Fall 2024

ArcUser

The Magazine for Esri Software Users

Revolutionizing Access to Transportation and Supply Chain Services 12

The Importance of Building a GIS Portfolio 60

NASA Provides a Valuable Source of Earth Observation Data 66

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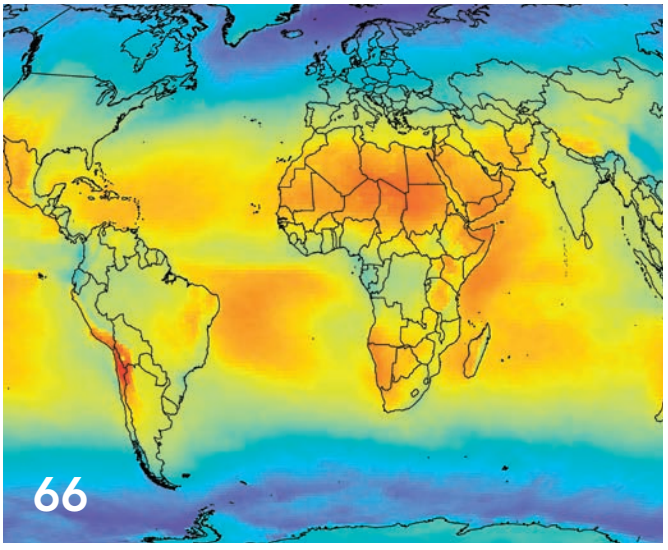
Contents

Fall 2024 Vol. 27 No. 4

Focus

Special Section



End Notes

Supporting Better Outcomes

GIS is a critical aspect of the digital revolution that is transforming the world. It is the technology that applies the geographic approach. By organizing, integrating, and analyzing data, it yields the answers needed to deal with a world profoundly affected by rapidly evolving technologies that are changing how people think, interact, and respond.

Through its visualization and spatial analysis tools, GIS shows the world at scales from the local to the global in new ways. It illuminates relationships in data from disparate and often seemingly unrelated sources to reveal patterns, causes, and effects. Adding the element of "where" also amplifies the value of other technologies, from CAD to CRM systems.

Articles in this issue illustrate how GIS improves government decisions, business operations, and health care delivery in ways that benefit individuals as well as organizations.

The State of Minnesota relies on its portfolio of GIS maps and dashboards to support its data-driven policies on energy, employment, and education. The state's chief geospatial information officer, Alison Slaats, noted, "If you have solid geospatial data and GIS tools, you can really empower people to see the answer, with the goal of improving people's lives."

Watco is a business that other businesses rely on for transportation and supply chain services. By moving from spreadsheets to spatially enabled processes, the company helps its customers locate the railcar services and storage facilities they require using a customized web application. Watco's internal operations optimize processes for currency and security using ArcGIS Enterprise.

Where appropriate clinical trials are being conducted is vitally important to persons living with amyotrophic lateral sclerosis (ALS). A GIS-based app provides current information on the type, time frame, and location of ALS research trials. A site created with ArcGIS Hub and run by volunteers makes data, stories, and information on the disease easily accessible.

In a little more than six decades, GIS has grown from a niche software for departmental projects to a system that spans organizations. As GIS has become more powerful and readily available, its tools can support better outcomes for society.

Monica Pratt
ArcUser Editor

ArcUser

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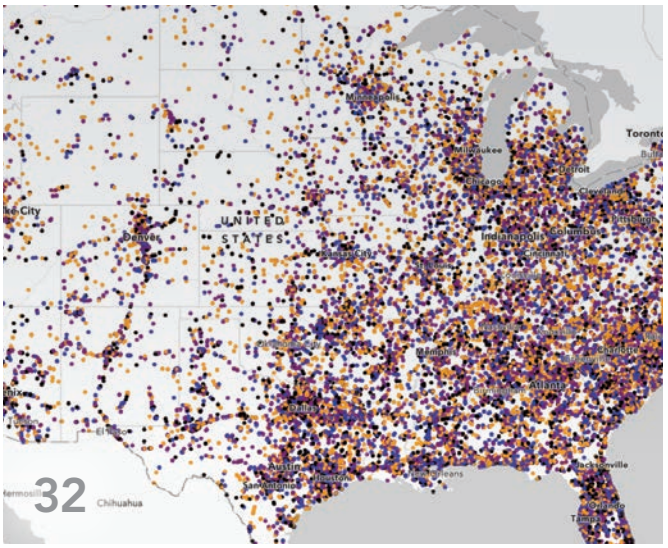


Software and Data

Manager's Corner

Developer's Section

Hands On

Bookshelf

Faces of GIS

Education

Briefly Noted

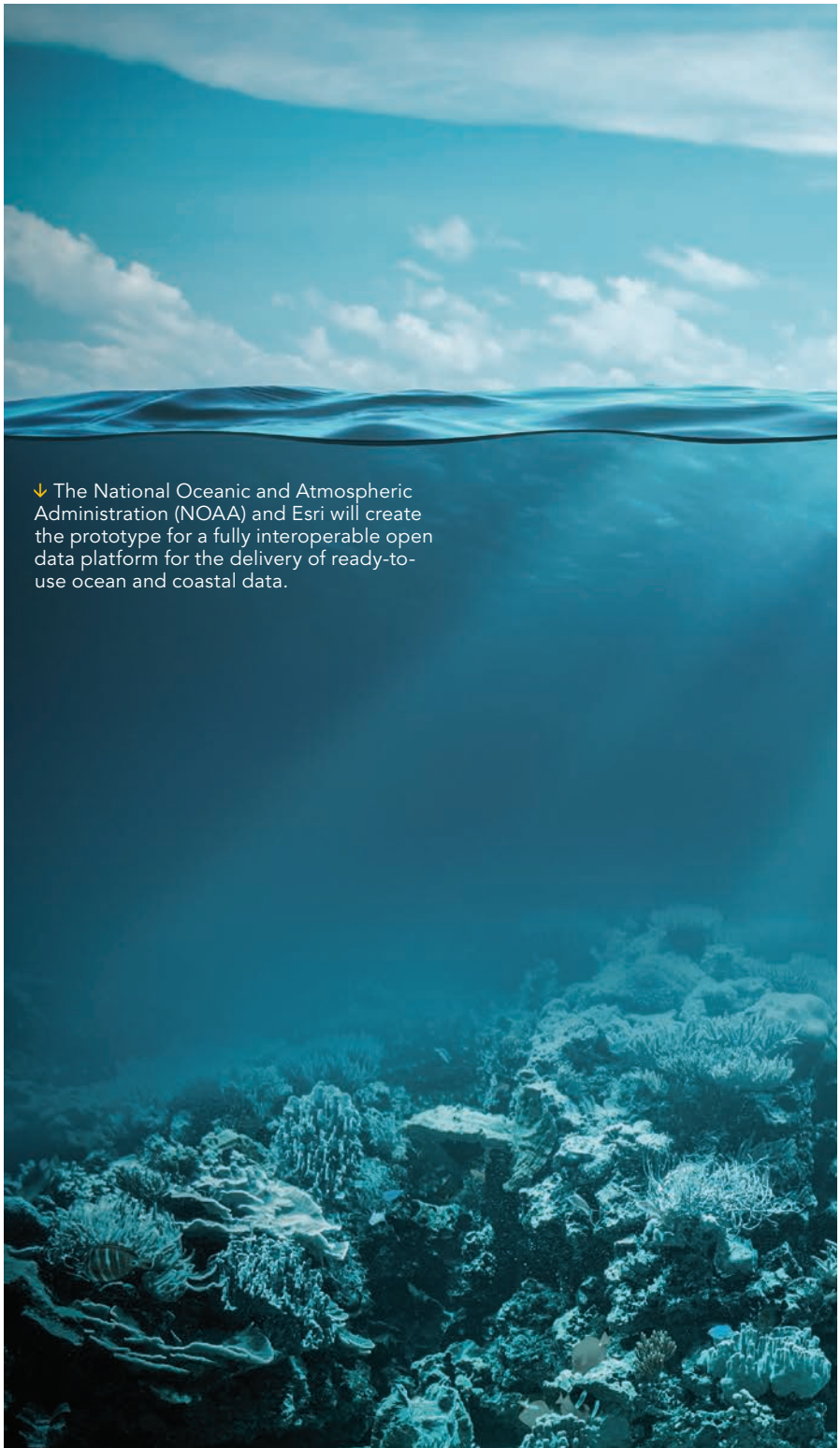
→ NOAA and Esri Make Ocean Data More Actionable

The National Oceanic and Atmospheric Administration (NOAA) and Esri will create the prototype for a fully interoperable open data platform for the delivery of ready-to-use ocean and coastal data. With Esri geospatial technology, the platform will make NOAA's massive data stores accessible and actionable for use by decision-makers to help address critical issues.

"This collaboration could not come at a more important time in helping our coastal communities remain vibrant now and in the future," said NOAA administrator Rick Spinrad. "Combining NOAA's ocean and coastal expertise with Esri's long history of user-centered tools will unlock the true value of these data in the hands of the communities that need them most."

This agreement will break down the barriers that hinder the use of NOAA data. Currently, ocean and coastal data are kept in disconnected sources that require translation before it can be used by stakeholders. NOAA and Esri will build a prototype ocean and coastal data hub that will provide a proof of concept for organizing NOAA data and translating it into actionable knowledge.

The hub will facilitate cross-sector partnerships and collaborations among ocean community organizations, nongovernmental organizations (NGOs), academia, and the private sector. The project's goal is the development of an ocean and coastal data information system that provides data access and guidance in the interpretation and use of that data.



↓ The National Oceanic and Atmospheric Administration (NOAA) and Esri will create the prototype for a fully interoperable open data platform for the delivery of ready-to-use ocean and coastal data.

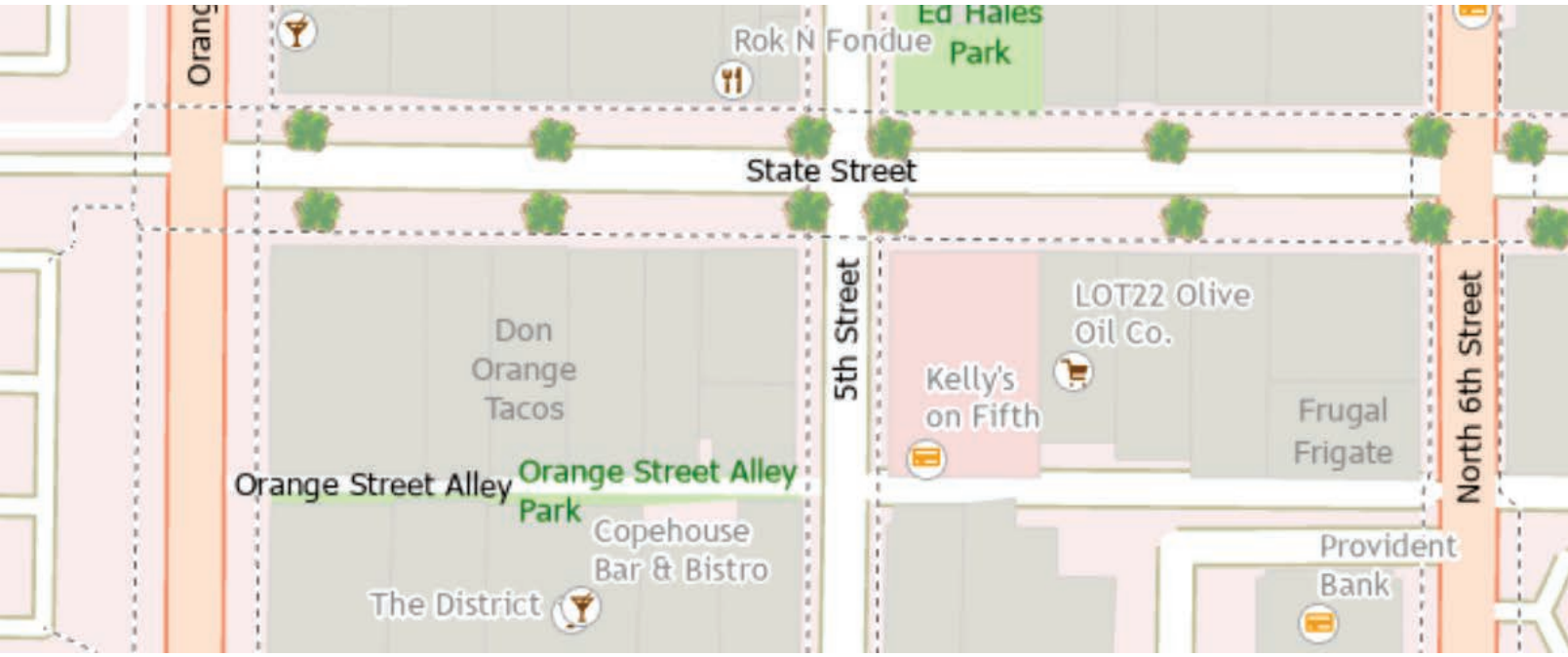
→ Overture Maps Data in ArcGIS

In 2023, Esri joined the Overture Maps Foundation to support its work to create more complete, accurate, and extensible map data provided under an open data license. Since joining Overture, Esri has been contributing data to different data themes, most notably buildings and divisions, and supporting the design of new themes, including addresses. In addition, Overture Maps data will become available in ArcGIS to enhance existing content offerings and add new offerings.

