

ArcUser

The Magazine for Esri Software Users

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Less Gray:
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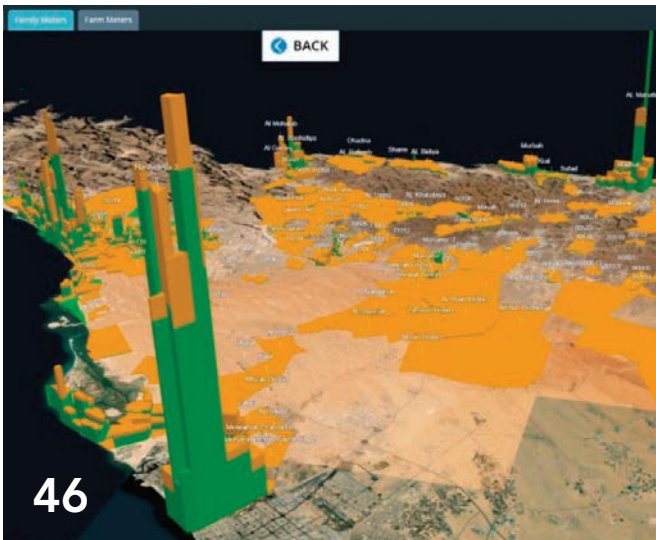
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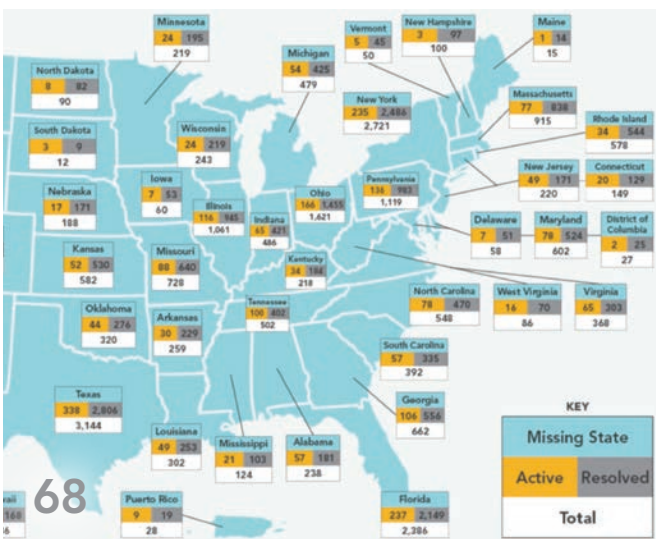
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Our Future and Water

Water is critical to our lives. It makes up, on average, 60 percent of our bodies. It is fundamental to biochemical processes such as photosynthesis and cellular respiration. It is essential to all life on Earth.

And water is inextricably bound up with the challenges brought on by climate change. United Nations Water, an interagency coordinating mechanism for working on water and sanitation issues, has characterized climate change as “primarily a water crisis” that is manifested in more severe flooding, rising sea levels, loss of polar ice, an increase in the occurrence of wildfires, and more prolonged and widespread droughts.

Articles in this issue describe how government agencies and nonprofit organizations are using the geographic approach and GIS to increase the water supply, protect water quality, monitor water usage, and control stormwater.

Los Angeles County’s Safe, Clean Water Program (SCWP) is using a GIS-based, holistic approach to water management that funds projects to improve the local water supply while invigorating communities. These projects help offset the effects of climate change. They divert stormwater while recharging groundwater and supporting green infrastructure elements such as parks, landscaping, and trees. These elements make urban environments more livable by moderating temperatures and providing recreational areas to residents.

Although 75 percent of the Earth’s surface is covered by water, only 3 percent of that water is the freshwater that human life depends on. Articles in this issue describe how government agencies are applying GIS tools to monitor water consumption, detect the presence of dangerous chemicals, and safeguard water quality. The ability of GIS to collect, integrate, and analyze information about drinking water infrastructure is making the formidable task of identifying lead lines and managing their replacement feasible.

Employing the geographic approach to water management is an integral component of mitigating the impacts of climate change and ensuring a more resilient and sustainable world.

Monica Pratt
ArcUser Editor

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Editorial

Editor Monica Pratt

Contributors Keith Cooke, Matthew Lewin, Rosemary Boone

Technical Adviser Paul Dodd

Copyediting Lois Stuart

Design

Creative Director James Hitchcock

Designer Doug Huibregtse

Illustrator Dan Gill

Photographers Rachel Kinney, Eric Laycock

Print Coordinator Lilia Arias

Advisory Board

Corporate Marianna Kantor

Products Damian Spangrud

International Dean Angelides

Marketing Communications Jeff Brazil

Industries Damian Spangrud

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Editorial Inquiries

Monica Pratt, ArcUser Editor
380 New York Street
Redlands, CA 92373-8100 USA
arcuser_editor@esri.com

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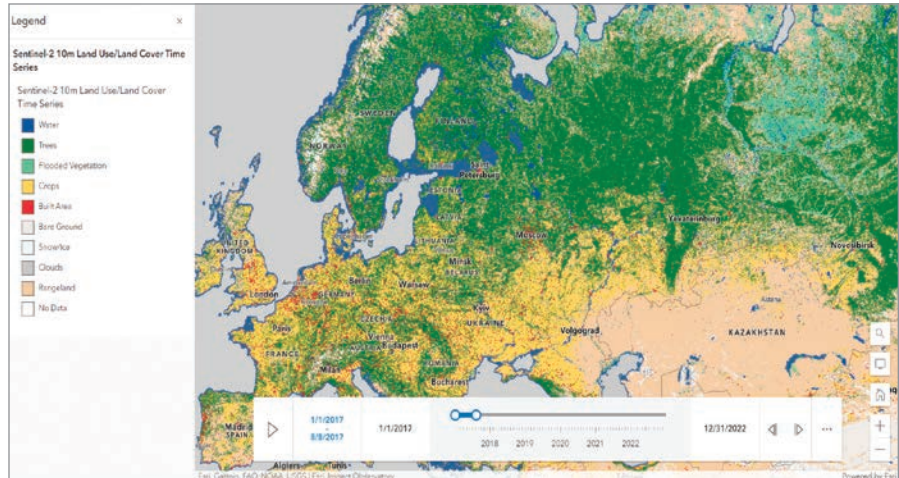
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Briefly Noted

→ AI Makes Latest Land-Cover Map More Temporally Consistent

In partnership with Impact Observatory, an artificial intelligence (AI)-powered geospatial monitoring company, Esri has released a global land-use/land-cover map of the world based on the most up-to-date 10-meter Sentinel-2 satellite data for every year since 2017. Following the latest 2022 data released earlier this year, the AI model for classification has been improved, making the maps more temporally consistent. This enables users to work “with maps that will accurately reflect events and Earth processes that are happening in reality,” said Sean Breyer, Esri program manager for ArcGIS Living Atlas of the World. With planned annual releases, users can make year-over-year comparisons in global land cover. This is especially important for organizations such as national government resource agencies that use this data to define land-planning priorities and determine budget allocations. To explore this in ArcGIS Living Atlas, go to livingatlas.arcgis.com/landcoverexplorer.



↑ Esri has released a global land-use/land-cover map of the world based on the most up-to-date 10-meter Sentinel-2 satellite data for every year since 2017.

→ Microsoft and Esri to Speed Up Access to Earth Observation Data

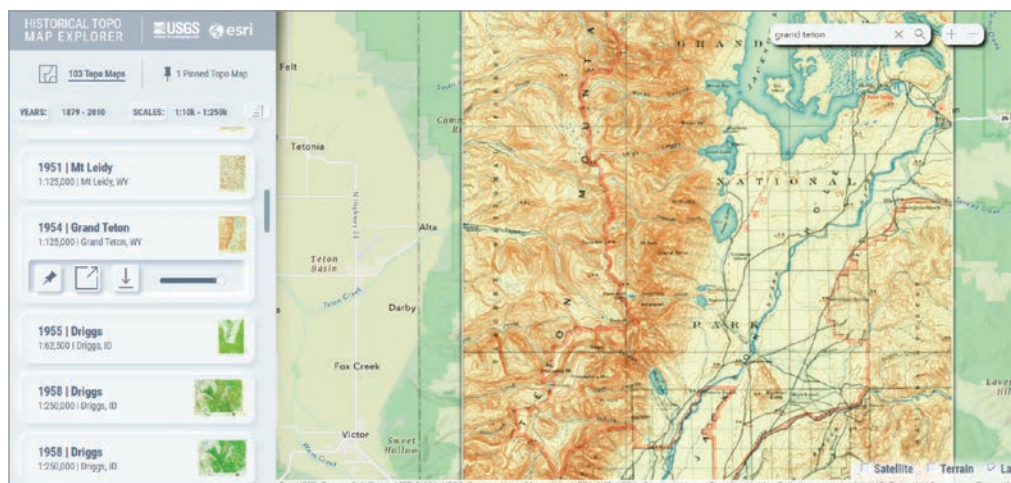
Esri is closely integrating ArcGIS with Microsoft Azure Space to improve access to Earth observation data. Esri is placing its entire technology stack in Azure Space data centers. Colocating Esri technology with the Azure Space antennas will reduce system latency, automate a lot of the postprocessing, and help users get to the meaningful data as quickly as possible.

→ Search Historical USGS Topo Maps

The United States Geological Survey (USGS) has a rich history of creating exquisite topographic quadrangle maps. The USGS Historical Topo Map Explorer makes this trove of digital topo maps more accessible with a new updated version. Now in beta, this free app provides a visual way to search and explore these maps via geographic extent, publication year, and map scale.

You can do many different things with the USGS Historical Topo Map Explorer. You can create beautiful mashups of old and new by blending the modern World Hillshade layer from ArcGIS Living Atlas of the World into these historic maps for added topographic context and visual interest. You can pick out digital maps of interest and pin them together to assemble broad coverage or you might stack up several maps of the same location to compare its changes over time.

These topo maps can be downloaded to your computer as spatially aware GeoTIFF image files and added to an ArcGIS Pro project, or you can create a new web map in ArcGIS Online. You can also explore historical topo maps on your mobile device. Try out the new USGS Historical Topo Map Explorer at <https://livingatlas.arcgis.com/topomapexplorer>.




↑ The USGS Historical Topo Map Explorer makes historical topo maps accessible and usable.

→ Emergency Response Dashboard Receives NASCIO Award


The California Health and Human Services Agency (Cal HHS) Center for Data Insights and Innovation received the 2023 National Association of State Chief Information Officers (NASCIO) State IT Recognition Award for a cloud-based tool that uses GIS to improve situational awareness and emergency response. Cal HHS received the award in the Data Management, Analytics & Visualization category for the All-Hazards Dashboard. The dashboard visualizes facilities, identifies priorities during emergencies, and can help handle the logistics of moving people and equipment to better keep residents safe. The All-Hazards Dashboard was built using Esri technology and with assistance from Esri. The NASCIO State IT Recognition Award highlights the use of information technology by states to improve how government functions and provides services to residents.


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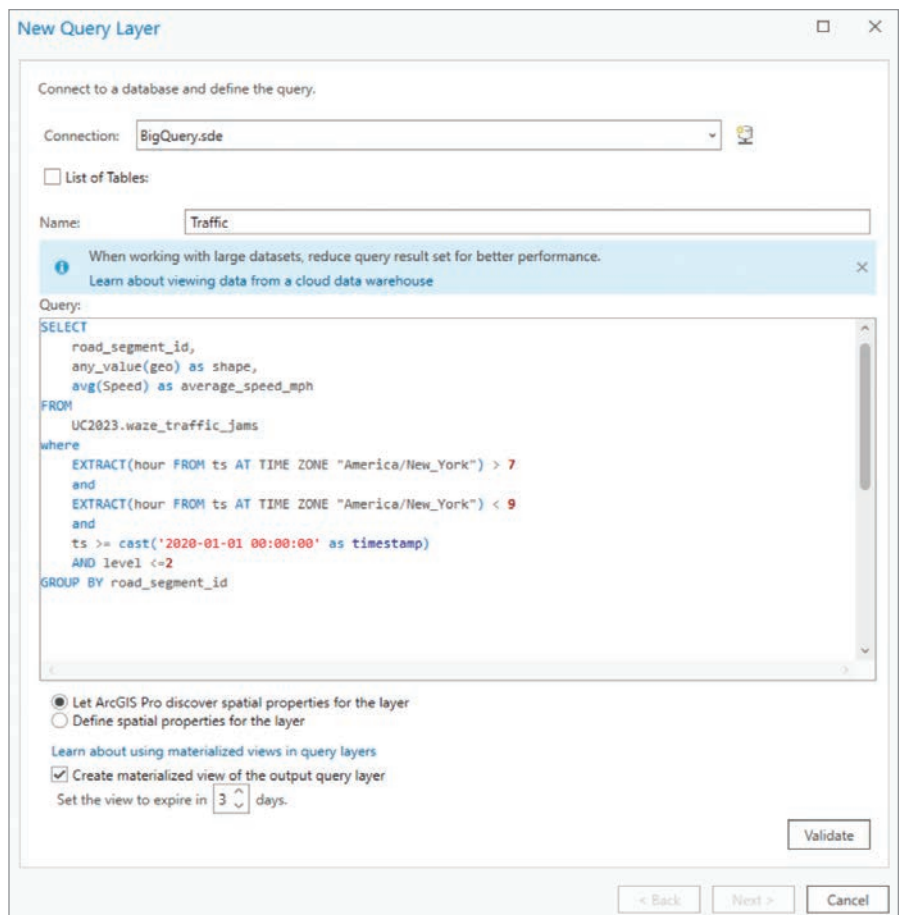
Leverage Cloud Data Warehouses with ArcGIS Pro and ArcGIS Enterprise

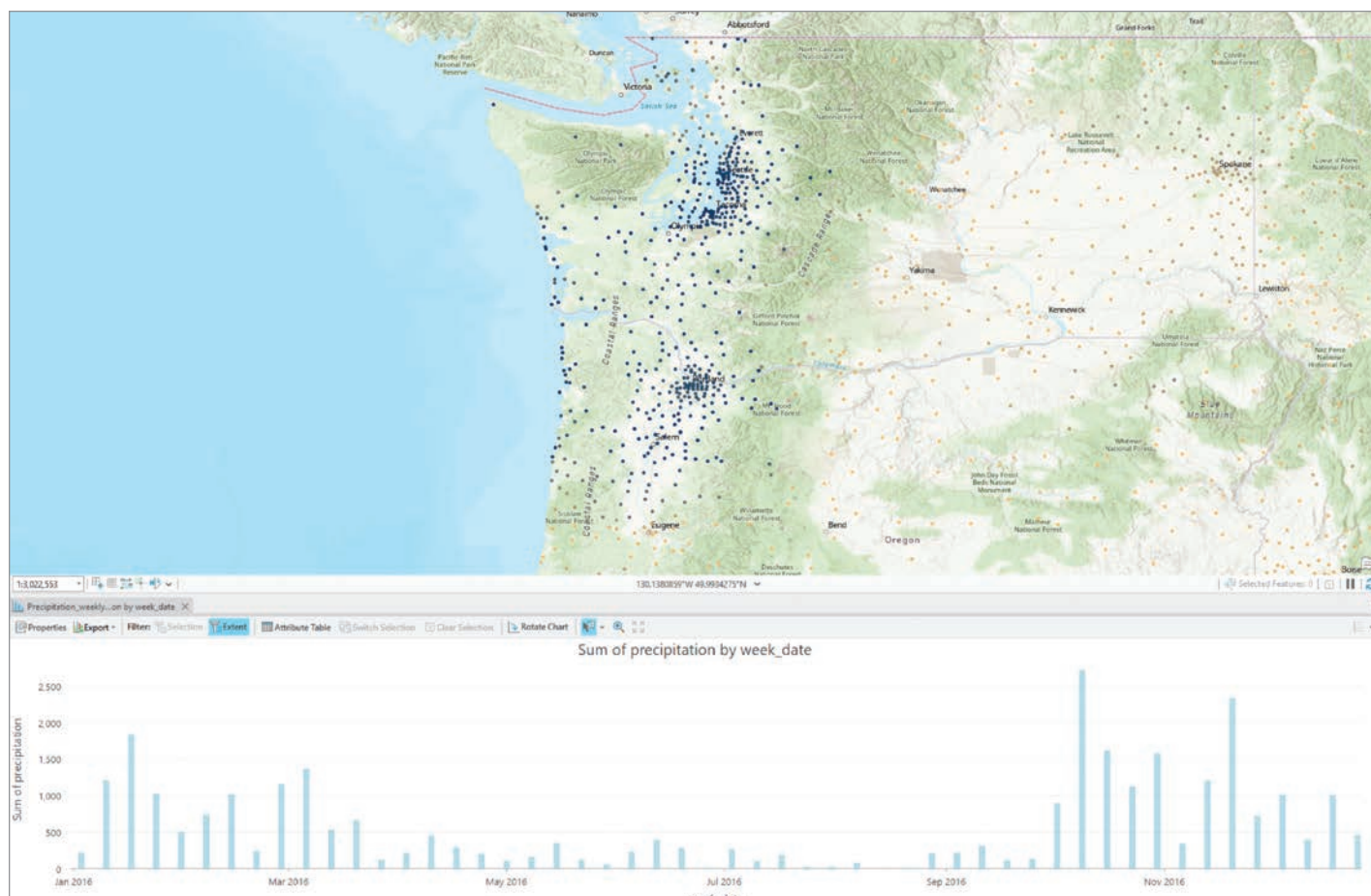
By Sarah Hanson

Cloud data warehouses are scalable, resilient, secure, and performant solutions for storage that are available in public clouds as managed services. Cloud elasticity means that they can scale infinitely and automatically—in terms of both storage capacity and processing power—to support demand at any given time. Cloud data warehouses offer a pay-as-you-go model so that organizations only pay for the resources they use as they use them.

For all these reasons, cloud data warehouses are becoming an integral part of many organizations, especially those that have adopted or are moving toward a cloud-first strategy. The 2021 fall release of ArcGIS Pro 2.9 and ArcGIS Enterprise 10.9.1 added functionality that allows you to directly connect to and access data stored in cloud data warehouses. Support for cloud data warehouses creates an opportunity for organizations using ArcGIS Pro and ArcGIS Enterprise to integrate yet another type of cloud-native service with their systems. Like database as a service (DBaaS) and cloud storage (blob storage), cloud data warehouses are available in public clouds as managed services.

Cloud data warehouses are not designed for transactions, or row-based editing. Instead, they are designed to support analysis. Most commonly, organizations move to the cloud and use cloud data warehouses to archive their historical records. These records could have been previously maintained in a transactional database, a relational database management system (RDBMS), or some other tabular format. Cloud data warehouses are also utilized for writing Internet of Things (IoT) sensor data,





- ↑ Esri has enhanced many chart types available in ArcGIS Pro.
- ← SQL queries are used to create a query layer definition.

which can generate tremendous volumes of data in a short amount of time.

Get Started by Creating a Query Layer

You can connect from ArcGIS Pro to three of the most widely adopted cloud data warehouses: Amazon Redshift, Google BigQuery, and Snowflake. Once a connection is established, you can create a new query layer (spatial) or a query table (nonspatial) to extract the features and attributes you want. For example, an analyst for a retail chain could create a query layer that aggregates sales information by product category and store location. Or a transportation organization could visualize where traffic congestion occurs during the morning rush hour.

To create query layers from any database, whether a relational database or a cloud data warehouse, you need to be familiar with Structured Query Language

(SQL). SQL queries are used to create query layer definitions.

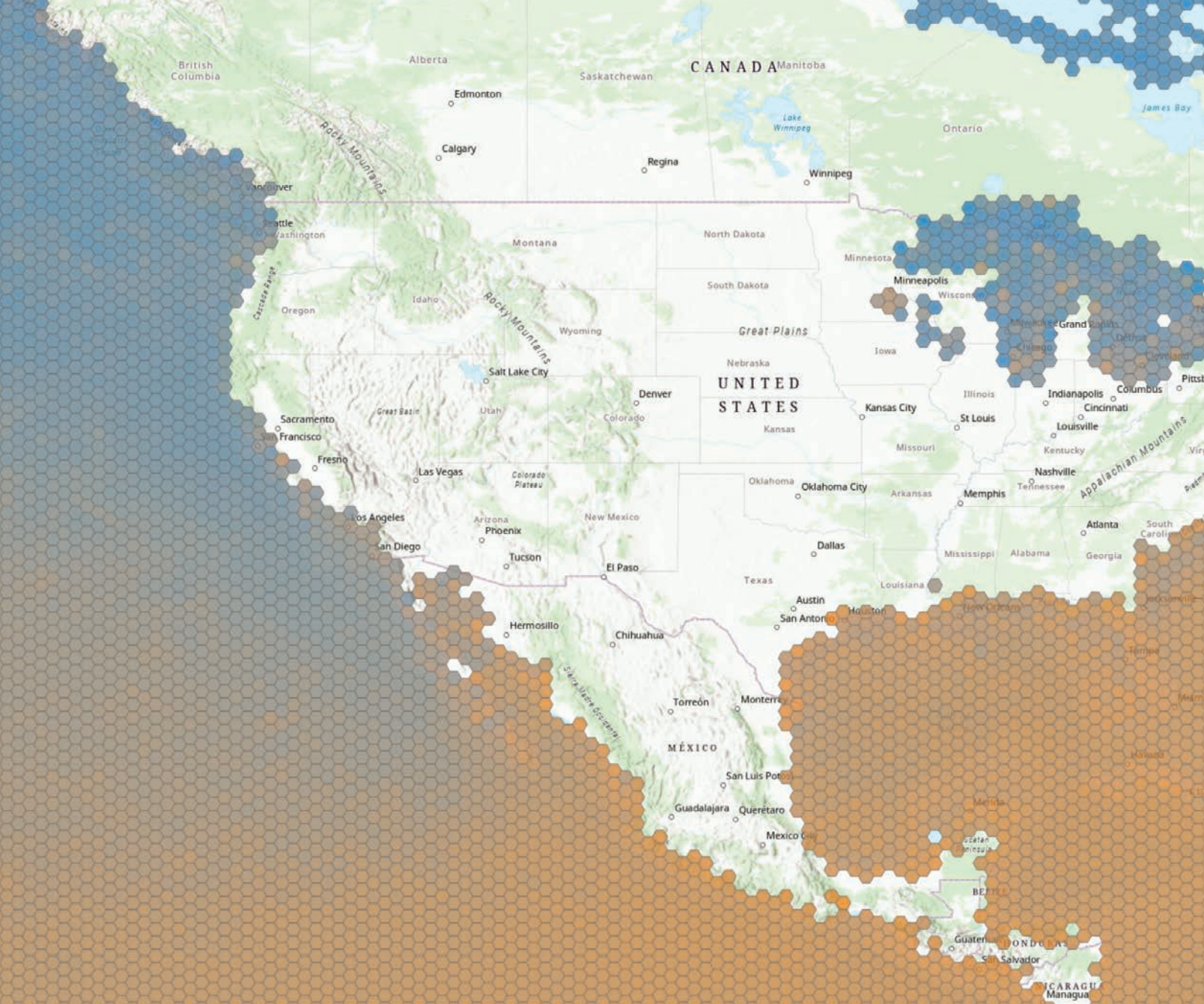
Revealing Patterns and Trends in Your Data

ArcGIS Pro also includes tools, such as charting and feature binning, that can be used to detect patterns and trends in data. Imagine a bar chart showing annual average precipitation amounts by week. With the map extent set to the entire United States, the chart may not be very revealing. However, as you zoom into a more localized area, the chart updates, showing the average precipitation for a specific area or region throughout the year. Suddenly, you have a charting tool that is exploratory and interactive and allows you to gain new insight. Chart results can be updated by simply panning around the map.

Feature binning is another great way to detect patterns and trends, especially when you are working with datasets that

have thousands or even millions of point features. To try this technique, run the Enable Feature Binning geoprocessing tool to use database-driven feature binning or set the display properties on a layer to use application-driven feature binning.

Most commonly, organizations move to the cloud and use cloud data warehouses to archive their historical records.



Esri recommends using database-driven feature binning for datasets that contain a large number of features because bin information is stored in the database, so this results in better performance. In addition, you can create summary statistic fields such as mean, min, max, and standard deviation for the numeric fields in your dataset and use those fields to symbolize feature bins.

Sharing Web Layers to ArcGIS Enterprise

Esri has added support for BigQuery, Redshift, and Snowflake in ArcGIS Enterprise and ArcGIS Pro. Users with permissions to publish to ArcGIS Enterprise

may share their query layers to ArcGIS Enterprise. Like sharing other datasets by reference, your cloud data warehouse must be registered as a data store with ArcGIS Enterprise. When sharing, you will need to determine two things: the type of web layer that you want to share and how ArcGIS Server should access the data.

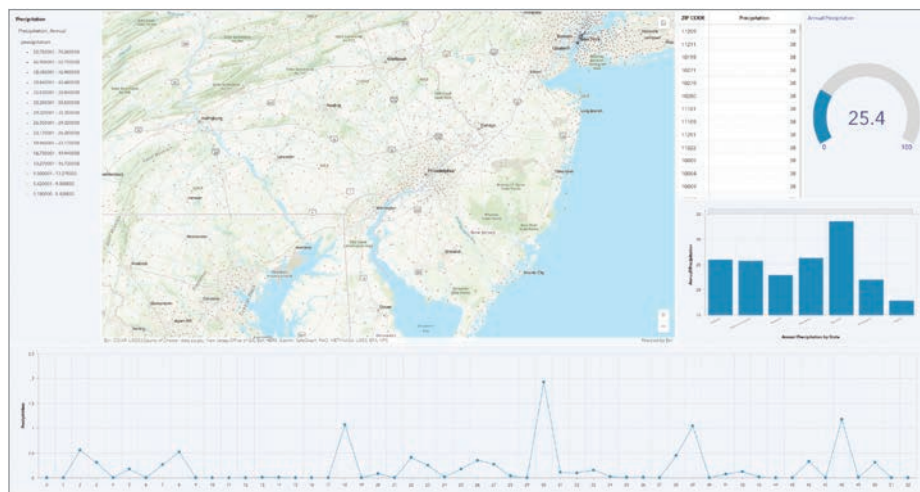
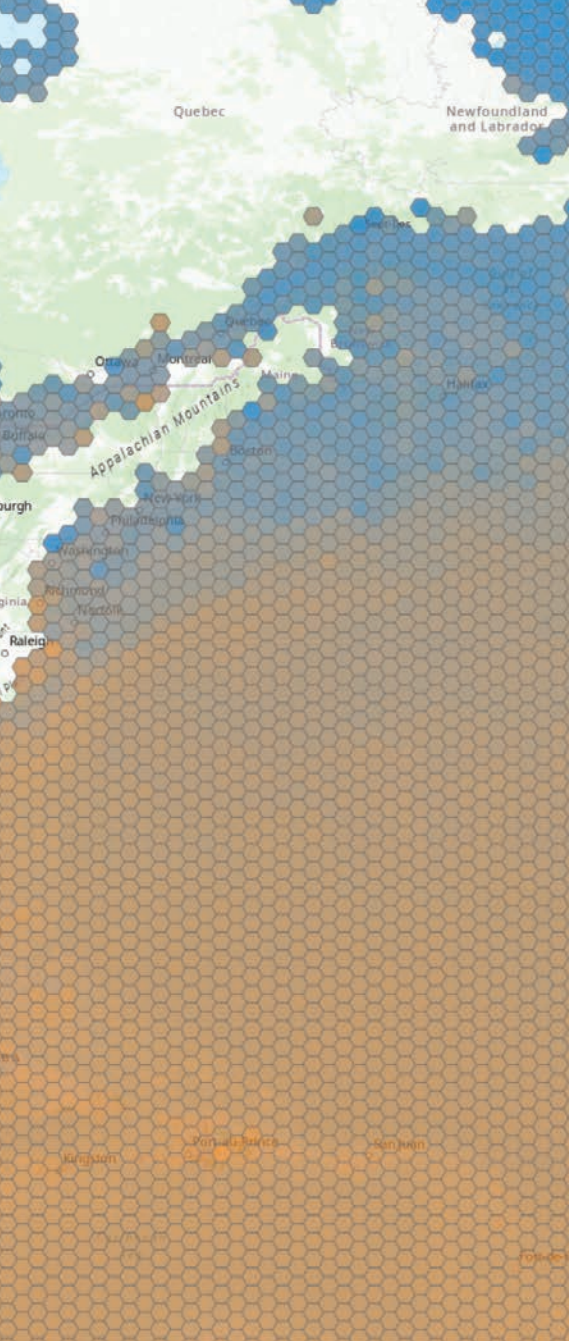
Considerations for Sharing

Query layers that reference data in cloud data warehouses can be shared as map image layers to ArcGIS Enterprise 10.9.1 or later. Support for sharing web feature layers was added with ArcGIS Enterprise 11.0. This release supports

sharing a read-only feature layer for Google BigQuery. In ArcGIS Enterprise 11.1, support for sharing a read-only feature layer was added for Snowflake. Feature layer support for Amazon Redshift is planned for a future release of ArcGIS Enterprise.

While neither the map image layer nor the features layer supports editing in the context of cloud data warehouses, there are some differences between these layer types.

If you're using complex symbology or dynamic joins or relates, you will want to publish a map image layer. If you want the web layer to be able to be used as input to analysis tools, you will want to publish a



- ↑ Data that references cloud data warehouses can be displayed in ArcGIS Dashboards.
- ← Feature binning can be used to detect patterns and trends in data. These bins were aggregated from more than 350 million individual point observations.

cloud data warehouse each time the layer is accessed. Both materialized views and snapshots store the SQL query result set as a persisted table (either in the cloud data warehouse or the relational data store). While materialized views within the cloud data warehouse will update automatically if the underlying data changes, snapshots are static and must be explicitly refreshed from the web layer's item page in the ArcGIS Enterprise portal.

