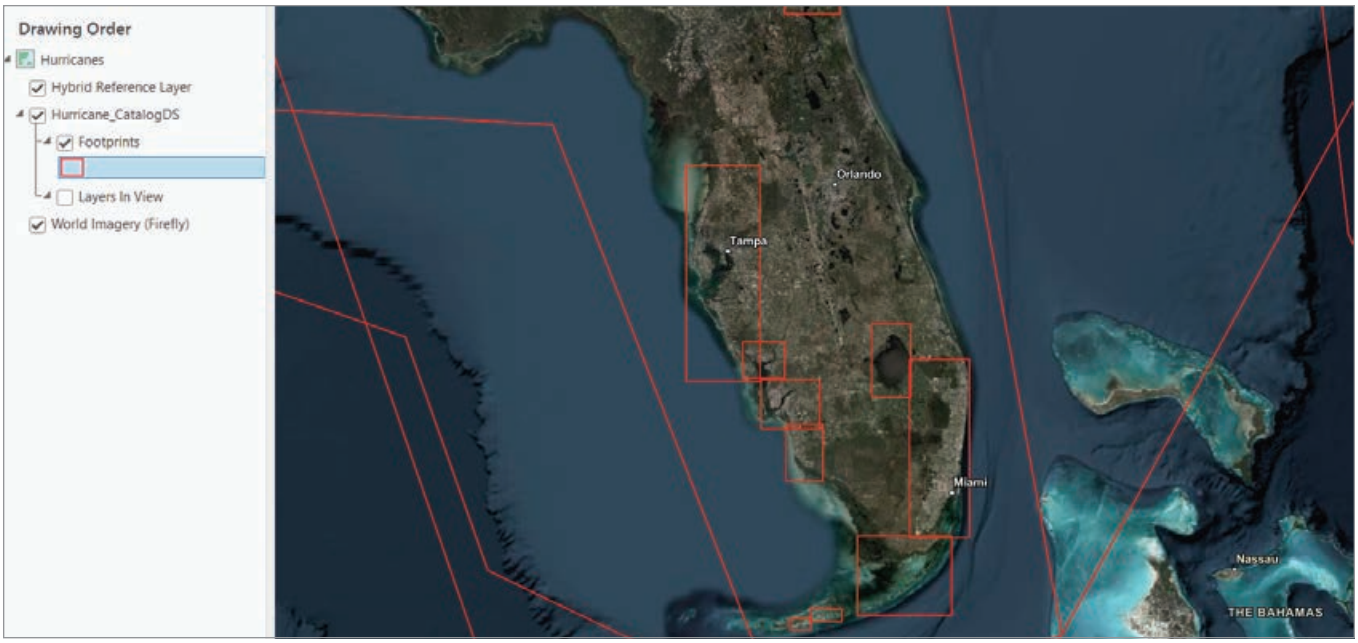
There are core aspects to creating catalog layers, such as item type filters, that aren't covered in this article. To learn how you can create a catalog dataset and establish item references, you can read the web help documentation at https://tinyurl.com/5n767z4x.

A Scenario Using Catalog Layers

Imagine you work for a natural disaster agency that collects data for an incoming Category 3 storm. You get data from models that constantly update their forecasts. The information evolves frequently and rapidly, and it comes in various stages. After the hurricane makes landfall, on-the-ground crews provide access to data they've collected to your agency. That data is collected at different times and in different formats. All this data adds up

↓ Hurricane data provides a good use case that illustrates the value of using catalog layers.





Field: Add Calculate Selection: Select By Attributes Zoom To Switch Clear Delete Copy

	OBJECTID *	SHAPE *	Item Name	Item Source	Item Type	Minimum Scale	Maximum Scale	Dra...	Footpri...	Hurricane_Name	Observ_Date
20	20	Polygon	KeyWest	https://tiles.arcgis.com/tiles/DO4gTjwJVIJ7O9Ca/arcgis/rest/services/Key	MAP_SERVICE	10000000	<Null>	70	<Null>	Irma	9/10/2017
21	21	Polygon	Miami	https://tiles.arcgis.com/tiles/DO4gTjwJVIJ7O9Ca/arcgis/rest/services/Mia	MAP_SERVICE	10000000	<Null>	70	<Null>	Irma	9/10/2017
22	22	Polygon	PortComfort	https://tiles.arcgis.com/tiles/DO4gTjwJVIJ7O9Ca/arcgis/rest/services/Por	MAP_SERVICE	<Null>	<Null>	70	<Null>	Harvey	8/28/2017
23	23	Polygon	Goliad	https://tiles.arcgis.com/tiles/DO4gTjwJVIJ7O9Ca/arcgis/rest/services/Gol	MAP_SERVICE	<Null>	<Null>	70	<Null>	Harvey	8/26/2017
24	24	Polygon	PortCharlotte_Orthos	https://tiles.arcgis.com/tiles/DO4gTjwJVIJ7O9Ca/arcgis/rest/services/Por	MAP_SERVICE	10000000	<Null>	70	<Null>	Irma	9/11/2017
25	25	Polygon	NOAA Hurricane Harve...	https://www.arcgis.com/home/item.html?id=d9a57c23eb3540 92a9f3bd	WMTS	<Null>	<Null>	75	<Null>	Harvey	9/1/2017
26	26	Polygon	NOAA Hurricane Harve...	https://www.arcgis.com/home/item.html?id=2567d773e93M025a617c8	WMTS	<Null>	<Null>	75	<Null>	Harvey	8/31/2017
27	27	Polygon	Harvey Track and Swath	https://services7.arcgis.com/M1GdlfrBNFtdTD7r/arcgis/rest/services/Har	FEATURE_SER...	<Null>	<Null>	99	<Null>	Harvey	8/17/2017
28	28	Polygon	Harvey DFO Inundation...	https://tiles.arcgis.com/tiles/nzS0F0zdNLvs7nc8/arcgis/rest/services/Harv	MAP_SERVICE	<Null>	<Null>	90	<Null>	Harvey	8/26/2017
29	29	Polygon	Harvey River Flood Lay...	https://services2.arcgis.com/C8EMgrsFcRFL6LrL/arcgis/rest/services/Han	FEATURE_SER...	<Null>	<Null>	90	<Null>	Harvey	8/26/2017
30	30	Polygon	Harvey Water Depth	https://services.arcgis.com/dVL5xxth19juhrDY/arcgis/rest/services/Hurric	FEATURE_SER...	<Null>	<Null>	90	<Null>	Harvey	8/26/2017
31	31	Polygon	Harvey Total Rainfall (Es...	https://services.arcgis.com/DO4gTjwJVIJ7O9Ca/arcgis/rest/services/Total	FEATURE_SER...	<Null>	<Null>	90	<Null>	Harvey	8/26/2017
32	32	Polygon	Hurricane Harvey Crow...	https://services.arcgis.com/0ZRg6WRC7mxSLykX/arcgis/rest/services/har	FEATURE_SER...	<Null>	<Null>	85	<Null>	Harvey	8/26/2017
33	33	Polygon	Hurricane Harvey Shelt...	https://services5.arcgis.com/TBEibzxOE0dzXLJyc/arcgis/rest/services/Hurr	FEATURE_SER...	<Null>	<Null>	95	<Null>	Harvey	8/31/2017
34	34	Polygon	Hurricane Harvey Video...	https://services1.arcgis.com/Hp6G80Pky0om7QvQ/arcgis/rest/services/I	FEATURE_SER...	<Null>	<Null>	85	<Null>	Harvey	8/28/2017
35	35	Polygon	Harvey Wind Damage P...	https://services2.arcgis.com/C8EMgrsFcRFL6LrL/arcgis/rest/services/Han	FEATURE_SER...	<Null>	<Null>	90	<Null>	Harvey	8/26/2017
36	36	Polygon	Direct Relief Partner Cli...	https://services1.arcgis.com/ZGrptGILV2IILABw/arcgis/rest/services/Direc	FEATURE_SER...	10000000	<Null>	95	<Null>		<Null>
37	37	Polygon	US Interstate Hwy Syst...	https://tiles.arcgis.com/tiles/VAI453sU9tG9rSmh/arcgis/rest/services/US_	MAP_SERVICE	10000000	<Null>	0	<Null>	<Null>	<Null>
38	38	Polygon	CDC's Social Vulnerabili...	https://services3.arcgis.com/ZvidGQkLaDJxRSJ2/arcgis/rest/services/Soci	FEATURE_SER...	<Null>	<Null>	5	<Null>	<Null>	<Null>