A new Esri Open Basemap built with Overture Maps data will include a curated and integrated collection of open data from OpenStreetMap and many other sources. This basemap will be designed and delivered as a vector tile basemap available in multiple map styles that can be easily customized into many other styles. The Open Basemap will be released in beta later this year and updated monthly with each Overture data release going forward.

Esri has been working with other Overture Maps members to include more buildings with 3D attributes into the Overture data, including building heights from open lidar and data from Esri Community Maps contributors. The new 3D scene layers for buildings, trees, and place labels are built with Overture Maps data and used to update the existing 3D Basemaps in the basemap gallery. These scene layers will include open data from OpenStreetMap, Esri Community Maps, and other open data from Microsoft and Google.

↓ A new Esri Open Basemap built with Overture Maps data that will include a curated and integrated collection of open data from OpenStreetMap and many other sources.



FedRAMP Authorization Protects ArcGIS Online Organizations

Esri has achieved a significant milestone by securing the Federal Risk and Authorization Management Program (FedRAMP) Moderate authorization for its cornerstone software as a service (SaaS) product, ArcGIS Online.

In today's digital age, as cyberthreats continually evolve, organizations across various sectors require dependable solutions to protect their data. FedRAMP Moderate authorization ensures that cloud service providers like Esri meet stringent security standards that are essential for safeguarding sensitive data.

This compliance makes more data eligible for use in ArcGIS Online, which is vital for high-risk sectors, such as finance and health care, that handle sensitive information and are susceptible to data breaches. Additionally, small businesses benefit from these robust security measures, since they gain high-level protection without needing to invest in their own security infrastructure. FedRAMP's standardized security assessments and ongoing monitoring also improve cybersecurity overall, creating a safer digital environment for everyone.

The authorization reflects Esri's ongoing commitment to software security and compliance. To achieve FedRAMP Moderate authorization, ArcGIS Online security infrastructure and processes underwent rigorous evaluation and received approval from an independent third party. By meeting FedRAMP Moderate standards, ArcGIS Online provides a secure and reliable environment for the storage, processing, and management of moderate-risk data, including financial, health, and personally identifiable information.

With growing cybersecurity risks and tightening data privacy regulations, organizations across all sectors can enhance their mapping and spatial analysis workflows by adopting and expanding their use of ArcGIS Online.

Key Benefits for Organizations

The FedRAMP Moderate authorization for ArcGIS Online presents a range of advantages for organizations that use the SaaS technology, from expanding the types of data that can be stored and processed to strengthening opportunities to collaborate.

A Reliably Secure SaaS Infrastructure

ArcGIS Online is the first SaaS-based GIS to achieve FedRAMP Moderate authorization based on the US Department of Commerce's National Institute of Standards and Technology's (NIST) SP 800-53 Revision 5 security controls. As a cloud-based solution, ArcGIS Online enhances organizational efficiency by reducing the time and costs required to set up the system, since it eliminates the need to invest in infrastructure, engineering, and system administration. Not only did Esri seamlessly increase the security assurance level of ArcGIS Online, but the company also migrated to NIST's latest security control revision with no impact to customers.

Confidently Store and Process Moderate-Impact Data

Organizations that use ArcGIS Online can confidently collect, maintain, process, disseminate, and dispose of Low- or Moderate-Impact data. This enables users to perform a wide range of geospatial workflows while adhering to the highest standards of security and compliance.

Enhanced Collaboration and Sharing

Organizations can expand their collaboration with external stakeholders to include those that need to ensure a higher degree of security compliance. With more data in the system and more people able to work with that data, processes such as sharing data, conducting analysis, and expanding situational awareness become more powerful.

A Seamless Integration with ArcGIS Enterprise

Organizations can seamlessly integrate ArcGIS Online with their existing ArcGIS Enterprise deployments to scale beyond the reach of on-premises capacity, facilitating data sharing, collaboration, and comprehensive geospatial workflows.

Using Advanced Geospatial Capabilities for Critical Operations

For organizations that engage in emergency response, disaster management, infrastructure planning, and environmental monitoring, they can expand their use of ArcGIS Online to incorporate a wider variety of geospatial data in support of critical operations.

Value and Relevance for International Users

For international users that need to align with standards such as the International Organization for Standardization's ISO/IEC 27001, the ArcGIS Trust Center provides information on mapping FedRAMP compliance to ISO 27001 security controls. This tool shows how FedRAMP meets international security and compliance requirements, aiding users from around the world in understanding the authorization's relevance to their needs.

Depend on Continually Monitored Infrastructure

Maintaining FedRAMP Moderate authorization requires Esri to continuously monitor ArcGIS Online services, perform annual penetration testing, and get approval by an independent third party. ArcGIS Online is segmented from corporate systems so that any compromises that affect corporate systems do not affect ArcGIS Online, providing resilience.

The Unique Advantages of Enhanced Security

Since every organization has its own data classifications, IT resources, and specific requirements, each will experience unique benefits from the enhanced security posture of ArcGIS Online.

For example, Organization A, which has stringent security requirements and limited IT resources, can use ArcGIS Online FedRAMP Moderate authorization to meet its compliance obligations and integrate ArcGIS Online into its existing systems. This will allow staff members to access and analyze geospatial data without investing in additional hardware or software. Leaders can be confident that the organization's data is protected at the highest level, building trust with stakeholders and strengthening the organization's reputation.

Organization B, which analyzes utility networks, can now efficiently integrate more workflows into ArcGIS Online while maintaining custom database configurations in its ArcGIS Enterprise deployment. This organization has various options for hybrid deployments with ArcGIS Online and ArcGIS Enterprise, allowing users to incorporate moderate-risk data in workflows that extend beyond the reach of on-premises capacities.

Organization C is a federal agency known for its stringent security measures and vast amounts of sensitive data. It offers public information through a scalable external platform. By adopting ArcGIS Online, this agency can now share previously inaccessible data with external stakeholders, improving situational awareness and communication across teams, emergency centers, and local emergency response leaders. This integration streamlines workflows, boosts collaboration, and supports better-informed decision-making.

In each of these scenarios, the ArcGIS Online FedRAMP Moderate authorization helps organizations meet their unique security needs. This enables them to leverage the power of GIS technology to collaborate, share data, and develop innovative location-based solutions in new ways, ultimately allowing them to achieve their missions.

Understanding Your Organization's Responsibility

Organizations that align their workflows with the FedRAMP Moderate authorization are responsible for implementing and maintaining certain security controls and practices.

These organizations should review the Customer Responsibility Matrix (CRM)—available in the Documents tab of the ArcGIS Trust Center once signed in—and determine how best to implement any required changes. The CRM describes elements of user engagement outside of Esri's scope, such as the requirement that end-users employ multifactor authentication and categorize datasets to align with Zero Trust Architecture (ZTA) stipulations and privacy regulations, whether at the state or international level.

Visit the ArcGIS Trust Center at trust.arcgis.com to learn more about what the ArcGIS Online FedRAMP Moderate authorization means for your organization.

Storytelling for a Better World

Share your vision of the world you want to see by entering the 2024 ArcGIS StoryMaps Competition. Combine cartography, data analysis, graphic design, and photography to propose solutions to the world's greatest challenges. Your storytelling can inspire action and showcase innovation in GIS and storytelling. Entries are due December 6, 2024.

You may submit one entry, either as an individual or as a member of a group. You can submit your ArcGIS StoryMaps story as a professional or student. To qualify as a student, you must be 18 years or older and a student pursuing a degree at a two- or four-year college or university. All members of a student group entry must qualify as students. All stories must be published to the public.

There are five competition categories. Esri has enlisted five organizations—all subject-matter experts in their respective fields—to judge entries in one of the five categories and select the winners. The five categories and the organizations involved in judging them follow.

→ Digital Humanities and Popular Culture

Use your story to explore the intersection between humanistic study and technology.

Stanford Libraries Map and GIS Team

→ Health and Safety

Show how communities use GIS to connect their members with health and safety resources, better understand infrastructure capacity, allocate critical resources, or identify vulnerable populations.

San Bernardino County Department of Public Health

→ Humanitarian and Disaster Response

Create a place-based story about a disaster, challenge, relief effort, or personal experience.

UN Refugee Agency

→ Nature and Physical Science

Use a story to show how technology supports conservation success.

International Union for the Conservation of Nature

→ Planning and Infrastructure

Craft a story about how geospatial science and technology are being used to plan and build sustainable communities.

Old Dominion University

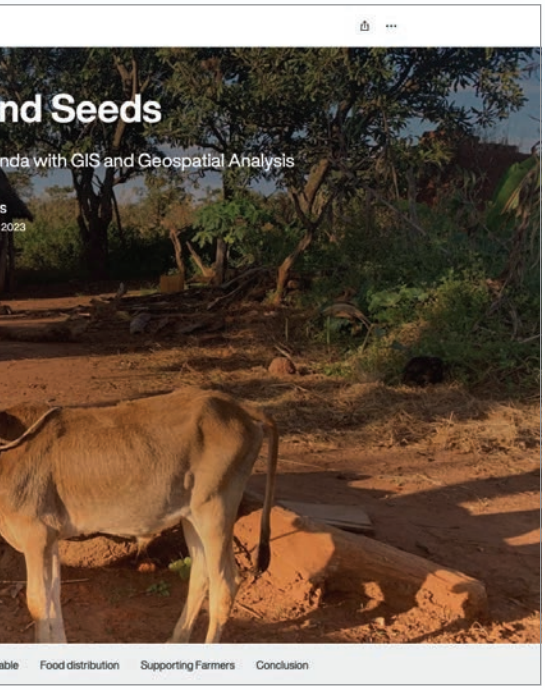
There are many resources to help you create your entry. Read about the contest at links.esri.com/storymapcomp24. Submit your entry at links.esri.com/storymapcomp24entry. Competition finalists will be announced on February 12, 2025. The competition winners will be announced on April 22, 2025.

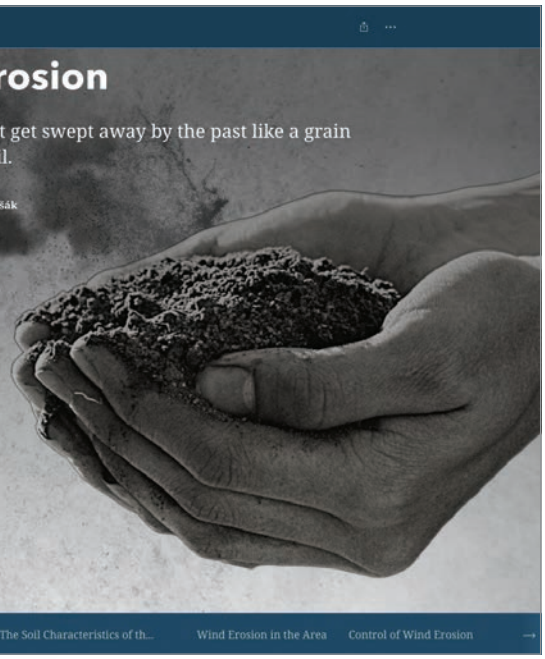
↑↑ The 2023 runner-up in the research and science-focused track, "Satellites and Seeds: Improving Food Security in Northern Uganda with GIS and Geospatial Analysis" was submitted by Helen Mazalon, Alcis GIS, and Alison Hall MBE, Seeds for Development.

↑ 2023 student winner, "Wind Erosion," was submitted by Petr Zálešák, Mendel University in Brno.