Refreshing the snapshot will overwrite the data stored in the relational data store with the latest results set. Updates to the snapshot require a manual refresh, but you may see the best performance using this option because the web layer is referencing data in the relational data store and does not need to reach out to the cloud data warehouse when a request is made.

The option you choose for accessing data in your cloud data warehouse will depend on considerations related to cost, performance, and the frequency of updates to the underlying data. In general, sharing a materialized view or a snapshot will result in better performance and incur less cost.

Summary

If you have a cloud data warehouse and want to get started integrating it with ArcGIS Pro and ArcGIS Enterprise, you can start immediately. ArcGIS is a powerful tool for enhancing and unveiling patterns and trends in your data to make better, more

informed decisions, and cloud data warehouses are a great way to get the most out of your ArcGIS system.

About the Author

Sarah Hanson is a product manager for ArcGIS Enterprise, with a focus on cloud data management. In her free time, she loves to travel and spend time outdoors.

feature layer. Once published, your cloud data warehouse-backed web layers can be used in your maps and apps or shared across the web just like any other map image layer. Esri has noticed that many users want to share data that references their cloud data warehouse for use in ArcGIS Dashboards, a web-based application that presents analytics using interactive maps, charts, and tables.

You must also consider how you want the data in your cloud data warehouse to be accessed. There are three choices: directly, by creating a materialized view, or by creating a snapshot. When data is accessed directly, the SQL query will be run in the

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Why You Should Upgrade to ArcGIS Enterprise 11.1

By Maggie Busek

ArcGIS Enterprise 11.1 will help your organization work more efficiently, integrate data, and support data-driven decision-making.

ArcGIS Enterprise 11.1 for Windows and Linux and ArcGIS Enterprise on Kubernetes were released in the second quarter of 2023. This article discusses why you want to upgrade to ArcGIS Enterprise 11.1 and how to plan for this upgrade.

New features and improvements in ArcGIS Enterprise 11.1 are designed to help your organization work more efficiently, integrate data, and support data-driven decision-making. Key highlights of this release include custom data feeds, service webhooks, organization webhooks interface, Map Viewer and Scene Viewer enhancements, administration enhancements, and app and server role updates.

Custom data feeds allow you to create read-only feature services from any data source that are ready to be used anywhere in the ArcGIS system. The data does not need to be in a native format supported by ArcGIS clients. This data can remain in its custom format and location while being fetched by ArcGIS Enterprise. Custom data feeds open up possibilities for bringing in data that is not natively supported by ArcGIS and using it to inform decision-making.

Webhooks for feature service events implement CRUD [*create, read, update, and delete*] operations for referenced and hosted services. Geoprocessing service webhooks are also available to provide job status on asynchronous services. These webhooks are configurable within the ArcGIS Enterprise portal. Service webhooks can help improve efficiency for your organization by providing notification when an event occurs instead of requiring regular checks for updates.

Organization webhooks can be used to track events for portal-level actions such as user-, item-, and group-related operations. Although ArcGIS Enterprise has supported organization webhooks for the last several releases, with 11.1

organizational webhooks can be configured in the ArcGIS Enterprise portal. Organization webhooks, like service webhooks, improve efficiency by providing notification when specific events occur.

Visualize data in new ways with pie charts in Map Viewer and the Daylight and Weather tools in Scene Viewer. These enhancements provide additional context to your data visualizations.

To learn more about 11.1 enhancements, read the blog post "What's New in ArcGIS Enterprise" (<https://shorturl.at/ryTY7>). For a full overview of this release, read the product documentation (<https://shorturl.at/flpzQ>).

Maximize the Value of Your GIS Investment

ArcGIS Enterprise constantly evolves. New versions are regularly released. To get the full value from the product, you need to upgrade regularly to get new features, functionality, enhancements, and security updates. The product life cycle provides a window of support for each version of ArcGIS Enterprise as it moves from general availability to extended support to mature support to retirement over a predetermined period.

There are two release support categories for ArcGIS Enterprise: short term and long term. Short-term support releases receive technical support for three years and patches for 18 months. Long-term support releases receive technical support for six years and patches for four years.

It is critical to upgrade regularly so that your organization stays on a supported version of ArcGIS Enterprise. Retired versions no longer receive technical support or patches. Once your organization's current version of ArcGIS Enterprise reaches extended or mature support, you must have a clear plan for upgrading before that

version is retired. For more information, refer to documentation on the product life cycle (<https://shorturl.at/dwAGM>) or the technical support website (<https://shorturl.at/ad259>) for the support status for versions of ArcGIS Enterprise.

In addition to its many improvements, ArcGIS Enterprise 11.1 is a long-term support release. The 11.1 release of ArcGIS Enterprise is especially important if your organization is a utility or telecom company because it is designated as a network management release. For more information, read “What’s New with the Network Management Release Plan” (<https://shorturl.at/ACHM6>).

Things to Consider before Upgrading to ArcGIS Enterprise 11.1

Substantial changes were made to ArcGIS Enterprise with the 11.0 release in 2022. Beginning with ArcGIS Enterprise 11.0, the ArcMap-based runtime is not supported, ArcMap services cannot be published to ArcGIS Enterprise, and ArcGIS Enterprise SDK moved from .NET Framework 4.x to .NET 6.

At the 11.0 release, the following products have been retired:

- ArcGIS Dashboards Classic
- Esri Story Maps Classic Templates
- Presentation for Map Viewer Classic
- Many ArcGIS Configurable Apps templates

You will need to migrate content from Esri Story Maps Classic, ArcGIS Configurable Apps, and other retired templates to new templates.

Any ArcMap-based services your organization uses will need to be migrated to ArcGIS Pro so they can be used in ArcGIS Enterprise. Map, feature, geodata, and image services will automatically migrate when you upgrade. Some service types, including geoprocessing, geocoding, and

network analysis services will not upgrade automatically migrate and will need to be manually migrated to ArcGIS Pro. For more information on this process, see the tech paper *Manually migrating services from the ArcMap-based to ArcGIS Pro-based runtime* (<https://shorturl.at/hHISY>).

With version 11.1, the ArcMapServiceCheck tool can be used to generate an HTML report that provides details on the status of ArcMap-based runtimes that existed prior to the upgrade process. The report provides information on the services that were successfully migrated and the services that require additional steps to use the ArcGIS Pro-based runtime.

At ArcGIS Enterprise 11.1, the IIS Web Adaptor and Enterprise SDK now use .NET 6. This new generation of .NET is one of the many ways that ArcGIS Enterprise continues to modernize its underlying technology. Make sure your machines can meet system requirements for these updated tools by installing .NET 6.

If your organization needs to continue using ArcMap-based services or can’t migrate to the new apps yet, Esri recommends using ArcGIS Enterprise 10.9.1 prior to upgrading to 11.1 because this is the last version to support both ArcMap- and ArcGIS Pro-based runtimes and includes support for old and new app templates. ArcGIS Enterprise 10.9.1 is a great version to do any migration work needed prior to upgrading to ArcGIS Enterprise 11.1. See “Enterprise 10.9.1 until you’re ready to turn it up to 11” (<https://shorturl.at/rsHXZ>) and documentation on upgrading (<https://shorturl.at/fnEMZ>) for more information.

About the Author

Maggie Busek is a product manager for ArcGIS Enterprise.

In addition to its many improvements, ArcGIS Enterprise 11.1 is a long-term support release.



More Green, Less Gray

By Christa Campbell and Sophia Garcia

LA County Maps Big Plans for Its Water Supply

Los Angeles County's Safe, Clean Water Program (SCWP) uses geospatial technology to manage, report, and track nearly 200 stormwater projects and studies to show taxpayers how improvements are being made to the local water supply.

The winter storms that drenched much of California from December 2022 through March 2023 refilled reservoirs. However, this increased stormwater and snowmelt was mostly uncaptured because the state's outdated infrastructure was designed to swiftly carry rainwater to the ocean.

LA County aims to change that.

In a typical year, about 15 inches of rain falls in the Los Angeles area. Nearly half of that fell in August 2023 as the aftermath of a historical tropical storm, a remnant of Hurricane Hilary, passed through Southern California. Roughly a third of the

water supply in the area comes from locally pumped groundwater that is continually replenished by percolation when it rains. Nevertheless, not all rain can be captured so it can be used as drinking water or used to restock the groundwater. Some years have seen more than 100 billion gallons of flow into the Pacific Ocean.

That's a big reason voters approved Measure W in 2018. It created LA County's SCWP, which receives \$280 million in tax dollars per year. Now in its fifth year, the program has funded more than 126 stormwater improvement projects. Most use solutions that mimic natural processes to increase water supply, improve water quality, protect public health, and invigorate communities.

SCWP projects include green infrastructure elements such as infiltration



basins, rain gardens, bioswales [which are landscape features that collect polluted stormwater runoff], dry wells, wetlands, and permeable pavement. This green infrastructure contrasts with gray infrastructure—such as storm drains, which are typically built with concrete and steel—that are designed to move water underground and away from property.

SCWP administrators map and track each project using GIS. The map provides a better understanding of each project with information about the project's location and goals. Los Angeles residents can view the map to see their tax dollars at work.

"Mapping provides a 'wow' element for us to show progress to interested stakeholders and the public," said Kirk Allen, senior civil engineer at LA County Public Works and lead administrator of the SCWP portal. "They can see how these projects

are equitably distributed. It adds a perspective you can't do without a map."

Local Approaches to Water Concerns

At over 4,000 square miles, Los Angeles County is one of the largest in the nation, with a population of 9.8 million residents. It contains six major watersheds where rain and runoff collect and then drain into a river, lake, reservoir, or the ocean.

The Los Angeles County Flood Control District (LACFCD), administered by LA County Public Works, is one of the key stewards of these watersheds, which it manages with various infrastructure and programs. LACFCD assists in improving the region's clean drinking water, recreation, and wildlife habitats. It also leads efforts to reduce potential hazards caused by flooding and mudflows.

SCWP brings together watershed and infrastructure managers from LACFCD, water agencies, local and county governments, businesses, academia, nonprofits, and other organizations. Many of the projects developed through the SCWP program include input from community-based organizations that focus on public health and environmental conservation.

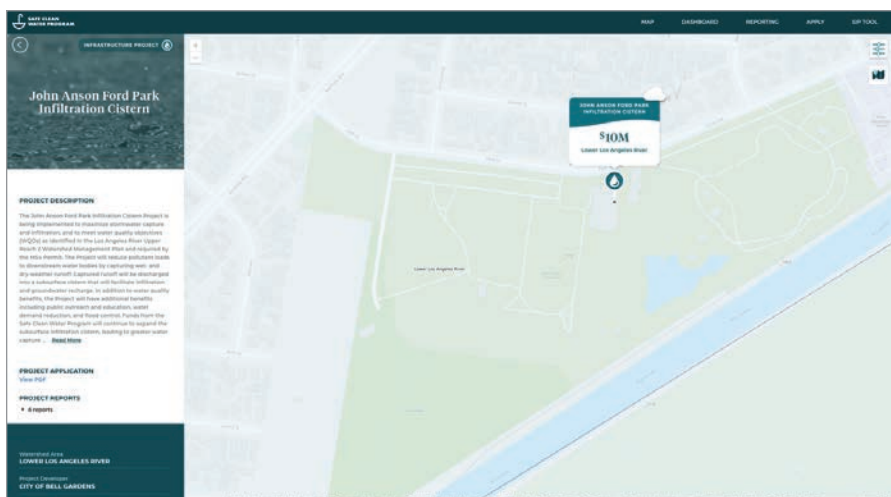
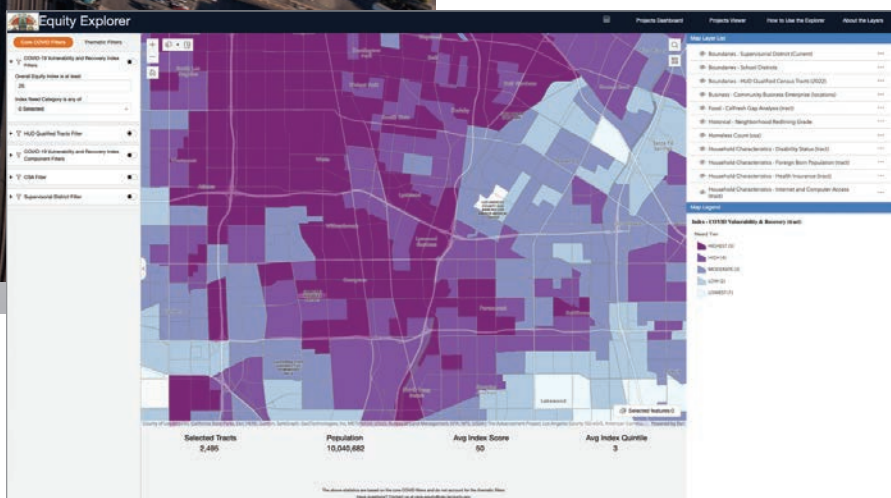
For instance, in Boyle Heights, a predominantly Latino community, the City of Los Angeles Sanitation and Environment Department engaged with a local organization, Promesa Boyle Heights, during the conceptual phase of the Hollenbeck Park Lake Rehabilitation Project and will involve the department during its ongoing development. The project will beautify the park, mitigate flooding, and teach youth about water resources.

Each locally led SCWP project addresses important outcomes such as the following:

- Stopping toxins and trash from flowing into local waterways
- Cleaning and treating rainwater
- Adding green spaces and enhancements for communities and habitat

▢ The County of Los Angeles Equity Explorer provides in-depth details about the makeup and social vulnerability of people and communities.

▢ The John Anson Ford Park Infiltration Cistern project will capture water under baseball and soccer fields.



Improving Quality of Life

Equity is a guiding principle of the SCWP. According to researchers at the University of California, Davis, communities of color in Los Angeles lack the green space that not only cools neighborhoods but soaks up rainwater. And these communities face the greatest burden from flooding.

SCWP project applicants and those involved in the governance of the program are encouraged to consider the needs of the community. They have access to the County of Los Angeles Equity Explorer, which is a map-based tool and collection datasets that can be used to identify areas where communities are experiencing disadvantages. It pinpoints places where historical racism and inequities in investment have occurred, and land-use planning has been lacking. The SCWP prioritizes the

development of projects in those areas with input from the community about the enhancements they want to see.

By focusing attention on neglected areas, SCWP collaborators want to improve the quality of life for more people, especially those living in treeless paved places that retain more heat. Researchers found that US residents in low-income neighborhoods endure temperatures that are higher by 7 degrees Fahrenheit than residents in wealthy neighborhoods. Proximity to parks, plant life, and water bodies provides cooler places to escape the harmful impacts of heat.

"The maps help us orient projects in relation to disadvantaged communities," Allen said. "They help us steward public dollars to help make water infrastructure more resilient and cleaner for the communities we serve."

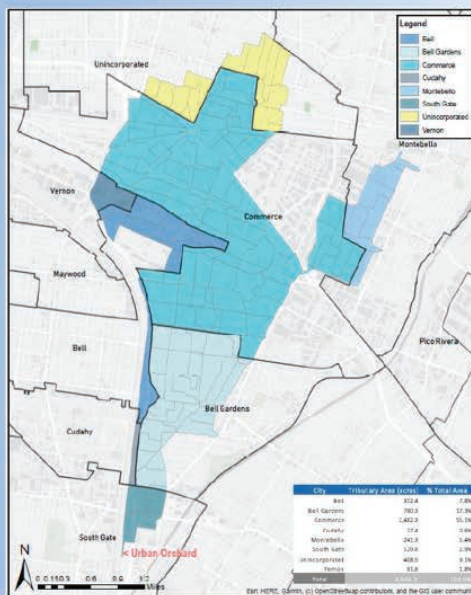
Benefits for Watersheds and Residents

Projects along the Lower Los Angeles River Watershed Area, one of the nine areas within SCWP, collectively advance the goals of the program. The Safe Clean Water Portal (<https://shorturl.at/EHU13>), which is accessible to the public, showcases funded, completed, and ongoing projects. The site is a repository for project-specific information and includes the benefits provided by each project.

"Having a map showcases the drainage area and community benefits," Allen said. "The map in the SCWP portal highlights the potential relationships between projects and is a good resource to facilitate discussion among stormwater management groups. Those involved can easily analyze the map and its accompanying information,

Urban Orchard Project

Upstream City Tributary Area



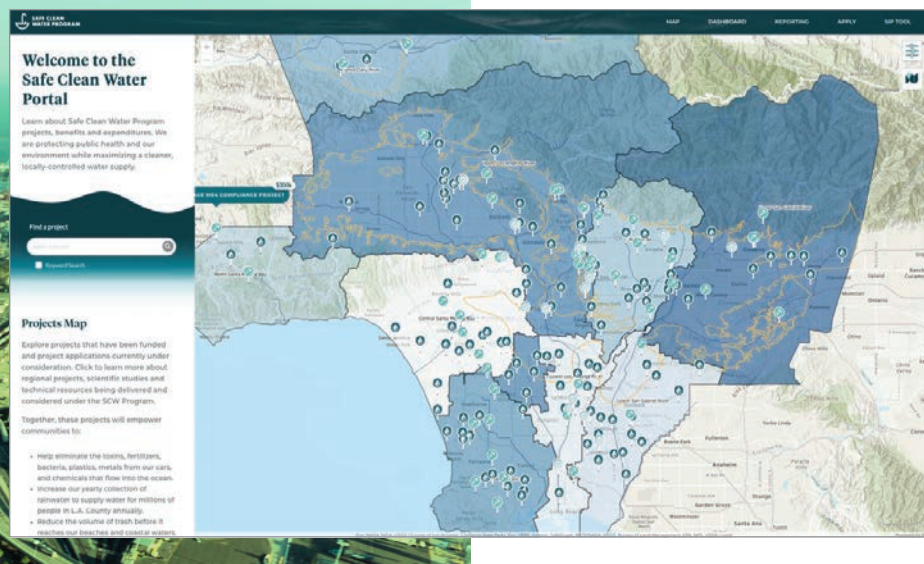
Treatment Facility



Wetland BMP Summary:

- 4,504.2 acres watershed drained via the Bandini Channel
- 1 cfs est. average inflow capture
- 5 cfs max. diversion rate
- ~97 acre-feet of water pumped through annually
- Removal of ~27 lbs. of zinc per year and 33 lbs. of suspended solids
- Storage capacity: 1.8 acre-feet wetland and 2.3 acre-feet reservoir
- ~70% of park irrigated with recycled water
- Habitat for native fish
- Native and drought tolerant plants





identify opportunities for collaboration, and better understand how projects (individually and collectively) can contribute to the effectiveness of the regional stormwater capture system. This tool, combined with others, promotes informed decision-making, coordination of efforts, and efficient resource allocation.”

As of August 2023, the SCWP has funded 126 stormwater infrastructure program projects, 37 technical resources program feasibility studies, and 18 scientific studies. The following SCWP projects are examples of the scope and benefits of these projects.

The John Anson Ford Park Infiltration Cistern project captures water under baseball and soccer fields. This park in the Bell Gardens neighborhood hosts hundreds of games in a community that is 95 percent Latino. The project diverts stormwater from the Lower Los Angeles River to recharge groundwater and reduce pollutants. Restoration efforts include new turf, trees, landscaping, irrigation, lighting, paving, and signage. The \$9.9 million project will capture and treat 22-acre-feet of stormwater. *[An acre-foot is a volumetric*

↑ The Safe Clean Water Portal lets the public view a map of projects and access project benefits and expenditures.

← The Urban Orchard Project will turn 30 acres of post-industrial land into a grove of 200 fruit trees, a playground, and wetlands. This \$5.4 million stormwater retention project will capture and filter 32 million gallons of stormwater for reuse on-site.

unit of measurement equal to the volume of a sheet of water one acre in area and one foot in depth.]

The Urban Orchard Project will turn 30 acres of postindustrial land into a grove of 200 fruit trees, a playground, and wetlands. Led by Trust for Public Land, the project’s landscaping will create shade and contribute fresh produce to the community. It will also include walking paths, native plants, and an education garden. The wetlands will provide habitat for native fish, migratory birds, and pollinators. The urban orchard will cool the air, reduce air pollution, and create 30 jobs for underserved youth. The \$5.4 million stormwater retention project will capture and filter 32 million gallons of stormwater for reuse on-site.

The Lynwood City Park Stormwater Capture Project enhances an existing park. It will add permeable pavement in the parking lot and an underground storage reservoir. Trees will provide shade to reduce the heat island effect and improve flood management. The restoration effort will include planting native landscapes and a butterfly garden along with developing two new soccer fields. Because the park is next to the Lynwood Youth Center and Lynwood Middle School, it allows educators to provide an integrative setting for teaching habitat restoration, water conservation, erosion control, and stormwater management. The \$12.9 million restoration and water management project will capture and treat 647 acre-feet of stormwater.

Since Measure W passed and the SCWP has been in progress, many projects have advanced the program’s complex goals and accelerated climate resilience in Los Angeles County.

About the Authors

Christa Campbell is an experienced water industry professional with 20 years of success using and promoting technology to solve problems in the water industry. A passionate GIS advocate, she has been recognized for industry thought leadership, strategic thinking, and building success with organizations across the globe. She is a lifelong learner, and collaborator. Builds success jointly with teammates, peers, and customers. Campbell is a certified GIS Professional and holds a graduate degree in geography.

Sophia Garcia is Esri’s industry solutions specialist for equity and civic nonprofit organizations. In her previous work at the Dolores Huerta Foundation and as a consultant, she collaborated with community organizations and local governments across California to enact equitable redistricting and champion community GIS.


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↓ Wisconsin Department of Natural Resources (Wisconsin DNR) created a tool to capture data on levels of per- and polyfluoroalkyl substances (PFAS), a notoriously pervasive class of contaminants present in drinking water sources such as Lake Superior.

COMBATING FOREVER CHEMICALS

By Sunny Fleming

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals found in everyday products such as food packaging, clothing, cosmetics, and toilet paper. They are called "forever chemicals" because they don't break down in the environment or human bodies and have been linked to adverse health conditions that range from cancers to birth defects. According to a 2023 study by the US Geological Survey, 45 percent of US tap water is estimated to have one or more types of PFAS.

The thought of so-called forever chemicals coursing through bodies of water or across the Earth's surface paints an ominous picture. Substantial efforts are now underway to combat PFAS, a notoriously pervasive class of contaminants.

The Wisconsin Department of Natural Resources (Wisconsin DNR) is mapping the

prevalence of these dangerous chemicals in drinking water supplied by two of the world's largest lakes, Lake Superior and Lake Michigan. Wisconsin DNR created a tool to capture levels of dangerous chemicals in the water and guide remediation efforts.

"We all have PFAS in our blood at this point," said Melanie Johnson, director of the Office

of Emerging Contaminants at Wisconsin DNR. “We’re all kind of dealing with it.”

Since the 1940s, toxic chemicals have been used to create a multitude of industrial and consumer products, including firefighting foam and household cleaners. PFAS have traveled through water systems, poisoning wildlife and people. Healthcare professionals have tied these chemicals to liver and immune system issues in both humans and animals. Researchers continue to study the damaging effects of long-term exposure.

As the understanding of the risks associated with PFAS continues to grow, governments around the world are sampling water and mapping PFAS concentrations using GIS. The maps created show the areas that need to be targeted to address the presence of these enduring chemicals.

After Wisconsin DNR identified PFAS contamination levels that exceeded health recommendations in five communities, staff began implementing measures to address the problem. Spearheaded by Johnson and her colleague Jesse Papez, supervisor for the GIS Data Analysis and Integration section, Wisconsin DNR developed the Wisconsin PFAS Interactive Data Viewer (<https://shorturl.at/pqEGV>) to visualize the occurrence of PFAS across the state.

“PFAS have been around for almost 100 years,” Johnson said. “Two or three years ago, there were about 3,000 chemicals that we knew about, and now we’re at 10,000. We’re learning something

new every day—learning how they behave in the environment, and how they impact our health. We’re starting to understand a lot more about the science behind them and what we can do to mitigate their impact.”

Addressing PFAS in the Water Worldwide

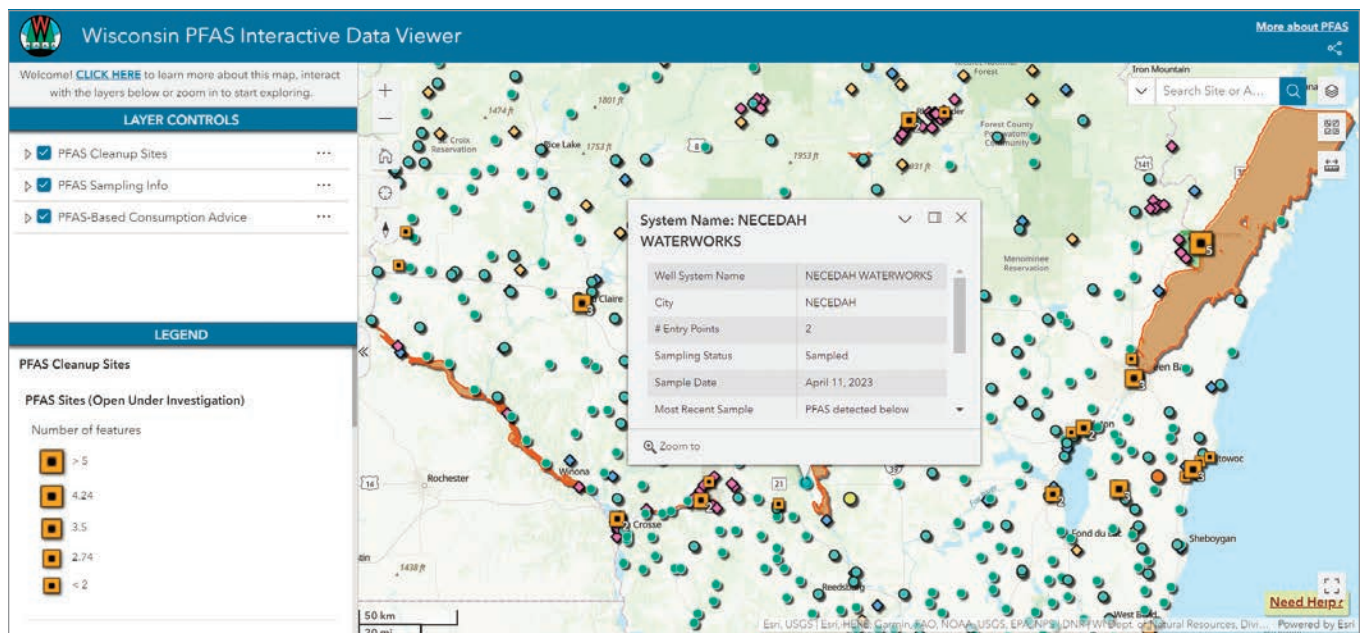
Companies that create and use PFAS are under intense scrutiny. They also face lawsuits for contributing to water pollution. The European Union has proposed a ban on the production, use, and sale of about 10,000 of these substances. In Japan, the government focused on improving water quality after a group of residents in Okinawa had high levels of PFAS in their blood. Recently, the US Environmental Protection Agency (EPA) proposed the first-ever national drinking water standard for six PFAS. With the recent funding, the EPA plans to help communities on the front line of the fight against forever chemicals.

Wisconsin is one of several Great Lakes states that have made PFAS a priority in keeping their residents and abundant water resources safe. Because more than 1.6 million Wisconsin residents depend on Lake Superior and Lake Michigan for their drinking water, lowering PFAS levels has become a critical health priority. To this end, Wisconsin is increasing water testing, setting clear standards, and openly sharing its progress.

For Johnson and her team, GIS provides a

“We’re starting to understand a lot more about the science behind them [PFAS] and what we can do to mitigate their impact.”

↓ The Wisconsin PFAS Interactive Data Viewer maps cleanup sites, water samples, and fish consumption advice.



“As more communities witness the impact of PFAS, it will become more of a unifying issue.”

better view of PFAS pollution and the health of water systems that are contaminated and most in need of ongoing cleanup.

“I think there’s great value in visualizing it,” Johnson said. “One of the things we really wanted to visualize is the drinking water results.”

Communicating and Collaborating

With the help of the PFAS data viewer, the Wisconsin DNR team can map contamination sites as well as locations where remediation efforts are underway. By visualizing and integrating this extensive location-based data, the team can effectively plan strategies, allocate resources, and share information.

Initially, Wisconsin DNR focused on remediation sites, while conducting statewide sampling of surface water and wastewater treatment plants. DNR staff wants to broaden the understanding of fish and wildlife contamination by sharing data and collaborating with neighboring states.

“If we’re studying a specific fish, we share that data with the other states and they share their data,” Johnson said.

Wisconsin DNR led the effort to study the smelt found in Lake Superior and issued a public advisory not to eat more than one meal of fish per month due to high levels of PFAS. That finding was confirmed by studies conducted in Michigan and Minnesota, and those states followed up with their own warnings.

One of Wisconsin DNR’s primary objectives is to ensure effective communication with the public. Through the Wisconsin PFAS Interactive Data Viewer, the team aims to provide a user-friendly interface for essential information. Anyone can navigate the PFAS data viewer to determine if there is any contamination within an area. Stakeholders, including those interested in detailed raw data or the history of a contaminated site, can delve deeper.

“We had a design goal of keeping it as intuitive as possible, yet as information rich as possible so the learning curve would be minimal,” Papez said, adding that the goal included “providing

as much data as we could without it being overwhelming or requiring data science skills.”

Bridging the Divide

Wisconsin DNR recently received funds from the Infrastructure Investment and Jobs Act to address emerging contaminants and ensure excellent water quality. Johnson and her team believe that tools like the Wisconsin PFAS Interactive Data Viewer will play a crucial role in gaining stakeholder support to tackle PFAS, not only at the state level but also nationally.

“This tool can be very helpful for legislators to understand if PFAS contamination has been detected in their districts and how it impacts their constituents,” Johnson said. “As more communities witness the impact of PFAS, it will become more of a unifying issue.”