↑↑ The Footprints layer shows the extent of each sublayer.

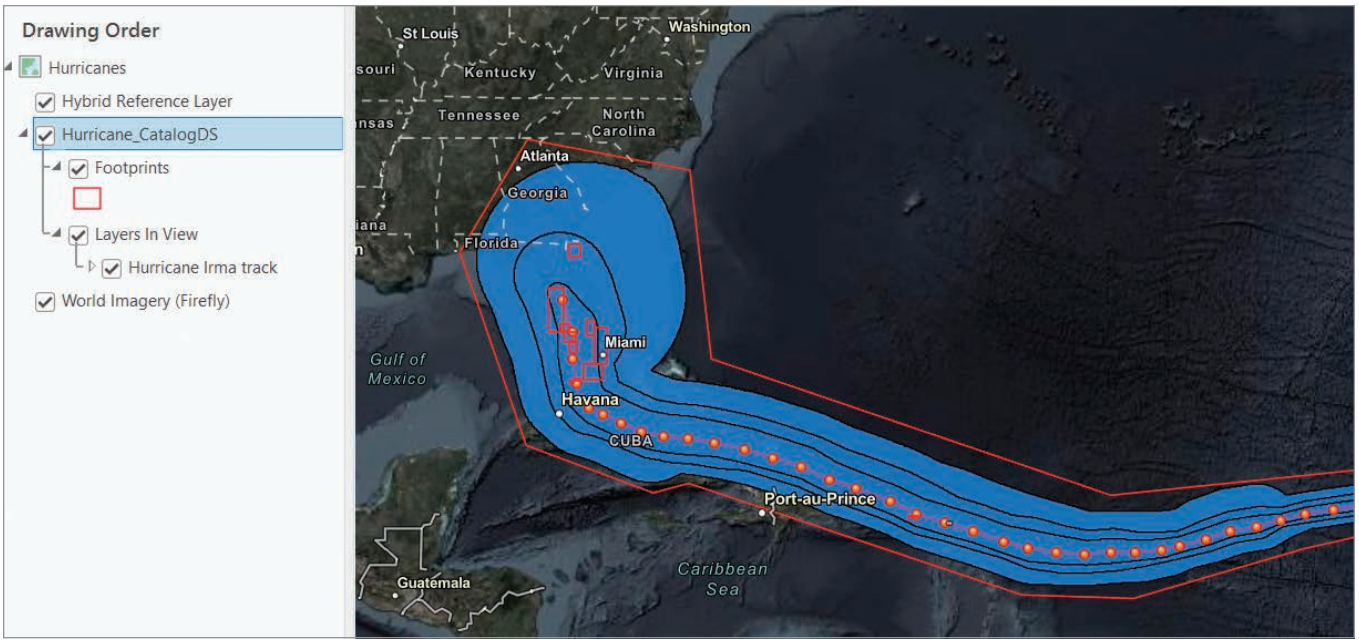
↑ When viewing the catalog layer's attribute table, you will see that each item is a record in the table. The Item Source field stores the path of the item. The Item Type field tells you what kind of data it is.

quickly. Every piece of data is important, but consuming all this data is a different story. Everyone involved in collecting, editing, and uploading the data has done their work, but now you must make something from it.

The file cabinet is overflowing—but you can manage it. In any map with a catalog layer, one of the two sublayers you will see is a Footprints layer. When the catalog dataset is created, it builds convex hull polygons of each item's footprint and puts them into one feature layer. The footprints show the spatial extent of every item (like the footprints in a mosaic dataset). Any given layer's spatial extent isn't immediately clear when looking at a geodatabase or a service layer in a file directory.

If you right-click the catalog layer in the Contents pane and open its attribute table, you will see that each item is a record in the table. The Item Source field stores the path of the item. Meanwhile, the Item Type field tells you what kind of data it is. It's like the files in your file cabinet tell you what's inside without needing to open them. The other fields you see are detailed in the help documentation. You can also add fields.

The second layer in the catalog layer's structure is named Layers In View. It is a composite sublayer that does exactly what the name implies. Catalog layers dynamically load layers in your map based on spatial, temporal, or range filters. If an item in your catalog layer is in view, it is listed in the Contents pane under the Layers In View heading.



↑ Use a definition query to filter catalog layer data by category to display only the items of interest and limit what gets drawn in the view. In this case, only Hurricane Irma data is displayed.

Items in the catalog layer appear in the Contents pane as you pan around the map. But which layers get drawn? That's where the Feature Order Weight field in the catalog layer attribute table comes into play. Feature drawing order was introduced with the release of ArcGIS Pro 3.1. Catalog layers are included as one of the default fields. You can edit which items are drawn on top by giving them a larger value—like keeping your most important files toward the front of the file cabinet.

There are other ways to limit what gets drawn as well. You can modify the layer limit, or you can also set scale ranges for each item in your dataset. These settings will be reflected in your map as you change scales.

Lastly, the contents of a catalog dataset include feature classes, BIM files, and LAS datasets. Because each of these items are references to the data—not the actual items—there are limitations with what you can do with them. In almost all cases, consider catalog layer contents as read-only. That means you cannot view a sublayer's attribute table, make edits to its features, or make changes to the symbology.

However, there is one solution. You can right-click any item reference in the catalog layer and choose Make Layer from Catalog Dataset Item. This builds the item as a separate layer in your map with all the functionality that normally comes along with it. Meanwhile, the item remains a member of the catalog dataset.