Understanding the Location Services System Pattern

The ArcGIS Well-Architected Framework provides IT and GIS professionals with a comprehensive set of ArcGIS system patterns to assist in designing an effective ArcGIS system tailored to an organization's needs.





This article takes a deep dive into one of these patterns to help you better understand the basics of system patterns. The location services system pattern enables the delivery of ready-to-use, location-based services for enterprise-wide and public use. This introduction will provide the key characteristics, user personas, applications, capabilities, and architecture considerations of this pattern.

The location services system pattern serves as a foundational system that delivers a range of location-based capabilities to all parts of an enterprise. These capabilities include basemaps, geocoding, routing, and spatial analytics. It provides authoritative, foundational geospatial content and capabilities to maps, applications, systems, and workflows within an organization. By centralizing the operations and management of core location services, this pattern ensures that location-based services are delivered consistently and efficiently.

The location services system pattern brings value to organizations by:

- Delivering foundational geospatial content that is authoritative and capabilities that support the workflows and applications within an organization.
- Centralizing operations and management of core location services, ensuring efficient delivery and maintenance of these services. Centralization also builds trust in data quality as relevant data processes can be defined and implemented once, with consistent and observable results.
- Exposing standards-based service application programming interfaces (APIs) that can be integrated into any system or workflow using an organization's preferred software development kit (SDK).

Organizations commonly leverage a combination of services that are hosted and managed by Esri, for example, software as a service (SaaS) or platform as a service (PaaS); services hosted and managed by other organizations; and services hosted within the organization in their own location services system, such as assets or customer locations.

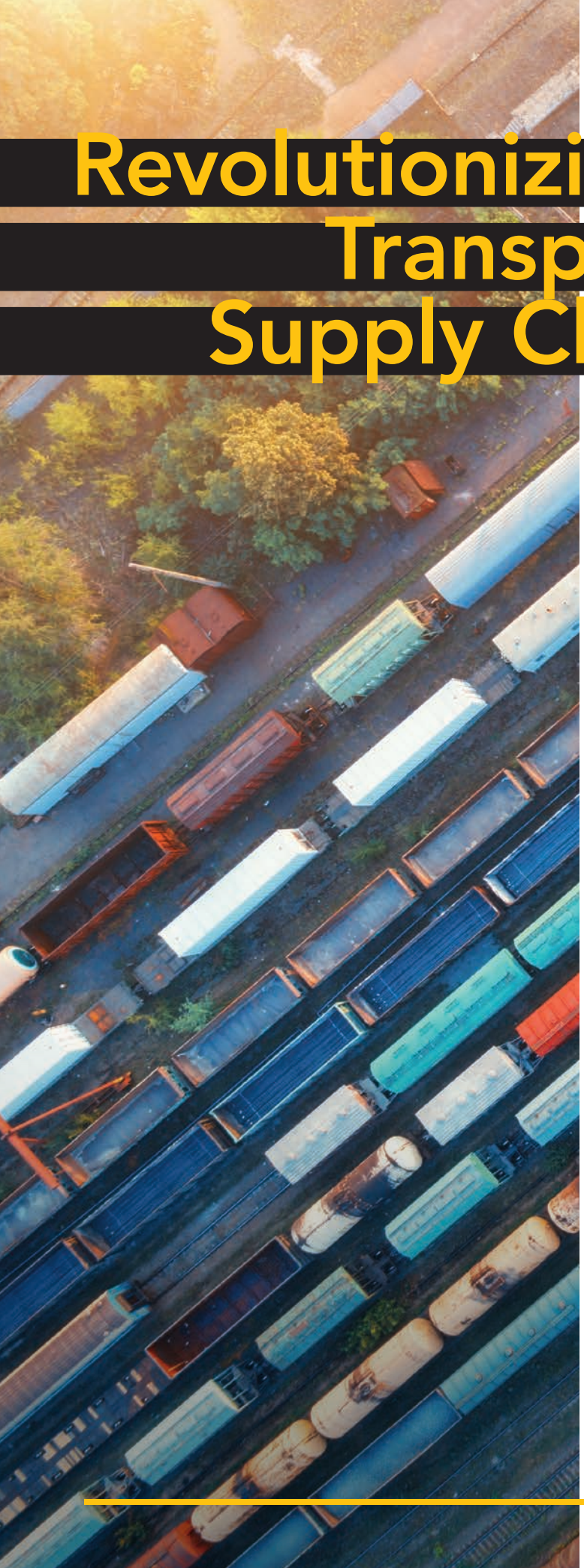
Organizations in industries from transportation and logistics to utilities and governments at all levels—national, state, and local—leverage the location services system pattern to enhance decision-making, optimize operations, improve service delivery, and protect people and property.

Transportation and logistics companies leverage location services with their customer data to optimize delivery services, incorporating factors such as weather, traffic, and customer details. Esri-provided location services, such as network analysis, can optimize last-mile delivery to improve customer service and better allocate resources.

Esri-provided location services enable state governments to leverage GIS to help evaluate and prioritize infrastructure projects based on key criteria that can include safety, congestion, accessibility, and economic development. State transportation officials collect data and use it with Esri-provided location services to power a live dashboard to make better-informed investment decisions.

The location services system pattern within the ArcGIS Well-Architected Framework provides organizations with a robust foundation for delivering location-based services. Whether it's creating maps, analyzing spatial data, or optimizing routes, the location services system pattern plays a crucial role in building effective ArcGIS systems.

Learn how to build your location services system or read about other ArcGIS system patterns in the ArcGIS Well-Architected Framework at links.esri.com/WAF.



Revolutionizing Access to Transportation and Supply Chain Services

By Seth Johnston

Transportation and supply chain services provider Watco worked with geospatial IT services company and Esri partner GCS to move the company from spreadsheets to a spatially enabled process that helps its customers identify the best locations for railcar storage, transloading, and industrial properties.

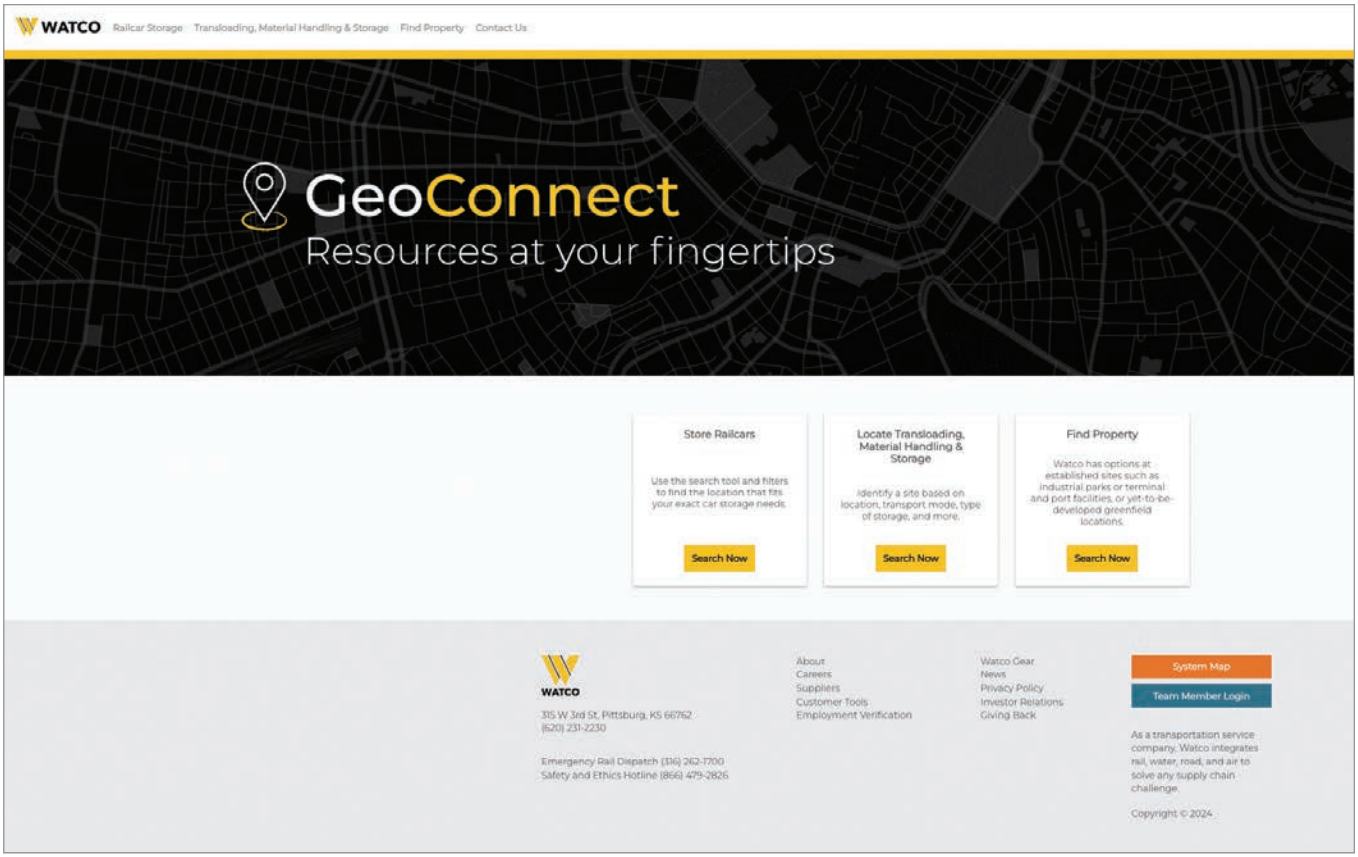
Established in 1983, Watco operates throughout North America and Australia with an extensive network of short line railroads, terminals, ports, and railcar repair facilities. Their services cater to diverse transportation needs and offer solutions for various materials, commodities, and products across different markets.

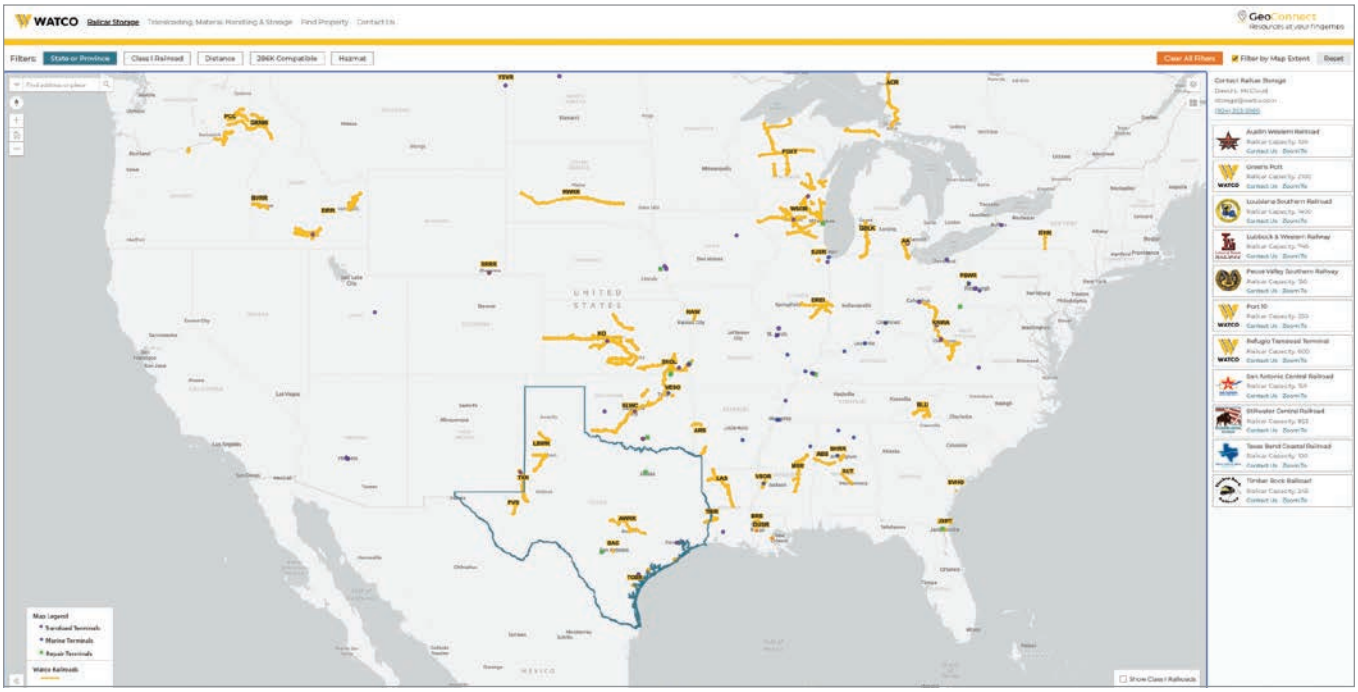
Watco wanted a web-based solution that would help its customers find the locations with services and space for development that they needed. GCS collaborated with Watco in designing, developing, and implementing an intuitive geospatial web application that showcased Watco's solutions to existing and perspective customers.