In the US, the Great Lakes states have been quick to act on PFAS, given their role as stewards of 95 percent of the fresh surface water in North America. More states are taking on this problem, starting with testing, and putting test results on a map. As PFAS contamination becomes more understood and strategies emerge, maps will be central to the worldwide cleanup effort.

Continued sampling will improve understanding about the need to reduce PFAS contamination levels and break the cycle of forever chemicals.

About the Author

Sunny Fleming is Esri’s industry lead for the domains of environment, conservation, and natural resources. Throughout her career, she has applied GIS concepts and technology to environmental policy, conservation, and natural resources, from monitoring species in the field to helping state parks manage assets and assess their economic impacts. She continues to pursue her passion for the environment by helping industry leaders streamline and improve their work with GIS technology, whether in the field or in the office, and whether setting policy or managing wildlife and resources.





↑ Watersheds in the Watershed Boundary Dataset are not cut off at national boundaries and include watersheds that extend into Canada and Mexico.

NEW AND IMPROVED WATERSHED BOUNDARY DATASET

A new collection of watershed layers for the United States, the Watershed Boundary Dataset (WBD), is available from ArcGIS Living Atlas of the World (<https://shorturl.at/oBF36>).

WBD is produced and updated by the US Geological Survey (USGS). It is the official, seamless watershed dataset and is the companion dataset to the National Hydrography Dataset (NHD). These new layers have the most up-to-date information and will replace Esri's older watershed layers. This new content is served as hosted feature layer views published in ArcGIS Pro, which will allow Esri to make updates behind the scenes with zero downtime of the online services.

Data for drainage areas includes regions, subregions, basins, subbasins, watersheds, and subwatersheds that are delineated and georeferenced to the USGS 1:24,000-scale topographic basemap. The design revisions Esri has made allow the collection to be more versatile for mapping and understanding hydrology and other environmental variables.

The cartography for the six layers provides further clarity, especially when WBA layers are drawn with other ArcGIS Living Atlas layers such as the National Hydrography Dataset, National Land Cover Tree Canopy Cover, and terrain relief. The six polygon layers are designed to work together so that layers nest visually and logically within each other, but each layer also can work as a stand-alone, legible boundary layer in your map. When drawn together, you will notice the drainage basin boundaries change subtly in width and color as you zoom out, adjusting from local to regional to national scale.

In addition, watersheds are not awkwardly cut off by a border. With help from the National Institute of Statistics and Geography (INEGI) and Environment Canada, WBD watersheds don't stop at national borders; they extend to incorporate parts of Mexico and Canada that share a watershed with the United States.

These watersheds are ready for analysis in ArcGIS Pro against scores of ArcGIS Living Atlas layers.

The
Watershed
Boundary
Dataset is
available
from ArcGIS
Living Atlas
of the World.

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Saving Water by Tracking Code Violations

By Risa Patarasuk

According to a 2020 US Geological Survey report, *Water Withdrawals, Uses, and Trends in Florida, 2015*, roughly 60 percent of residential water consumption can be attributed to outdoor water use, which is typically irrigation for landscapes.

Residential and commercial water customers in Alachua County, Florida, use more than 26 million gallons each day. To help with the water conservation efforts, Alachua County's Environmental Protection Department (EPD) created the Irrigation Restriction Program in 2011. Under this program, EPD established water use codes that restrict the days and times that residents and businesses can use their irrigation systems. These water codes require more efficient irrigation system designs.

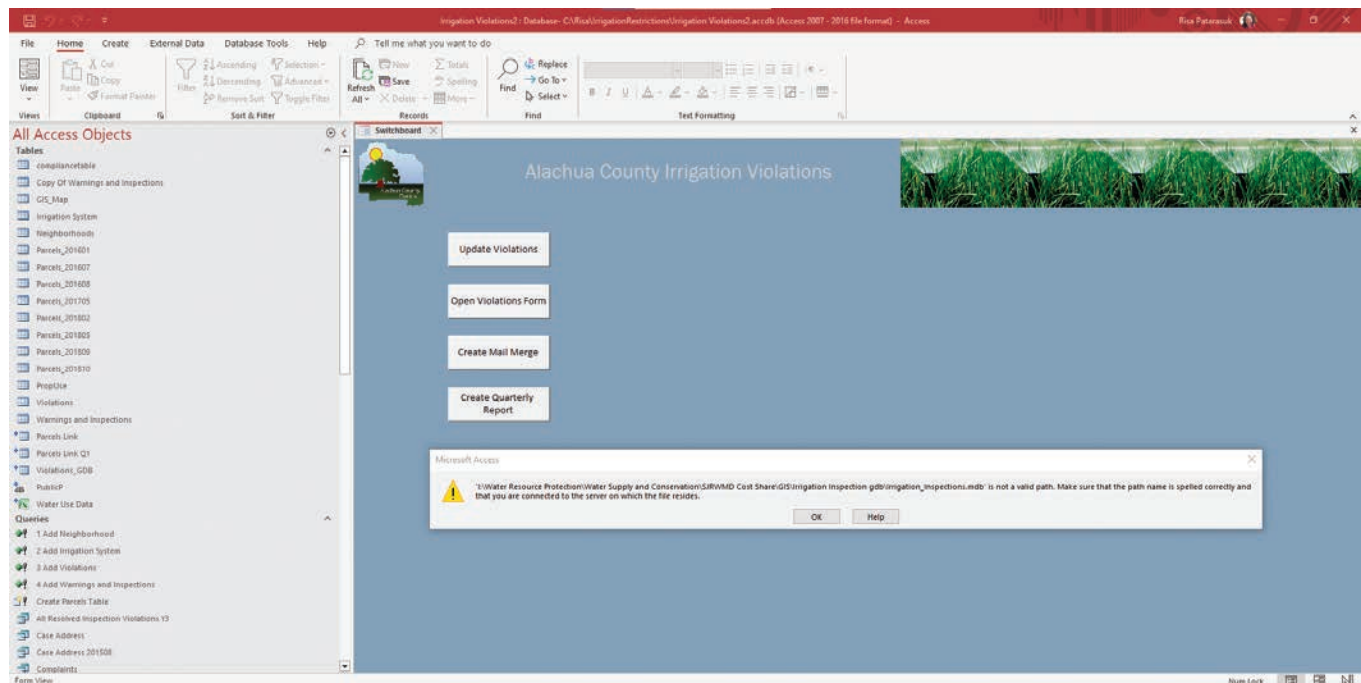
The Irrigation Restriction Program aims to curb unnecessary water use and minimize runoff that may impact local springs and natural waterways. Throughout the year, EPD uses ArcGIS Field Maps from Esri to track properties that violate the irrigation restriction code.

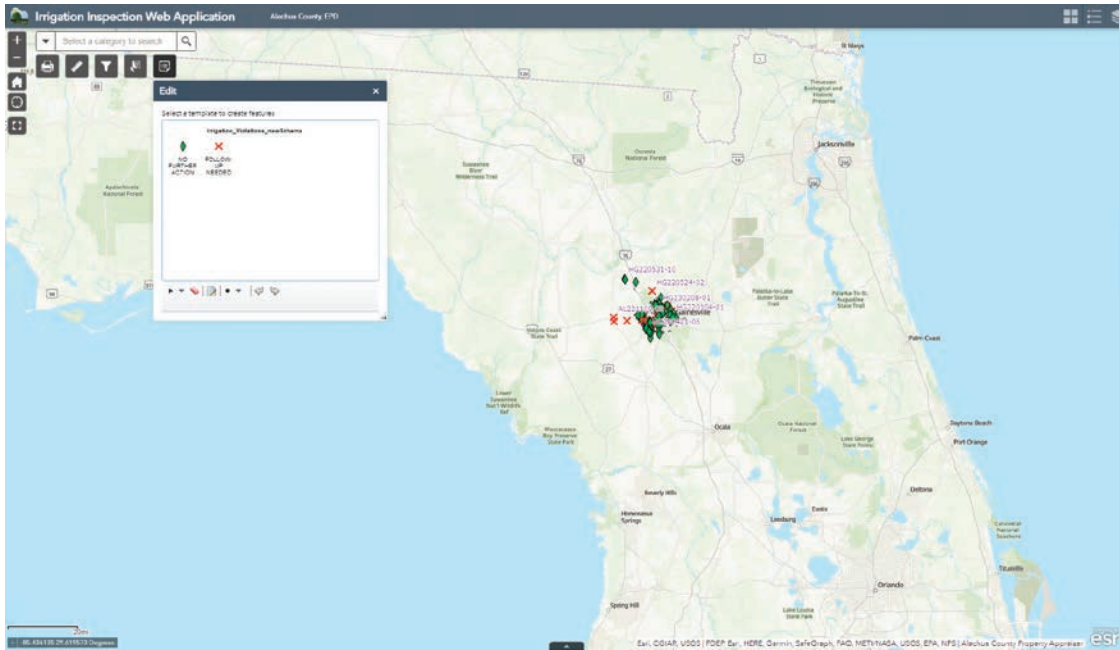
Manual Updates and Data Entry Errors Hamper Workflow

When the Irrigation Restriction Program was first implemented in 2011, field staff members used ArcPad to collect data. When ArcGIS Online became available, they moved from ArcPad to Collector for ArcGIS. Microsoft Access was incorporated into the workflow because most field staff members were more familiar with Microsoft Access than with ArcGIS Desktop.

Using Collector for ArcGIS, an earlier version of ArcGIS Collector, staff members had to locate a property, obtain the parcel identification number (PIN) from the property appraiser's office, and manually enter it in the feature layer. PINs provide a link to parcel owner names and mailing addresses so mailing lists can be generated for

↓ The previous workflow did not function properly because URL/file links used in Microsoft Access were broken.





← The Edit widget was added to the web application so the date could be directly edited.

enforcement purposes. Manually entering PINs led to data entry errors that prevented the retrieval of correct parcel data.

With the previous workflow, a custom-built Microsoft Access interface was configured using forms, SQL, and various URLs or folder paths to link the data sources needed to generate the mailing list. Between 2011 and 2018, this Microsoft Access file was created and maintained by a GIS analyst and a programmer.

However, using Microsoft Access was cumbersome because it required downloading parcel data from the property appraiser every three or four months to generate an updated mailing list so that notices could be sent to irrigation restriction violators. The data was saved in ArcCatalog as a personal geodatabase (.mdb) format file on a shared network drive so that it could be accessed by field staff members and used in Microsoft Access.

Updating the mailing list every few months created a time lag just when time-sensitive enforcement letters needed to be generated and sent. In addition, when multiple properties with the same owner were identified as being in violation, information for each parcel record had to be copied and pasted between tables to generate the mailing list. These processes were time-consuming and tedious.

Emily Rodriguez, a staff member who worked on this project between 2014 and 2016, said, "Because follow-up work in the office took so long, I had to cut my fieldwork short to be able to send the letters the same day. Instead of identifying additional properties with opportunities to save water, I was spending lots of time following lengthy protocols for transfer of information from the field to the computer."

During the past few years, the workflow did not function properly because URL and file links used by Microsoft Access were broken because folders had been deleted or moved. In addition, the GIS analyst and programmer who maintained the process left the organization and no current staff members knew how to fix the applications. Consequently, there was an urgent need to develop a new, more efficient workflow.

Working More Efficiently Using ArcGIS Online

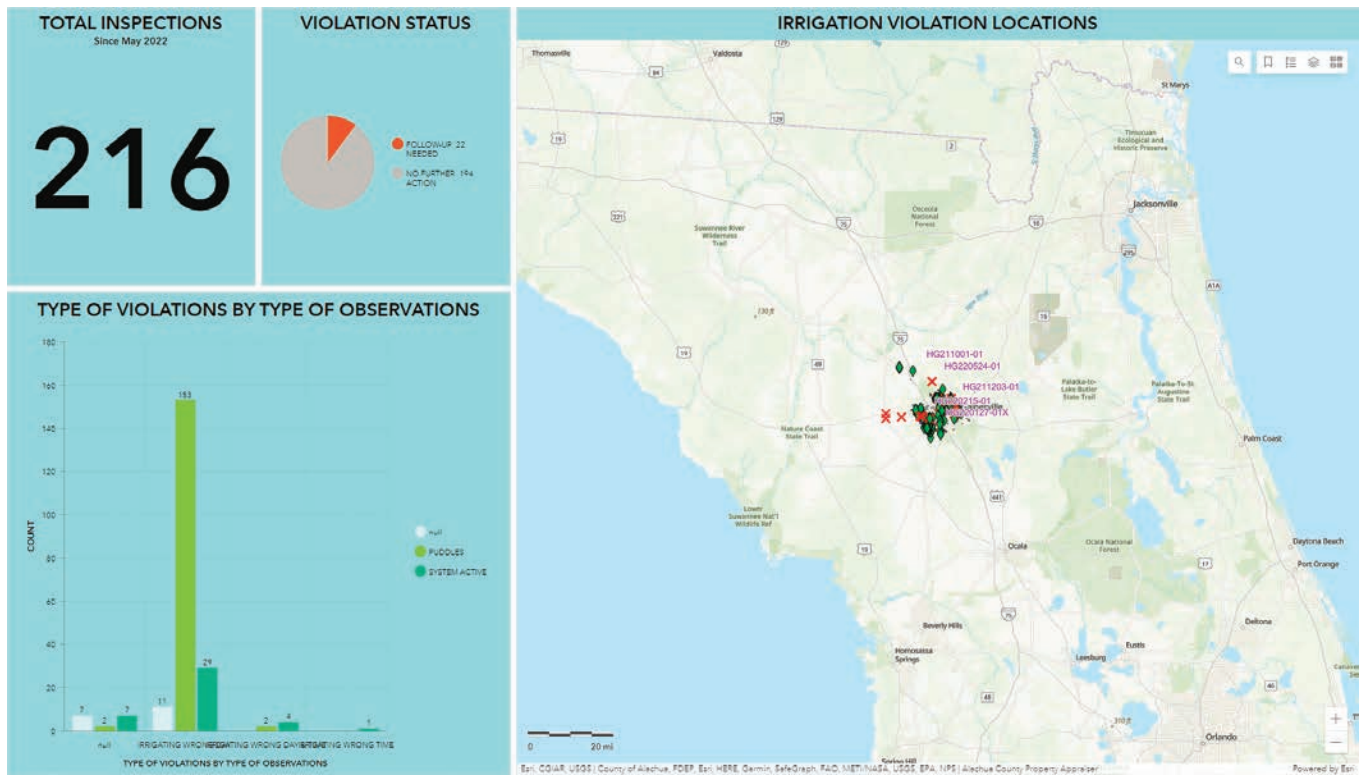
In May 2022, new staff members wanted to use ArcGIS Field Maps to develop a new workflow for the Irrigation Restriction Program. They created a new point feature class with a new schema for field data collection and published it to ArcGIS Online. The feature layer was added to ArcGIS Field Maps.

With recent enhancements, ArcGIS Field Maps could now use ArcGIS Arcade code in smart forms, so fields could be automatically populated with PIN and address data from the property appraiser and added to the feature layer. This saved time and eliminated both manual entry of PINs and the associated data entry errors.

Parcel data automatically updates in ArcGIS Field Maps when it is updated by the property appraiser's office because its parcel feature layer is a REST service added to ArcGIS Field Maps. Also, mailing list generation is simpler. Staff members can download field data from ArcGIS Online as a Microsoft Excel file that can easily be sorted and filtered to capture values needed to generate a mailing list.

With the new workflow, EPD incorporated data from other agencies including University of Florida's (UF) H2OSAV data and Gainesville Regional Utilities (GRU) reclaimed water lines data. [H2OSAV (Water Savings, Analytics & Verification) is a UF Institute of Food and Agricultural Sciences (IFAS) Extension program that is working to measurably save Florida water. GRU is a multiservice utility owned by the City of Gainesville, Florida.] These feature layers were also added to Field Maps.

H2OSAV data provides water use data within the GRU water service area. Field staff members can now determine if a property that violates the Irrigation Restriction Code is in a high-water use area and send a warning letter to the owner. However, if GRU data shows that a parcel uses reclaimed water for irrigation, it is exempt from the irrigation code and no action is taken.



↑ This dashboard, created using ArcGIS Dashboards, summarizes the data on inspections, violations types, and violation locations.

“The autofill for parcel ID numbers has improved the efficiency of data collection in the field with less opportunity for data errors. A few new data layers added during the update have been important strategic targeting tools to make more effective use of field time and improve water conservation efforts,” said Hollie Greer, a senior environmental specialist with EPD.

The reclaimed water data layer allows staff members to quickly identify areas where current irrigation restrictions do not apply. The H2OSAV data layer provides a quick resource tool in the field to identify higher areas of water use so that EPD can focus its inspection work and have the most impact.

“It also helps to build a better working knowledge of water use patterns across the county, which is helpful for our existing staff and in training new staff to work more effectively,” said Greer.

In addition to ArcGIS Field Maps, a web application was created so that data collection points can easily be viewed in the office. The Edit widget was added to the application, so Greer could easily make edits, such as adding notes, directly to the data.

Finally, using ArcGIS Dashboards, a dashboard was created to give staff members and their managers an overview of the program including a summary of the number of properties inspected, violations, and types of violations. Dashboard users can also zoom in/out or pan on the map to see a summary on a particular area of interest.

More Applications for ArcGIS Field Maps

With current ArcGIS Field Maps development, staff members can now collect data more efficiently than they could with the previous workflow, which used ArcPad, ArcGIS for Collector, and Microsoft Access. New staff members are currently being trained to use

ArcGIS Field Maps and help with data collection processes. With the success of the Irrigation Restriction Violation Field Map app, EPD plans to utilize ArcGIS Field Maps for other data collection processes, including water sampling for water quality monitoring programs and wetlands field surveys for land development permits.

For more information, contact

Risa Patarasuk, GIS Analyst for EPD
 Alachua County Board of County Commissioners
 408 W University Ave., Suite 106
 Gainesville, Florida 32601
 Email: rpatarasuk@alachuacounty.us
 Phone: 352-264-6826

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About the Author

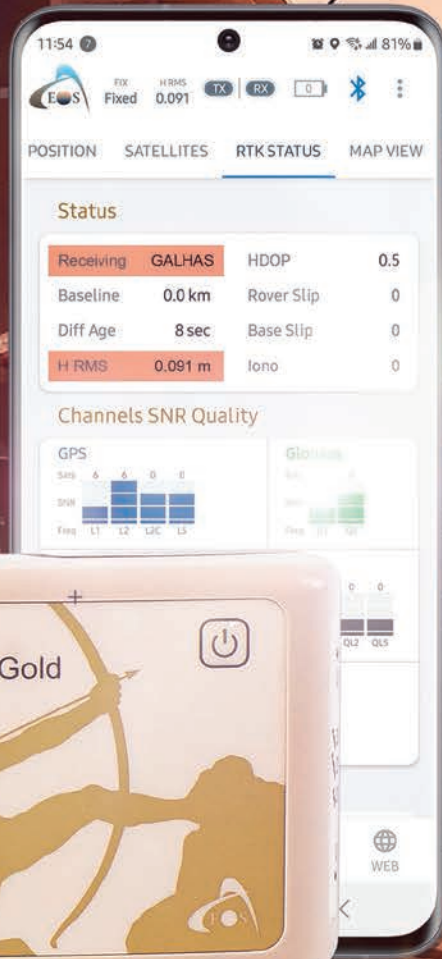
Risa Patarasuk is a GIS analyst in the Environmental Protection Department (EPD) at the Alachua County Board of County Commissioners. She received a doctorate in geography from the University of Florida. Prior to coming to Alachua County, she worked as a GIS analyst at the Citrus County Board of County Commissioners in Lecanto, Florida, and as a research assistant specialist at the University of California, Riverside. Her work includes spatial data management, managing datasets on CO₂ emissions and land-use/land-cover change, and creating ArcGIS Field Maps applications.



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Building a Service Line Inventory

By Christa Campbell



Does my state require more than the EPA?

In 2021, the US Environmental Protection Agency (EPA) revised the requirements of the Lead and Copper Rule to better protect our communities from the risks of lead exposure. The Lead and Copper Rule Revisions (LCRR) are focused on protecting our children and removing lead from our drinking water systems.

The LCRR requires water systems to prepare and maintain an inventory of service line materials by October 16, 2024. In addition, any water system that has lead service lines, galvanized lines requiring replacement, or service lines that have an unknown lead status in its distribution system must submit to the state a lead service line replacement plan. Water systems are also required to share this information with the public and update their inventory at least annually until they have demonstrated that they have met the requirements.

EPA Guidance

In August 2022, the EPA released *Guidance for Developing and Maintaining a Service Line Inventory*, a document to support water systems' efforts to develop inventories and provide states with the information needed for oversight and reporting to EPA. This document will help water systems comply with the requirement by October 16, 2024. Specifically, the EPA's lead

service line inventory guidance provides the following:

- Best practices for inventory development and communicating information to the public
- A template for water systems, states, and tribes to use or adapt to create their inventory
- Case studies on developing, reviewing, and communicating about inventories
- Information highlighting the importance of prioritizing inventory development in disadvantaged communities where children live and play

Tackling an Immense Project

The 2023 EPA Drinking Water Infrastructure Needs Survey and Assessment, mandated by the Safe Drinking Water Act (SDWA), estimates that there are more than 9 million lead service lines and 2.8 million stand-alone galvanized service lines in the United States. Inventorying the location of lead lines and meeting the requirements of the LCRR is overwhelming for many water service providers. While performing an inventory may sound simple, it can be complicated. Many questions need to be answered when preparing to perform an inventory and create a replacement plan. These are some of the questions that must be answered:

- Does my state require more than the EPA?

- What historical records can be used to start my inventory?
- Can customers help by gathering information for the inventory?
- Do I need to partner with a third party?
- Can I use GIS to help meet the LCRR requirements?

Does my state require more than the EPA?

This isn't always an easy question to answer. In California, the State Water Resources Control Board, through the Division of Drinking Water (DDW), enforces the California Lead and Copper Rule, which is aligned with the EPA's Lead and Copper Rule. In response to the LCRR, the DDW released an inventory template (spreadsheet) that contains the minimum amount of information required for water systems to comply with the LCRR's initial lead service line inventory.

Although the inventory template provides guidance on what data needs to be provided to the state, it does not identify how the data may be different from what is on the EPA template. For example, in California, the state wants to know if material other than lead was used in the past. In addition, water systems are not required to use the template. They may choose to create a custom spreadsheet, database, or map.

Although the data requirements may be understood, there are still uncertainties about how

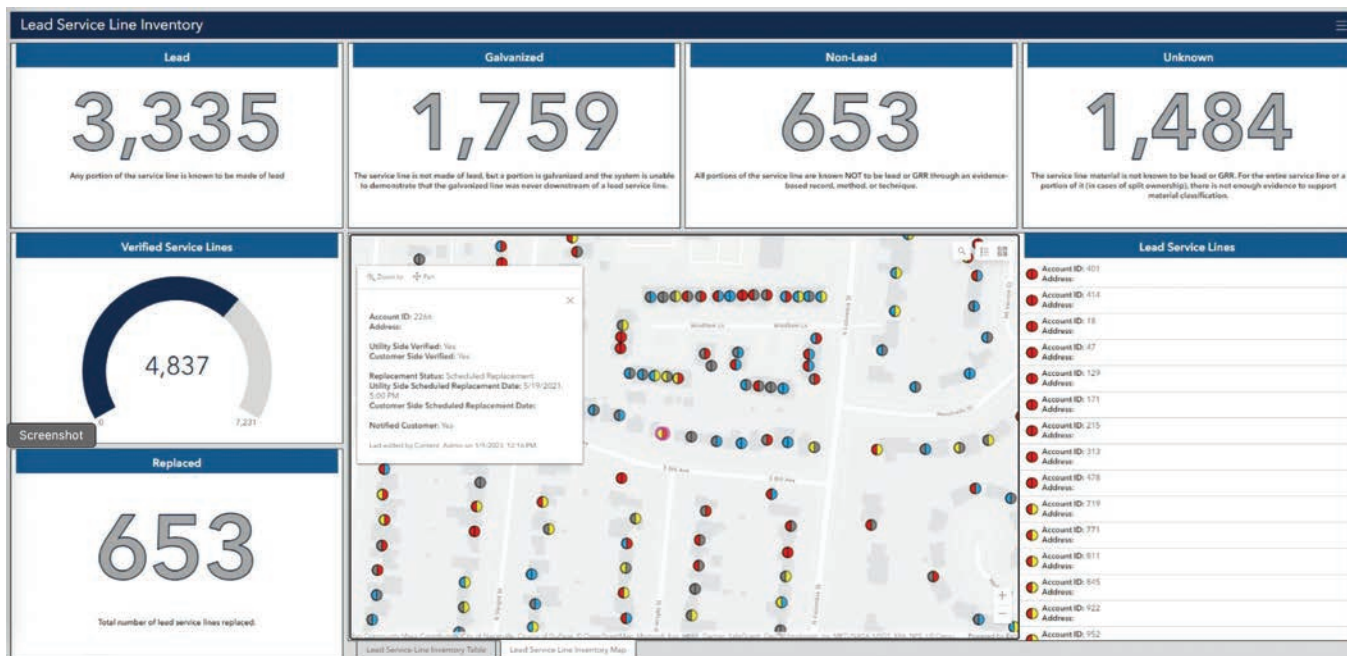
to perform the inventory. According to the DDW, lead service lines are not common in California. Many water providers believe that they have no lead or very little lead in their system and prefer to use statistical verification to complete their inventory. The approved method of statistical verification is the 95 percent confidence level interval approach. This approach is impacted by how well you understand your data and how you evaluate the data. It can play a significant role in determining what percentage of service lines need to be physically verified. This is where working with your state representative will help.

Several methods of material identification are approved by the state on a case-by-case basis: water quality sampling; predictive models; interviews; emerging technology; and interpolation, a category that includes statistical verification. The best way to understand what your state requires and if the work you are doing will be accepted is to collaborate with your regional water resource control engineer.

What historical records can be used to start my inventory?

Various historical records can be reviewed to create an initial inventory. Previous evaluation of materials performed in response to the regulatory revisions to the National Primary Drinking Water Regulation in the 1980s and the 1991 Lead and Copper Rule can be a good place to start.

↓ Dashboards are a great tool for managing and tracking your service line inventory.





↑ Suffolk County Water Authority (SCWA) in New York linked images of tap cards so that users could instantly view service line records of each home while developing a service line inventory. Read more about the project at <https://shorturl.at/hBl28>.

Can I use GIS to help meet the LCRR requirements?

Construction records, plumbing codes, and permits can be used to identify materials used to connect to the distribution system. In addition, tap cards, system maps and drawings, water main replacement records, meter installation records, capital improvement plans, inspection records, water loss studies, and annual reports can be used.

Although historical records can provide a starting point for your inventory, keep in mind that they may be inaccurate and unreliable. They may not reflect changes made in the system. Service line material that is uncertain should be listed as unknown. The results of reviewing all available records will guide you in the next step to investigate service lines of unknown material.

Can customers help by gathering information for the inventory?

Many utilities have turned to the public for help in identifying the material on the customer-owned portion of the service line. To do this successfully, the utility should start by educating its customers. Customers may not know where to start. They don't know the best place to access their service line. If the water meter is in the basement, the service line may be visible where it comes into the building and connects to the meter. If the meter pit is in the sidewalk or yard, it may be harder for the customer to locate where the service line enters their house. Utilities should

provide guidance on the most probable scenario for their service area.

In addition to locating the service line, customers will need to understand how to identify service line material. Utilities have various methods for guiding customers through this step. They often ask customers to perform a scratch test and upload pictures. A magnet test can be used to confirm service line material. (A magnet will not stick to lead.) These methods can be provided in a pamphlet mailed to customers, shared via the utility website, or even shown in an instructional video. Data collected by the customer can be gathered using a web form, a mobile app, or paper surveys. Using paper surveys is not recommended because they result in additional work for utility staff.

Having customers participate in the service line inventory not only educates the customer about the work being done to remove lead from the water system but also provides important information to the utility.

Do I need to partner with a third party?

The EPA encourages water systems to build partnerships that will support them in completing their service line inventory. For example, third parties such as plumbers, building inspectors, and public health departments may be able to

provide service line material information based on their work. Community-based organizations, universities, and homeowner associations can be strong partners when educating and engaging your customers. Technology providers and consultants can be strong partners as well, providing digital solutions and services.

An evaluation of existing technology and staff should be done to determine the best use of resources. Supplementing staff and growing technology-based solutions should be done strategically to get the best results.

Can I use GIS to help meet the LCRR requirements?

Yes, GIS can help streamline the work you are doing to meet the LCRR requirements.

Initially, GIS can be used to integrate disparate data types and perform analytics. Analysis can be used to identify gaps and discrepancies in your data. As you add and improve data, analytics can be used to prioritize field verification of material type. Data can be viewed spatially and sorted into categories enabling organizations to pinpoint areas that are likely to have lead.

In addition to the powerful analytics that GIS provides, in response to the EPA's Lead and Copper Rule Revisions, Esri developed the Lead

Service Line Inventory solution (<https://shorturl.at/nFTX3>). This solution delivers a set of capabilities that help utilities

- Streamline service line inventory.
- Validate service line material in the field.
- Monitor replacement activities and optimize replacement programs.
- Share information with the public.

The Lead Service Line Inventory solution is updated as Esri experts learn more about the LCRR requirements and how to best help utilities meet these requirements. The solution is supported by Esri's technical support team and—the best part—it's free for Esri customers, who can download it, configure it, and start using it.

About the Author

Christa Campbell is an experienced water industry professional with 20 years of success using and promoting technology to solve problems in the water industry. She has been recognized for industry thought leadership, strategic thinking, and building success with organizations across the globe. She is a passionate GIS advocate, lifelong learner, and collaborator. She builds success jointly with teammates, peers, and customers. Campbell is a certified GIS professional and holds a graduate degree in geography.

↓ Xenia Rural Water District in Iowa designed a short, easy digital survey that guided customers on how to gather quality information about their service line.