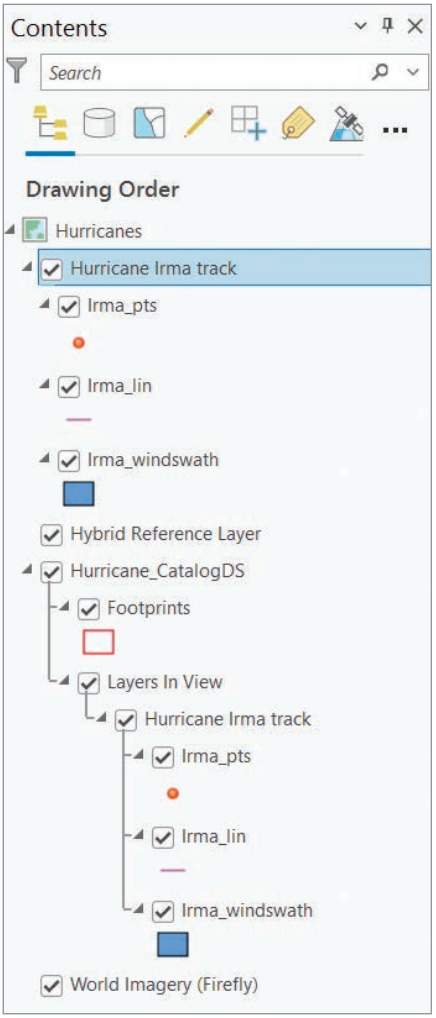
Takeaways

To summarize, consider adding catalog layers into your current workflows. Read the help documentation (https://tinyurl.com/5n767z4x) to learn more, and share your thoughts or use cases on the ArcGIS Pro page on Esri Community (https://tinyurl.com/2p8yvn94).

About the Authors

Greg Lehner is a product engineer for the mapping team on ArcGIS Pro. His interests include cartography, symbology, data visualization, and technical writing. He is a Wisconsin native and started his Esri journey in 2013.

Tanu Hoque is a product engineer on Esri's mapping team, focusing on map service, print service, and ArcGIS Pro. He also works on spatiotemporal analysis, spatial aggregation, and real-time data. Hoque's background includes earning a master's degree in urban planning from the University of Akron, Ohio, and a bachelor's degree from Khulna University, Bangladesh. Prior to coming to Esri, he worked as GIS coordinator for the City of West Springfield, Massachusetts, and a GIS specialist in a hydrology modeling center in Bangladesh.

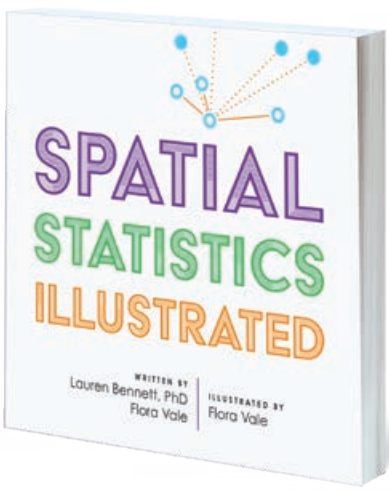


↑ Make Layer From Catalog Dataset Item builds and adds the selected sublayer to the map with normal functionality, while the item remains a member of the catalog dataset.

GIS Bookshelf

Spatial Statistics Illustrated

By Lauren Bennett and Flora Vale



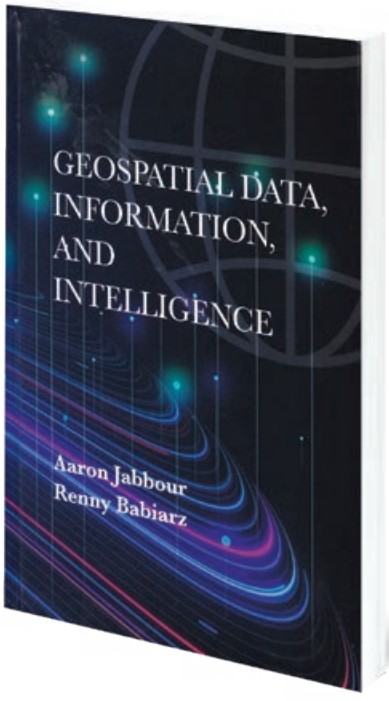
Recent improvements in computational capacity and access to data mean that data science can now be applied to many complex problems. *Spatial Statistics Illustrated* by Lauren Bennett and Flora Vale provides an approachable introduction to a key area of data science: spatial statistics.

Spatial statistics is a vast and special field of statistics. This book focuses on understanding what makes spatial statistics special and illustrates this through explaining the capabilities and tools available in ArcGIS and the concepts they are built on. With this understanding, readers will know when to use spatial statistics and how to apply and interpret them. The topics covered include means and medians, finding clusters with machine learning, statistical cluster analysis, spatiotemporal pattern mining, and modeling spatial relationships and making predictions.

The authors have extensive experience in the development of GIS tools for applying spatial statistics. Bennett leads the spatial analysis and data science product engineering team at Esri. In her role, she oversees the R&D for the ArcGIS geoprocessing framework, which includes spatial and spatiotemporal statistics, raster and multidimensional analysis, machine learning, and big data analytics. She holds a bachelor's degree in geography, a master's degree in geographic and cartographic science, and a doctorate in information systems and technology. Vale is a product engineer on the spatial analysis and data science product engineering team at Esri. She is currently pursuing a doctorate in information systems and technology. Esri Press, 2023, 176 pp., print ISBN: 9781589485709, ebook ISBN: 9781589485716.

Geospatial Data, Information, and Intelligence

By Aaron Jabbour and Renny Babiarz



The premise of *Geospatial Data, Information, and Intelligence* is that location is central to understanding the world and that geospatial analysis can help people arrive at solutions to many problems. Instead of employing the historical approach used in many texts, this book introduces principles and practices of using geospatial data and information through an approach structured around observation, analysis, and communication processes. The emphasis on communicating the results of analysis is unique and valuable since the best analysis has little impact if it is not well communicated. The target audience of students, faculty, and practitioners can benefit from the authors' 30 years of experience in the geospatial intelligence (GEOINT) field. Artech House, 2023, 262 pp., ISBN: 9781630819798.

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

My Career Asking Questions with a Geographic Approach

By Nanette Star

You don't need a geography degree to get paid to talk about using a geographic approach across industries or understand how to mitigate some of the most severe challenges of our time with GIS.

Psychology, sociology, anthropology, and epidemiology are a testament to this. The ologies were helpful to me. They set the stage—so to speak—by providing a viewpoint that sent my career path toward inquiry. Truthfully, long before academia, I had many questions about the world and our modern Western social system. Those questions explored where the system might have blocks, inefficiencies, and even gaps that lead to sickness and a lower quality of life for so many.

Because I had more questions than answers, I knew that school was the place I needed to go, so off to college I went. Although it seems like an obvious next step from high school, I started this journey as a dropout and then a teen mom, so college was not on my radar.

I was a hard worker, and the longer I worked—first in the service industry and then in social services—the more I kept accumulating more questions about our world and the state of our systems. In college, surrounded by the ologies, I began understanding that pattern dynamics were emerging from my ad hoc queries. That led me to develop my top five geographic approach questions—a core set of questions that could only be answered spatially.

1. What exists at a location?
2. Where are certain conditions satisfied?
3. What has changed in place over time?
4. What spatial pattern(s) exist(ed)?
5. Where do variables interact?

In academia, I encountered some unique and inspiring professors. The most influential ones in GIS were Dr. Sheila Lakshmi Steinberg and Dr. Steven Steinberg. Both were university professors who were starting a new course based on a book they coauthored, *GIS for the Social Sciences*.

I was in! I loved the idea of using a spatial intelligence platform to provide information in a logical system. I did not know what GIS was then, nor did I know it would change my life forever.