The goal was a site that would allow customers to easily navigate through Watco's offerings via a map-based interface. Key priorities for the project included ensuring mobile compatibility, creating a unified resource hub for both prospective and existing customers, accommodating future enhancements, optimizing filter functionalities, and incorporating a customer-centric form for contacting Watco.

The effort involved converting legacy spreadsheets into spatial data features. The result was GeoConnect, an application built using ReactJS and the ArcGIS API for JavaScript 4.25 that seamlessly integrated with Watco's existing WordPress website and infrastructure. GeoConnect's three modules—Railcar Storage; Transloading; Material Handling & Storage; and Find Property—offer versatile functionality to customers. These modules provide Watco with a GIS-powered solution that is tailored to customers' needs.

In late 2022, Watco launched GeoConnect with the Railcar Storage module, a tool designed to facilitate railcar storage searches. The Railcar Storage module employs search tools and

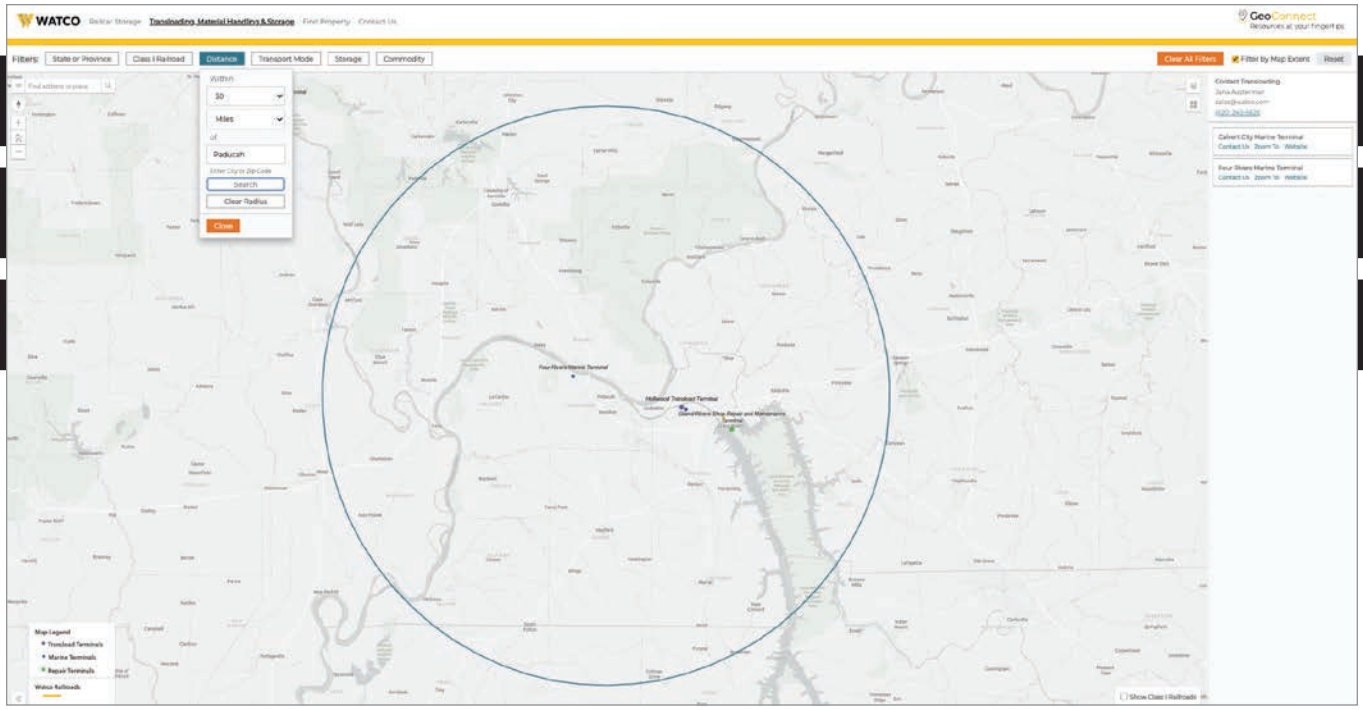


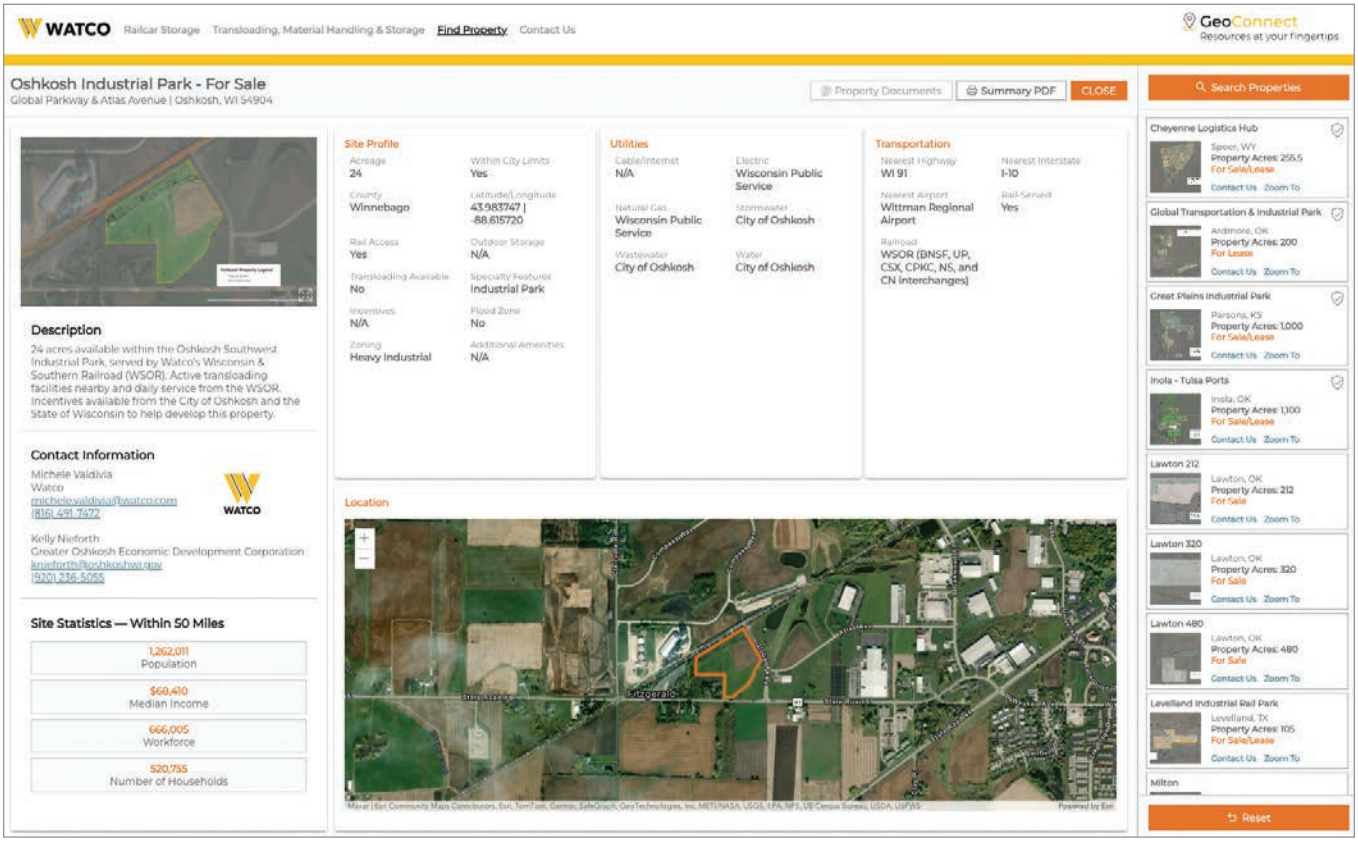


↑↑ The GeoConnect home page provides access to the Railcar Storage; Transloading, Material Handling & Storage; and Find Property modules.

↑ The Railcar Storage module uses search tools and filters to find the location that fits the customer's exact storage car needs.

filters to pinpoint locations that precisely match the customer's railcar storage requirements. They use an interactive map to explore storage locations, perform address searches, or generate a comprehensive list of Watco sites that offer this service. Users can refine search criteria by state, Class I railroad affiliation, distance





to city, track capacity, and hazmat suitability. Detailed information, such as railcar capacity and Class I interchanges, is available for individual locations.

Watco expanded GeoConnect in spring 2023 to include the Transloading, Material Handling & Storage module. This module

↑↑ The Transloading, Material Handling & Storage module identifies a site based on customer location, preferred transportation mode, type of storage, and more.

↑ Customers come to the Find Property portal with the intent of purchasing or leasing land for the purpose of designing functional transportation facilities.

assists customers in identifying sites based on factors such as customer location, preferred transportation mode, and storage specifications. Customers can use a map with filtering options to explore available transport modes, Class I railroad connectivity, storage capacities, and other pertinent location details.

The Find Property module was added to GeoConnect in early 2024. This module empowers customers to discover sites for business development that are owned or operated by Watco. Buildings and sites for development can be located using extensive search criteria and interactive maps with informative pop-ups. Property detail pages summarize property offerings and include associated images, documents, and area statistics.

Watco key services are seamlessly integrated into a user-friendly online platform hosted by ArcGIS Online. Watco uses an air-gapped system to ensure secure data management. GeoConnect data is curated by staff in the ArcGIS Enterprise environment. The data flagged for publishing is synced to the public-facing ArcGIS Online organization and visible on GeoConnect. This hosted-copy pattern ensures that customers can interact with up-to-date data, staff can continue to manage the data in their enterprise system, and Watco's internal GIS is not exposed to the public.

This fully customized application is meticulously tailored to meet the precise requirements outlined by Watco to benefit its customers. It serves as a prime example of workflow streamlined with ArcGIS technologies. The GCS solution empowers potential Watco customers by offering ArcGIS-enabled tools that unlock the spatial potential of Watco's data. GeoConnect has transformed Watco's data into actionable information for its customers.

The project team of GCS staff members that created this solution was led by GIS analyst Jay Egenhoff. The other project team members were Cass Kalinski, senior GIS analyst; John McIntosh, senior software architect; Peter Puczkowskyj, software developer; Ryan Greene, software developer; Seth Bettwieser, software developer; and Rachel Bryant, GIS analyst.

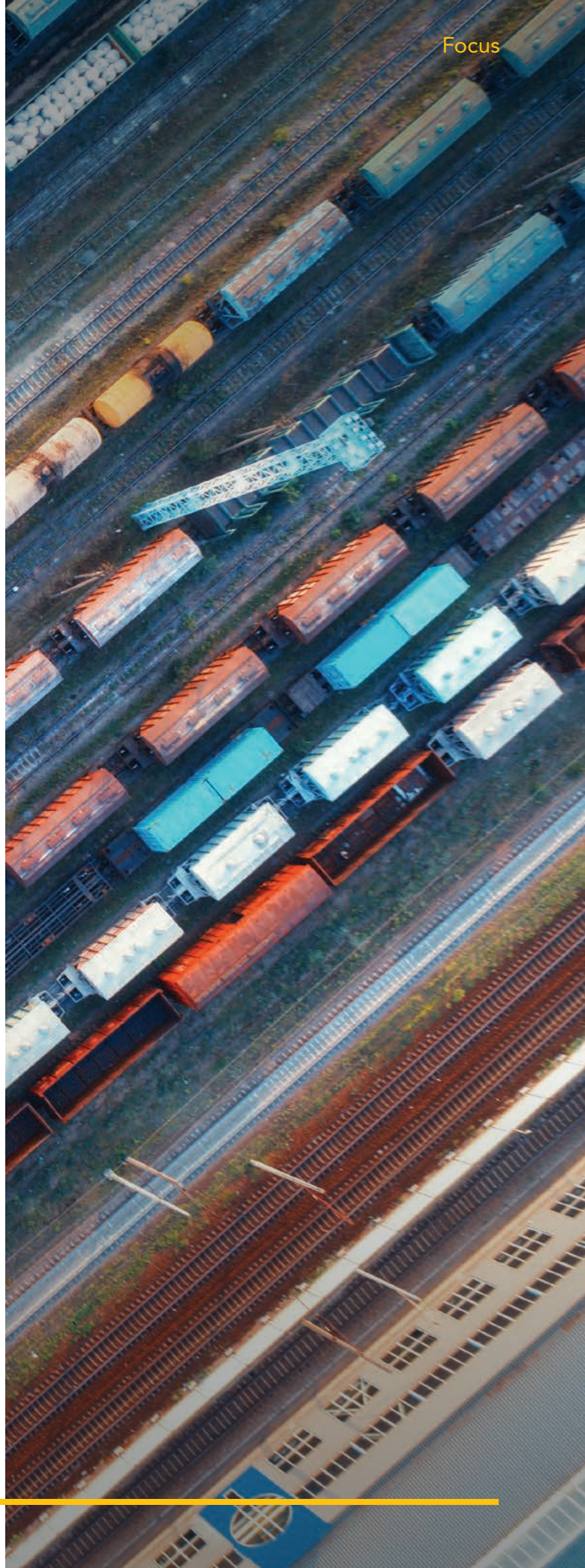
"GeoConnect has revolutionized the way customers explore railcar storage and transload solutions at Watco. In a crowded marketplace, GeoConnect stands out, offering potential and existing customers an intuitive way to identify premier sites, railcar storage locations, and transload options," said Aaron Baumgarden, manager of GIS programs at Watco.