Water Service Line Material Survey

Please complete the form below.
Fields with the red asterisk * are a required field.

Resident Information
Please list only account holder information.

First Name

Last Name / Business/ Nonprofit*

Phone Number*

Email (Recommended)

Service Property Address*

Type of Service*
Tell us what type of a water service it is? If this service is a farm use only service, please mark it as a business.

Single Family
 Business
 Multi Family

Account Number*
Please enter the account number found on your water bill.

Pipe Information

Identify Water Service Line Material
Use the links, and images below to help determine the material of your water service line.


Identifying Service Line Material
Below is a 2 minute video on how to identify common serviceline material.

[How to Determine Your Water Service Material](#)


IDENTIFYING LEAD SERVICE LINES AND PLUMBING

Lead Service Lines and Plumbing Identification

The public water system which supplies water to your facility may have records about the material used in the service lines. If records are unavailable, a physical inspection can help determine if lead is present. Contact a licensed plumber for assistance to determine if your service line or plumbing is lead. Service line pipes may be exposed and accessible where the pipe enters the building through a basement wall or floor. An inlet valve and the water meter are generally installed on the pipe after the point of entry.



Source: U.S. Environmental Protection Agency



Source: U.S. Environmental Protection Agency

Lead service lines can be connected to facility plumbing using solder and have a characteristic solder "ball" at the end.

Lead service lines often lead just inside the front or side wall of the facility, but they may extend further into the building as shown. The service line here comes out of the basement floor in the water meter and then back onto the floor, continuing further into the building.

Water Service Line Material*
Based on the appearance, testing, or existing records, please select the appropriate material of your water service line. This is for the line outside of the home that comes through the basement wall.

-Please select-

Water Service Line Install Date (Optional)
Please provide the install date of your water service line. If you do not know the install date, please provide the year the home or building was built.

yyyy

Water Line Material Inside of the Dwelling (Optional)
Based on the appearance, testing, or existing records, please select the appropriate material of your waterline inside of your dwelling. If you have more than one type please select the type that has the most.

-

Interior Plumbing Date (Optional)
If you know what year your dwelling was plumbed, please indicate it below. This date may be different than the above answer if a dwelling was replumbed but the outside serviceline was not replaced at the same time.

yyyy

Source of Information*
How did you determine the material of your water service line?

-Please select-

Geospatial Technology Supports Early Flood Warning in Nigeria

Using Africa Geoportal, Esri's open GIS community data and mapping platform, volunteers from the Geohazard Risk Mapping Initiative (GRMI) (www.georiskmap.org) created a real-time flood reporting tool, interactive flood maps, web applications, and a comprehensive flood event database. GRMI's work helps communities in Nigeria prepare for and respond to recurring flooding events spurred by changes in rainfall patterns attributed to climate change.

A youth-led nonprofit organization, GRMI volunteers are skilled at using GIS tools and analyzing satellite imagery. They use these skills to create maps and applications of current or anticipated geohazards caused by the impact of climate change in Nigeria and other African countries. Their susceptibility and prediction maps and applications are created at local scales and shared with disaster and emergency management organizations, government ministries, and others. Since its inception in September 2020, GRMI has assembled a team of 20 youth GIS volunteers skilled in hazard mapping.

The work of GRMI supports the United Nations' Sustainable Development Goals (SDGs) 11 (Sustainable Cities and Communities) and 13 (Climate Action). GRMI activities also align with the goal of the Sendai Framework for Disaster Risk Reduction

↓ The GRMI team created a user-friendly flood reporting tool using ArcGIS Survey123 to report flooding events in real time.

agreement to substantially increase access to multihazard early warning systems and disaster risk information assessments.

On the Front Line of Climate Change

According to the Centre for Research on the Epidemiology of Disasters (CRED), floods accounted for 43.5 percent of all deaths from disasters in 2019, marking an increase in events compared to previous years. Furthermore, floods disrupt human activities and the economy, significantly affecting the most vulnerable populations. African communities frequently face natural disasters such as the 2022 flooding in Nigeria, Niger, Chad, and the surrounding region, which displaced more than 1.3 million people and caused the deaths of more than 600 people.

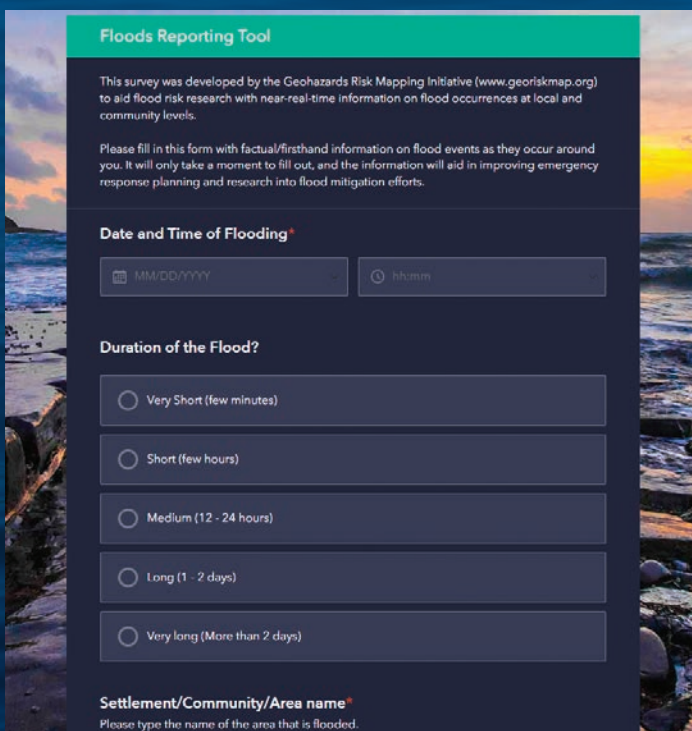
Nigeria, the most populous country in Africa, is increasingly vulnerable to the escalating effects of climate change, particularly flooding. The lack of a flood reporting tool and an effective system for communicating early warning hazard information exacerbates these challenges, leaving communities unprepared and vulnerable to flooding. Despite the Nigerian government's commendable efforts to minimize flooding risks, early warning information and a real-time flood reporting tool were needed. To address this challenge, GRMI developed a strategic approach utilizing geospatial technology to meet this need.

Using Tools from Africa Geoportal

The Africa Geoportal (www.africageoportal.com) is a gateway to web-based geospatial resources powered by Esri. It enables users to discover, view, and access geospatial information and services made available by participating organizations. Data providers can use the Africa Geoportal to make their geospatial resources discoverable, viewable, and accessible to others.

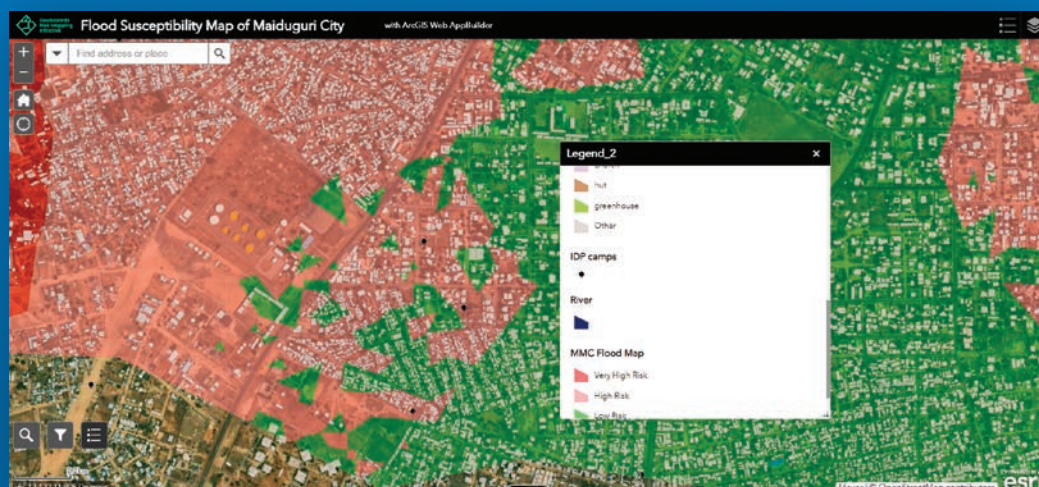
The geoportal also makes a variety of ArcGIS tools and tutorials available including ArcGIS Survey123. Using the form functionality of the Africa Geoportal, the GRMI team created a user-friendly flood reporting tool to capture data on flooding events in real time. This information is relayed to the national emergency agency, facilitating flood response in affected locations and contributing to a flood event database that can be used to mitigate future risks. Using this data and the analysis and mapping tools available from the Africa Geoportal, the team produces high-precision static maps and digital interactive flood susceptibility maps.

The Africa Geoportal's capabilities for sharing allowed the maps and applications to be easily distributed to government institutions and local disaster management agencies and disseminated through various media platforms. Communities can interact with these maps and applications through a browser to better understand flooding risks and make appropriate preparations.



The screenshot shows a mobile-friendly web form titled "Floods Reporting Tool". The form is set against a background image of a flooded beach. The form content includes:

- Title:** Floods Reporting Tool
- Introduction:** "This survey was developed by the Geohazards Risk Mapping Initiative (www.georiskmap.org) to aid flood risk research with near-real-time information on flood occurrences at local and community levels." and "Please fill in this form with factual/firsthand information on flood events as they occur around you. It will only take a moment to fill out, and the information will aid in improving emergency response planning and research into flood mitigation efforts."
- Date and Time of Flooding***: Two input fields, one for the date (MM/DD/YYYY) and one for the time (hh:mm).
- Duration of the Flood?**: A vertical list of radio button options: "Very Short (few minutes)", "Short (few hours)", "Medium (12 - 24 hours)", "Long (1 - 2 days)", and "Very long (More than 2 days)".
- Settlement/Community/Area name***: A text input field with the instruction "Please type the name of the area that is flooded."

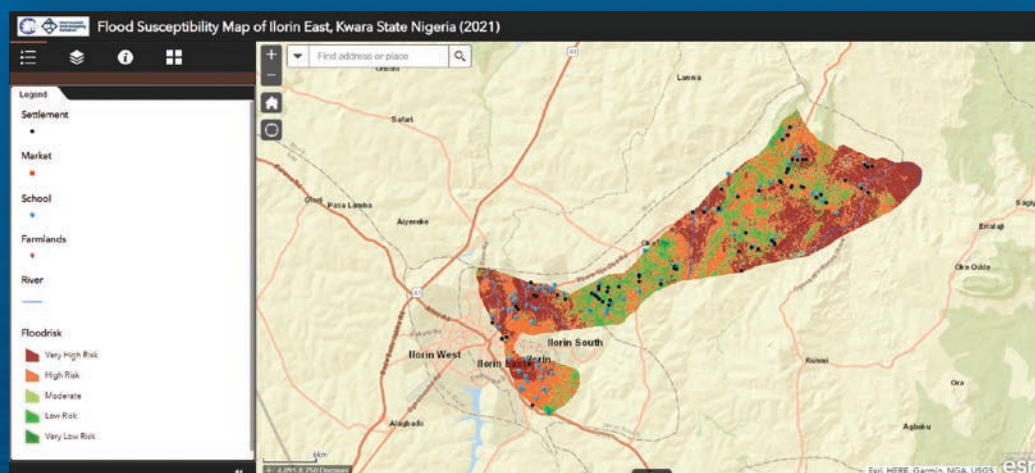


about infrastructure development and land-use planning. GRMI's user-friendly web app has significantly improved the flood reporting process in Nigeria, enabling real-time data sharing with national emergency agencies.

Call to Action and Next Steps

While GRMI has made great strides, there is still much to be done. The initiative is planning to convert its web app into a mobile app to enhance its accessibility and ease of use. However, this project requires additional funding. Stakeholders, which include governmental and nongovernmental organizations, need to provide the support necessary to realize this goal.

GRMI is continually looking for more volunteers who have skills in geospatial analysis and environmental management so it can assist more communities. Volunteering is a great opportunity for young professionals to gain practical experience and contribute to a project with significant societal impact.



↑↑ This interactive web application shows flood susceptibility of Maiduguri City, Borno State, in northeastern Nigeria, and the location of camps for internally displaced people that are at high risk of future flooding.

↑ Flood risk susceptibility map of Ilorin East, Kwara State, Nigeria

Helping Communities Be Better Prepared

GRMI is making significant strides in mitigating the impact of floods in Nigeria, and this has benefited communities. Since its launch, GRMI has mapped 25 communities across different states in Nigeria, significantly improving disaster preparedness. The initiative's efforts are making a tangible difference in underrepresented communities. For example, GRMI's flood maps for the Maiduguri Local Government Area revealed various internally displaced camps that are at risk from future flooding.

The flood maps produced by the initiative have offered data that governments, communities, and individuals can use to better prepare for flood events. The maps GRMI produces reveal the level of flood susceptibility of farmlands, schools, and marketplaces. This information is crucial in initiating preventive measures and reducing the damage caused by flood events.

For example, educational institutions can now use these maps to improve their emergency preparedness strategies, ensuring students' safety. Moreover, susceptibility maps guide the government and local planning agencies in making informed decisions

Members of Nigerian communities are encouraged to use the flood reporting web app and share it with others. Every report contributes to the comprehensive flood event database and helps provide crucial data that can save lives and properties.

"The flood maps produced by Geohazard Risk Mapping Initiative were an absolute game changer for our climate action project," according to Azeez Tobi Abubakar, Ilorin Climate Action Project lead, World Economic Forum Global Shapers Community, Ilorin Hub. "With their accurate and detailed mapping, we were able to better assess the communities that are susceptible to floods in Ilorin East and West Local Government Area of Kwara State, Nigeria. The maps guide our flood awareness campaign and other climate adaptation projects that we conducted in those communities."

GRMI is a testament to the power of geospatial technology in addressing climate-change-related challenges. Through this initiative, Nigerian communities are better prepared to handle flooding, thereby reducing loss of life, property, and livelihoods. With additional support and resources, the initiative can continue to make an even more significant impact.

Seven Practical Tips for Driving Tech Adoption—Starting Today

By Matt Lewin

Last month I met with the head of a city government’s geospatial unit to review the state of the program, and the topic of technology adoption came up. His challenge was getting staff to actually use the tools they put in place, which was concerning considering how much time, effort, and money they had invested. How could they improve this situation? It’s a complex and worthy topic.

The sobering fact is that despite the best efforts of organizations, only 20 percent of organizations consider their digital transformations a success, and low user adoption is singled out as one of the most common points of failure. People simply didn’t use what we built. I’d wager that the geospatial space isn’t much different.

At a macro level, there are a few trends currently driving changes in tech adoption habits within organizations. One is the general consumerization of technology. This is the trend of corporate systems resembling consumer-grade applications in terms of form and interaction. People expect easy-to-use, fast, and aesthetically pleasing applications and won’t tolerate the stodgy, monolithic systems of IT departments past. Couple that with the fact that users have a wide array of readily available apps and data options, and organizations have a real challenge on their hands.

The democratization of technology and data means that corporate users can often access tools and relevant data and perform at least some aspect of their jobs without the corporate-supplied technology. When you factor in less restrictive IT governance policies that promote bring-your-own-device, low-code/no-code and open data philosophies, you get a power shift away from corporate-driven technologies toward a user-driven environment.

So, what’s a manager to do? Despite the trends, there’s still a need for corporate-delivered systems as part of a strategic digital transformation, and adoption is an essential outcome. That’s true for geospatial solutions too. The key is to get ahead of it and take proactive steps to overcome specific adoption barriers while respecting the trend toward greater user choice. Below I’ve compiled some guidance for driving adoption in your organization.

1 Make a Compelling Case

It might seem like change management 101, but generally, people don’t change their ways unless they have a compelling reason. That means one of your first jobs as a geospatial advocate is to build a case that captures the hearts and minds of your users and motivates them to embrace your vision.

It’s human nature that most people will be hesitant to embrace a new technology due to fear of the unknown or concerns about their ability to adapt. By presenting a persuasive argument that highlights the advantages of the new solution, particularly the geospatial benefits, and addresses potential challenges, managers can alleviate these concerns and generate buy-in from stakeholders.

As highlighted in a 2015 *Harvard Business Review* article, “Convincing Skeptical Employees to Adopt New Technology,” the best argument for new technology is that it will make your life better/easier/more productive. Of course, what improves one person’s life doesn’t necessarily improve another’s. Work on building a nuanced story that highlights the value proposition of your solution for multiple audiences.



2 Set a Deadline for Legacy Tools

One of the primary barriers to adoption is people's tendency to cling to their old, favorite tools. Setting a clear deadline for these tools to be retired or downgraded helps create a sense of urgency and encourages timely action. Deadlines signal that the organization is committed to progress and encourages employees to adapt to the new solutions within a specific time frame. This helps prevent complacency and ensures a smooth transition—maximizing the potential benefits of technological advancements.

Additionally, setting a deadline helps allocate resources effectively. Legacy systems often require significant maintenance, support, and training, which can be a drain on time, staff, and financial resources. By implementing a deadline, organizations can strategically plan and allocate resources toward the adoption of new technologies. This ensures that the necessary investments, such as infrastructure upgrades, training programs, and system integrations, are completed within a defined time frame, streamlining the transition process and maximizing the potential benefits of the new tools.

3 Make New Tools Easy to Learn

How easy a tool is to learn directly affects the willingness and confidence of individuals to embrace and utilize new tools. If, for example, a new field data collection app is complex and difficult to understand, users will often revert to workarounds or look for other solutions. On the other hand, when new tools are user-friendly and intuitive, individuals are more likely to engage with and adopt them.

Simplicity reduces the learning curve. Users can quickly grasp the basics and utilize the technology to its fullest potential. It empowers individuals to navigate the tools confidently, boosting their productivity and efficiency. Moreover, an intuitive user interface and well-designed user experience enhance user satisfaction and engagement, creating positive associations with the technology.



4 Ensure Sufficient Training

Technology adoption without proper training can lead to frustration, resistance, and underutilization of the technology's potential. Training provides individuals with the knowledge and skills necessary to navigate and leverage the features and functionalities of new technologies. It helps them understand the purpose, benefits, and best practices of using the tools, enabling them to incorporate them seamlessly into their workflows.

Sufficient training helps users overcome any initial apprehension and builds a foundation of proficiency that allows them to maximize the benefits of the technology. Effective training programs also address individual needs and learning styles, catering to a diverse range of users and ensuring inclusivity in the adoption process.

5 Encourage Feedback

User feedback is often the most valuable source of insights into how new technology is being used or not used. By actively seeking feedback, managers can understand their unique requirements, workflows, and pain points related to a new solution—and, ideally, incorporate them into the solution.

Users may face challenges in understanding the technology, integrating it into existing systems, or extracting meaningful insights from geospatial data. By soliciting feedback, organizations can proactively provide support, training, and resources to overcome these obstacles. Feedback can also highlight areas for enhancement, suggest new features or functionalities, and uncover novel use cases.



6 Implement Quickly and Deliver Early Wins

Going back to the first point about building a solid case for your new solution. The last thing anyone wants is to be sold a promise and then wait for ages, potentially years, to see any results. That's why you need to implement quickly and get some early wins.

Early successes build trust and credibility. They show users that your business case is not just a theoretical concept but a real solution that delivers real value.

Quick wins also generate excitement and engagement among stakeholders. When people see the positive impact of technology firsthand, they become more motivated and enthusiastic about using it. This enthusiasm can often spread throughout the organization, and it becomes easier to secure additional resources, support, and commitment for the technology's long-term integration and utilization.

7 Engage Influencers

Often overlooked but powerfully important is the role of influencers in advocating for your solution.

Influencers are people with clout. They hold sway within your organization based on their credibility, expertise, or seniority. Getting the support of one or more influencers can help build trust, generate excitement, and encourage broader adoption among users.

Do you know someone like this? Try to engage them right from the case development stage. Influencers can share their experiences, success stories, and practical insights, providing valuable guidance and inspiration to others. Their thought leadership can help address misconceptions, dispel resistance, and promote a deeper understanding of the technology's capabilities and applications.

By actively using and championing geospatial technology, they can inspire and motivate others to follow suit. They can even help drive conversations, organize events, and create platforms for knowledge sharing and collaboration, further accelerating geospatial technology adoption.

About the Author

Matthew Lewin is the director of Strategic Advisory Services for Esri Canada. His efforts are focused on helping management teams optimize and transform their business 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. At the intersection of business and technology is where his interests lie, and he thrives on helping organizations bridge the gap to achieve their most challenging GIS ambitions.

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GIS Maps a Path to Economic Mobility

By Keith Cooke

While economic mobility can be variously defined, at its core it focuses on the need to increase opportunities for middle- and low-income households to achieve greater economic success. The concept of economic mobility is not new, but it has gained greater notoriety over the last decade.

According to a 2017 article in *Science*, “rates of absolute economic mobility had fallen from approximately 90 percent for children born in 1940 to 50 percent for children born in the 1980s. However, distributing current GDP growth more equally across income groups as in the 1940 birth cohort would reverse more than 70 percent of the decline in mobility.” That is where the modern concepts of economic mobility come into play.

It Starts with Housing

Access to affordable housing is one of the most impactful ways to create generational wealth. Lower-income households experience burdensome housing costs, which are classified by US Department of Housing and Urban Development (HUD) as constituting greater than 30 percent of household income. These households are usually left with a hurdle to economic mobility that they cannot clear.

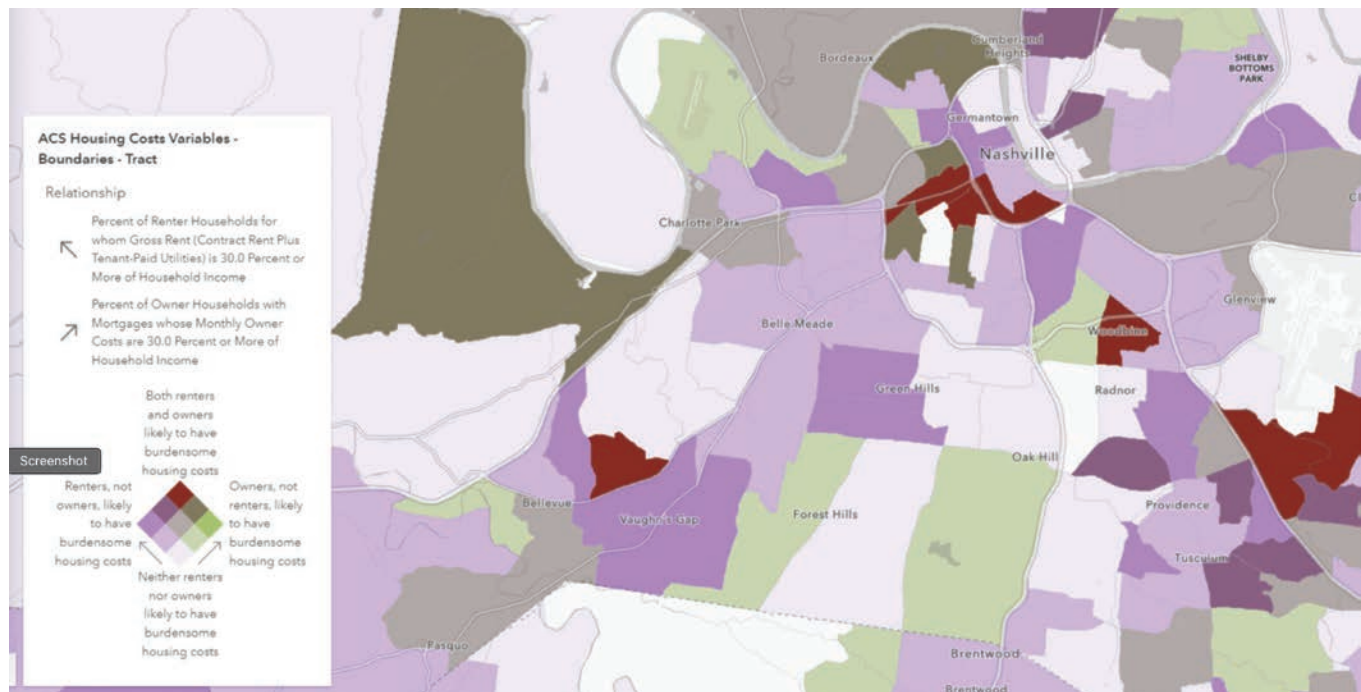
This is one of the reasons there is greater demand from planners for zoning reform that will allow developers to provide housing opportunities that are more attainable for these households. Most walkable communities today prioritize mixed land use with medium-density residential areas near commercial, office, and public spaces.

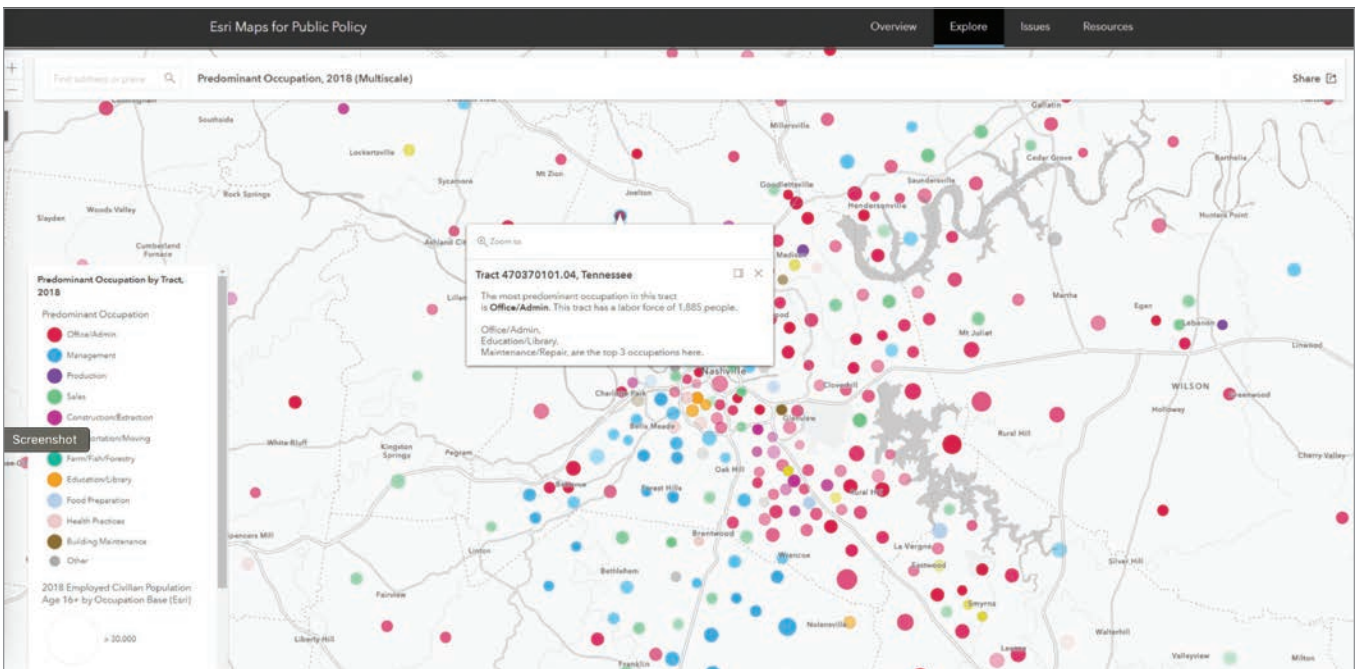
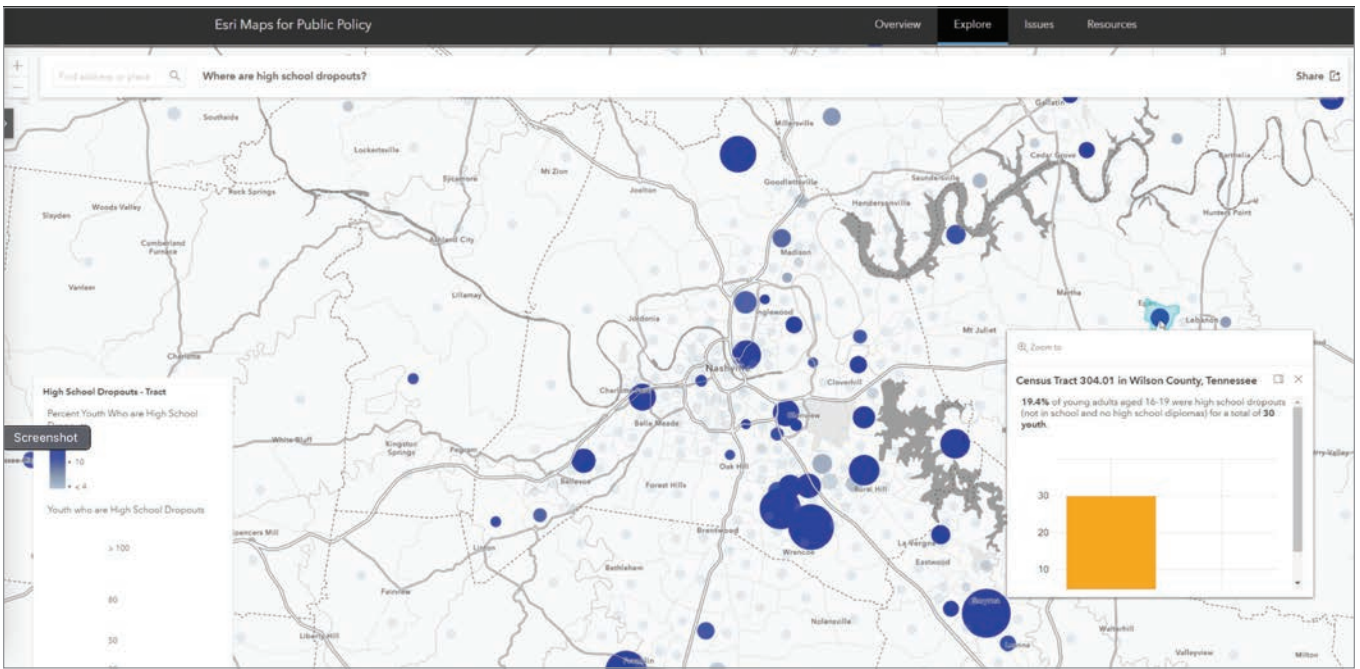
It is preferable that walkable communities are designed so that residents don't have to own a car to travel to their jobs, grocery stores, and parks or obtain health-care, education, and other services. This frees residents from the financial burden of owning and maintaining a car. Creating housing opportunities that have easy access transit, employment, services, and amenities provides a strong foundation for economic mobility.