The Case for Participatory GIS

This one GIS course, along with my love of research and data exploration, allowed me to get my first paid student job on a

↓ My first paid student job was working on a GIS participatory research team examining pesticide drift. (Photograph courtesy of Dr. Sheila Lakshmi Steinberg)

↑ During my work for the Agricultural Workers Health Initiative (AWHI), I collected pictures and measurements and led participatory GIS mapping. (Photograph courtesy of Dr. Sheila Lakshmi Steinberg)

GIS participatory research team for the Agricultural Workers Health Initiative (AWHI). *[AWHI was an intervention funded by the California Endowment to empower agricultural workers to improve overall health in the community.]* I examined pesticide drift in agricultural worker communities across the state and collected pictures and measurements and helped lead the qualitative portion of the participatory GIS mapping. I developed key informant questions, went into homes, and led focus groups. I asked questions about pesticide exposure and home decontamination procedures. I was able to work side by side with some excellent cartographers.

My team traveled throughout the agricultural lands of California, gathering stories of pesticide exposure in migrant communities. This work was an immediate success and led to publications and presentations to inform decision-makers of opportunities for real change and provided a precedent for using GIS to tell a community story and improve lives.

A few years later, I entered graduate school and continued as a research assistant, still exploring my top five spatial questions as applied to the ologies. I was the only person in the public health program with any experience in GIS. Yes, I still had only taken one class, but what I learned in that class—coupled with applied expertise and how to use location intelligence to communicate toward effective change—was still very applicable.

Making Effective Change with GIS

Dr. Lisa Pawloski, department chair in the Department of Global and Community Health at George Mason University, asked me to create a map of food deserts in Washington, DC, for a peer-reviewed paper. With my participatory GIS background and statistical knowledge, I could quickly link data and ground truth findings to ensure the story was accurate. We found that while many areas had grocery stores, those grocery stores carried no fresh food and had only processed or junk food. Understanding a community and its data are paramount for telling an accurate visual story. This is our responsibility as researchers and mapmakers.

The analysis I performed informed the paper, "The spatial food environment of the DC metropolitan area: Clustering, co-location, and categorical differentiation" by Timothy F. Leslie, Cara L. Frankenfeld, and Matthew A. Makara. Published in *Applied Geography*, Volume 35, Issues 1–2, this article is still used in literature reviews as a precedent for mapping food insecurities and telling the story of the food deserts in urban areas.

My previous experience in GIS—although minimal—left an impression and led to a paid graduate practicum experience in the

↑As part of my work for the Agricultural Workers Health Initiative (AWHI), I went into homes, led focus groups, and asked questions about pesticide exposure and home decontamination procedures. (Photograph courtesy of Dr. Sheila Lakshmi Steinberg)

Division of Maternal and Child Health of the Kentucky Department of Public Health. This work included environmental health. I was the only applicant with any GIS experience. Although it had been some time since I had used GIS, I got the gig. (This is a reminder to brush up on those GIS skills.)

The project focused on determining if there were any correlating geographic factors between children in Kentucky who were hospitalized for asthma and children who tested positive for lead poisoning. Using my top geographic approach questions, I explored the story behind the data. This was no easy task because no single variable could easily correlate both datasets. I was intrigued by this conundrum.

Of course, the solution was a spatial one—rural-urban classification codes. This project told a powerful story that led state officials to pass housing ordinances targeting areas with the most significant exposures. This experience let me learn on the job and make positive changes. I also received a job offer before my graduation.

What I have learned—and applied throughout my career—is that place matters. My first job out of grad school was as a contract employee for two initiatives—Health Happens for All and Health Happens Here—that were being run by The California Endowment (THE), a private nonprofit statewide foundation dedicated to making California a healthier place. I primarily worked under the prevention component of both Health Happens initiatives, although I touched all portions of Building Health Communities (BHC), another THE initiative.

Quality of life and life expectancy can be influenced by where you live, so ZIP codes helped focus these programs on areas that were most in need. These initiatives employed ZIP codes to target preventive programmatic efforts across California and developed innovative approaches to address the social determinants of health and promote racial and health equity. Along the way, these programs reimagined the role of philanthropy in public health through the creation of a new model for effectively supporting communities.

I was interested in examining policy, systems, and environmental change to enhance disease prevention and continued working in the health field and creating change through tribal health initiatives. I worked on the Good Health and Wellness in Indian Country initiative, a cooperative agreement with the Centers of Disease Control and Prevention (CDC) and tribal epidemiology centers and a few tribal nations. As an example, one of my projects supported sustainable farming practices at some reservations.

Using spatial thinking, I have brought my skills and knowledge of GIS to all my work as an advocate for this amazing technology and helped open the doors for folks to ask questions that can only be answered through a

Esri Young Professionals Network Is for Everyone

Have you ever wondered why it's called the Esri Young Professionals Network (YPN)? Well, it's not about age. Esri YPN (https://tinyurl.com/223jay6h) was created with three goals in mind:

1. Provide a space for GIS professionals to learn and supplement their skill sets in GIS.
2. Connect GIS professionals to further enhance community and collaboration
3. Promote leadership skills and qualities in the GIS community.

We need help from all members of the GIS community to achieve these three goals, especially professionals beginning their careers, and here's why. Esri YPN defines "young" as within seven years of starting your GIS career. If you've recently discovered the world of GIS in school or decided to make a career change, you are considered a young professional.

Can You Be Part of Esri YPN If You've Worked in GIS for Years?

This is a great question, and one Esri often gets. After several years in the GIS world, you may no longer consider yourself a young professional. While this might be true, you're still a significant member of the YPN community because you could be a mentor or a subject matter expert to newer members.

Esri YPN would not be around without Esri's more seasoned GIS members who help deliver new content. This content can include anything from sharing stories to speaking at conferences and webinars to writing blog posts. Esri YPN is always looking for new content. If you or someone you know is interested in creating blog posts, ebooks, or videos, send an email to ypn@esri.com.

geographic approach. Every academic and professional path I have explored over a few decades has included some perspective of a geographic approach. Geography is everywhere. A picture is worth a thousand words, and a map is worth a thousand pictures. Keep asking questions and use those maps to tell the data story.

About the Author

Nanette Star is the health and human services industry specialist at Esri. She has been at Esri since 2022. Prior to joining Esri, she served as assistant director for the Butte County Public Health Department in Northern California. Star has more than 15 years of experience in public and tribal health as a project director and epidemiologist on systems, policy, and environmental initiatives focused on addressing health inequities. She holds a master's degree in public health and a graduate certificate in epidemiology from George Mason University.

Helping Students Get Ahead by *Meeting Workforce Needs*

Every university graduate wants to know that their future work will be valued and valuable, so preparing for the careers that will be highly sought after is crucial. Data and business analysts will be in increasingly high demand soon, according to the US Bureau of Labor Statistics. By 2029, these fields are expected to grow by 26 and 11 percent, respectively, higher than average growth rates.

The College of Business and Public Management at West Chester University (WCU) in West Chester, Pennsylvania, is helping students get ahead and meet workforce needs by using locational analytics in undergraduate and graduate programs. The school's Department of Geography and Planning has taught GIS for more than 20 years.