Watco first learned about GCS during a presentation by GCS staff at a GIS for Railroads workshop. GCS is a leading provider of geospatial information technology services to a wide array of industry sectors and specializes in crafting GIS solutions that effectively convey geographic insight to its clients and optimize workflows. Watco entrusted the entire application life cycle to GCS, which continues providing ongoing enhancements and support for the solutions.

Explore GeoConnect at www.watco.com/geoconnect. For more information, please contact Seth Johnston at sjohnston@yourdatasmarter.com.

About the Author

Seth Johnston, a technical sales representative with GCS, has been with the company since 2021.



Modernizing Airport Tenant Inspections

By Sirisha Muppala

Located in the heart of Silicon Valley, San José Mineta International Airport (SJC) transformed its process for managing tenant inspections from a manual data collection process to one that is GIS based.

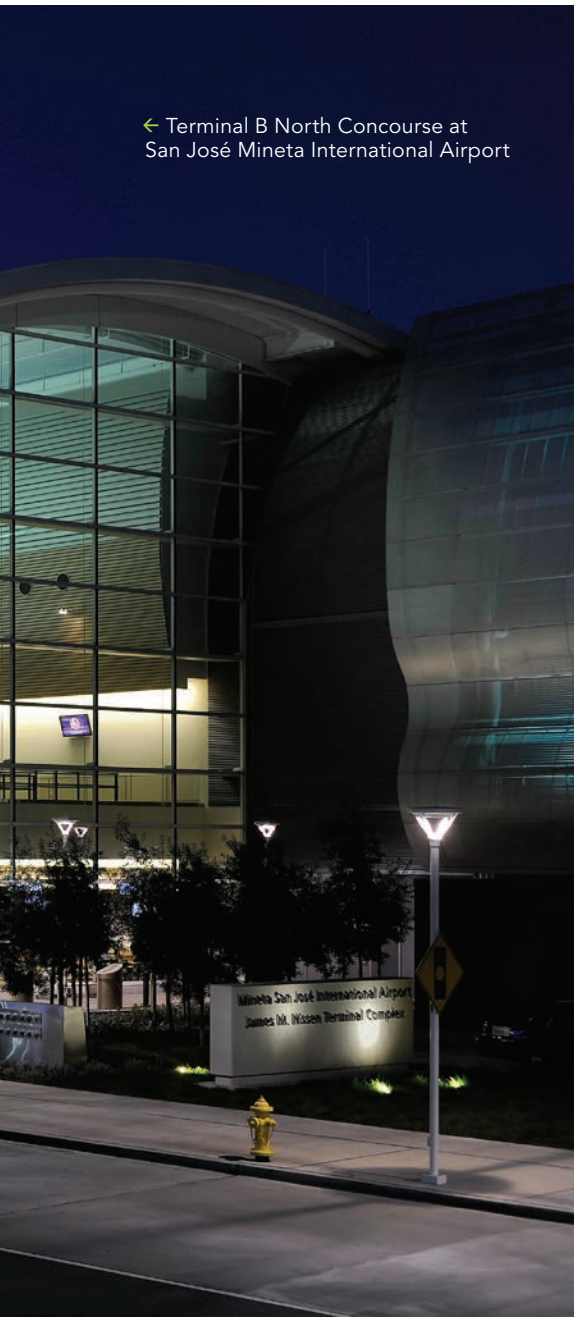
Managing Airport Tenants

SJC is an international airport that encompasses 1,120 acres, hosts 11 commercial airlines, and sees approximately 12 million passengers pass through its gates each year. Airports are often referred to as cities, given the multifaceted nature of their operations and the diverse spaces they encompass. Central to this characterization is the pivotal role of interior space maintenance, as it significantly contributes to creating a welcoming environment for passengers within these bustling hubs.

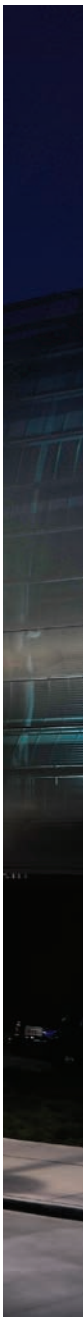
SJC carries out regular inspections of its spaces leased or rented by retail shops, restaurants, and service providers to evaluate their condition and compliance with contracts. Inspections cover the safety, cleanliness, and general maintenance of tenant spaces. The goal is to ensure that all tenant areas meet the airport's standards and regulatory requirements.

Maintaining operational excellence is paramount. For years, dedicated property managers relied on manual data collection methods to conduct quarterly tenant inspections. Each inspection involved handwritten notes and manual data entry into Microsoft Excel spreadsheets.

Inspection findings were communicated through lengthy email chains, leading to inefficiencies and occasional errors. The system, while functional, was far from optimal. Another challenge encountered by property managers using manual methods was the absence of a systematic process for tracking inspection follow-ups. In addition,



← Terminal B North Concourse at San José Mineta International Airport



although inspection findings were communicated, there was no integrated mechanism to monitor the completion status of the required repairs.

As the airport grew, the limitations of this manual process became increasingly apparent. The property management team faced numerous challenges: data inaccuracies, delayed reporting, insufficient tracking of identified repairs, and a cumbersome workflow that struggled to keep pace with the dynamic needs of a modern airport. It was clear that a change was necessary to elevate operations.

Recognizing the potential of technology to revolutionize its processes, SJC embraced a new survey system that integrated GIS into the process of tenant space inspections. By leveraging GIS technology, SJC aimed to streamline inspections and ensure a proactive and systematic approach to facility maintenance.

Food and beverage outlets and retail stores are vital commercial spaces at SJC. Maintaining the cleanliness of these spaces is critical. The move from manual to digital concession inspections began with these tenants, although the plan is to eventually employ digital methods for the inspection of all tenant spaces, including airline offices, service providers, and maintenance facilities.

The Role of GIS in Streamlining Airport Business Processes

Ten years ago, SJC implemented GIS technology to oversee the geospatial data associated with the airport, including data on runway and taxiway layouts, airfield signage and lighting, passenger terminals, aircraft parking stands and jet bridges, baggage handling areas, building footprints, and utilities.

Recently, there has been a concentrated effort to integrate the geospatial data with other business processes or systems within the airport. GIS at SJC was migrated from a stand-alone ArcGIS Server to ArcGIS Enterprise, which made tools such as ArcGIS Survey123 available.

GIS was adopted to modernize and enhance the efficiency of managing tenant spaces by centralizing data management and consolidating all tenant inspection data into a single, accessible platform. As part of this comprehensive integration strategy, the survey system is seamlessly linked with GIS.

The airport's GIS team conducted a comprehensive analysis. They examined ways to modernize and identify areas where GIS data can be used to streamline the inspection data collection process. As a result, the GIS team proposed implementing ArcGIS Survey123, a form-centric data gathering GIS method, as a transformative solution to replace handwritten survey notes.

Transforming Workflows for Efficiency

The strategy employed for implementing ArcGIS Survey123 divided the implementation process into three phases: 1) analysis and migration; 2) pilot testing and user adoption; and 3) full deployment and optimization.

Analysis and Migration

The transition began with a comprehensive analysis of the existing workflow. Previously, the procedure entailed using a paper form created in Microsoft Excel to evaluate tenant maintenance activities across categories such as customer service, facility, and equipment, back-of-house procedures, and exterior appearance. Each metric was subdivided to furnish detailed information on specific elements These field observations were entered manually into a computer, and the inspection findings were emailed to tenants.

Subsequently, this entire process was migrated to ArcGIS Survey123 and integrated with the GIS database containing tenant information, so that it became the primary repository for that information. Criteria were systematically organized into user-friendly drop-down menus within ArcGIS Survey123 to facilitate scoring. An overall score field was added for each metric in the inspection findings, along with a new field to compute the total possible score for each concession, which represented the highest achievable score for tenants. This system provides a comprehensive overview and aligns the new system with the current workflow.

Pilot Testing and User Adoption

To maximize the effectiveness of the new methodology, pilot testing was initiated in June 2023. Over three months, a select group of users with the Survey123 system installed on Apple iPad devices conducted extensive testing. Valuable feedback was incorporated into ArcGIS Survey123, ensuring that the changes implemented addressed the practical needs and concerns

CONCESSION			TOTAL SCORE : ____ / 110
	AUDIT ITEM	RANGE ITEM SCORE	COMMENT
	CUSTOMER SERVICE		
1	**HOURS OF OPERATION:** Store is open for business as required during normal business hours	0-5	
2	**STAFFING:** Staffing levels are adequate to provide prompt customer service at all times	0-5	
3	**APPEARANCE:** Personnel are well-groomed, dressed appropriately in clean clothes or are wearing the full and correct uniform when on duty, including name badge	0-5	
4	**APPEARANCE:** Staff is not drinking, eating or chewing gum	0-5	
5	**APPEARANCE:** Employees are actively working while on duty and are not using cell phones or discussing personal matters	0-5	
6	**SERVICE:** Customers are acknowledged by staff with a friendly greeting within ten seconds of arrival and are greeted as they walk through the shop	0-5	
7	**SERVICE:** Employees who are engaged in non-customer service needs quickly shift to greet customers as they enter the store, offer assistance or ring sales	0-5	
8	**SERVICE:** Employees demonstrate a positive attitude, upbeat and eager to help customers	0-5	
9	**PRICING:** All displayed items for sale are appropriately signed and/or priced	0-5	
10	**SERVICE:** Average wait time is less than 3 minutes per customer	0-5	
	SCORE	50	
	FACILITY AND EQUIPMENT		
1	Floors are clean; no damage to floor tiles or epoxy, coving, and grout	0-5	
2	Light fixtures are illuminated during operating hours	0-5	
3	Areas are free of visible dust	0-5	
4	Grab 'n go coolers are working and in like new condition	0-5	
5	Entrance isn't too blocked/cluttered by display racks	0-5	
6	Extra stock of product is not visible to the passengers	0-5	
7	Clean and restock condiments stations and grab 'n go areas are clean	N/A NA	
	SCORE	30	

identified during the testing phase. Iterative feedback allowed for the identification and resolution of any issues and inclusion of any adjustments and improvements needed before full-scale implementation.

Concurrently, a robust training program was executed to familiarize all relevant personnel with the new system, ensuring a smooth transition and minimizing disruptions. This training was crucial in preparing the staff for the changes and ensuring they could use the new system effectively.