Education as an Equalizer

The National Association of Counties (NACo) noted in its 2021 economic mobility report, *County Levers to Drive Economic Mobility*, that education is one of the factors that helps break the cycle of poverty and inequality and fosters economic

↓ This ACS *Housing Costs Variables* map is from the Esri Maps for Public Policy site. The darker purple colors downtown denote burdensome housing costs for both owners and renters, which inhibits economic mobility in that area.





↑↑ This map from Esri Maps for Public Policy shows the location of high school dropouts in the Metro Nashville area by census tract.

↑ A map from Esri Maps for Public Policy shows the predominant occupation by census tract in the Metro Nashville area.

mobility in current and future generations. Those with postsecondary education credentials will likely have greater employment options and opportunities than those without. Either individuals will continue to suffer a lack of educational opportunities, further impeding their mobility, or they will leave and go where they can find the opportunities that enable them to grow.

Neither option is viable for a community. Education should also be tied to workforce development, either through separate facilities or partnerships with postsecondary education institutions. Tailoring vocational and on-the-job training services to nearby employment opportunities is an effective way to meet the needs of residents and employers.

Empowering Entrepreneurs for Prosperity

Walkable communities can provide a supportive environment for small businesses and entrepreneurship. Lower transportation costs and higher foot traffic can help local businesses thrive, leading to more job opportunities and economic growth within the community. Working with local



What's in My Community?

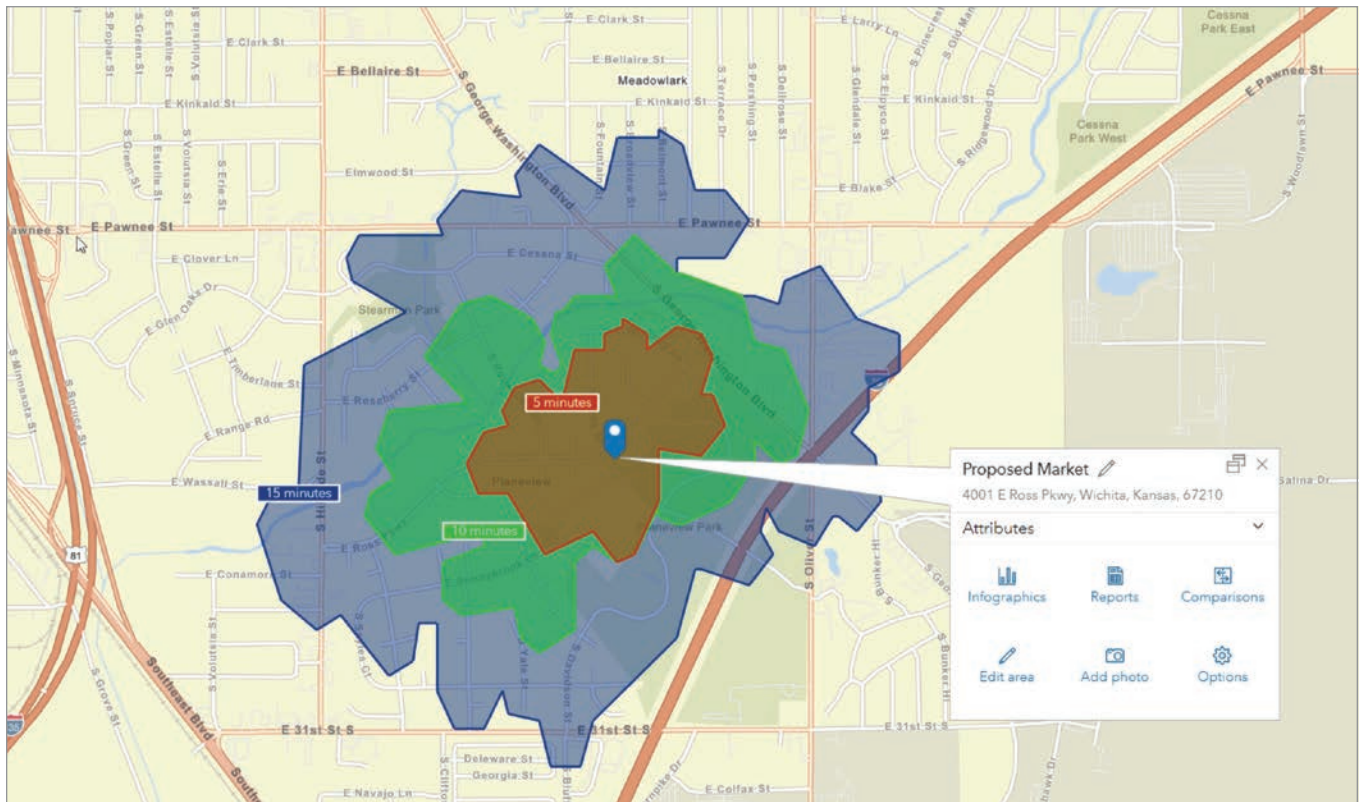
Places that make your life richer and community better

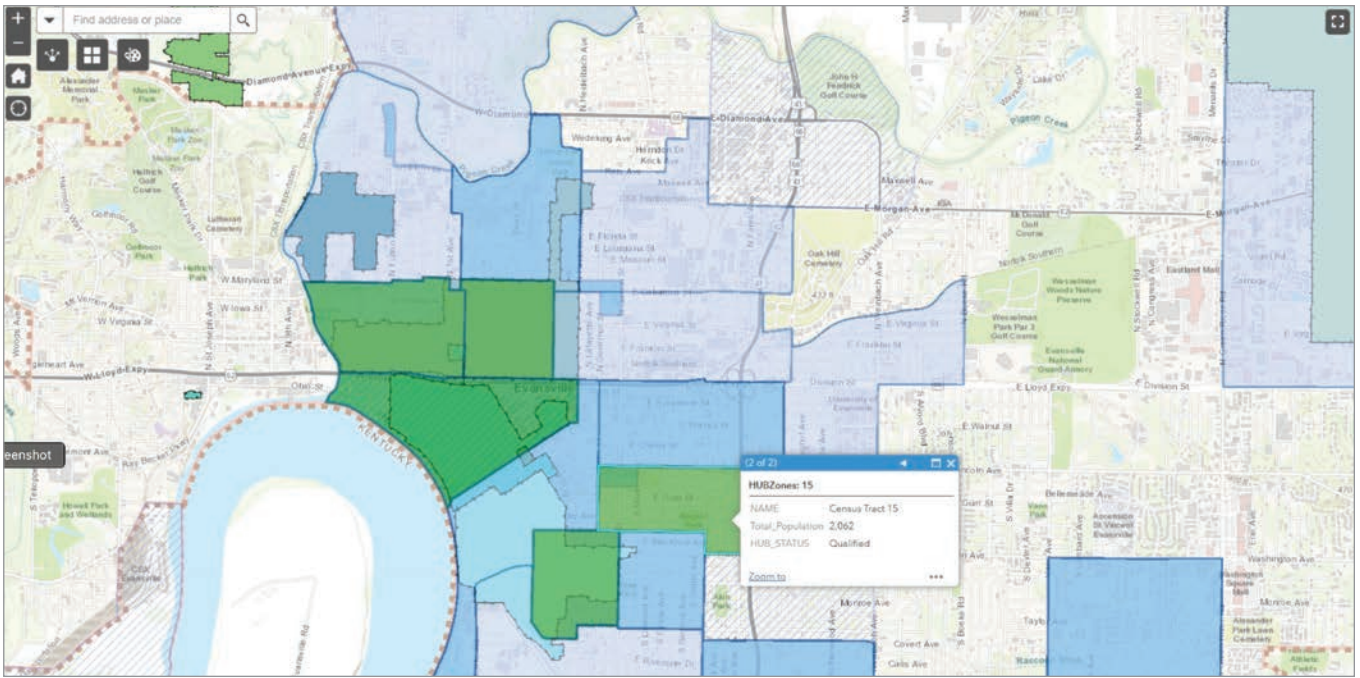
Proposed Market
15 minutes



↑ ArcGIS Business Analyst was used to generate an infographic providing more insight into services in the community.

↓ This map, created using Justice40 data, shows 5-, 10-, and 15-minute walk buffers around a proposed market.





↑ This map shows opportunity zones for the city of Evansville, Indiana.

economic development organizations (EDOs), cities can incentivize and support this type of business growth. In turn, this can help promote similar walkable communities in other parts of the city or county.

This process can also work in the other direction. Businesses can encourage walkable residential development. With a concentration of existing small businesses, nearby areas can be targeted for development into walkable communities with affordable housing. A favorable and conducive regulatory environment for small business is key. This entails reducing bureaucratic hurdles, simplifying regulations, and lowering barriers to entry, even if these steps only exist in a specific opportunity zone. This requires collaboration between the EDO, planners, community leaders, and administrators.

A Geographic Approach to Economic Mobility

From housing to education and health-care access to business development, every facet of economic mobility is centered around or driven by location. GIS helps answer the critical questions in a city or county's policy development, such as

- Where are the highest concentrations of low- and middle-income households?
- How are key demographics (e.g.,

household size, age, race, income) changing over time across neighborhoods?

- Where are sufficient educational, health-care, and other key services accessed?
- Which workforce development skills are needed and where should they be located?
- Where are neighborhoods most burdened by housing costs?
- Which areas are the most conducive to building walkable communities that can support existing (or soon-to-be-developed) local businesses?
- Where is the service area for a new business and does it contain the right type of customers?

The success of an economic mobility strategy requires a geographic approach. GIS provides the tools to help establish policies that are data driven rather than anecdotal ones. Cities and counties have an obligation to provide residents with an economic path forward by providing equitable access to opportunities. GIS provides the foundation for initiatives with this worthwhile goal.

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 account executive at Esri for 15 years, working with over 100 local governments.

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Mapping Complex Data with Multipart Geometries Using ArcGIS Maps SDKs for Native Apps

By Priyanka Rupani

Do you have an application that requires mapping complex geometries and data, such as a network of interconnected pipes, a complex railroad system, lakes within islands, or multiple islands, but don't know where to start?

Multipart geometries allow users to represent complex spatial features using simpler geometry types.

Termed *multipart geometries*, these are a collection of simpler geometries combined to form a more complex shape. This article explores multipart geometries using ArcGIS Maps SDKs for Native Apps and describes multipart geometry types, how to create and apply them, and the benefits of using them. Although the code snippets are written using ArcGIS Maps SDK for Kotlin, all the concepts described apply to the other ArcGIS Maps SDKs for .NET, Qt, Java, and Swift.

Let's get started with the terminology used in this article. The ArcGIS Developer Glossary (developers.arcgis.com/documentation/glossary/) defines a feature as a single record that represents a real-world geographic entity. A feature will store its geographic representation—which could be a point, line, or polygon—as both geometry and attribute data.

Geometry refers to the spatial aspects of a feature (e.g., length if it is a line or area if it is a polygon) and is used to define the shape and position of the feature. *Attribute data* is data associated with that feature, such as the number of people

Multipoint



Single Point



Multipart Line



Single-part Line



Multipart Polygon



Single-part Polygon



↑ Multipart geometries allow users to represent complex spatial features using simpler geometry types.

or the temperature. An ArcGIS-hosted table contains information about a set of geographic features. Each row represents a feature, and each column represents one feature attribute.

What Are Multipart Geometries?

Multipart geometries allow users to represent complex spatial features using simpler geometry

types. These complex features can be composed of multiple points, lines, or polygons that are combined to form a more complex shape. Multipart geometries are categorized as multipoints, multipart lines, and multipart polygons. These geometries, which are composed of multiple simpler geometries grouped into one complex geometry, can be represented as a single entry in a hosted table, instead of having multiple entries for each single geometry.

Multipoint Geometry

Multipoint geometry is a type of geometry that represents features that consist of clusters of points, such as weather station networks, lidar point clusters, or a collection of trees in a forest. For example, each individual tree in a collection of trees of the same species could be represented as a single point feature on a map, or each point could be represented in a multipoint geometry that represents the entire collection of trees.

Choosing a single multipoint geometry, which uses a single row in the database, has many advantages over using many single point geometries. It allows efficient management and analysis of spatial data such as the location and characteristics of individual trees. In addition, calculating the density of trees in different areas or determining the distance between trees can be performed on multipoint geometry. Such analysis helps with planning and development.

The code snippet in Listing 1 demonstrates the creation of a multipoint geometry using ArcGIS Maps SDK for Kotlin. Each individual tree is a point feature that is combined to form a multipoint geometry. View the complete code for all examples on GitHub (<https://shorturl.at/gqvZ1>).

Multipart Line Geometry

Multipart line geometry is a type of geometry that represents a set of two or more individual line features combined to form a more complex feature. It is used to represent linear features that cannot be shown as a single line feature. These individual line features can be disconnected, which means that they do not share endpoints with adjacent line features.

Examples of multipart line geometry features would be a braided river composed of multiple river channels that form part of the same river, a complex railroad system, or a pipeline network. An aerial image of the Brahmaputra River in Bangladesh (figure 1), shows that the many



```
// Create Multipoint geometry using collection of points
// representing each individual tree
val multipoint = Multipoint(
    listOf(
        Point(-13046198.211, 4036513.863),
        Point(-13046194.120, 4036524.953),
        Point(-13046188.702, 4036519.410),
        Point(-13046198.404, 4036504.248)
        ...
        ...
    ),
    SpatialReference.webMercator()
)
symbol lifecycleScope.launch {
    // create a tree symbol
    val treeSymbol = createPinSymbol()
    // creates a graphic with the tree point and
    val treeGraphic =
        Graphic(multipoint, treeSymbol)
    graphicsOverlay.graphics.add(treeGraphic)
}
}
```

channels that form this river share the same attribute since collectively they make up the Brahmaputra River.

↑ Listing 1

Representing this complex river system as a single multipart line geometry helps in efficient data analysis. An example of this would be computing the length and width of the complete river system. One can easily manage, analyze, and visualize the spatial data for the entire system, rather than having to work with individual segments of the river.

The code snippet in Listing 2 illustrates how to create complex multipart polylines using ArcGIS Maps SDK for Kotlin. This code creates different river streams that connect to the main river. The four river streams constituting a single river that eventually connects to the ocean are represented as one multipart polyline feature.

Multipart Polygon Geometry

In GIS, when a path encloses an area, it is called a ring. The ring starts and ends at the same place. A collection of one or more such rings make a polygon. A multipart polygon is composed of many such individual polygons that combine to form a complex shape. Each polygon in the multipart polygon is termed as a part. Each part has its own size and shape. Parts also represent areas that are completely contained within another area, like an island in a lake.

The code snippet in Listing 2 illustrates how to create complex multipart polylines using ArcGIS Maps SDK for Kotlin.

```
//create river streams and add graphics to display these polylines in an overlay
private fun constructRiverStream() {

    // create first river stream which is basically a Mutable Part and connects to the ocean
    val riverstream1 = MutablePart.createWithPoints(
        listOf(
            // add points to the point collection
            Point(-13431206.32, 5131073.67),
            Point(-13431209.45, 5131072.27),
            Point(-13431212.87, 5131071.16),
        ),
        SpatialReference.webMercator()
    )

    // create second river stream which is basically a Mutable Part and connects to the first river
    stream
    val riverstream2 = MutablePart.createWithPoints(
        listOf(
            // add points to the point collection
            Point(-13431212.87, 5131071.16),
            Point(-13431214.08, 5131068.29),
            Point(-13431216.15, 5131064.61),
            ...
        ),
        SpatialReference.webMercator()
    )

    // create third river stream which is basically a Mutable Part and connects to the first river
    stream
    val riverstream3 = MutablePart.createWithPoints(
        listOf(
            // add points to the point collection
            Point(-13431212.87, 5131071.16),
            Point(-13431216.00, 5131068.84),
            Point(-13431217.36, 5131065.42),
            ...
        ),
        SpatialReference.webMercator()
    )

    // create fourth river stream which is basically a Mutable Part and connects to the first river
    stream
    val riverstream4 = MutablePart.createWithPoints(
        listOf(
            // add points to the point collection
            Point(-13431211.06, 5131071.87),
            Point(-13431219.33, 5131070.76),
            Point(-13431225.88, 5131066.53),
            ...
        ),
        SpatialReference.webMercator()
    )

    // create fifth river stream which is basically a Mutable Part and connects to the first river
    stream
    val riverstream5 = MutablePart.createWithPoints(
        listOf(
            // add points to the point collection
            Point(-13431209.30, 5131072.27),
            Point(-13431219.33, 5131075.44),
            Point(-13431225.88, 5131072.17),
            ...
        ),
        SpatialReference.webMercator()
    )

    // add all the parts created above to a List
    var parts = listOf(riverstream1, riverstream2, riverstream3, riverstream4, riverstream5)

    // Create a Polyline geometry using the list of parts created above. This Polyline Builder is
    // essentially a MultipartPolyline geometry comprising of the river streams which are ultimately part of a
    // main river which connects to the ocean
    var polylineBuilder = PolylineBuilder(parts)

    // define a line symbol which will represent the river stream with its width defined.
    val riverSymbol = SimpleLineSymbol(SimpleLineSymbolStyle.Solid, Color.blue, 4f)

    // create a Graphic using the polyline geometry and the riverSymbol and add it to the
    GraphicsOverlay
    graphicsOverlay.graphics.add(Graphic(polylineBuilder.toGeometry(), riverSymbol))

}
```

→ Listing 2

For example, agricultural fields with complex shapes and multiple sections can be represented as a multipart polygon geometry that permits farmers to understand and analyze agricultural output. Complex geologic formations, such as mountains, ridges, and canyons, can be represented as multipart polygons to help geologists analyze the structure of the Earth's crust and its formation process.

The state of Hawaii can be represented as a multipart polygon. It is made of eight main islands, each with its own shape and size. Hawaii can be stored as a single multipart polygon feature in the database table. This allows for a detailed and accurate representation of the state's geography in GIS applications such as land-use planning or disaster response.

The code snippet in Listing 3 creates complex multipart polygons by adding a couple of islands and a lake within an island on the map using ArcGIS Maps SDK for Kotlin.

Applications of Multipart Geometries

Multipart geometries can be used to represent complex road and transportation networks, such as highways with multiple lanes, ramps, and intersections, and help analyze the connections between different parts of the network. Complex urban features, such as city blocks, neighborhoods, and complex building structures, can be represented as multipart geometries. This can help users understand the relationship between different city zones.

Multipart geometries can also be used to represent complex environmental features, such as national forests, nature conservancy land, wildlife sanctuaries, and various water bodies, when performing environmental assessments and planning.

Benefits of Multipart Geometries

Using multipart geometry over multiple individual geometries has many benefits. One of the

↓ Brahmaputra River in Bangladesh can be represented as a multiline geometry feature. The different streams highlighted in blue connect to the Brahmaputra River, which eventually joins the Indian Ocean.



The code snippet in Listing 3 creates complex multipart polygons by adding a couple of islands and a lake within an island on the map using ArcGIS Maps SDK for Kotlin.



```
//create input polygons and add graphics to display these polygons in an overlay
private fun createPolygons() {

    // create an island which is the first polygon part
    val island1 = MutablePart.createWithPoints(
        listOf(
            // add points to the point collection
            Point(-16983394.627, 1725046.488),
            Point(-16967695.178, 1741475.672),
            Point(-16939145.948, 1736705.524),
            ...
        ),
        SpatialReference.webMercator()
    )

    // create a another island which is the second polygon part
    val island2 = MutablePart.createWithPoints(
        listOf(
            // add points to the point collection
            Point(-16858450.243, 1742851.240),
            Point(-16855023.117, 1750367.747),
            Point(-16851622.565, 1754465.787),
            ...
        ),
        SpatialReference.webMercator()
    )

    // create a another island which is the third polygon part and acts as an outer ring
    val outerIsland = MutablePart.createWithPoints(
        listOf(
            // add points to the point collection
            Point(-16894265.768, 1780130.116),
            Point(-16888215.299, 1785870.657),
            Point(-16877750.891, 1783166.995),
            ...
        ),
        SpatialReference.webMercator()
    )

    // create a lake which is a polygon part and an iner ring to the above outer ring
    val innerLake = MutablePart.createWithPoints(
        listOf(
            // add points to the point collection
            Point(-16895378.882, 1773374.994),
            Point(-16887986.287, 1772724.682),
            Point(-16883906.162, 1768680.088),
            ...
        ),
        SpatialReference.webMercator()
    )

    // add all the parts created above to a List
    var parts = listOf(island1, island2, outerIsland, innerLake)

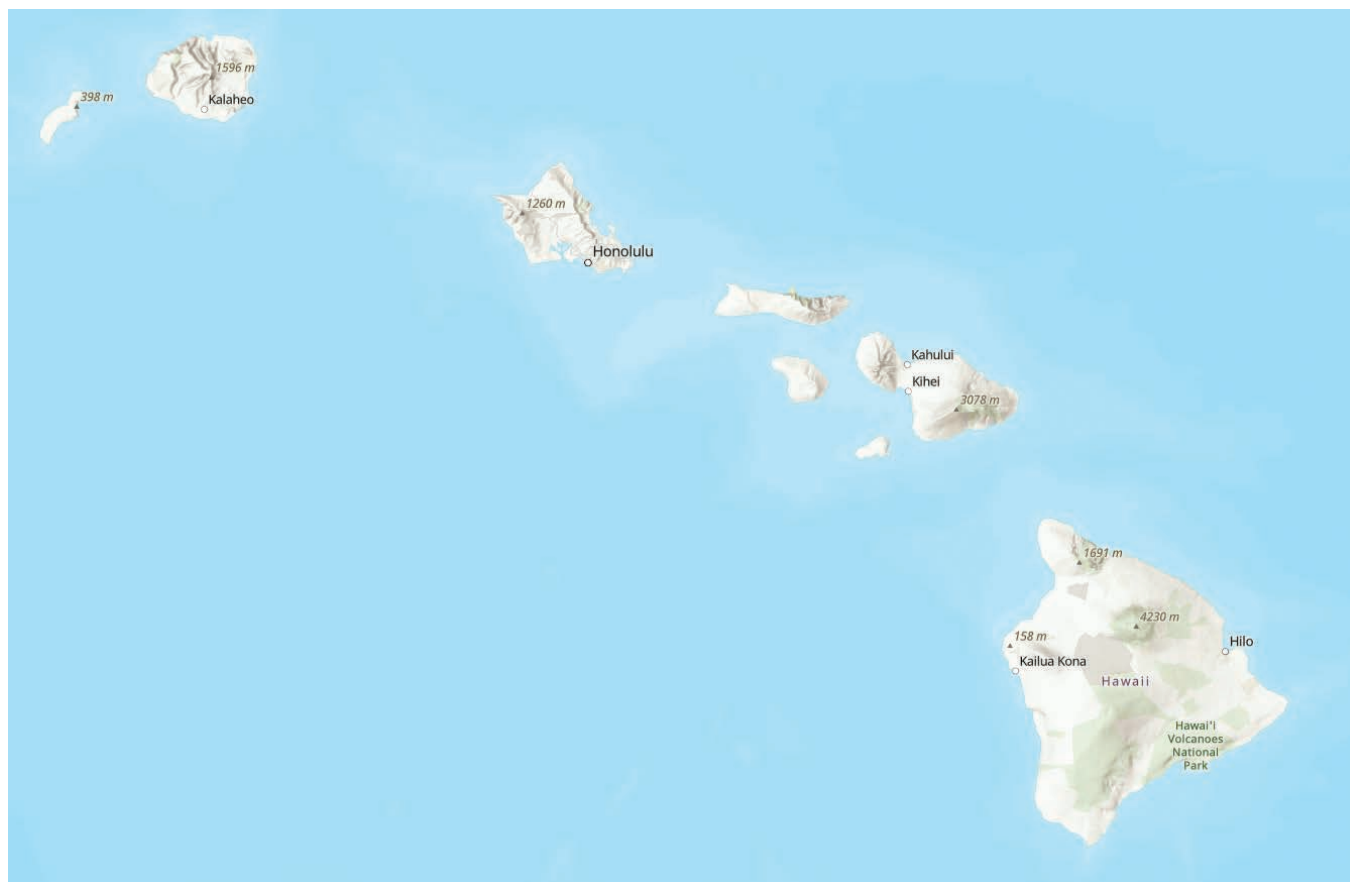
    // Create a PolygonBuilder using the list of parts created above
    var polygonBuilder = PolygonBuilder(parts)

    // define a line symbol which will represent the boundary of the polygon
    val lineSymbol = SimpleLineSymbol(SimpleLineStyle.Solid, Color.fromRgba(153, 221, 255),
2f)

    // create and add a green graphic to fill color of the Polygon Builder.
    val greenFill = SimpleFillSymbol(SimpleFillStyle.Solid, Color.fromRgba(128, 255, 170 ),
LineSymbol)
    graphicsOverlay.graphics.add(Graphic(polygonBuilder.toGeometry(), greenFill))

}
```

→ Listing 3



important benefits is enhanced performance. The amount of memory required to store these geometries is reduced significantly when multiple related parts or features are stored as a single multipart geometry object, which in turn boosts the efficiency of spatial queries and analysis.

Multipart geometries help simplify data management. If a map feature consists of multiple polylines, it can be stored as a single multipart polyline geometry and updated as a single geometry object, instead of many individual geometries. This makes it easier to update and maintain data integrity.

Another benefit of multipart geometries is increased flexibility in representing complex spatial features. By representing features as a single multipart geometry, it is easier to visualize and analyze the feature as a whole, rather than treating each part as a separate feature.

Conclusion

In summary, using multipart geometries in your mapping applications is an efficient way of representing a wide range of complex features in geographic data. From water bodies and land masses to buildings and transportation networks,

multipart geometries allow for a detailed representation of complex features, which is helpful in urban and town planning, environmental resource planning, and other applications.

This article showcased examples using ArcGIS Maps SDK for Kotlin to map complex features. To learn more about adding attributes to a feature, look at this sample code (<https://shorturl.at/fCNO9>) on the ArcGIS Developers site, which creates and adds features with attribute values that satisfy a predefined set of contingencies. Also, see the Kotlin samples on the Esri GitHub repository (<https://shorturl.at/oBDK9>).

If you're new to developing ArcGIS Maps SDKs for Native Apps, the SDKs for .NET, Qt, Java, Kotlin, and Swift each have guides, documentation, API references, tutorials, and samples. Sign up for a free ArcGIS Developer account at developers.arcgis.com and access everything you need to develop your apps.

About the Author

Priyanka Rupani is a product engineer at Esri who develops Android samples that showcase the features available using ArcGIS Maps SDKs for Native Apps.

↑ The eight main islands that make up the state of Hawaii can be represented as a multipart polygon and stored as a single multipart polygon feature in the database table.

Geospatial Could Revolutionize the SDG Agenda beyond 2030

By Marwa El Kabbany

For nearly two decades, I've worked with geospatial science and technology across various regions and sectors, including the private sector, academia, and government. Throughout my journey, I have come to recognize the pivotal role of geospatial information in driving sustainable development, not just in the present but also as we chart our path toward achieving the 17 Sustainable Development Goals (SDGs) set forth by the United Nations, beyond the target year 2030.

Acting as our "eye on Earth," geospatial data allows us to understand our current state, forecast challenges, and identify root causes. For instance, geospatial data plays a crucial role in assessing and monitoring the state of the environment, pinpointing areas of concern, and tracking changes over time.

Geospatial technology, specifically GIS, enables us to analyze spatial patterns and relationships, providing invaluable insight for root cause analysis, targeted interventions, and resource allocation. Through the application of geospatial information, we gain a more profound understanding of complex environmental processes, supporting evidence-based decision-making for sustainable development initiatives.

Geospatial information has the capacity to revolutionize

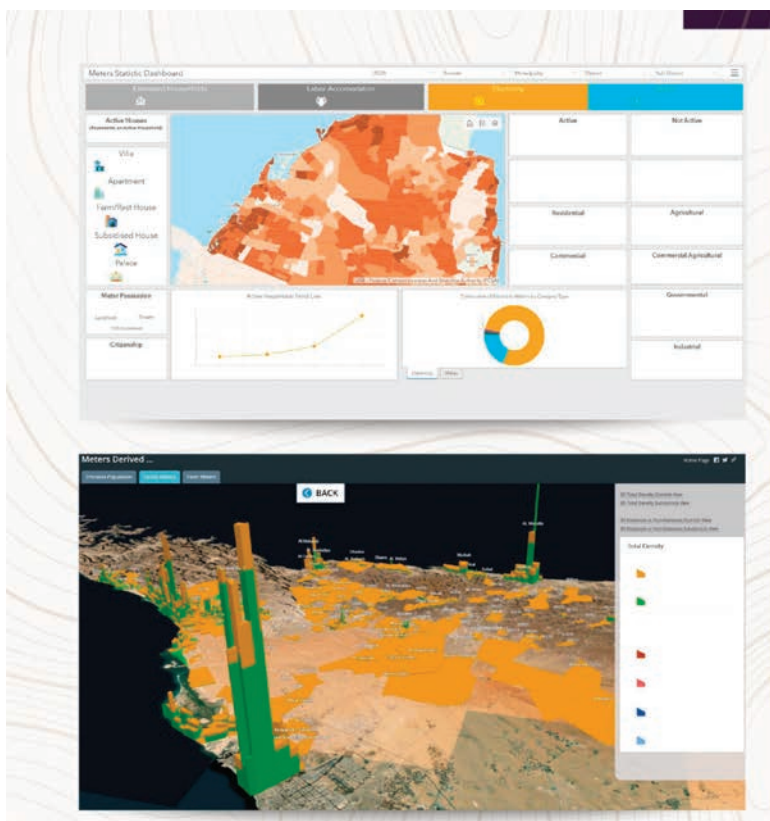
sustainable development by enabling GIS integration into all possible systems. This integration includes creating a real-time digital twin of our world, in which spatial data is woven seamlessly into various domains and sectors. By geoenabling everything, we can enhance decision-making, optimize resource allocation, and enhance the efficiency of infrastructure and services. This integration will result in a comprehensive understanding of the interconnectedness of social, economic, and environmental systems, paving the way for more holistic and effective approaches to sustainable development.