"WCU takes an interdisciplinary approach to our programs and colleges. We consider GIS to be another form of analytics that just uses location as the focus," said Evan Leach, PhD, dean and professor of management at WCU. "GIS is a really important tool to answer strategic business questions and address business challenges."

"Our hope is that students don't approach today's problems with the mindset of siloed majors like business and geography, but rather approach problems holistically and through an interdisciplinary lens," said Leach. "Achieving that comes from not thinking in a traditional sense. Just because a business program hasn't had a prominent GIS program in the past, doesn't mean it shouldn't be open to developing one in the future."

And developing a business-centered GIS program is what WCU faculty have set out to do.

Introducing a Location Perspective

A major contributor to WCU's status as a leader in location-informed business education is Phuoc Pham, PhD, assistant professor of management at the College of Business and Public

← West Chester University (WCU) in West Chester, Pennsylvania

Management. Pham teaches a supply chain course required for both business majors and minors that is typically offered year-round. Pham's course explores the fundamentals of supply chain management, including how to leverage big data and other technologies to solve supply chain issues. Course topics include cloud computing, machine learning, the Internet of Things (IoT), and—most recently—GIS and location analytics.

"We don't want to throw a bunch of theory and textbook materials at students to solve a supply chain problem. We wanted them to be able to analyze them and know how to use a specific tool to do so," said Pham.

Pham was looking for a way to add a stronger analysis component to the course when he attended a GIS presentation in the fall of 2019 that was hosted by WCU's geography department. The department had invited an Esri representative to present on the technology. "It was a eureka moment," said Pham. "This was the technology I was looking for, and I began learning how to integrate the tool into my course to make it more relevant to solving the problem."

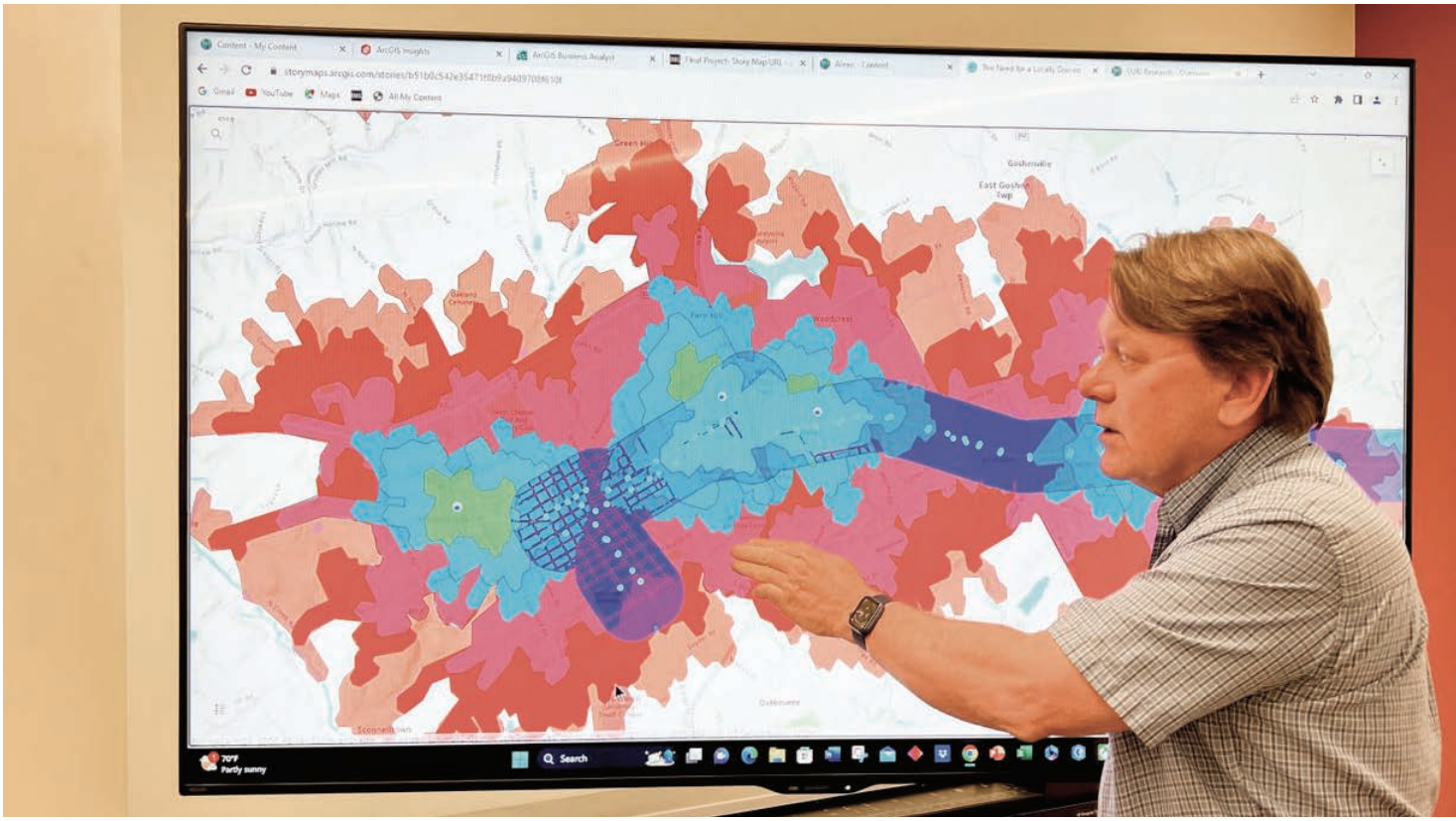
Pham collaborated with fellow WCU staff members to learn how to use ArcGIS technologies. In the winter of 2020, he began testing core concepts in his class using Learn ArcGIS (https://tinyurl.com/ymyrak6f), a collection of online tutorials that contain ready-to-use lessons based on real-world problems. By spring 2020, Pham had fully integrated ArcGIS Business Analyst, ArcGIS Pro, and ArcGIS Online into his course so that students could analyze and map supply chain challenges. Students also used ArcGIS StoryMaps to present and publish their assignments on the web.

To help students adapt and become comfortable with the software, he created guidelines on how to use the technology in a supply chain context. He paired these resources with sample business problems he had created and supplied data for the students to analyze.

"It really was the right time to integrate these technologies and prove how important location was to these business problems," said Pham. "The pandemic was happening, and supply chain challenges were a hot topic to discuss."

Pham shared with his students some examples of supply chain problems that were happening due to the pandemic and thought leadership pieces about solving them with maps. "Students really enjoyed the course because they could clearly see the application of these tools," said Pham.

↓ Gary W. Coutu, PhD, chair and professor in the Department of Geography and Planning, shares the benefits of GIS with other programs at WCU.



↑ Phuoc Pham teaches students in his supply chain course at WCU about how GIS can aid their analysis.

Applying GIS Knowledge to Real-Life Problems

While Pham worked with organizations to get case studies for his course, the business school eventually developed a case competition in spring 2022. The competition exposed students to a real-world business challenge to build their résumés, provided an opportunity to network with executives, and revealed job opportunities. The success of the first case competition has led to new sponsorships with other businesses and provided students with internship, job, and experiential learning opportunities.

"It's clear that these skills are highly desired in the market. Students need to know how to use data to solve problems and make decisions," said Pham. "I am lucky to work on a team that has the same mindset and strategy that we are doing the right things for students."