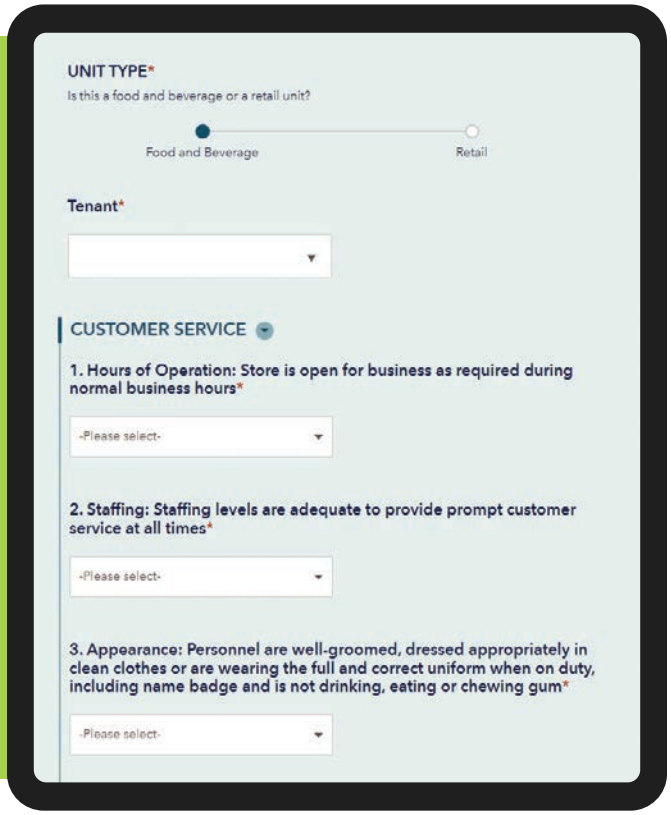
Full Deployment and Optimization

Following the successful completion of pilot testing and training, the project moved to the final phase in March 2024. It focused on the full deployment of ArcGIS Survey123 to all users. Continuous monitoring and feedback mechanisms were established to address any unforeseen challenges during the initial stages of widespread use.

With the final deployment of ArcGIS Survey123, all users had a dynamic and automated communication channel to inform tenants of inspection results. Using Microsoft Power Automate, an email was issued after a survey was submitted. The email included detailed information such as ratings and inspection photos from the survey. This automated communication ensured timely and accurate dissemination of inspection results, further streamlining the process, and enhancing overall efficiency.

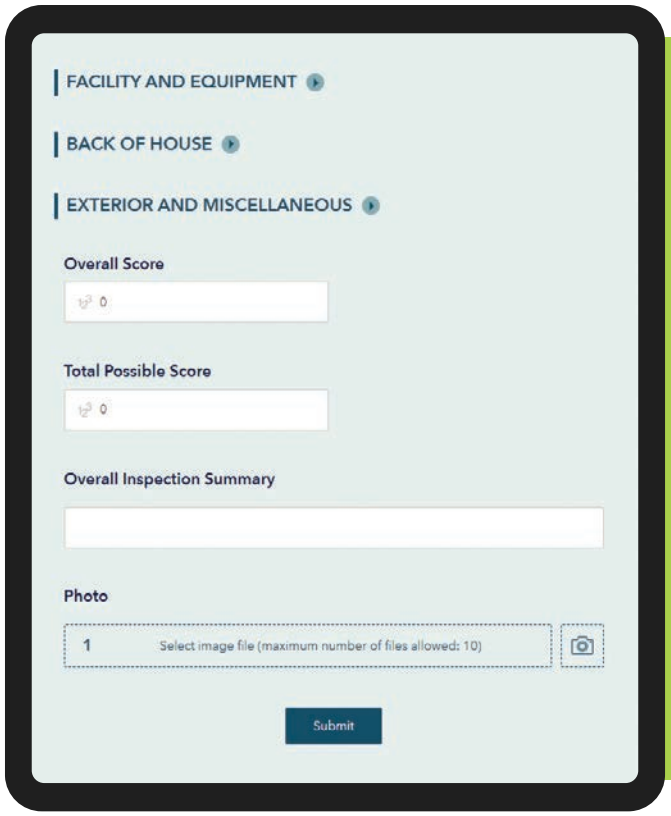
↑ The inspection workflow and metrics as originally captured in a spreadsheet.

→ Criteria were systematically organized into user-friendly drop-down menus within ArcGIS Survey123 to facilitate scoring.



The Benefits of the Move to Digital Methods

By adopting ArcGIS Survey123, the airport property managers were able to automate data collection, streamline inspection processes, and enhance overall operational efficiency. This integration reduced data collection errors and improved tenant space management. It also provides insight into operations by monitoring compliance with lease agreements and regulatory requirements,



← An overall score field was added for each metric, along with a new field to compute the total possible score for each concession, which represents the highest achievable score for tenants.

→ Sirisha Muppala

maintenance, and required repairs.

Real-time visibility into the outcomes of inspections helps airport property managers quickly identify and address issues within tenant spaces such as safety violations. This visibility helps mitigate potential risks and prevent minor problems from developing into major issues that could adversely affect airport operations.

The successful implementation of ArcGIS Survey123 not only modernized the inspection workflow but also aligned with the airport's strategic goal to innovate by leveraging technology and fostering a culture of innovation. The benefits from the new data collection methodology included substantial time and cost savings.

Previously each inspection took several hours to complete. The time for inspections was reduced by 50 percent. Data accuracy was increased by 80 percent and reporting speed was reduced from days to hours or minutes. This led to enhanced decision-making and significant improvements in strategic collaboration. These benefits allow for the timely resolution of issues and judicious allocation of resources. This transformative journey, which began in November 2022, was completed in March 2024.

Conclusion

With the cumbersome process of gathering and analyzing inspection data streamlined, the property management team can focus on strategic decision-making rather than being bogged down by administrative tasks. The integration with GIS established a centralized platform for data collection, analysis, and reporting and provides real-time insights that enhance efficiency and accuracy. This advanced system not only modernized the inspection workflow but also improved tenant space management, integrating seamlessly with GIS data to elevate overall operational standards.

About the Author

Sirisha Muppala, GISP, is the senior GIS specialist for the San José Mineta International Airport. For the past eight years, she has been involved in developing the airport-wide GIS program. During this time, she led the migration to ArcGIS Enterprise. Prior to her role with the airport, she was a water resources scientist at HDR Engineering Inc., and worked with several local governments in California. She holds a master's degree in civil engineering.

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ADDING LOCATION CAN MAKE ALL THE DIFFERENCE

By Monica Pratt

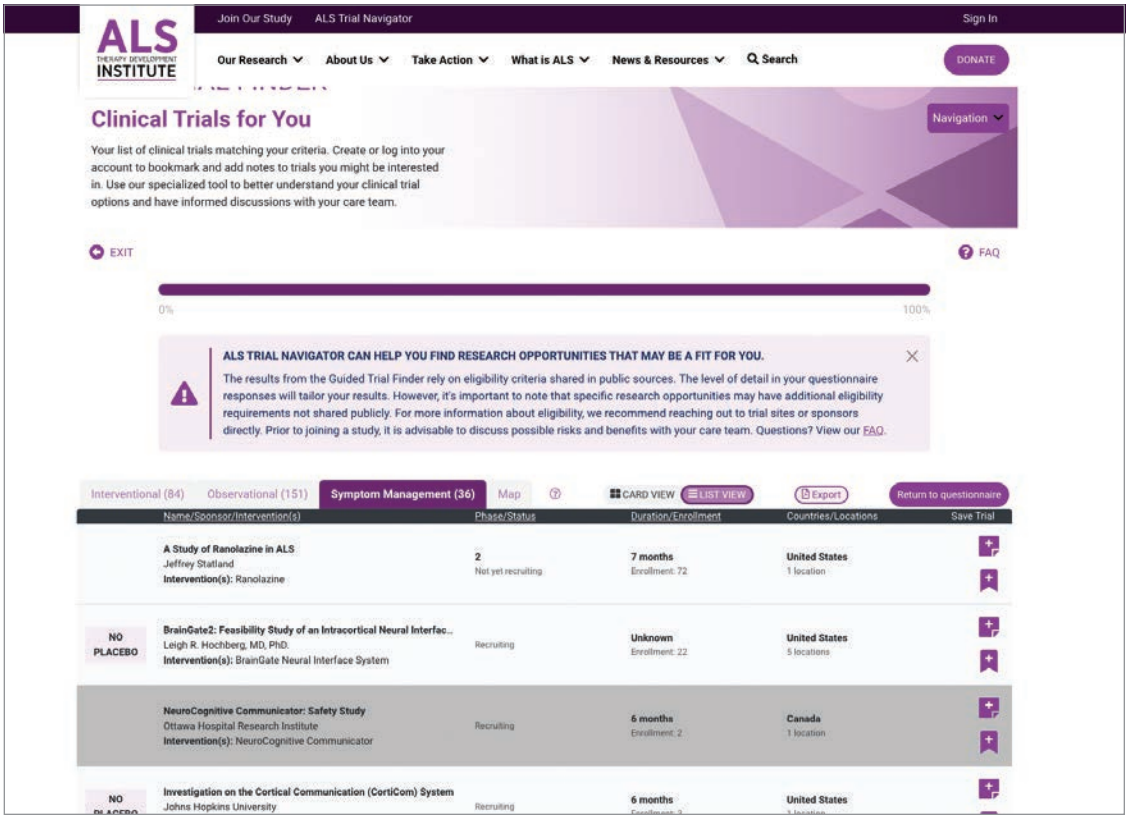
A nonprofit biotech organization, ALS Therapy Development Institute (ALS TDI), has partnered with Esri to help persons living with amyotrophic lateral sclerosis (ALS) more easily identify and potentially participate in ALS clinical trials.

ALS Trial Navigator (www.als.net/als-trial-navigator/), launched in February 2024, brings an important dimension—geography—to the research that is being conducted on this devastating disease. ALS is one of a collection of motor neuron diseases that are characterized by the deterioration of motor nerve cells in the brain and spinal cord. Motor nerve cells control muscles. As these cells deteriorate, they no longer stimulate muscles, causing the loss of muscular strength and muscle control.

In the United States, ALS is often referred to as Lou Gehrig's disease. Henry Louis Gehrig, a professional baseball player with the New York Yankees, was legendary for his durability and skill. His 17-year baseball career ended in 1939 when he developed symptoms and was subsequently diagnosed with ALS. He died in 1941.

Although ALS is more common in men than in women and its incidence increases with age, the majority of cases are considered sporadic with no clearly associated risk factors or links to family history. Approximately 10 percent of cases are genetic.

The probable life expectancy of persons diagnosed with ALS after the onset of symptoms is typically between two and five years. The rapid progression of the disease has made it problematic to



→ ALS Trial Navigator, which provides detailed information about trials located across the world, includes information on a trial's goal and duration, its eligibility and exclusion criteria, and its locations.

↑ The ALS Geospatial Hub, built using ArcGIS Hub, brings data, stories, maps, organizations, and volunteers together.

conduct research not only to conquer the disease but also advance treatments that prolong and improve the lives of those living with ALS.

Location strongly affects participation in clinical trials because mobility and access are significant challenges for persons with ALS. Eligibility for participation in trials is often based on the time since onset of symptoms, so it is vital that trial information is current and readily available. The trial must be near enough to allow travel to the trial site.

"Location is everything for the chronically ill, and—amazingly enough—this information wasn't mapped," said Pat Dolan, an ALS advocate, GIS professional, former solutions team lead at Esri, and a person living with the disease.

The challenges Dolan personally experienced in obtaining treatment inspired him to apply his GIS expertise to the problem by building a web app that helps locate and rate nearby clinics. The app can be navigated using an eye-gaze device so it can be used by people with ALS as well as their caregivers.