Applying Geospatial Expertise

In my role as a geospatial expert at the United Arab Emirates (UAE) Ministry of Cabinet Affairs, Federal Competitiveness and Statistics Centre (FCSC), as well as during my earlier experiences as a researcher and my collaborative work with the Food and Agriculture Organization (FAO) of the United Nations in Libya, I had the privilege of contributing to multiple real-world projects. These initiatives harnessed geospatial information to advance sustainable development, demonstrating the profound impact that geospatial analytics can have across diverse contexts.

→ UAE FCSC used geospatial visualization to analyze historical trends in population, land use, and economy for planning sustainable cities and addressing climate change in line with SDG goals. (Source: Green Areas Growth in UAE)





SMART METERS DASHBOARD FOR HOUSING UNITS



Calculation of indicators using geo-analysis and artificial intelligence

This application represents the output of a smart approach to extract household units density through deriving active residential utility meters from water and electricity meters data showing the growth from 2013 onwards.

Information depicted include:

- Statistics at the levels of the emirate, municipality, district, and sub-district
- Statistics based on the type of building: villa, apartment, or other
- Statistics by type of unit: residential, farm, and commercial
- Statistics by citizenship of meter owners
- A summary of the growth pattern since 2013
- Maps for meters distribution density

↑ FCSC harnessed the power of geospatial intelligence in remote sensing to extract meaningful insights from imagery and combine it with administrative data to integrate building footprints extracted from satellite imagery with millions of administrative records for electricity meters.

Tracking Growth

FCSC utilized Landsat imagery and National Aeronautics and Space Administration (NASA) night light imagery to monitor the growth of various areas since 1972. Historical Landsat imagery and imagery from the UAE's Mohammed Bin Rashid Space Centre (MBRSC) helped track changes in green and built-up areas, and the rate of land consumption. NASA night light maps were used to monitor the expansion of night light from 2010. These geospatial visualization capabilities allowed us to understand space-time factors and historical trends related to population, land-use, and economic patterns. Such information is crucial for planning sustainable cities, combating climate change, and protecting terrestrial ecosystems in alignment with the SDGs. (See the UAE 50 Years of Prosperity webpage at <https://shorturl.at/eortY>.) This project aligns with SDG 11: Sustainable Cities and Communities, particularly Target 11.3, which focuses on enhancing inclusive and sustainable urbanization.

Leveraging Earth Observation and Geospatial Intelligence

FCSC harnessed the power of geospatial intelligence in remote sensing to extract meaningful insights from imagery and combine it with administrative data. For instance, in the context of housing and household surveys, we successfully integrated building footprints extracted from satellite imagery with millions of administrative records for electricity meters.

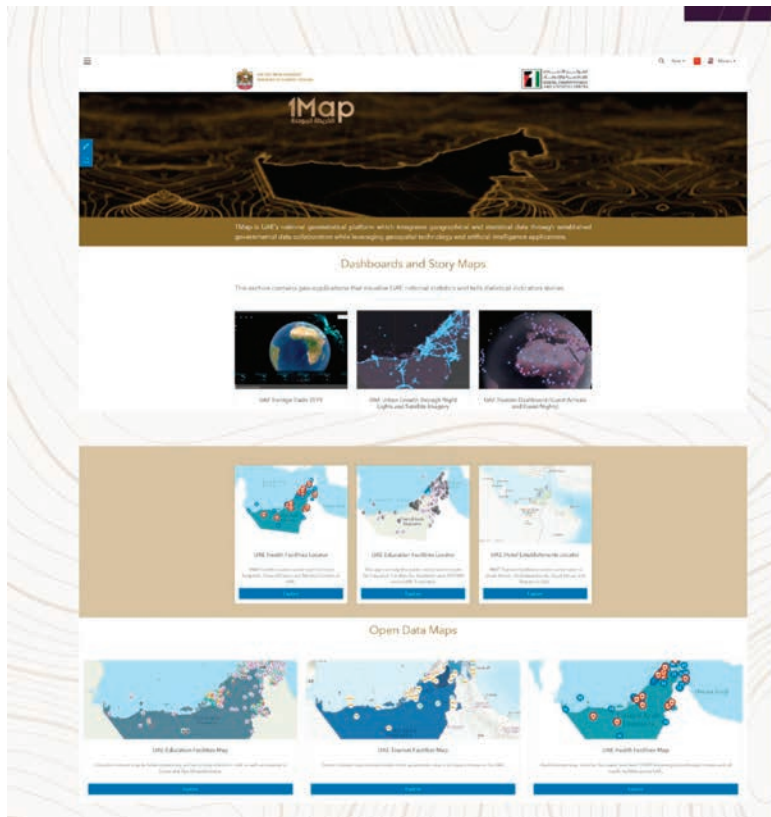
This amalgamation allowed us to discern the use and status of buildings and distinguish between residential and commercial properties. By employing this approach, we significantly reduced the need for physical fieldwork, which saved the government substantial time, effort, and money. Furthermore, these technologies enhanced the quality and accuracy of the information obtained, ultimately more effectively propelling us toward our SDG targets. (See "Smart Meters Data" at <https://shorturl.at/BDSZ8>.)

Geoenabling National Statistics

In the UAE, FCSC pioneered two groundbreaking projects: the 1Map (<https://shorturl.at/bdFMR>) and the UAE SDG Data Hub (<https://shorturl.at/cgq26>), both of which underscore the transformative potential of geoenabling national statistics.

1Map is the UAE's national geostatistical platform that integrates geographic and statistical data through established governmental data collaborations. The platform aims to support planners and decision-makers across diverse sectors as well as provide the community with authoritative maps and official statistics through leveraging the latest geospatial and artificial intelligence (AI) technology to support planning, crisis management, and research.

Concurrently, the UAE SDG data hub is a comprehensive platform that aims to track, monitor, and report progress toward the implementation of the SDGs in the UAE and is integrated with the Sustainable Development Goals Data Hub (<https://shorturl.at/epX19>). It features four main elements that make it unique and



1Map
الخريطة الموحدة

1Map is the UAE's national geostatistical platform that integrates geographical and statistical data through established governmental data collaborations.

The platform aims to support planners and decision makers as well as provide the community with authoritative maps and official statistics, all while leveraging latest geospatial technology and artificial intelligence to serve in planning, crisis management as well as research purposes.

		
25+	30+	100+
Federal & local entity	Dashboard & application	Map National Indicator
		50+

↑ 1Map, the UAE's national geostatistical platform, integrates geographical and statistical data through established governmental data collaborations.

engaging: open data on SDG indicators, engaging data stories, dynamic initiatives, and a robust media section. (See *Data for Good: Innovative Ways the UAE is Joining Hands for a Better World* at <https://shorturl.at/mGK78>.)

The utilization of geoenabled statistics in both platforms introduces a spatial dimension to the understanding of statistical data, facilitating the extraction of nuanced insights for the development and implementation of more targeted and efficient policies. Such projects underscore the significance of integrating geographical and statistical data and set a benchmark for future endeavors aimed at tackling complex socioeconomic and environmental challenges.

Assessment of Environmental Challenges

In my master's degree thesis at Lund University in Sweden, I undertook a study on sea level rise to gauge the vulnerability of coastal cities. A key output of this thesis was a dashboard that effectively organized, summarized, and presented the results of the assessment. The dashboard underscored the vulnerability of Abu Dhabi's natural and built environment to long-term sea level rise and provided insight derived from surface analysis using geospatial models.

This study aligns with SDG 11–Target 11.5, which focuses on reducing the impacts of disasters and enhancing cities' resilience to climate-related hazards. By emphasizing the vulnerability of coastal cities to sea level rise, the study contributes to understanding and managing climate risks, promoting sustainable urban

development, and enhancing city and settlement resilience. (See *Sea Level Rise Vulnerability Assessment for Abu Dhabi, United Arab Emirates* at <https://shorturl.at/acmBT>.)

Land and Resource Management

Working in collaboration with the Libyan government, the United Nations Development Programme (UNDP), and the FAO, I played an important role in the creation of the Land Resources Information Management Systems (LRIMS) project. This project is a prime example of how GIS-based systems can be used to manage land resource information. With a focus on Libya, this initiative incorporated 10 modules, including climate, soil, vegetation/land cover, water, land suitability, crop, socioeconomic, topography, land utilization types, and reporting tools.

Opportunities and Challenges

As we navigate the intersecting domains of Earth observations and the SDGs, we encounter both opportunities and challenges.

A key factor in the success of the previously mentioned projects was the availability of a wide variety of geospatial data collection and analysis tools. For these diverse initiatives, we utilized both commercial and free satellite imagery, aerial photographs, and digital elevation models. We also drew upon authoritative geospatial databases provided by municipalities and governments, as well as data from ground-based surveys.

In addition, we leveraged platforms such as OpenStreetMap and

US Geological Survey (USGS) EarthExplorer, in conjunction with GPS data. Collectively, these resources provided invaluable information about the Earth’s surface, such as land cover, vegetation, climate, infrastructure, population demographics, and community facilities. Certain sources also provided critical, precise, and location-specific data. The breadth of these sources greatly enriches sustainable development projects.

At the same time, collecting and processing geospatial data for sustainable development projects poses several formidable challenges. These include limited data availability and the need to navigate varying data formats and integrate data from multiple sources. Furthermore, data preprocessing tasks such as image calibration, geometric correction, and atmospheric correction can be time-consuming and require specialized knowledge. Adding to these complexities are the costs of acquiring commercial geospatial data and maintaining their updates. Above all, ensuring the quality and accuracy of data is crucial, as any errors or inconsistencies can lead to inaccurate analysis and unreliable results.

Unleashing the Power of Collaboration

Collaboration among different stakeholders from government, the private sector, nongovernmental organizations (NGOs), and academia is crucial for realizing the full potential of geospatial information for sustainable development. By working together, stakeholders can share data, expertise, and resources. This will lead to more comprehensive and cost-efficient solutions.

I have been involved in various projects that have fostered collaborative efforts and led to successful outcomes. Such partnerships not only help reduce cost and increase the quality and scalability of the outputs, but also facilitate knowledge exchange in the process. Partnerships remain at the core of successful SDG implementation since they promote interdisciplinary approaches and enhance the impact of geospatial information on SDG initiatives. This core

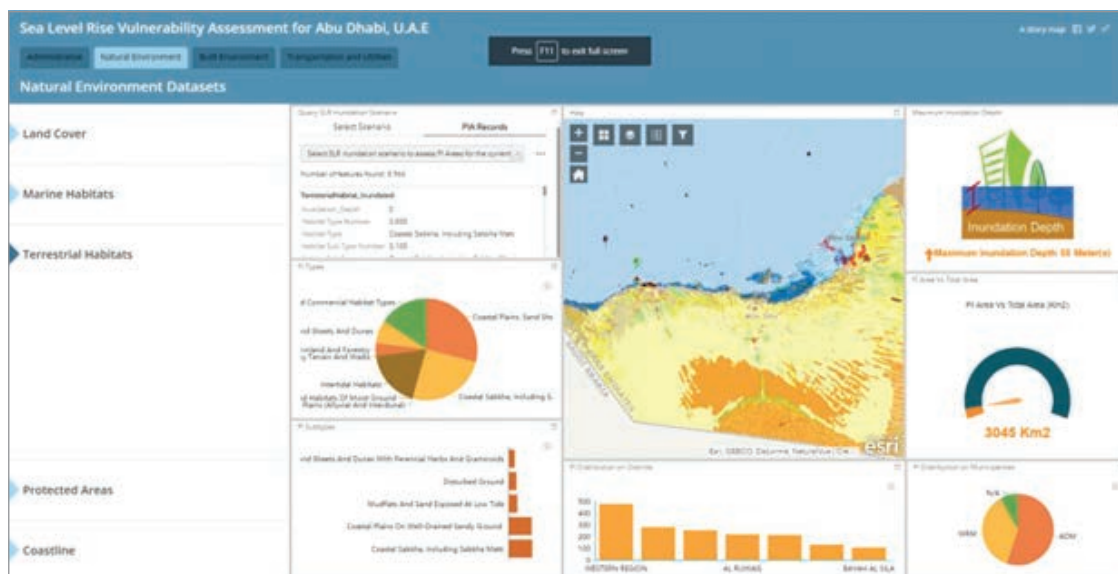
principle is embodied in SDG 17: Partnerships for the Goals.

For example, the UAE has established multiple national and international partnerships to accelerate the implementation of SDGs. At the national level, the governance structure includes a national committee focused on SDGs, a private sector advisory council, and a youth advisory council that serves as a bridge to communicate between various sectors and the country’s youth. Similarly, academia and civil society are actively engaged through innovative projects.

International relations are equally important. The UAE continually partners with many multilateral organizations to further the SDGs. For instance, the UAE SDG Data Hub was established through significant joint efforts. The United Nations Department of Economic and Social Affairs (UN DESA) not only provided guidance and support but also hosted the centralized Open SDG Data Hub-FIS4SDGs into which UAE’s hub was integrated.

Esri and the UN Statistical Division (UNSD) worked together to design the Sustainable Development Goals data hub, which is the data framework for the UN 2030 agenda. The geospatial web portal connects the UNSD with a network of national-level SDG hubs that form the Federated Information System for the SDGs. It provides insight into the progress on the goals at both national and sub-national levels. The partnership with Esri enabled FCSC to configure the UAE SDG Data Hub and leverage Esri’s geospatial platform ArcGIS. (See “UAE Data Hub Drives Sustainability Goals” at <https://shorturl.at/cgwxH>.)

Together, these collaborations help make the UAE SDG Data Hub a powerful and award-winning tool. It features an array of best practices, data stories, and open data at the emirate level, incorporating initiatives that span the UAE and include the private sector and nonprofit organizations. In addition, it functions as a tool for creating awareness, shaping culture, and engaging all of society in sustainable development opportunities.



← Sea Level Rise Vulnerability Assessment for Abu Dhabi, U.A.E., uses maps, charts, and graphs to demonstrate the anticipated 1-meter sea level rise impact on terrestrial habitats, a subdomain of natural environment domain. (Source: Sea Level Rise Vulnerability Assessment for Abu Dhabi, U.A.E.)

→ The Land Resources Information Management System (LRIMS) enables matching soil properties with crop requirements, identifying sustainable water withdrawal areas, generating output layers for land use and crop suitability based on changing climatic conditions, and intricate analysis of meteorological data. (Source: LRIMS)

Countries and government organizations also benefit greatly from initiatives such as EO4SDG (eo4sdg.org) and the Earth Observations Toolkit for Sustainable Cities and Human Settlements (<https://eotoolkit.unhabitat.org/>), which serve as lighthouses that guide organizations in the effective use of Earth observation and geospatial intelligence.

These initiatives provide valuable use cases that demonstrate practical applications of these technologies in addressing sustainable development challenges.

By bringing awareness to relevant open data sources, these initiatives help ensure access to relevant and reliable information for decision-making. Additionally, they underscore the power of collaboration, fostering partnerships among diverse stakeholders to collectively leverage Earth observation and geospatial data for the realization of the SDGs and the development of sustainable cities and human settlements.

Looking to the Future

As the geospatial industry evolves, I foresee several trends emerging, the most notable one being the increasing availability of high-resolution satellite imagery, coupled with the advancement of remote sensing technologies. This development will enable more detailed and accurate monitoring of environmental changes, supporting targeted interventions and adaptive management approaches. The fusion of geospatial data with other emerging technologies such as machine learning and big data analytics will enhance the capabilities of geospatial information systems and enable more sophisticated analysis and decision-making.

Citizen science and participatory mapping can have a significant

impact on achieving sustainability. By involving citizens in the process, communities are empowered to contribute invaluable information and local knowledge. The community can contribute by mapping, collecting, and monitoring data; conducting spatial analysis and modeling; supporting spatial planning and land management; developing decision support systems; and advocating for geospatial information in policy formulation. Through these endeavors, citizen scientists enable the collection of geospatial data at multiple scales. This fosters community engagement, heightens environmental awareness, and propels sustainable development efforts forward.

Finally, collaboration and partnerships will continue to be integral in refining the SDG agenda. They will serve as the bedrock for ensuring evidence-based decision-making and successfully addressing complex spatial challenges. As we continue leveraging geospatial information, cooperation can guide us along the path toward a sustainable future.

About the Author

Marwa El Kabbany is a veteran of the geospatial industry. She has developed geospatial road maps and utilized Earth observation, geospatial information science, and technology to promote sustainable development for more than 17 years. Until recently she was the GIS expert at the UAE Ministry of Cabinet Affairs, FCSC. She is currently engaged in research at the Université Libre de Bruxelles, focusing on the study of mobility data, specifically vessel movement, and satellite-derived air quality measurements. She also sits on the EO4SDG Board.

This article originally appeared on eo4sdg.org.

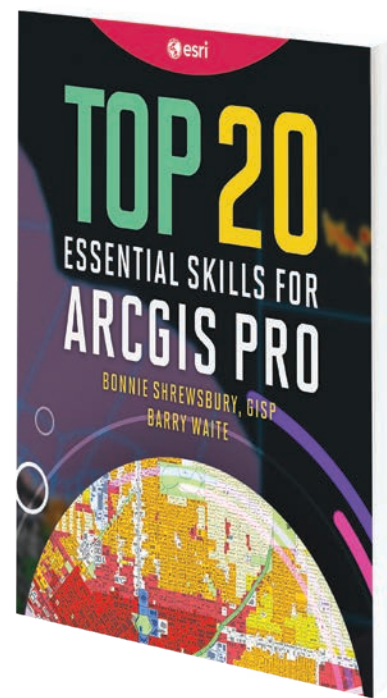
GIS Bookshelf

Top 20 Essential Skills for ArcGIS Pro

By Bonnie Shrewsbury and Barry Waite

Top 20 Essential Skills for ArcGIS Pro introduces the most important skills needed to get up and running with ArcGIS Pro. This book puts you on the fast track to productivity with clear illustrations, step-by-step exercises, and time-saving tips. Build a foundational GIS skill set by learning how to work with spatial data, create maps, and perform basic analysis.

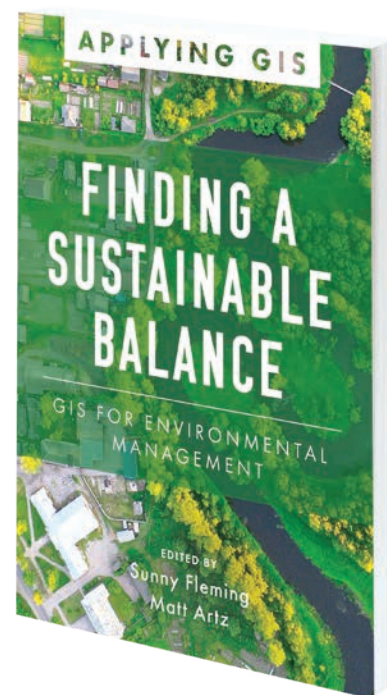
Authors Bonnie Shrewsbury and Barry Waite have many years of real-world experience in applying GIS. Shrewsbury, the GIS manager for the City of Manhattan Beach, California, has more than 26 years of experience with GIS, holds a geographic information system professional (GISP) designation and has a master's degree. Waite has nearly 40 years of experience in local government as an administrator and city planner. He has a master's degree in public administration from the University of Southern California (USC). Shrewsbury and Waite teach a GIS course at USC for graduate-level planning and public policy students. Esri Press, 2023, 190 pp., print ISBN: 9781589487505, ebook ISBN: 9781589487512



Finding a Sustainable Balance: GIS for Environmental Management

By Sunny Fleming and Matt Artz

Finding a Sustainable Balance: GIS for Environmental Management explores a collection of real-life stories about how environmental and natural resource management organizations successfully use GIS to monitor environmental assets in real time and provide transparency for better outcomes for all, to track environmental assets, and to prevent environmental hazards from becoming disasters. Learn how GIS can help improve operations across land and wildlife management, outdoor recreation, and environmental regulation. The book also includes a section on next steps, providing helpful ideas, strategies, tools, and actions to help jump-start your use of GIS for environmental management. A collection of online resources, including additional stories, videos, and downloadable tools, complements this book. Esri Press, 2023, 125 pp., print ISBN: 9781589487581, ebook ISBN: 9781589487598



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

AMP UP YOUR PRESENTATIONS

BRIEFINGS, a storytelling tool that is ideal for presentations, was released as part of ArcGIS StoryMaps in August 2023. Its slide-based functionality is designed for simple information-sharing presentations. This app gives you an organized, highly visual way to communicate complex information.

To create a presentation in briefings, open the ArcGIS StoryMaps builder and choose briefings from the left side menu. Like stories, collections, and themes, briefings are a type of ArcGIS StoryMaps output that has its own place in your ArcGIS StoryMaps content library, organized by My Briefings, My Favorites, My Groups, and My Organization.

Build a presentation slide by slide, starting with a cover slide that includes a title, subtitle, byline, and image or video. Each slide you create appears in the slide panel on the left. Click the plus button at the bottom of the slide panel to add a new slide. Pick one of the four slide layouts. Always add a slide title that is clear and concise because it will be included in the table of contents and aid viewers in finding content.

To add content to a slide, simply type or paste in text and apply formatting options for heading style, color, and bullet lists. You

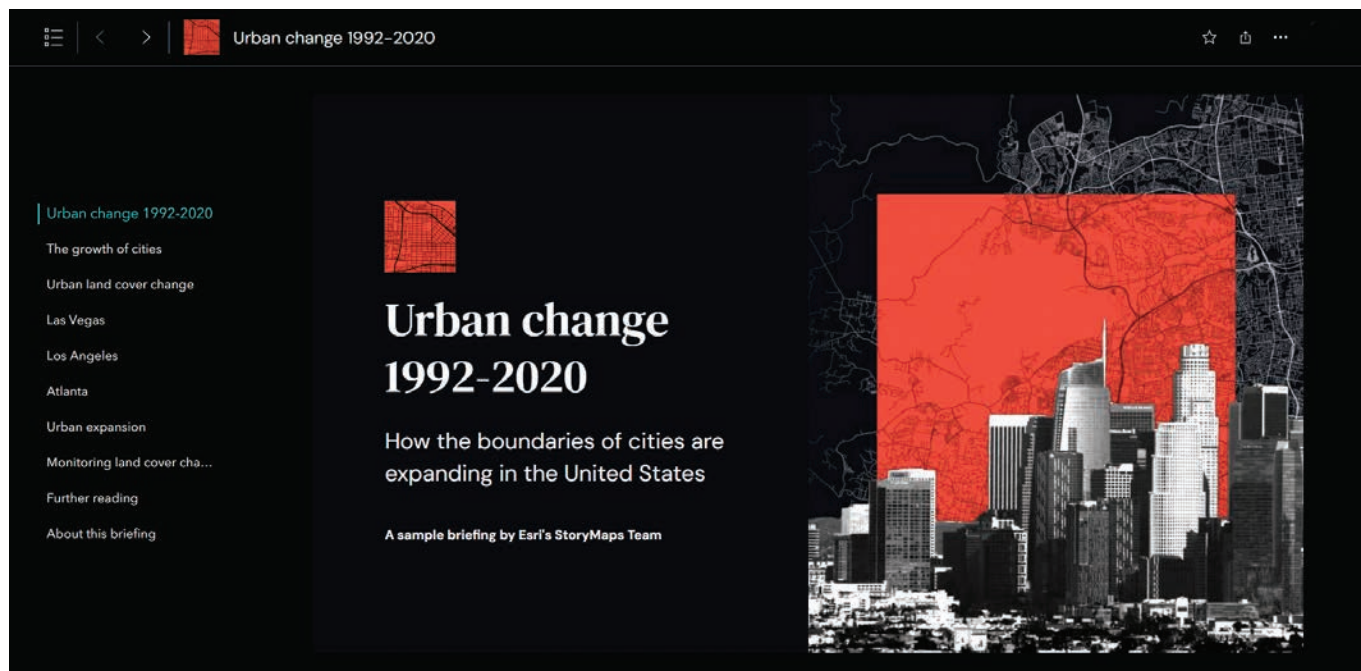
can add images, videos, maps, or a swipe block to compare two maps or images, or embed content from the web using a link. If you want to add a map, you can choose a map from your content, your favorites, your groups, your organization, or ArcGIS Living Atlas of the World.

You can also add attachments to snippets of text. Attachments can be content from the ArcGIS ecosystem or an image or video you upload. Attachments open within the briefing and can be closed using the x in the upper right-hand corner.

You can use the design panel to apply a theme, a custom theme, or a featured theme from the gallery, just as you can when designing stories and collections. You can add a logo that will appear in the briefing header and on its cover slide.

You can navigate between slides by using the left and right arrows in the header and by clicking on the table of contents icon in the header on the left side. If you are using the table of contents, click on a slide title to jump to that slide.

If there is a feature or functionality you would like to see in briefings, click the help button in the header and choose Feedback to use the in-app feedback form.



↑ The briefings app gives you an organized, highly visual way to communicate complex information.

WITH BRIEFINGS

↓ You can format and color text and add images, maps, videos, or a swipe block on a slide.

Urban change 1992-2020

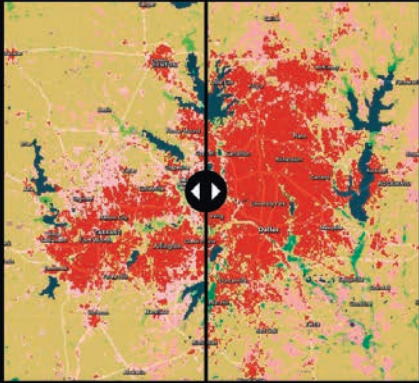
Urban land cover change

Urban change 1992-2020

- The growth of cities
- Urban land cover change
- Las Vegas
- Los Angeles
- Atlanta
- Urban expansion
- Monitoring land cover cha...
- Further reading
- About this briefing

Unchecked growth can result in the conversion of adjacent **forest**, **grassland**, and **agricultural land** into a sprawling **urban** landscape.

While difficult to perceive from the ground, satellite imagery can reveal these changes and help monitor long-term trends. Here, land cover in the greater Dallas area from **1992** (left) is compared to **2020** (right).



Urban change 1992-2020

Atlanta

Urban change 1992-2020

- The growth of cities
- Urban land cover change
- Las Vegas
- Los Angeles
- Atlanta
- Urban expansion
- Monitoring land cover cha...
- Further reading
- About this briefing

Strategically located at the intersection of multiple railroads, Atlanta developed as an economic hub.

The city continues to thrive in this role, and between **1992** and **2020**, urban land cover in the area has grown by **54.5%**.



↑ Navigate through a briefings presentation using the table of contents on the left-hand panel.

GET STARTED

Administering an Existing ArcGIS Online Organization

By Kathy Cappelli Breier

Imagine this scenario—your supervisor just left your office after delivering some news: you’ve just been tasked with administering your company’s ArcGIS Online organization. You have account credentials and not much else because the previous administrator didn’t leave documentation, and you’re not sure how to get started.

If this sounds familiar, then look no further for answers. This article provides a checklist of tasks, broken down by time frame. These tasks are organized by what you’ll want to accomplish soon after taking over administration of the organization, then later on when you are more comfortable in your new role, and finally things you’ll need to do to ensure everything’s running smoothly.

While it may also be helpful to think of this list as tasks to accomplish within the first week, month, and quarter after taking ownership of the administrator role, these tasks can be done mostly at your own pace. These tasks will help you start understanding how your ArcGIS Online organization runs, then teach you tricks you need to keep it running.

Getting Started with Your New Administrator Role

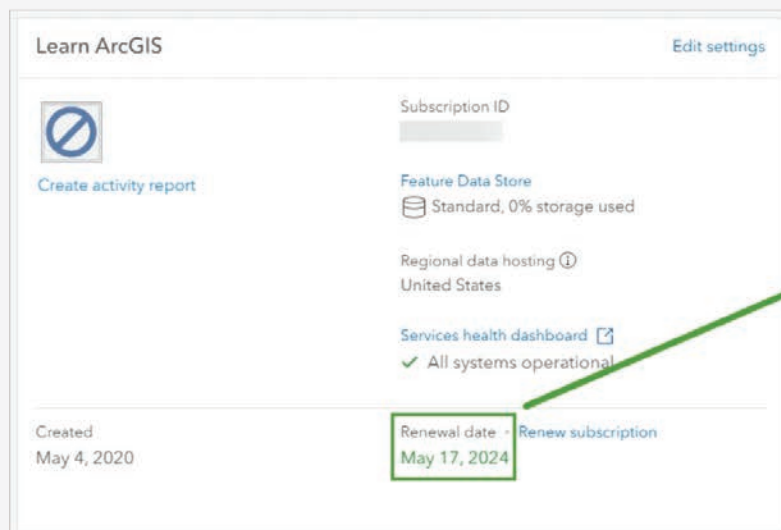
Your first step as a new administrator is to ensure you have the correct administrator account and necessary permission settings.

- Ensure that you can sign in to the organization.
- Ensure that you have the default Administrator role (not a custom role with administrative privileges).
- Find your organization account’s renewal date and mark it on your calendar.
- Set yourself as the organization’s administrative contact.