From the success of integrating location analytics in his supply chain courses, Pham hopes to expand the use of this technology in his logistic courses. He encourages other university professors to bring tools or skills they find valuable into the classroom.

"I saw this was a great tool, and that I just needed to do it, so I learned by doing as I went, " said Pham. "I want to see other business schools do this too; you can do it, and your students can too."

A Foundation of Essential Workplace Skills

Undergraduates at WCU can pursue a bachelor of science degree in geography with a location analytics track, as well as minor in GIS, business analytics, or business GIS. The college also boasts accelerated master's degree programs in geography from business management, international business, marketing, and supply chain management perspectives.

Leach observes that as organizations and businesses leverage the benefits of big data, business schools will need to adapt curricula to marketplace expectations and student preferences. "Universities need to have a lifelong learner mindset and develop a model that supports students long after they graduated with their bachelor's *[degree]* and throughout their careers," said Leach. He noted that it will be crucial for universities to consider developing certification programs that meet business needs for workforce technology training.

WCU has already begun this process by developing a new major in business analytics with a GIS-focused track and requiring students in the major who are on other tracks to take one dedicated GIS course. The college is also developing a GIS certificate for undergraduate students who want to supplement or specialize their skill sets, regardless of their major.

"Our hope is that GIS becomes a tool that is widely used by people strategizing and making business decisions," said Leach. "We are proud of what we have been able to accomplish at WCU and remain in constant conversation to move forward."

New MOOC on Using GIS to Deal with Climate Change

GIS for Climate Action, the latest addition to Esri's collection of massive open online course (MOOC) offerings, opens on October 25, 2023. MOOCs are free online courses designed for anyone who wants to acquire new skills, explore additional aspects of GIS, or grow professionally. They are self-paced, range from four to six weeks in length, provide hands-on practice with the latest ArcGIS software, and furnish a certificate upon completion.

GIS for Climate Action is hosted by Dr. Dawn Wright, Esri's chief scientist and a professor of geography and oceanography at Oregon State University. The course is enriched by contributions from Esri staff members and partner organizations such as Project Drawdown, Katherine Hayhoe, The Nature Conservancy, the University of Redlands, and state and local agencies.

In this MOOC, you will discover how GIS is being used to understand and prepare for a future that requires more resilient communities, systems, and infrastructure. You'll explore the latest ArcGIS capabilities and learn how to create insight that drives positive action. Through course exercises, you will

- Assess climate change indicators and risks and evaluate options for mitigating greenhouse gas emissions.
- Identify the potential risks of flooding and other climate-related hazards over time.
- Evaluate climate change impacts on vulnerable populations and plan adaptive strategies.
- Create a dashboard to monitor climate data.
- Use engaging stories to inspire action.

Esri provides enrolled students with free access to ArcGIS Pro, ArcGIS Online, ArcGIS Network Analyst, ArcGIS Instant Apps, ArcGIS Survey123, ArcGIS Dashboards, and ArcGIS StoryMaps software to complete course exercises. However, you must have access to a machine that meets the requirements for running ArcGIS Pro, a broadband internet connection, and a web browser that allows access to embedded video files such as Google Chrome, Apple Safari, or Microsoft Edge. Familiarity with GIS concepts and ArcGIS Pro is helpful but not a prerequisite. Course exercises will require two to three hours of study per week.

Register for this course at https://shorturl.at/cmPQX.

USING GIS TO CONTROL A BIG SNAKE PROBLEM IN THE EVERGLADES

TWO Florida government organizations used GIS to coordinate efforts to protect native animals from predation by the Burmese python (*Python molurus bivittatus*). This large constrictor, which is native to Southeast Asia, was introduced to Florida through the exotic pet trade industry. Burmese pythons have survived in the wild because south Florida has a subtropical climate and expansive regions of suitable habitat.

With a large reproducing population and almost no natural predators, Burmese pythons have become one of the most destructive invasive species within Everglades National Park and the surrounding natural areas. According to a 2011 journal article in the Proceedings of the *National Academy of Sciences (PNAS)*, road survey observations of mammals throughout southern Florida show a dramatic decline in raccoon, opossum, and bobcat populations, and these findings suggest the decline is due to predation by Burmese pythons.

The limited options available to control this predator led the South Florida Water Management District (SFWMD) and the Florida Fish and Wildlife Conservation Commission (FWC) to collaborate in 2017 to develop independent but parallel incentivized python removal programs. In 2019, Florida governor Ron DeSantis directed these two programs to align in land access processes, program regulation, and python removal requirements.

Together, the programs maintain a roster of 100 removal agents under contract. These agents are trained to safely and humanely remove pythons and other invasive snake species from Florida's natural areas, which cover approximately 4 million acres, span 11 counties, and include more than 1,000 miles of gravel levee roads. Enhanced interagency coordination and collaboration have optimized invasive constrictor detection and response, and the total number of pythons removed since 2017 is nearing 12,000.

Survey Data and Agent Accountability

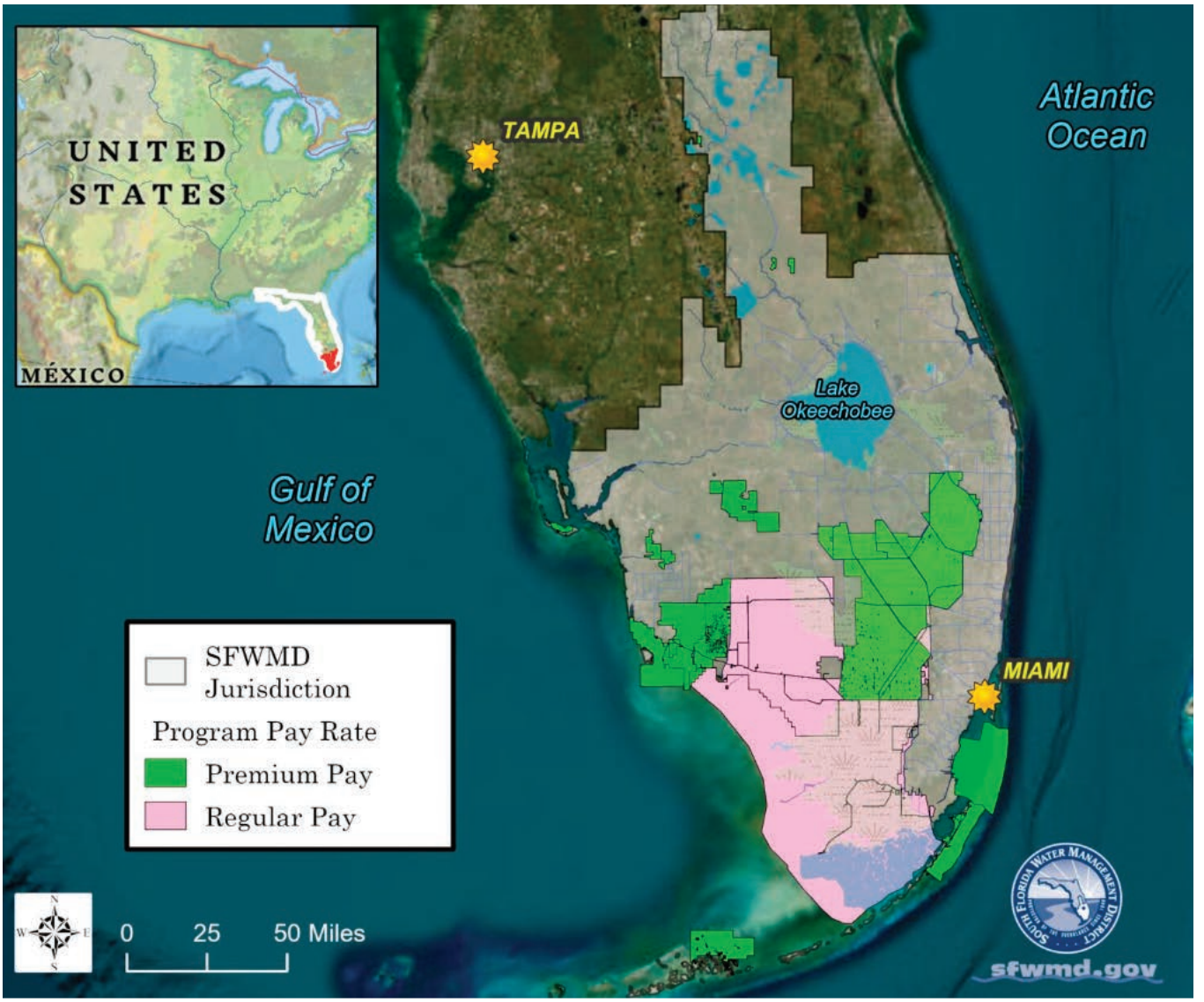
Both programs deploy experienced python removal experts to specific areas and compensate them for conducting surveys, collecting useful data while searching for snakes, and removing pythons from public lands. Initially, removal agents manually