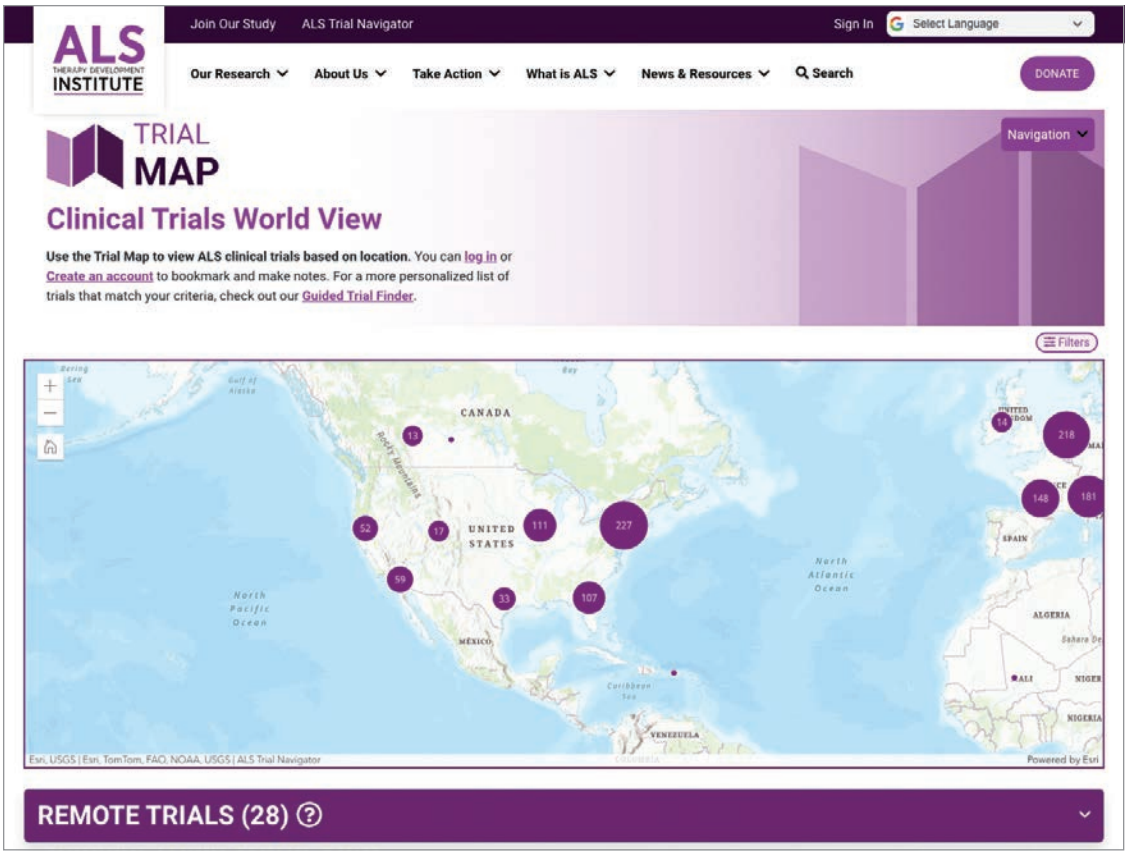
"By having this information, it helps patients like me have a sense of hope and gives us the opportunity to put an action plan together," Dolan said.

Dolan expanded his advocacy activities to urge members of Congress to support an updated version of the Accelerating Access to Critical Therapies for ALS Act (ACT for ALS). Collaborating with Amanda Stanko, senior solution engineer at Esri, he built a dashboard that monitored which lawmakers supported the bill and provided information on the number of veterans who lived in each congressional district. Some studies have suggested that military veterans are more than twice as likely to be diagnosed with ALS, according to the National Institute of Neurological Disorders and Stroke.

The team built a similar dashboard and app to enlist support from US senators. Their efforts were successful, and ACT for ALS was signed into law in 2021. This act requires the creation of a public-private partnership for rare neurodegenerative diseases that fosters research into drugs that improve or extend the lives of those living with ALS. That research is often conducted through clinical trials.

With legislation passed, Dolan turned to GIS-based efforts that would enhance its impact. He introduced developers at ALS TDI to Esri's developer tools. ALS TDI, a 501(c)(3) nonprofit, is the world's leading ALS drug discovery lab focused solely on ALS. Using Esri developer tools, ALS TDI built the ALS Trial Navigator to empower persons living with ALS and improve research results. It provides detailed information about trials that are located across the world, including each trial's goal and duration, eligibility and exclusion criteria, and locations.

The ALS Trial Navigator can be used in two modes: map-centric or guided. The Trial Map shows the location of trials and information about them. The Guided Trial Finder uses a questionnaire to identify treatment priorities, explain research terms, and locate ALS clinical trials that meet the



← The ALS Trial Map shows the location of current ALS trials all over the world.

needs of a potential participant and the requirements of a trial.

Dolan sees this approach to trials as a game changer. Trials are designed to test the safety and efficacy of specific drugs or therapies, so participants in those trials need to match the conditions the trial was designed to evaluate. The ALS Trial Navigator tool helps people living with ALS understand the available clinical trial options and make informed decisions about their participation.

> "LOCATION IS **EVERYTHING** FOR THE CHRONICALLY ILL..."
>
> **Pat Dolan**
> ALS advocate

"Finding the nearest trials doesn't do any good unless the trial is designed for your specific condition, genetic profile, and progression," said Dolan. "This is why many trials fail."

In addition to the ALS Trial Navigator tool, GIS continues to play a role in advocacy and research for people living with ALS. The ALS Geospatial Hub (links.esri.com/ALSHub), built using ArcGIS Hub, brings together data, stories, maps, organizations, and volunteers. Organized by geography, the site brings together data from federal agencies, research institutions, and nonprofit organizations.

The ALS Geospatial Hub is supported by a team of volunteers, known as The Mappers, who collect, analyze, map, and incorporate data into maps, apps, and ArcGIS StoryMaps. The Mappers are GIS professionals, ALS researchers, and ALS advocates.

There are numerous resources at the site. Apps for finding a clinic, adding clinic information, taking a survey, and viewing survey results are available. ArcGIS StoryMaps stories show patterns in access to care and the quality of care in the United States and around the world. A link to the National Amyotrophic Lateral Sclerosis (ALS) Registry lets persons with ALS provide information about their experience with the disease to aid research.

The ALS Geospatial Hub, like the ALS Trial Navigator, demonstrates how GIS is a powerful tool for improving treatment and research for the cure of ALS.

"The locations of clinics and trials are the first barrier to accessing care because patients are required to travel to the clinical trial site several times during it," said Dolan. "What took us months to do, the Navigator can do in minutes."

ABOUT THE AUTHOR

Monica Pratt is the founding and current editor of *ArcUser* magazine, the executive editor of *ArcNews* magazine, the editor of *Esri Globe,* and head of the Publications team at Esri. She has been writing on technology topics, specializing in GIS, for more than 28 years. Before joining Esri in 1997, she worked for newspapers and in the financial industry.

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Geospatial Awareness Lets USDA Comprehensively Evaluate Claims

By Nick Short and Charlie Magruder

When there's too much rain, or not enough, or another calamity strikes, US farmers and ranchers rely on insurance from the Federal Crop Insurance Corporation to provide a safety net. In 2023, crop insurance covered more than $207 billion in liability.

Although most farmers file claims for justified losses, occasionally fraudulent claims are filed. Investigators with the US Department of Agriculture's (USDA) Risk Management Agency (RMA) root out these schemes using modern crop monitoring. This integration of advanced technologies and data science techniques supports the investigative process.

The application of high-resolution aerial imagery to capture field conditions, machine learning algorithms to automate pattern detection, and GIS generates positive results. For example, RMA caught Colorado ranchers who tampered with rain gauges; Kentucky tobacco farmers who falsely reported hail damage; and a North Carolina farmer who produced crops, sold them under the names of other farmers, and claimed those crops were lost to natural disasters. Although it's only a small number of farmers and ranchers who look for ways to game the system, the financial savings of rejected claims adds up.

"We've been able to document a cost avoidance through our Spot Check List program that amounts to more than $1.75 billion over the past 20-plus years," said Jim Hipple, a physical scientist in the Business Analytics Division of USDA RMA. "Cost avoidance is even better than cost recovery because we haven't paid anything out,

so we don't have that added burden of trying to pull money back."

The work by Hipple and others at RMA also helps instill trust in the crop insurance system, which has an important role buffering farmers from major losses due to drought, excessive rain, hail, wind, frost, insects, and disease.

The Rise of Field-Level Awareness

"Crop insurance policies have gotten more specific about the field location," Hipple said. "That helped us better understand conditions on each farm."

The USDA Farm Service Agency, a sister agency to RMA, mapped the location of every field to the common land unit (CLU) level. *[A CLU is an individual contiguous farming parcel.]* To accomplish this, more than 2,500 field service centers across the country were equipped with GIS.

At the start of a growing season, farmers report their planting intentions through acreage reports. Field boundaries from these reports are compiled into a database. Over nearly a decade, more than 36 million CLU boundaries have been recorded along with the associated land ownership, soil, and crop type.

These digital records, which replace paper maps, can be easily updated and analyzed to visualize agricultural trends. They let investigators ask location questions related to claims and speed processing of insurance payments after disaster strikes. Having digital records at the CLU level was a big improvement in geospatial awareness, but it required more computational power.

A Data Science Partner

To handle big data processing at scale, the USDA works with the Center for Agribusiness Excellence at Tarleton State University in Texas. "We leverage the advanced analytics from the university effort to better understand the integrity of a policy, and to seek out waste, fraud, and abuse," Hipple said.

By adding tabular data to the map, crop insurance compliance investigators can spot patterns and irregularities that indicate potential insurance problems. The key, according to Troy Thorne, director of the Center for Agribusiness Excellence at Tarleton State University, is in identifying inefficiencies—places where the connection between the land and what it produces seems odd or unusual.

Thorne cited the practice of yield switching as an example. Crop insurance is based on a field's yield history. If a field has produced the same crop with the same farming practices for three years, insurers average the output to determine an approved yield history. That figure becomes the baseline for insurance claims.

To raise the baseline, a farmer might record the accurate overall yield total for all fields but move the numbers around to inflate one field's total, thus raising that field's yield history. When that field produces a normal yield the next year, it will appear to have underperformed, providing the basis for a potential insurance claim.

"Yield switching is a big deal," Thorne said. "You improve the outcome of your insurance claim without actually suffering the losses."

> "We leverage the advanced analytics from the university effort to better understand the integrity of a policy, and to seek out waste, fraud, and abuse."
>
> **Jim Hipple**

↓ The crop insurance system helps buffer farmers from major losses due to drought, excessive rain, hail, wind, frost, insects, and disease.

↑ US farmers and ranchers rely on insurance from the Federal Crop Insurance Corporation to provide a safety net when disaster strikes. This farm sustained crop losses from a hailstorm.

→ GIS helps the USDA Risk Management Agency investigators monitor conditions such as drought.

The ability to see all related data on a map rather than in a tabular format has helped analysts and investigators find incidents of yield switching and other anomalies.

"As a tabular perspective, it kind of gets lost in the detail," Thorne said. "But when you add the geospatial layer and drop these things on a map, you can look at historical yields, and see that the farmer's yields are constantly fluctuating."

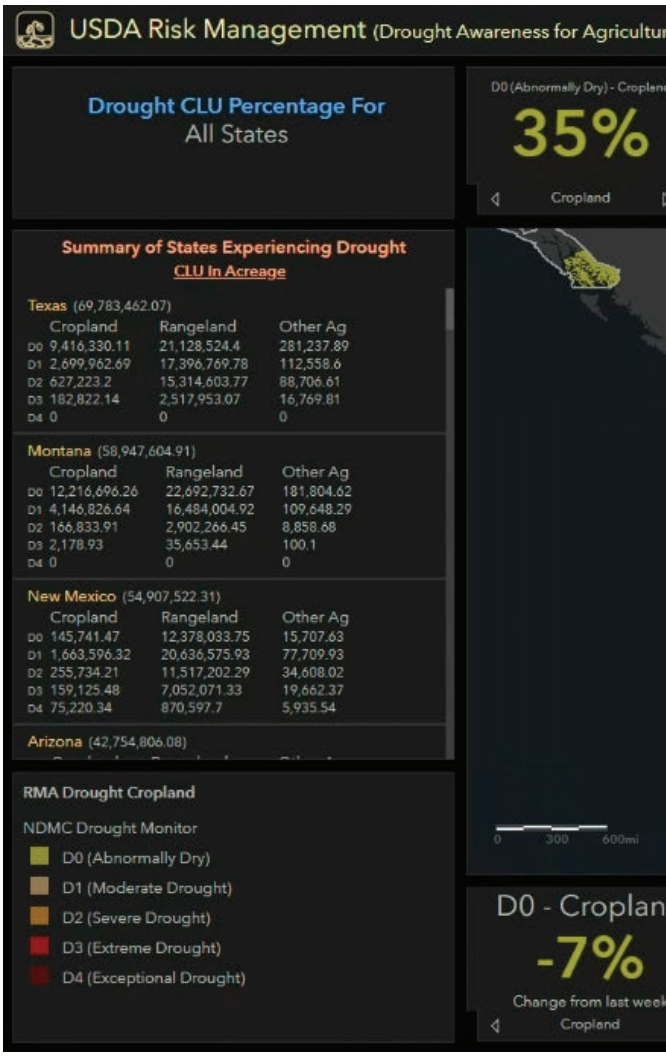
Empowering Analysts with Remarkable Results

The USDA RMA team of 90 compliance investigators can access GIS. Maps and data allow these investigators to dig into the forensics of farming—including planting time versus harvesting time, crop yields, and the impact of moisture.