Being the administrative contact will ensure that you receive important notifications about the organization, such as renewal, credit consumption notices, and notifications about releases and other product news. This is also how you will receive password reset requests. If a user in your organization hasn’t set up their security questions, you may have to manually reset their password.

Initial Member Management

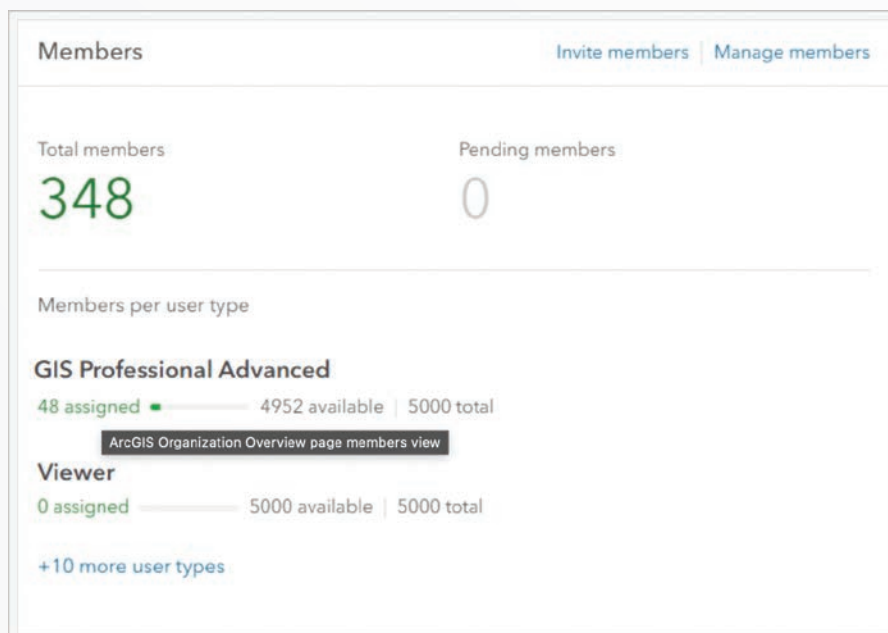
Now, you can start to explore the users in your organization and how they’re currently organized. Once they have a named user account in the organization, members are granted permissions through user types and roles.



MAY 2024						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

↑ One of the first things you should do is find your organization account’s renewal date and mark it on your calendar.

↗ Find out how many members you will manage. More members and more activity mean you’ll want to keep a closer eye on credit expenditure, content storage, and other categories.



job titles or categories. For example, a supervisor can have the Viewer user type, while a GIS professional can have the GIS Professional user type and a custom Publisher role.

Create a Report

Usage reports are an important tool for monitoring your organization. The reports help you identify how members are using, sharing, and contributing resources. In this case, the reports you'll generate will act as a snapshot of the organization when you took it over. Member reports are most helpful if you have a high turnover in your organization, and show details such as how many credits the member is using, their role and user type, and how many items they own.

1. Choose Settings > Member roles tab to view any custom roles that have been set up.
2. On the Organization > Status > Reports tab, click Create a report. Choose Single Report, and for Report type, choose Member.

Schedule a Quarterly Report

When generated consistently, reports can represent a history of events that occur in your organization over time. Scheduling reports ensures they'll be automatically created at regular intervals and can help with end-of-year reporting or other long-term tracking you may need to do.

Credit Management

Credits are the currency of ArcGIS. They are managed at the organization level and can be spent by users on actions such as geocoding and analysis, or on general management operations such as content storage. It's important to understand which activities use credits and keep tabs on credit levels. Running out of credits can lead to your organization being placed in restricted status. You want to understand your organization's baseline credit usage so you can determine how to manage it. Do that by clicking on the Organization section.

1. Click the Overview tab and use the Credits box to see how many credits your organization has available.
2. Click the Status tab to see how your organization's credit usage over the last few weeks breaks down by storage, analytics, subscriber content, and published content.
3. Click the Members tab to look at the Credits remaining column to see the credit budget for each member in your organization.

Content Management

Understanding your organization's content is important, especially if your organization publishes public-facing content. Depending

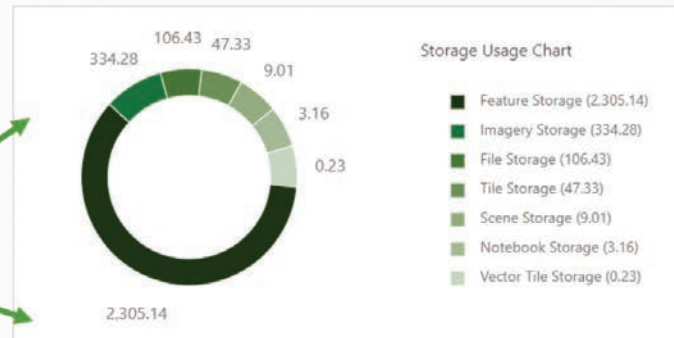
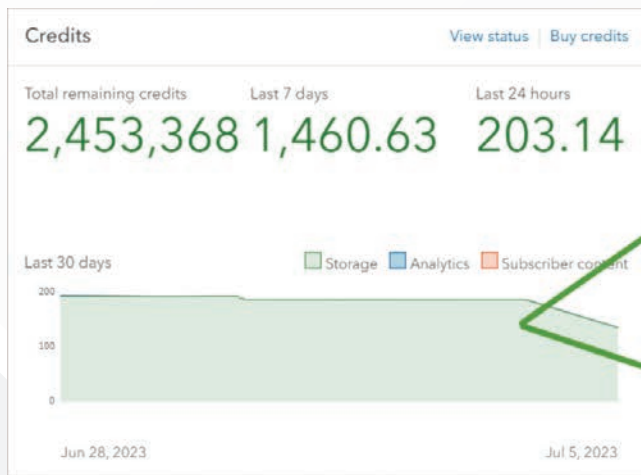
Custom roles and member categories provide the two methods that the previous administrator may have used to manage the organization's members. Roles are a method of giving privileges and access to features of ArcGIS that can be customized as necessary for different users or work requirements. Member categories are a hierarchical structure that can be set up based on jobs, level of access, or other characteristics that act as a filter when searching for users.

Learn more by reading "User types, roles, and privileges" (<https://shorturl.at/myDH0>).

Getting to Know Your Members

You'll start by looking at how many members your ArcGIS Online organization has and how many could be added. Some organizations are very small with just 1–5 active members, while others are very big with 50,000 or more users. Understanding the size of your organization will help you understand how frequently you'll want to check in on it. More members and more activity mean you'll want to keep a closer eye on credit expenditure, content storage, and other categories.

- On the Organization > Overview tab, view the Members box to see how many members you have and what user types are available.
- Explore member categories or custom roles. These are especially important for member management in larger organizations. Member categories act most simply like a filter, and member roles can additionally give specific privileges and permissions to users.
- On the Organization > Members tab, see what member categories or custom roles the previous administrator set up. Click through them to understand how these groupings are used and who is assigned to which user type and role. Note: If you have a large organization, it might be impractical to view every role or grouping. To help understand what kinds of permissions have been assigned, try to select users with a variety of



↑ Credits are the currency of ArcGIS. They are managed at the organization level. It's important to keep tabs on credit levels because running out of credits can lead to your organization being placed in restricted status.

on whom you want to see your content, you can share it in four primary ways:

- By default, content is private to the account that created it (and viewable by the administrator).
- Content can be shared with a specific group.
- Content can be shared with the organization.
- Content can be shared publicly so it can be viewed by anyone. Organizations can benefit from content categories, which act similarly to member categories in that they allow sorting and filtering.

To learn more about your organization's content, start on the Organization tab and click Status, then Content to see how many items your organization has, how many items have been created recently, what the breakdown of items is by type and sharing status, and other metrics.

To see if your organization has content categories set up, on the Content tab and click My Organization tab and sort the items by View Count to see the most popular items.

To get a snapshot of your organization as it is currently, create a report. Go back to the Organization tab and choose Status and click the Reports tab. Click Create a report, then choose Single Report. For Report type, choose Item. Item reports show details such as the storage size of each item, its usage or popularity, and its sharing status. Now, schedule a Quarterly Item report.

Tasks for When You're Becoming More Comfortable

Now is a good time to dig deeper into some of the management tasks you addressed earlier. For example, if your organization publishes content publicly, take time to understand the development, quality assurance, and publishing tasks. If your organization has frequent member turnover, spend time learning about the separation process for users. Tasks will largely depend on your organization's structure and usage. Before making changes to your organization's existing processes, talk to all stakeholders, including management and any ArcGIS users who might be impacted by the changes.

Member Management

Check in on member usage and credits regularly and then figure out what your most time-consuming member management tasks are and determine whether there's a way to simplify them. For example, if you're adding a lot of new members to your organization each month, investigate strategies such as using New Member Defaults and batch adding users. If you're consistently having to reset passwords or credits for users, ensure your organization members have their profiles configured with security questions and know how to check their credit budget and delete unused content. Here are some things you can do to identify ways to simplify your work:

- Learn about the onboarding procedures for new members by choosing Settings and click New Member Defaults from the left-hand menu to see the role and licensing assigned by default to new members.
- Learn how to add new users, either individually or in a batch, by reading the ArcGIS Online documentation at <https://doc.arcgis.com/en/arcgis-online/administer/invite-users.htm>.
- Learn about your organization's separation procedures for removing members from the organization.

Employee separation procedures can vary depending on the reason an employee is leaving. For example, employees who are retiring should be treated differently than someone in the company who's transitioning to a new job role. Decide whether the user account needs to be removed from the organization, disabled, or downgraded to a user type with fewer permissions. You will also need to decide whether content, group ownership, and other aspects of the user's account need to be transferred to another user account or deleted.

Content Management

Depending on how much content your organization publishes and maintains, whom it is shared with, and what kinds of work it is used for, your content management procedures can vary. Work with organization members to understand what kind of content they're creating, how, and for whom.

Long-Term Maintenance and Reporting Tasks

Now that you understand your organization's management procedures, you can decide how frequently to check back in on your

organization to ensure things are running smoothly. Your cadence may be monthly or quarterly or even more frequently, depending on your organization's activity level. Again, before making changes, check in with the appropriate stakeholders. For example, don't downgrade an inactive user or delete content without first checking with the owner.

- Review your quarterly administrative reports and check if there are
 - Inactive members who should be removed or be downgraded to user types with fewer privileges.
 - Old or unused content items that should be deleted from the organization.
 - Content items consuming a lot of the organization's credits for storage.
 - Items performing well that need to be updated or reviewed.
- Check the organization's credit usage to determine
- If members are staying within their credit budget.
 - What your organization credits are being spent on.

Follow Esri's ArcGIS Online product release cycle to keep up with changes to administration workflows and other functionality that may impact you and your members.

Continuing in Your Role

At this point you're feeling confident about administering your ArcGIS Online organization. As your administration skills improve

and your organization's needs change, keep in mind that there are many ways you can extend and automate your administration routines.

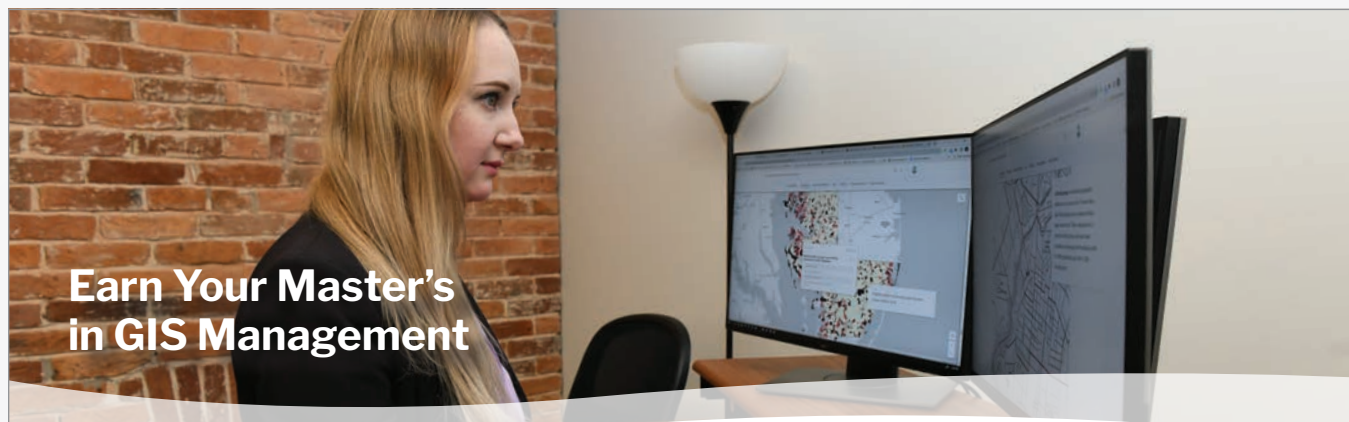
Implementation guides can help you at different stages of your role as administrator. *ArcGIS Online Implementation Guide* (<https://shorturl.at/goAMS>) is a guide for administrators setting up new ArcGIS organizations, beginning with account activation. *Extend the Reach of Your GIS* (<https://shorturl.at/ryJY4>) is a guide for administrators who are comfortable with the day-to-day operation of their organization and looking for more information about long-term management and best practices.

There are some other resources from Esri that will help you:

- Best practices for organization management (<https://shorturl.at/xMS79>)
- Time-saving tips for managing members in ArcGIS Online (<https://shorturl.at/aGLX4>)
- Get started with ArcGIS Notebooks (<https://shorturl.at/lmyzS>)

About the Author

Kathy Cappelli Breier is a product engineer on the Learn ArcGIS team. She is always hunting for a good story or a problem that can be solved with maps. For more free tutorials and workflows, go to learn.ArcGIS.com.



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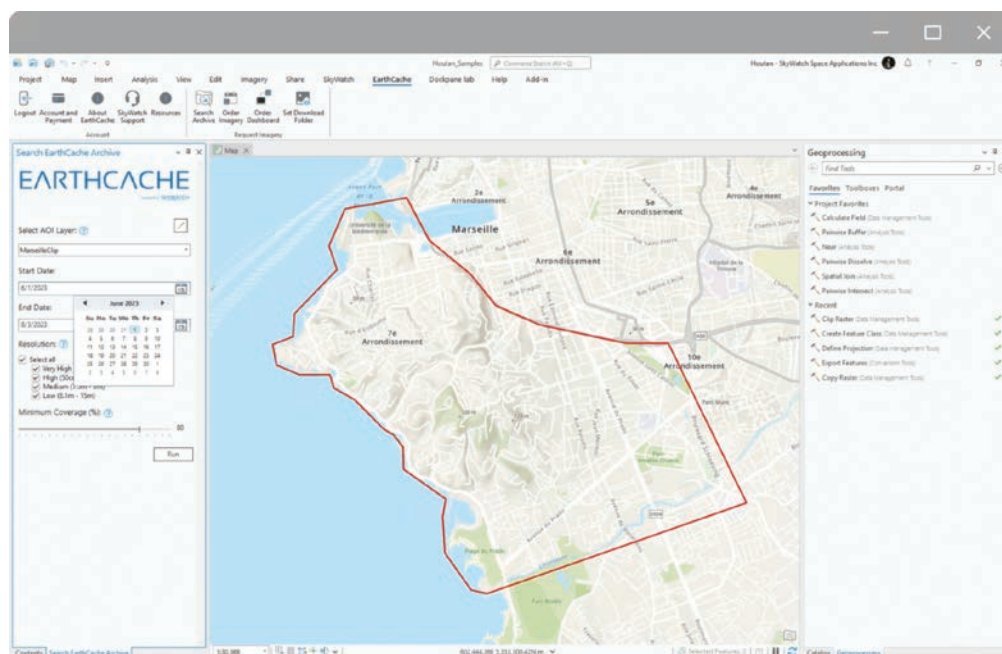
Access a Vast Library of Satellite Imagery with EarthCache Add-In for ArcGIS Pro

By Akshaya Suresh

Not too long ago, satellite imagery was often used simply to add visual interest to a map. Today, satellite imagery is used as a layer of information in GIS that empowers users to make informed decisions, address complex challenges, and explore the Earth's surface. Whether you want to monitor volcanic activity, detect anomalies in deforestation, assess damage after natural disasters, or manage urban growth, satellite imagery is a powerful tool for mapping and visualizing the world.

In ArcGIS, satellite imagery supports a wide range of applications—from observing different spectral bands on the electromagnetic spectrum to gathering images to observe change over time. Now you can go further to extract meaningful insights from imagery. Accessing massive collections of satellite imagery has never been easier with the recently introduced EarthCache add-in for ArcGIS Pro that was developed in conjunction with Esri partner SkyWatch.

↓ The EarthCache add-In for ArcGIS Pro lets you use existing polygon features as the area of interest (AOI) for imagery searches.



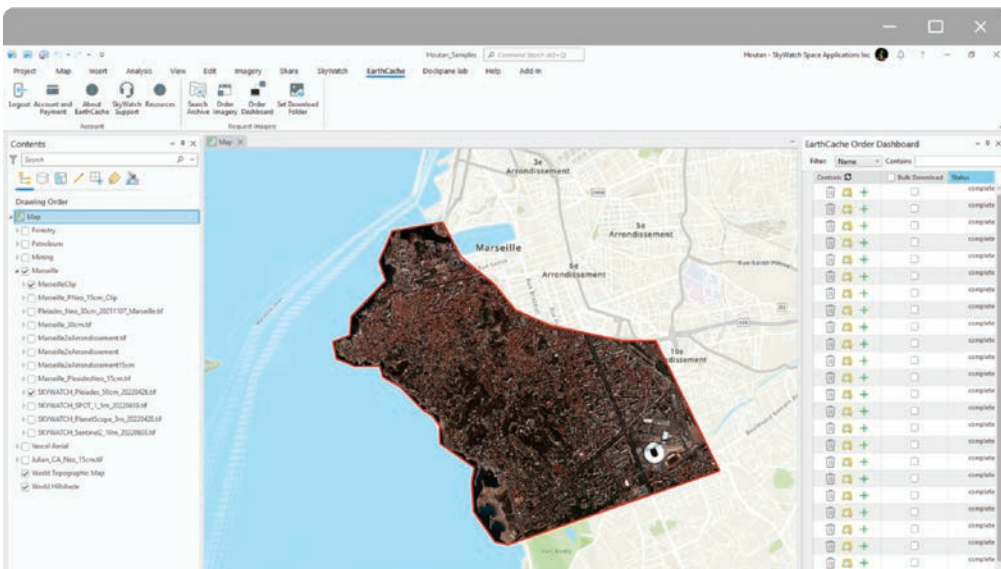
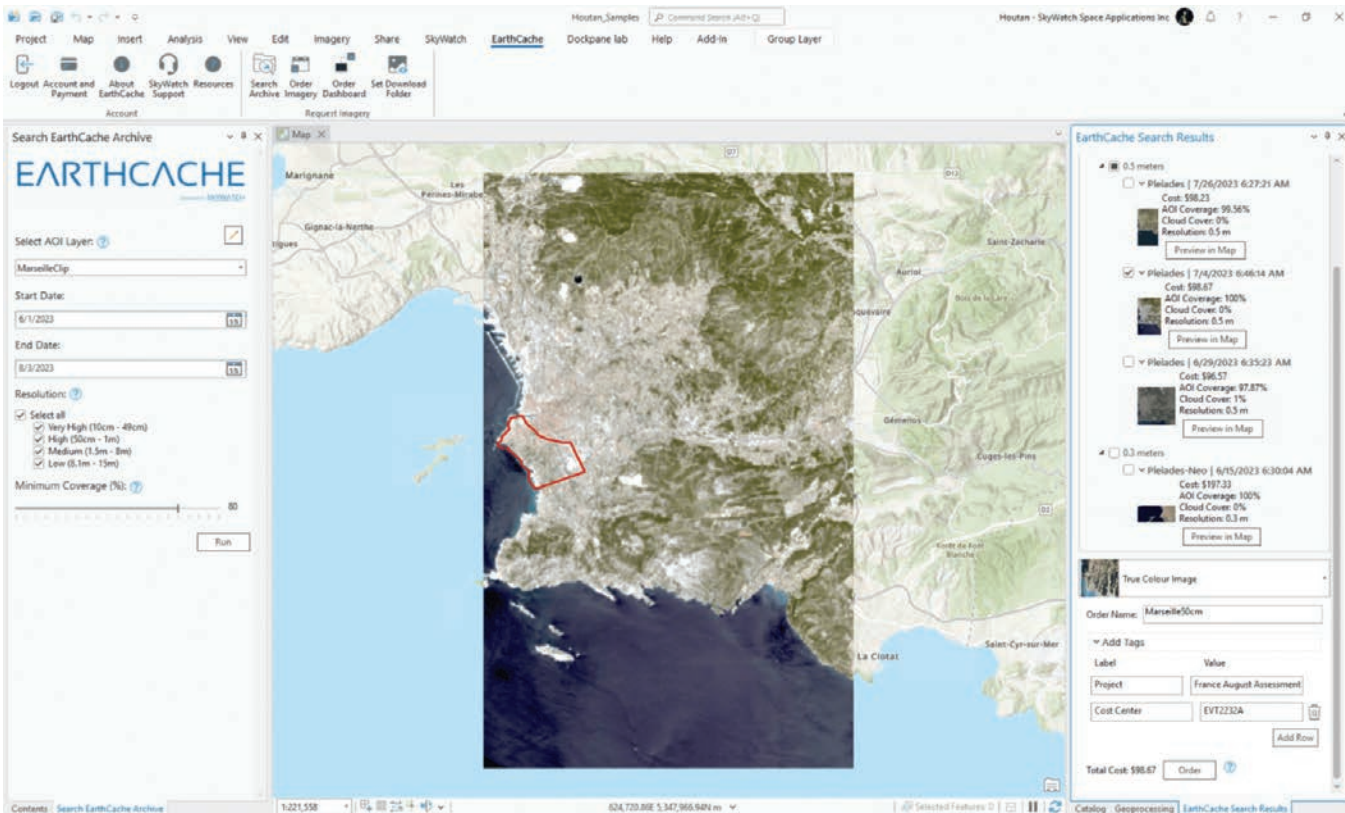
It can be daunting to sort through satellite imagery from a range of providers to find content that fits your needs. SkyWatch has simplified the process of procuring imagery content by bringing together data from a virtual constellation of more than 400 sensors from leading satellite, aerial, and high-altitude pseudo satellites (HAPS) imagery providers to amass one of the largest collections of remote sensing data in the world.

SkyWatch makes accessing and integrating commercial satellite imagery intuitive and simple with its EarthCache platform. This solution enables you to browse large imagery archives for historical data or task satellites to capture new images of an area of interest. Since imagery data needs vary by use case, EarthCache makes it possible to log in, search for images, and buy what you need without worrying about minimum volume commitments or data license agreements.

With the introduction of the EarthCache add-in for ArcGIS Pro, SkyWatch's EarthCache functionality is natively available to ArcGIS Pro users. With procurement of imagery easier than ever, users can now quickly perform analysis to extract features and insights from high-quality satellite imagery. Leveraging this add-in supports various business cases such as urban planning, first responder services, and ecosystem monitoring using capabilities such as artificial intelligence (AI), time series analysis, change detection, and radar analysis from within ArcGIS.

ArcGIS users can order from the archive and task satellites directly without leaving the ArcGIS Pro environment. The EarthCache add-in for ArcGIS Pro offers ArcGIS users

- A seamless experience for



↑ The add-in enables you to browse large imagery archives for historical data.

← Archive search results are shown with order preview overlay.

Get Started Now

- Create your free EarthCache account (<https://tinyurl.com/mr4cs2dz>).
- Download the free ArcGIS Pro add-in (<https://tinyurl.com/5fmzcrzj>) and start accessing satellite imagery in ArcGIS.

Additional Resources

View this video (<https://tinyurl.com/2udu9zr9>) on how to perform change detection in

- discovering and ordering satellite imagery within ArcGIS Pro.
 - Access to multiple data sources, including very high-resolution submeter satellite imagery.
 - Simple, transparent pricing with no subscriptions, credits, or minimum annual purchases required.
 - The ability to use existing polygon features as the area of interest (AOI) for imagery searches.
- Receive preprocessed, precropped results that are delivered within ArcGIS Pro.

ArcGIS Pro with satellite imagery from EarthCache.

About the Author

Akshaya Suresh is a product marketing manager on the imagery and remote sensing team at Esri who has a passion for AI and big data analytics.

This article was authored in collaboration with the SkyWatch team.

From Map Creator to Executive Leader

By Marcus Seepersad and Rosemary Boone

An ambitious GIS professional, Haseeb Malik has risen to an executive leadership role in his organization as the vice president of data operations at Iris Software, Inc. The authors sat down with Malik at the 2023 Esri User Conference to learn about his GIS journey and how internships and networking event opportunities led to an executive leadership role in his organization.



↑ Haseeb Malik

Q: How did you get your start in GIS?

A: My interest in GIS began when a family friend introduced me to geomatics. It sounded very technical and interesting. After a deeper look into the industry, I realized there were a lot of opportunities in this space. I discovered that GIS enabled people to solve real-life problems with location-based analytics. This really intrigued me and started me on my journey in GIS.

Q: Tell us about your college journey.

A: I went to the University of Toronto, where I received my bachelor of science in geographic information systems. My GIS program was very small, but this was a huge benefit as my cohorts became very close to one another. I started networking early on in studies with classmates and professors, and it was a valuable experience for relationship building. During my undergraduate studies, I was exposed to various GIS and city planning courses, which helped me become very familiar with the technology.

Q: Did you do any internships while in college?

A: During university, my program didn't offer internships. I had to take the initiative and responsibility for my success. So, I attended Esri events and would meet with career counselors to discover internship opportunities. My first internship came in my sophomore year for the City of Toronto, as a GIS research technician. I helped to develop analytical maps around the subway systems with the intent to improve pedestrian accessibility to those subway systems. In my junior and senior years, I worked for the local school board to use GIS to identify where schools should be built within the community. I volunteered with Esri Canada as a conference assistant, which helped [me] to gain more opportunities to network with professionals in various industries. These events were vital to my career success as I was able to interact with experienced GIS professionals and learn from their stories. I can't stress enough the importance of getting out of your comfort zone and putting yourself out there.

Q: What other opportunities were available to network while in college?

A: My GIS professors would promote various Esri events to my classmates, and I would band together *[with my classmates]* to attend these events. Having my colleagues with me provided an added layer of comfort because we weren't alone, and it also became a social thing.

We took advantage of discounted rates offered to students. That is something students can and should take advantage of when attending industry events and conferences. Don't be afraid to ask about special offerings for students. Very often, students gain access to these events for little to no cost simply by asking.

[Esri also offers student assistantships where admission and full conference access are available in exchange for volunteering.]

Q: What was your path to becoming VP of data operations?

A: Right now, I have the fancy title of vice president of data operations for Iris, an internationally recognized pioneer in solving the most difficult data collection challenges facing the roads, tunnels, and transport infrastructure sector today. It's very rewarding applying GIS data to help municipalities and governing bodies build and maintain safer roads—the very same roads you and I drive on.

I started as a municipal GIS analyst, which allowed me to become more engaged in customer-facing meetings, leveraging my experience working for the City of Toronto. After putting myself out there coordinating GIS projects and helping wherever there was an opportunity in both tech and customer success, I earned a promotion to GIS manager.

In this role, I managed a lot of our tools and databases—it was less technical and more of a leadership role. In addition, as the company began to grow, I was taking on even more responsibility. I maintained my loyalty and contributions to the organization and soon after, I became the VP of data operations.

In this role, I am not just responsible for the technical deliverables but also for customer success and sales. Now I get to wear multiple hats, ensuring the continued growth and success of the organization. While it's not always easy, I embrace the challenge. I believe in pushing yourself to the edge because that is where your growth lies. I've learned so much in this position, and I'm grateful for the exposure that I have received. I attribute much of my success to those earlier internships and industry events I attended. They truly helped me to understand the path and challenges that were ahead to take on a leadership role.

Q: What's your best advice to other young professionals?

A: Put yourself out there and be confident. Remember, you belong in this space. Put a smile on your face—it's important for you to be approachable.

Be open to feedback because not everything is rainbows and sunshine. You're going to make mistakes and that is OK so long as you learn from them.

The best way to elevate your career as a young professional is to build trust with your leadership. That is how I grew within my organization to a VP level today. My final word of advice is everyone's journey is not the same, so be mindful of comparing yourself to others. Go out there and give it 110 percent and everything else will fall into place.

About the Authors

Marcus Seepersad is a marketing automation specialist for Esri's digital performance management team. He stands up web forms and marketing campaigns supporting Esri's various marketing teams. He is also an advisory board member for the Esri Young Professionals Network, a community for GIS professionals to learn and collaborate while sharing ideas and insights. In his free time, he enjoys giving back to the community and volunteering with local youth organizations.

Rosemary Boone is a senior industry marketing manager for Esri, concentrating on executing marketing strategies for K–12 schools and higher education institutions. She holds a master's degree in education technology with an emphasis on multimedia. Prior to her career in marketing, she was an elementary school teacher and also taught overseas. In her free time, she likes to listen to music, exercise, spend time with her cats, and explore her favorite city in the world—Claremont, California.

Join the Esri Young Professionals Network (<https://shorturl.at/dsEFS>) on Esri Community to access additional resources for students in higher education or professionals who recently started their geospatial technology careers.

Migrating to ArcGIS Indoors to Manage University Infrastructure

By Jeffrey Ulrickson

In his role as assistant director of spatial services, the author is responsible for space allocation and analysis and integrating GIS into campus operations. In this article he describes how his university is moving to ArcGIS Indoors.

The University of Rhode Island (URI), like so many other higher education research institutions relying on indirect cost rate agreements, has long utilized a computer-aided facilities management (CAFM) system to maintain the institution's space database and floor plan library. Our current system is the INSITE suite of products including Net-FM and Visual-FM.