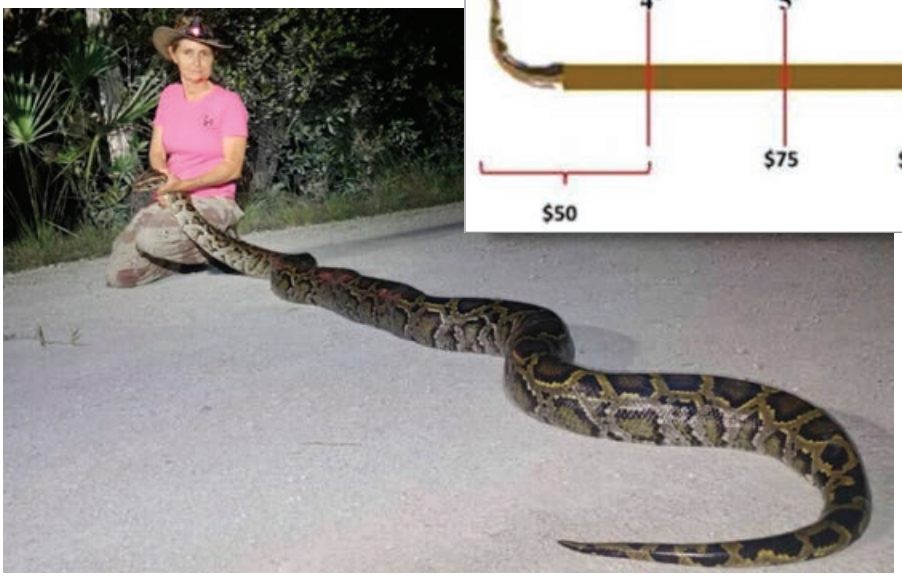
recorded date on search efforts and snake captures on paper forms. This system was not only inefficient and labor-intensive, but also produced low-quality data.

In 2018, SFWMD senior invasive-animal biologist and python elimination program manager Mike Kirkland approached the geospatial technology team at SFWMD for potential alternatives to paper forms. Geospatial technology developer Amy Peters provided an innovative solution through customized Esri mobile applications that standardized data collection, produced substantial operational efficiencies, increased program data collection, automated invoicing, and improved data quality. These enhancements informed program optimization and guided management decisions, benefiting not only SFWMD but also Burmese python control efforts by partnering agencies.

Employing Esri mobile applications for python removal programs is an adaptive data collection strategy that is continually improved. Each update to the mobile app solution has streamlined the workflow and made the dataset more consistent. In 2021, an organizational group sharing capability in ArcGIS Online let SFWMD offer the same solution to the FWC python

↓ The python removal program area (Map courtesy of Amy Peters)





↑ SFWMD python removal agent Donna Kalil is pictured with a 14-foot python. Inset: The Burmese python incentive payment schedule is based on the length of the snake. (Illustration courtesy of Mike Kirkland)

removal program and unify the two agencies' datasets.

ArcGIS Survey123 has been instrumental in field data collection by python removal agents. "Survey123 is a one-stop shop for entering all required information for each survey including our itinerary, our method of travel, passengers, and more," according to removal agent Anthony Flanagan. "Submitting the survey autogenerates email notifications to FWC wildlife law enforcement officers and serves as a written record so that we no longer need to call in when entering and leaving program lands."

Python Removal Payments

Peters configured two surveys from a common feature service: one survey for removal agents to enter field data, and one for agency staff to enter morphometric data for pythons being checked in to calculate incentive payments. The two surveys are connected by an inbox that is utilized when python captures are recorded in a removal agent's field survey. Each capture is assigned a unique snake ID. Pending check-in of these captures, agency program managers can access capture records to add attributes such as body length, weight, sex, and euthanasia method attributes for each python.

Removal agents are paid $50 for pythons up to four feet long and $25 for each additional foot. The app's autocalculation capability efficiently determines the total payment for each snake, down to the half inch. If a submitted field survey does not contain a python capture or the check-in survey is completed and submitted, the survey is designated as complete and will not be returned in the inbox query.

In addition to snake captures, python removal agents are paid for the time they spend surveying within designated program land boundaries. These areas include federal, state, and county-managed lands both within the core python population area and on the periphery of the known Burmese python range in Florida. Program areas continue to expand as new lands are included and new regions are identified as being at risk of Burmese python invasion.

Priority areas are those areas where pythons may be hard to locate, such as at the leading edge of a python range with lower population densities, or where there are sensitive native animal populations that are vulnerable to predation. In these areas, removal agents are paid a higher hourly rate to incentivize surveys.

To address the spatial component of pay rates, agents select a hyperlink from their survey to open ArcGIS Field Maps to view their location with an overlay showing areas that pay the regular hourly rate and areas that pay a premium rate. If removal agents turn on My Tracks when they operate within the project area, their track point data is spatially intersected with a highly detailed delineated program lands polygon layer. That layer is maintained in ArcGIS Pro by Heather Kostura, SFWMD geospatial data supervisor.

Automating Payments

Invoicing removal agents directly as an attachment to their email became a reality when geospatial lead developer Jamie Crandall pieced together two complex steps. First, a local Python script on a Windows Server virtual machine executes each hour via the task scheduler. The script copies track data from the Esri tracker service into a new hosted feature service. This ensures data is preserved, since Esri sunsets data from the default tracker service after 30 days.

The same script performs a spatial intersect of track points and program lands. The results are added to a hosted service containing agent attributes, such as vendor identification numbers. The enriched tracks service that is generated contains all the attributes needed to fill in invoices: the land management area identifier, pay rate, contractor information, and millions of point locations with date and time stamps.