INSITE has developed into a system of record for other needs as well. The Facilities Group uses it to manage the physical campus, and it aids Property & Support Services in managing the moveable asset inventory. Public Safety relies on accurate and up-to-date data for emergency planning and response, while Environmental Health and Safety requires the data for inspections, abatements, and mitigations. Additionally, INSITE location and occupancy data feeds location data to other enterprise systems for work orders and faculty data tracking.

URI recently learned INSITE was being deprecated and a

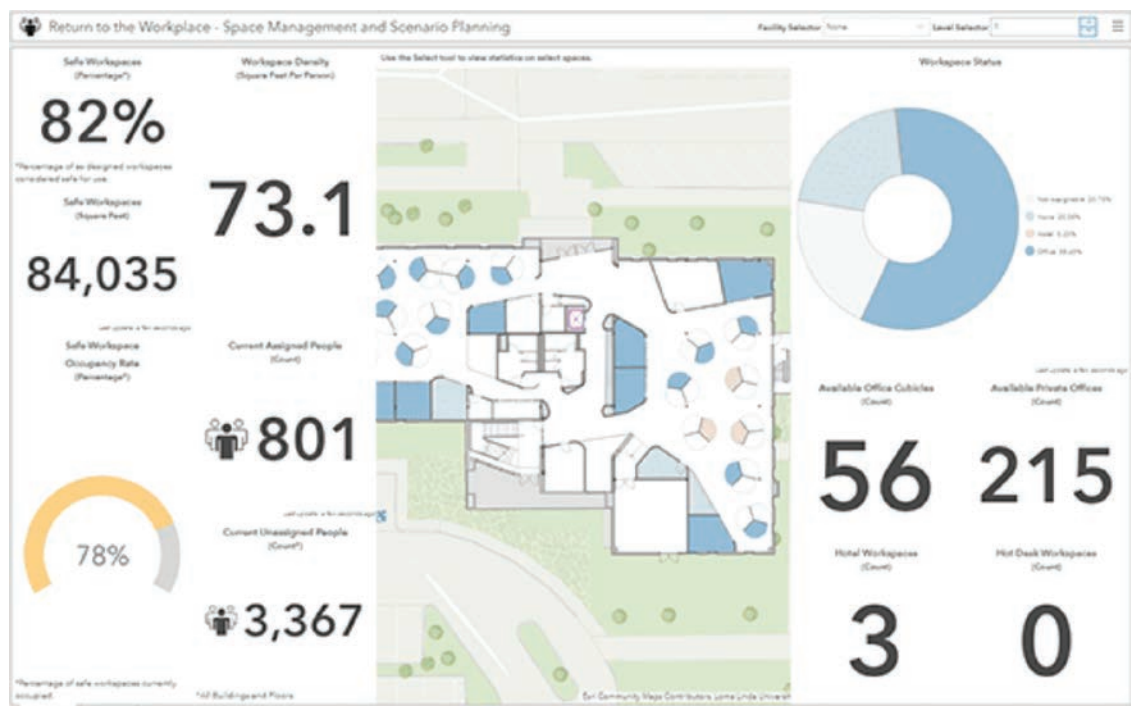
replacement was needed. It would be easy to say that URI considered ArcGIS Indoors based on a combination of existing GIS infrastructure and low licensing costs, but that would not tell the whole story.

Why ArcGIS Indoors?

Most CAFM systems are extremely useful to those who work in them daily. But how easy are they for others to use? We found that decision-makers relying on the CAFM data had difficulty interacting with the systems. As a result, CAFM operators spent too much time dumping data into spreadsheets or building reports and dashboards using third-party applications rather than focusing on data quality and creating new features. The data needs to be easier to retrieve, visualize, and analyze by decision-makers with less support from CAFM operators.

URI requires a system that also provides greater service to the

→ ArcGIS Indoors makes data easily accessible to decision-makers through dashboards.





↑ The campus community will be able to access ArcGIS Indoors via graphic interface available on the desktop, the web, mobile devices, and kiosk applications that are included with the license.

campus community. Operationally, the campus community needs to track location data for multiple types of assets, collect data in the field, easily share data, and quickly develop systems of record for departments where none currently exist. At the same time, the university must meet the stringent system/data security requirements established by centralized IT. Also, faculty, staff, students, and guests want wayfinding assistance, room and workstation scheduling, and directory information—especially in a post-COVID-19 world.

ArcGIS Indoors, combined with existing products already licensed through our Esri educational agreement, gives URI these capabilities and more. In addition, the campus community will be able to access ArcGIS Indoors using a sleek graphic interface that is available on the desktop, the web, and mobile devices and through kiosk applications that are included with the license.

Also, GIS will now manage spatial data both inside and outside our facilities. Can another CAFM system provide an interface that lets users interact with floor plans, occupancy information, asset locations, and campus features outside the facilities while also providing scheduling capabilities with navigation from building to building or space to space? And—when considering future needs—ArcGIS Indoors brings URI closer to a true digital twin of the campus that is ready to integrate 3D data from Autodesk Revit, building information models (BIMs), and lidar.

Implementation Challenges

Sounds great, doesn't it? It is, but there are going to be trade-offs. For starters, INSITE, like many other CAFM systems, is designed around the *Postsecondary Education Facilities Inventory and Classification Manual (FICM)*. Establishing the space inventory in INSITE was straightforward, as preexisting tables contained the FICM major uses and associated codes.

Can ArcGIS Indoors handle tables like this?

Yes, but the tables

aren't predefined. Modifications by our GIS staff will be needed to create attribute tables with the corresponding fields and domains. INSITE and other CAFM systems also offer a survey tool for conducting annual or ad hoc space surveys. We will be able to reproduce this functionality with either ArcGIS Field Maps or ArcGIS Survey123, but we will have to build the form and functionality from scratch.

On the asset side, INSITE handles many of the accounting functions for our moveable asset inventory including funding source, purchase order, and nomenclature for depreciation. While the asset feature class attribute table could contain some of these fields, URI is considering purchasing an accounting/inventory product that can manage the entire asset accounting life cycle including depreciation. Regardless, ArcGIS Indoors will be the system of record for space data and will feed the accounting system the location information used to identify where a moveable asset is located on campus.

Data Migration

The other challenge we face is the data migration from INSITE to ArcGIS Indoors, especially floor plan preparation. The Esri ArcGIS Indoors team has been a great resource for learning about how to prepare AutoCAD floor plans for ArcGIS Indoors. The team helped us understand the process, project scope, and data migration challenges.

However, URI utilizes INSITE's floor plan editing software, Visual-FM. URI plans are not AutoCAD files, so URI created a workflow to manually convert the plans to AutoCAD files. But with 800 floor plans, URI is seeking a third party to handle the AutoCAD

conversion using automated processes or scripting.

If you are not familiar with prepping floor plans for ArcGIS Indoors, the process typically includes some basic space data such as facility, floor, room name, and owner. Our CAFM system contains other important space attribute data such as office occupancy, research laboratory assignments, and space features. We needed a means to import the remaining data once ArcGIS Indoors was populated with the basic space inventory.

ArcGIS utilizes unique identifiers in the attribute tables and so do other databases. The INSITE space table includes unique IDs for each space. This space ID serves as a join for all the other related tables containing space attribute data and ties the attribute to the appropriate space.

These unique IDs are being copied to another field in INSITE that can be viewed on the floor plans through the INSITE floor plan editor in what is known as the INSITE space label. When the INSITE floor plans are converted to AutoCAD, the space ID will be included with the space label as it is transformed into an AutoCAD annotation. The annotation is then imported into ArcGIS Indoors when the floor plans are imported.

This will result in the ArcGIS Indoors space inventory containing the INSITE unique space ID. We can then utilize an Open Database Connectivity (ODBC) connection to transfer data from INSITE to related tables in ArcGIS Indoors by creating a join using the unique space ID as the common field. This will ensure that the INSITE space attributes are tied to the appropriate space in ArcGIS Indoors without manually editing each record. Once the data migration is complete, the INSITE unique space ID can be deleted from the ArcGIS Indoors data model.

The Bottom Line

Finally, let's talk bottom line. What is this going to cost? Our annual licensing costs are being reduced significantly. We estimate the ArcGIS Indoors migration will reduce our annual CAFM costs by almost 70 percent. That's after accounting for both the ArcGIS Indoors and AutoCAD licensing required to replace the INSITE suite of products.

Implementation costs are going to vary depending on current GIS infrastructure. Although we needed to upgrade our ArcGIS Enterprise instance, URI already has ArcGIS Enterprise in place and recently finished its first basemap. If you host your own data, both are critical to becoming ArcGIS Indoors ready. We anticipate the floor plan conversion and Esri professional support will cost approximately the same as one

year of licensing costs for our current CAFM system.

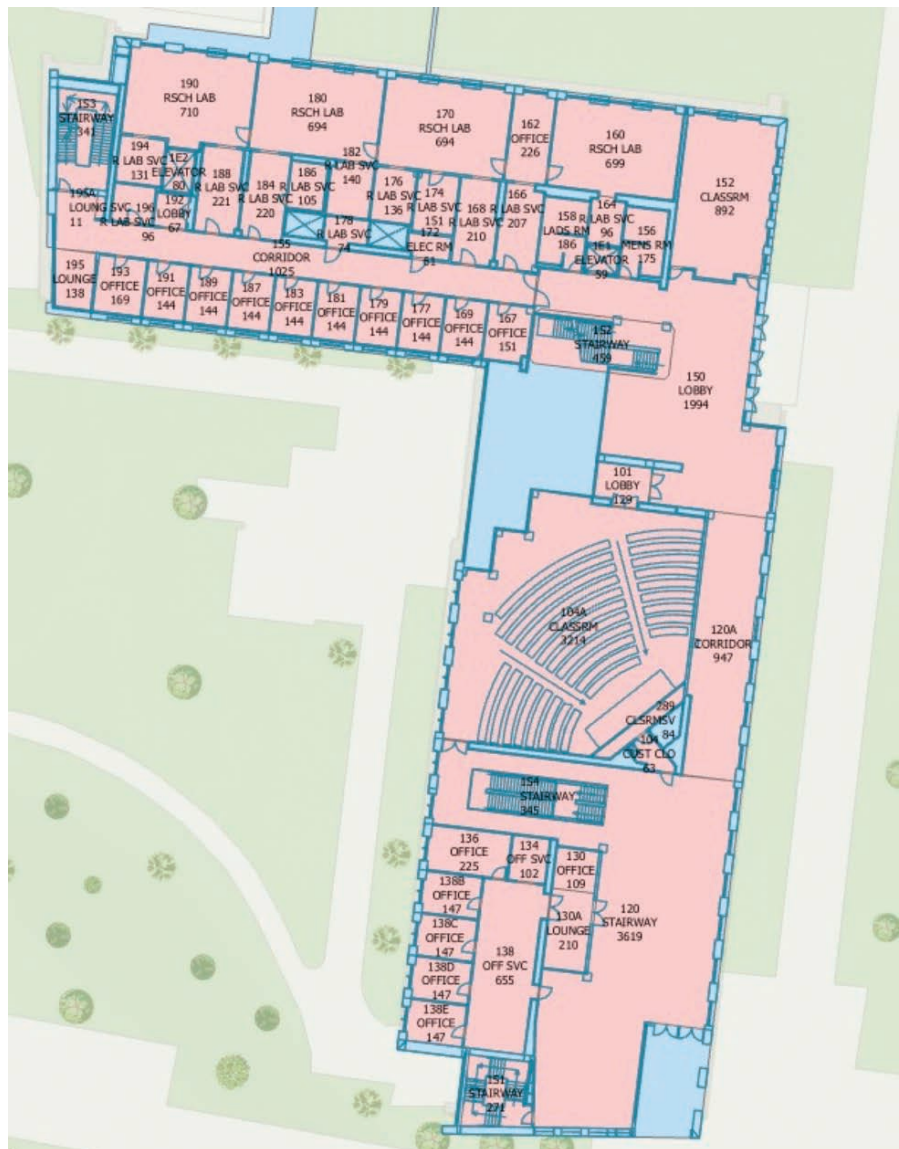
If you are interested in learning more about ArcGIS Indoors, go to <https://shorturl.at/hpwRS>. I would also encourage all higher education facilities managers to consider joining the Esri Smart Campus Operations community (<https://shorturl.at/koquT>), which brings together like-minded colleagues and industry experts seeking to integrate Esri technology with campus and building data to understand the complex needs of campuses.

For more information, contact Jeff Ulricksen at julricksen@uri.edu.

About the Author

Jeff Ulricksen is the assistant director of spatial services at the University of Rhode Island. The Office of Spatial Services is part of the planning and real estate development team within the Facilities Group. He is responsible for space allocation/analysis and integrating GIS into campus operations.

↓ The first floor of the pilot building displayed in ArcGIS Pro Indoors.



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Teaching Deep Learning Using Esri Resources

By Stephanie Hower

At the University of Pittsburgh, faculty from the department of geology and environmental science help teach modern GIS skills using resources available from Esri.

As GIS technology continues to attract growing interest among students and employers, higher education institutions must find ways to keep curricula on pace with innovations in technology. The university has a long and successful history teaching GIS, supported by its partnership with Esri. Access to comprehensive, advanced resources is giving University of Pittsburgh graduates an advantage upon entering the job market.

Deep learning has emerged as a pivotal function of machine learning and artificial intelligence (AI), enhancing the efficiency and accuracy of data analysis. When applied to GIS and remote sensing technologies, deep learning models can be trained to recognize complex patterns, shapes, and textures at numerous scales within images. This allows data scientists across all industries to analyze and derive meaningful insights from vast amounts of satellite, aerial, and drone imagery.

“When the department switched to ArcGIS Pro, the integrated deep learning toolboxes were a real advantage,” said Daniel Williams, a teaching assistant professor at the University of Pittsburgh. “And when students can go to an employer and show them an understanding of how to use these deep learning toolboxes, that’s something that is going to be vital moving forward.”

Williams first came to the university as a PhD student in 2012. He now teaches GIS, GPS, and Computer Methods, an introductory course in GIS that helps students across departments and disciplines incorporate basic GIS principles into their field of study. His aim is to keep students as close to the cutting edge as possible—which

can be challenging in a field that prides itself on rapid innovation.

Keeping Pace along the Cutting Edge

Until recently, Williams considered himself a novice in the realm of AI within GIS. As his colleagues began to apply deep learning to their own research, he knew he needed to gain practical experience of his own.

“Everything is evolving so fast within science and technology,” Williams said. “And we’re always going to be playing catch-up as educators because we’ve got to see these advances and then we’ve got to learn how to do it ourselves.”

Deep learning already had a place in

the GIS curriculum at the University of Pittsburgh. Professor Bill Harbert had been including it in the advanced GIS course. Furthermore, colleagues at the University of Pittsburgh and Istituto Nazionale di Geofisica e Vulcanologia (INGV) in Italy had applied deep learning techniques to their study of volcanic eruptions. They trained the software to identify thermally elevated pixels, or hot areas at the Earth’s surface that might indicate magma rising, which can lead to an eruption.

Williams—a passionate volcanologist—was inspired by their application of the technology. He used Esri resources, such as ArcGIS Labs, available from Esri Academy, to improve his understanding of deep learning. Esri Academy provides learning experiences for anyone using ArcGIS, including instructor-led courses, videos, and self-paced training sessions complete with software exercises.

↓ Daniel Williams, teaching assistant professor at the University of Pittsburgh and volcanist, performs fieldwork at a volcano in Guatemala, using a modified thermal camera to study the landscape.



He also used a simplified deep learning installer (<https://shorturl.at/nQZ38>) for ArcGIS, available from the Esri GitHub site. The installer streamlines the user experience by packaging the necessary dependencies and components for ArcGIS Pro, ArcGIS Server, and ArcGIS API for Python. The installer includes a broad collection of 99 packages with components for frameworks, such as PyTorch, TensorFlow, Fast.ai, and scikit-learn, for performing deep learning and machine learning tasks.

“My education on deep learning came from an Esri exercise finding shipwrecks from ocean bathymetry data,” said Williams. “There is another exercise that I gave to my students, looking for the location of wind turbines in aerial photographs. I understood it better by performing the actions and completing it myself.”

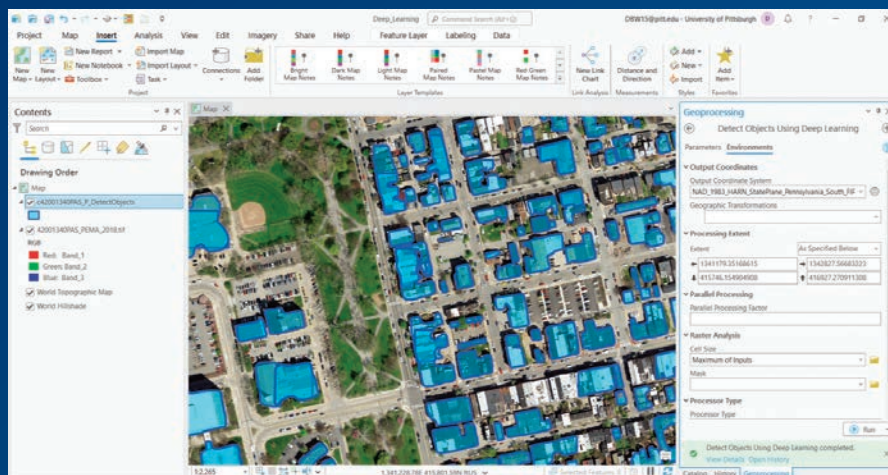
As he worked through the training sessions, Williams was surprised to find how simple the exercises were to navigate. Although he budgeted three hours for one set, he was able to complete the training in half an hour. He advises colleagues at other institutions who may be wary of AI to reach out to Esri for help.

“If you’re worried about how to go about installing and updating all these deep learning toolboxes, but you are already working with Esri, reach out to them. It’s going to benefit you in the future.”

Employers value graduates with exposure to deep learning and ArcGIS Pro. Organizations around the world are now using pretrained deep learning models available from ArcGIS Living Atlas of the World to perform tasks such as feature extraction, classification, redaction, detection, and tracking to derive meaningful insights from large amounts of data. For example, a data scientist can rapidly and accurately extract railway assets from lidar or classify land cover using satellite imagery, making workflows simpler and more efficient.

GIS Gains Traction among Students

According to the marketing research firm Research And Market, the global GIS market is poised to grow significantly through the end of the decade. Businesses rely on geospatial solutions for analysis and decision-making, and students are eager



↑ Above is the result of applying the building footprint extraction deep learning model on ~15 cm resolution orthoimagery from Pennsylvania Emergency Management Agency (PEMA). The area shown is Pittsburgh’s East Allegheny neighborhood.

to acquire GIS skills to stand out upon entering the workforce. Higher education institutions that cater to this need will appeal to graduates seeking a solid return on their educational investment.

Since his time as a student at the University of Pittsburgh, Williams has seen the enrollment in GIS courses expand from 70–90 students to more than 200 students per year.

“We’ve got students from so many different departments, different schools within the university, interested in GIS because their studies have some kind of spatial component. And we have a lot of careers available in environmental consulting in western Pennsylvania, which has a very strong GIS requirement,” said Williams.

The University of Pittsburgh also offers a certificate in GIS and remote sensing for eligible undergraduates. As part of the certificate program, students must complete a four-credit independent study course. This is a major project meant to reinforce and polish the students’ GIS or remote sensing skills, culminating in a published report or map that describes the results of their research.

In addition to gaining practical industry experience by completing their own research topic, students can use their GIS certificate to leverage themselves in the job market.

“The certificate is something that’s been appreciated by employers in the area and beyond,” said Williams. Students that take the independent study course after his

introductory class already know where to find resources. He makes a point of showing them the vast catalog of datasets and deep learning exercises available through Esri. Students can even get training to start developing their own deep learning models.

Williams has received encouraging feedback from students. “Many of my students—particularly those who started university later—they might have friends already working in some kind of field using GIS. Those students said that they feel that they’ve learned some things that their friends who are already professionals weren’t familiar with.”

Ultimately, Williams strives to give his students a solid foundation in the principles of GIS and a brief window into deep learning to inspire their professional pursuits.

“Graduates have been adding deep learning and AI methods to their CVs and have been picked up by employers who are saying to them, ‘We want this. You’ve done exactly what we would hope you would’ve done.’ And that makes them much more employable in that field. It’s exciting,” said Williams.

About the Author

Stephanie Hower is a content marketing specialist at Esri who enjoys telling stories about the innovative uses of GIS and its potential to shape the future. A graduate of Montana State University–Billings, she spent more than 10 years working as a freelance copywriter for local publications and small businesses across the country.



A Data-Centric Approach Helps to Reduce Child Exploitation

By John Beck

The surreptitious nature of child sex trafficking makes it difficult to locate and protect children and track down those who exploit them. Offenders keep children on the move and often cross jurisdictional lines. Analysts at the National Center for Missing & Exploited Children (NCMEC) use GIS to track child traffickers and missing children.

NCMEC (www.missingkids.org) is a private, nonprofit 501(c)(3) corporation devoted to recovering missing children, reducing child sexual exploitation, and preventing child victimization. It has the largest data repository on cases of missing children in the United States.

NCMEC has taken a data-centric approach to its work that empowers cross-agency collaboration. Driven by the core belief that every child deserves a safe childhood, NCMEC staff members apply advanced analytics to help find missing children and support law enforcement efforts to hold offenders responsible for their victimization.

From its inception, NCMEC has taken a geographic approach, using maps to

understand the many dimensions of this problem. Recently, NCMEC analysts adopted real-time maps to support operations that bring together multiple law enforcement agencies working to recover missing and exploited children.

Powered by GIS, the center's Missing and Recovered map and dashboard deliver important details to each investigator, including aggregated data from social media, online ads, and other leads. In the past, NCMEC reports for each child were 30- to 40-page PDFs. This made sorting information and finding key details difficult. GIS has enabled law enforcement to leverage real-time leads and information that resulted in the successful recovery of children who were actively being exploited through child sex trafficking.

"Missing and exploited child operations conducted by law enforcement involve multiple agencies working on a common mission in a shared space engaging in real-time collaboration and deconfliction," said Melissa Snow, executive director of

NCMEC's Analytical Services Division, Child Sex Trafficking Programs. "The maps provide a comprehensive and concise visual representation, sharing information about the child, indicators of possible victimization, and consolidated information to use as leads in locating them."

Tracking Down Child Traffickers

The constantly updated dashboards and maps have made a difference. Law enforcement officers can get current actionable data and see progress. Often, the information they need is related to a public event, such as a convention or sporting event, that is held at a specific location. As those involved in child sex trafficking try to evade law enforcement, geography can play a role in recovering missing and exploited children.

"There are a lot of components of movement and geography that can play a role in the crime of child sex trafficking to evade law enforcement," Snow said. "By mapping the data, we can start to see actively missing

kids slowly making their way to a venue. Let's say an event is happening in a southern state, and you have a kid that is actively being advertised online in a northern state. Over days, we see the geographic location of those online ads move toward that event."

When a law enforcement agency requests resources from NCMEC, Snow's team pulls together a dashboard with all the details reported to NCMEC about actively missing children the team thinks might be traveling toward a venue. The largest category of missing children reports NCMEC receives are children who have run away from child welfare or foster care and who have experienced a disrupted home life.

"Traffickers take advantage of that lack of connection, that lack of love and belonging," Snow said. "All the things that a young person is searching for becomes a way to target them for trafficking."

Analytical resources—both staff and access to tools—can vary widely between law enforcement agencies, but NCMEC fills that gap. Acting as a national clearinghouse, NCMEC has specialized and dedicated analytical teams to support law enforcement efforts to identify and locate missing and exploited children. These specialized analysts combine their expertise in identifying child sex trafficking online with access to dozens of donated analytical resources and tools. These two things allow NCMEC analysts to further develop

information into more actionable leads to locate missing children or identify child sex traffickers.

"We can identify and then question why a bunch of kids go missing here and are recovered there," Snow said. "It helps us better target our questions and then figure out, 'Is there a trend or pattern here that we need to be looking further into?'"

Fighting Exploitation in Neighborhoods and Online

Of the more than 25,000 missing children cases reported to NCMEC in 2022, 1 in 6 had run away and was likely the victim of child sex trafficking. Though people want to think this doesn't happen in their community, NCMEC tries to dispel that misconception.

"Unfortunately, we know that child sex trafficking is occurring in every type of community, big and small, rural and urban, including tribal land," Snow said. "We've received reports from every single state and every type of community and territory across the United States."

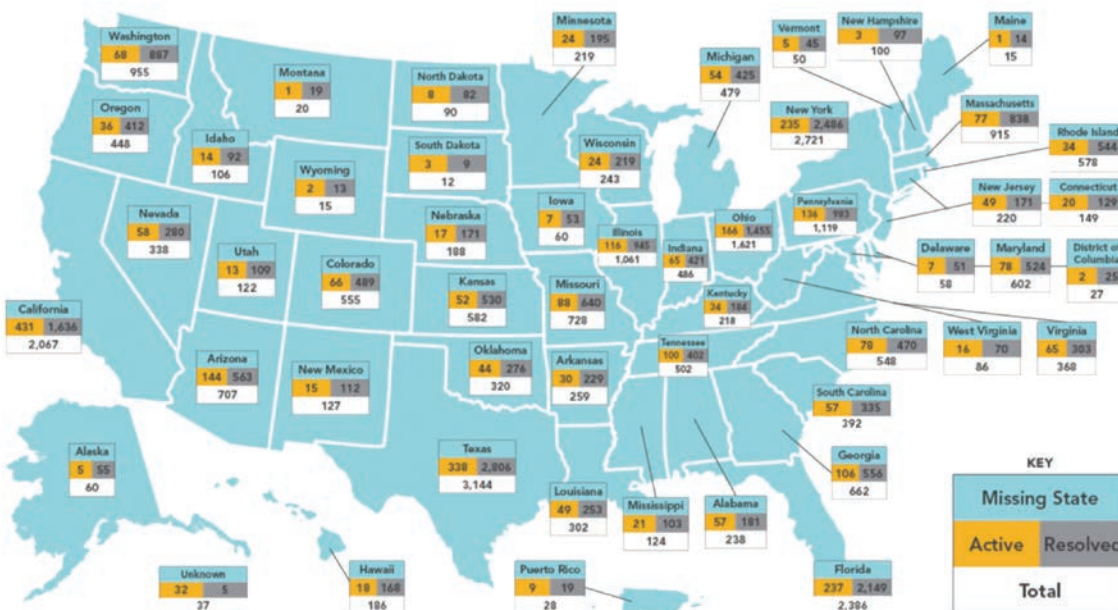
Traffickers use the internet to meet children and then learn about vulnerabilities they can target. Many young people are quick to trust and share personal information online. Traffickers target their victims by portraying themselves as having the same likes and dislikes as the child or having a lavish and enticing lifestyle.

"In the pre-internet days, traffickers had to do that one-to-one. They had to create a physical connection and that made them more visible," Snow said. "With social media they can sit in the comfort and protection of their home. They can be sitting in Washington, DC, and recruiting kids in California, Michigan, Wisconsin, and South Carolina simultaneously."

Through an online recruitment process, traffickers build connections with children in foster care who likely have friends in the system, and then take advantage of those connections to develop a network of children to target. They also use the internet to advertise and sell children.

Extending Expertise on Cases and Vulnerabilities

In the past 39 years, NCMEC has assisted law enforcement, families, and child welfare with more than 400,000 cases of missing children. NCMEC also operates the CyberTipline (<https://shorturl.at/wDJKW>), a global mechanism for reporting instances of suspected child sexual exploitation. Since its inception in 1998, the CyberTipline received more than 144 million reports. This data, combined with the organization's analytical skills, supports NCMEC's role as the nation's clearinghouse and resource center for information about missing and exploited children. NCMEC connects various agencies, organizations, and companies



← This national map of missing and recovered children attests to the scale of the problem.



↑ In 2022, Operation Cross Country coordinated by the Federal Bureau of Investigation (FBI), other federal agencies, NCMEC, state and local police, and social services agencies across the country to find and assist victims of human trafficking, particularly child victims.

that are working on these issues.

"One of the things that we have been absolutely critical on is deconfliction," Snow said. "Our missing child and CyberTipline databases hold millions of pieces of information that we can deconflict against and make connections. We routinely get requests from law enforcement to run a name in our system and often there is a hit, a potential missing piece of the puzzle that can lead to identifying an offender or locating a child."

The missing child map and dashboard include places where children have been previously recovered. NCMEC's location analysis has expanded to include known gang involvement in child sex trafficking, which has become a worrying phenomenon. In 2022, NCMEC tracked 400 cases in which a child went missing and was exploited through child sex trafficking that was associated with a gang.

The dashboard view gives NCMEC and law enforcement agencies hope that they can help those who are suffering. "Everybody can see the 10 missing kids in a specific geographic location on the dashboard, and when those numbers shift to show eight missing and two recovered, it's certainly inspiring," Snow said. "Every time we see that a child is recovered, we celebrate it. You have to celebrate these moments, especially when working on a topic so emotionally challenging."

But Snow cautions that every recovery is just the beginning of the next chapter

for that child.

"There's this expectation that with recovery of a child that everything goes back to normal, whatever normal is," Snow said. "There are a lot of traumas before, during, and after, and a lot of healing that needs to happen. At NCMEC, we're thankful for all these tech tools and analytical resources, but there's a whole other chapter that happens after every recovery moment."

About the Author

John Beck is the director of law enforcement solutions at Esri. He is responsible for helping police agencies worldwide understand and implement GIS for every mission. Before joining Esri, Beck was a police officer and crime analyst in Nevada. In his role at Esri, he helps police agencies apply GIS to crime analysis, strategic planning, patrol operations, investigative support, and citizen engagement. He has also worked with agencies to implement GIS for open and transparent policing and tackling hard problems such as the opioid epidemic and homelessness. He helps police realize the value of new geospatial technologies including machine learning and big data analysis to gain a real-time understanding of crime patterns and make better informed decisions. Beck earned undergraduate degrees in geography and anthropology and a master's degree in criminal justice from the University of Nevada.

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