The time when a given agent entered and exited a given management area is known so staff can simply calculate the elapsed time spent surveying there and create invoices, right? Not quite.

Pythons are primarily nocturnal hunters, which does not align with a conventional workday. Python removal agents can be on the job 24 hours a day, 365 days a year, but will be compensated for a maximum of 10 billable hours per calendar day. In addition, they can enter and exit program lands at their convenience, traverse several program lands in the same survey, or even camp within an area for any length of time.

Removal agents are only compensated for actively searching program lands. They aren't paid for time spent eating, camping, or other similar activities. Program logic needed to include criteria for setting the elapsed time back to 0 if the motion sensor on the agent's phone has been stationary for more than 30 minutes. Moreover, elapsed time must be set back to 0 if the contractor leaves the program area or travels into a different land polygon.

Once the elapsed time column was adjusted to account for the level of detail needed to model the behavior of a removal agent, the second step was accomplished by applying this cumulative logic to the geoprocessing (GP) service. A query of the enriched tracks service within a pay period for each agent is sorted by date and time and correctly summarized with a group-by statement on date, pay rate, and sum of elapsed time.

Lastly, the GP service supplies output in JSON via JasperReports software to populate a prebuilt template designed by IT lead developer David Stevens and generates a final invoice PDF that is attached in an email and sent to removal agents and program managers.

Safety, Data Analysis, and Data Maintenance

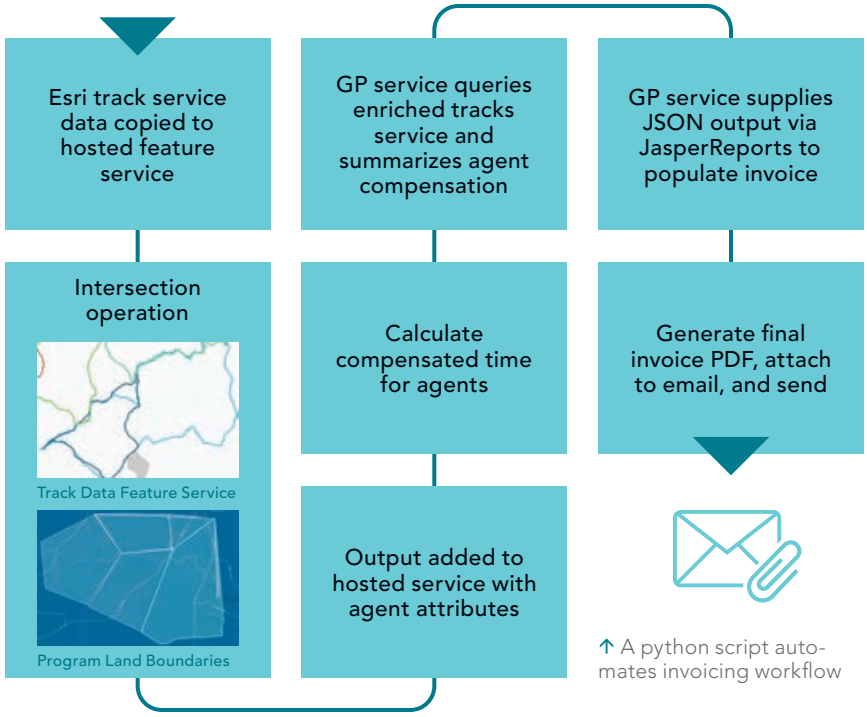
Prior to being used for automated invoicing, track data was a crucial support tool for program managers who monitor the real-time incoming locations of removal agents in the field using Esri's Track Viewer. This app helps optimize agent coverage of the project area, verify agent activities, and analyze search effort efficacy, as well as adding an invaluable layer of safety to the program.

The Everglades—especially at night—can be a very dynamic region. Being able to determine an agent's exact location within remote lands can be vital when directing assistance. On one occasion, Kirkland used Track Viewer to find the current location of a removal agent who was struggling to capture a 17-foot python in the water. Kirkland was able to locate another nearby agent, who was sent to help successfully remove the python and prevent injury to the agent.

The survey data is accessed via ArcGIS Online by an interagency group led by Ed Metzger, an invasive-animal biologist and herpetologist, who is a project manager at the University of Florida. The data is reviewed for accuracy and any errors corrected. Then geospatial tech developer Brian Diunizio links the survey feature layer with associated track data based on removal agent name and corresponding survey time stamps to create a spatially delineated survey dataset in spreadsheet form.

A time component is factored into the monthly summary table. For each removal agent survey, an elapsed time stamp corresponds to each land crossing. Adding this layer of spatiotemporal accuracy is

↓ Python agent tracks taken with ArcGIS Field Maps and displayed in ArcGIS Pro (Image courtesy of Heather Kostura)



↑ A python script automates invoicing workflow

valuable to program managers, who filter and deliver the data to partner agencies to document monthly survey efforts and captures by land area.

This data can be downloaded by contract invasive-species biologist researchers at the University of Florida to analyze spatiotemporal trends and covariates for a more comprehensive assessment of python behavior. To increase removal rates, the long-term goal for data analysis includes advanced biometrics for predicting python behavior patterns.

In addition to biological reports and publications, ArcGIS StoryMaps and ArcGIS Dashboards apps have been essential in quickly and effectively communicating with decision-makers. The python removal program lends itself to different dashboard products for removal agents, program and agency managers, and statewide lawmakers (which is in development).

The removal agent dashboard displays the data of individual contractors and shows the total number of captures, total hours worked, and capture locations. This dashboard uses a restricted-view layer that prevents other contractors from viewing the information. A separate web map with a time delay on the capture layer displays captures by month so that agents can plan future survey locations based on seasonal hot spots. The agency management dashboard provides insight into which program lands are being surveyed most frequently and includes removal agent performance metrics. It also displays a quarterly breakdown of captures for reporting purposes.

The feature layer contains millions of enriched track points, and the survey feature layer has many large photo attachments. These layers require a data maintenance workflow to back up these hosted services and sunset the data to reduce storage credit usage in ArcGIS Online. Track points are inserted into a local file geodatabase for archiving, and the ArcGIS Survey123 data sources are downloaded as zipped file geodatabases. All these tasks are completed with a collection of local Python scripts and hosted notebooks on ArcGIS Online that are scheduled to run at defined intervals.

"Data standardization and quality control are critical needs for the python removal program. Our geospatial team successfully leveraged Esri applications and tools to meet our data management goals while dramatically increasing efficiency," said LeRoy Rodgers, the section lead for SFWMD Vegetation and Invasive Species Management.

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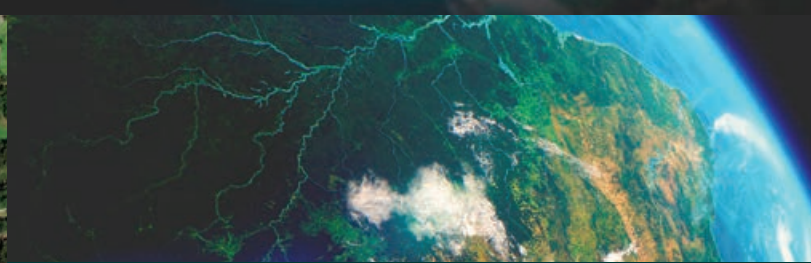

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