The biggest leap, according to Thorne, has been in the nuance of their analyses. They can compare each claimant's farms to those in similar geographies and consider geographic features in assessing claims.

"Your nearest neighbor from a geospatial perspective might be two states away, because that's where the soil, slope, and climate match," Thorne said. "One inch of rain on a sloped field versus a flat field makes a big difference. All these itty bitty things that are geospatially related become very important when you're trying to estimate crop yields or validate crop loss claims."

> "When you add the geospatial layer and drop these things on a map, you can look at historical yields, and see that the farmer's yields are constantly fluctuating."
>
> **Troy Thorne**



About the Authors

Nick Short works across all agencies within USDA to help ensure that Esri's GIS technology delivers value to its mission areas. He has more than 30 years of experience in the IT industry in areas such as AI, business intelligence, advanced analytics, GIS, and data management. Prior to joining Esri, he held senior management positions at Gartner, SAP, SAS, and several Silicon Valley startups. Previously, he was at NASA Goddard for 10 years, where his work focused on remote sensing, high performance computing, and AI in the earth sciences.

Charlie Magruder is senior account executive on the agriculture team at Esri. He has worked at Esri for more than 25 years. He helps organizations adopt and implement spatial technology for their agriculture-based businesses.

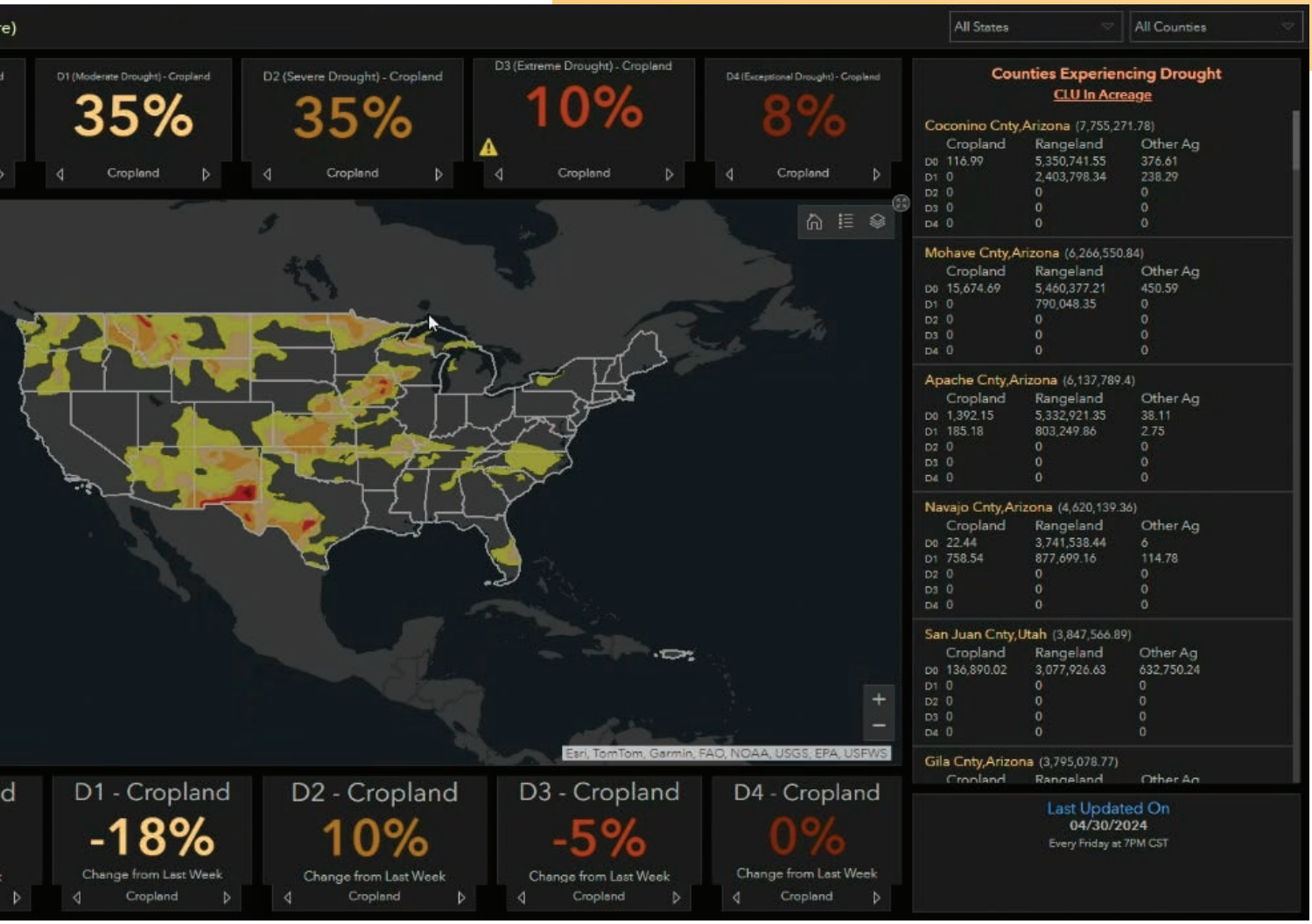
Climate Adaptation Strategy

The Tarleton Analytics Institute, part of the Center for Agribusiness Excellence at Tarleton State University in Texas, is one of two contractors RMA employs to examine crop insurance claims. Tarleton's expertise in data science has helped RMA save millions of dollars each year.

The center's director, Troy Thorne, has embraced GIS for its ability to "pinpoint areas on a map and examine different layers to not only understand our own results but to identify what's being impacted, why it's important, and to get the message across."

Tarleton has been helping migrate RMA's systems to the cloud to meet the federal government's cloud-first pledge. At RMA, cloud-based processing is listed as part of the agency's Climate Adaptation Plan to reduce the risk of disaster events damaging its systems. Distributed computing is just one adaptation strategy the agency employs to harden its infrastructure.

For farmers, Thorne sees a need for more data-driven decision-making. "Having geospatial and weather data at your fingertips will help farmers make better decisions," he said. "As we continue to see our farmland diminish, it's imperative that we help farmers address these challenges." USDA recently updated the federal crop insurance program to include conservation and climate-smart activities such as good farming practices. These practices promote the conservation of soil, water, air, animals, and energy resources.



FROM BIG DATA TO ACTIONABLE BUSINESS INSIGHT

Consumer movement data helps businesses understand their customers and more effectively deploy marketing strategies. Understanding how customers are attracted to locations such as hotels, restaurants, theaters, museums, shopping malls, and tourist attractions can improve segmentation and personalization strategies.

This data can include not only the types of visitors but also the frequency of visits, and overall movement patterns. Also, it is critical that this data is analyzed and reported on in a timely fashion to support decision-making.

JAKALA, a marketing technology company headquartered in Milan with offices worldwide, specializes in marketing and sales with a focus on artificial intelligence. By utilizing the power of location intelligence and the analysis of consumer movement data, JAKALA helps more than 900 clients in more than 30 countries unlock their potential by uncovering new opportunities, empowering decision-making, and enabling sustainable growth.

Gaining a comprehensive understanding of consumer movement demands a significant volume of data, and processing this data can be time-consuming. JAKALA needed a way to efficiently analyze large volumes of data so that the company could provide valuable and timely insights for its clients. JAKALA faced several challenges around scaling up its analytic workflows to deliver quality data and analytics on the timeline needed by its clients.

Data volume and analytic complexity present a challenge when performing big data analysis. JAKALA works with large-volume people movement data that the company sources from a vendor that amalgamates opt-in location tracking. The sourced data relies on more than 10 million devices, generating around 1 billion data points per day. For monthly analytics, this typically means 30–40 billion data points that need to be incorporated in the analyses.

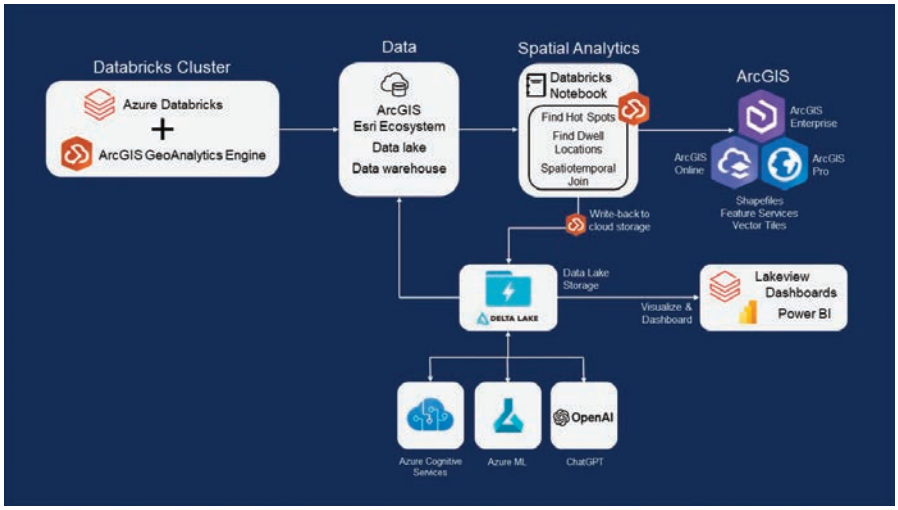
The size of the data made it so that many geospatial analysis tools could not handle the entire dataset at once. The JAKALA team had to subset the data into weekly segments to complete the workflow. While segmented data is useful in some instances, longer time periods of data need to be used for forecasting as well as achieving richer pattern analyses.

For big data projects, it is important to have systems that scale easily. JAKALA's large volume of data in the workflow could not all be analyzed in one place or with one tool. This led to the shuffling of data between different analytics tools and systems to combine the data and generate final products. Once one month's data was received, it would take almost another month to complete data cleaning and analysis, resulting in a significant lag between data collection and analysis delivery.

For this workflow, manual data compilation and analysis were time-consuming and inefficient, hindering JAKALA's ability to deliver timely insights to its clients. Shortening the time to delivering insights is critical to decision-making and requires processing large datasets quickly.

JAKALA needed a single environment that would facilitate working with large volumes of data and spatial and tabular inputs, as well as allow easy interoperability across all the company's data warehouses and analytics environments. To more efficiently provide customer insight for the company's clients, JAKALA used ArcGIS GeoAnalytics Engine in the Azure Databricks environment.

JAKALA is a Databricks partner and utilizes a comprehensive integration of Databricks' platform to leverage the scalability and performance provided by that platform. Databricks provides an Apache Spark-based cloud platform with a unified set of tools for building, managing, and working with data at scale. GeoAnalytics Engine can work with Databricks using Azure, Amazon Web Services (AWS), or the Google Cloud platform as part of an integrated spatial analytics environment connected with the Databricks lakehouse architecture.



↑ Architecture for an implementation of ArcGIS GeoAnalytics Engine in Azure Databricks Apache Spark-based cloud environment.

"Since our infrastructure is all on Azure, we can take our data stored there and easily combine it on Databricks with Esri's GeoAnalytics Engine. It's easier and more efficient to combine these environments instead of having to move the data somewhere else for analytics," said Stefano Angarano, manager of web development and mobile data analysis at JAKALA.

ArcGIS GeoAnalytics Engine provided the perfect solution with a Spark-native library of more than 160 spatial functions and tools that work seamlessly within a Databricks workflow. As a bonus, JAKALA is now able to save time and energy on maintenance because working with GeoAnalytics Engine in Databricks allows staff to focus on the analytics instead of managing the company's cloud or server infrastructure.

The integration of GeoAnalytics Engine with Azure Databricks substantially improved analytics processing time for JAKALA. In addition, GeoAnalytics Engine has streamlined the overall analysis process and improved automation, scalability, and maintenance efficiency.

"With GeoAnalytics Engine, we are able to receive all the data and perform the necessary analysis within a couple of days, whereas without it, it would take us weeks. This makes it much easier to provide our clients the data that they need, at the speed needed to make timely decisions," said Angarano.

The shortened analysis time speeds data delivery and enables JAKALA to complete analysis on much larger datasets. Staff members can now examine annual patterns instead of weekly or monthly patterns to facilitate longer-range analysis and forecasting. This helps staff members conduct more comprehensive and accurate analyses and provide valuable insights and forecasts to the company's clients based on a more detailed understanding of annual patterns and trends.

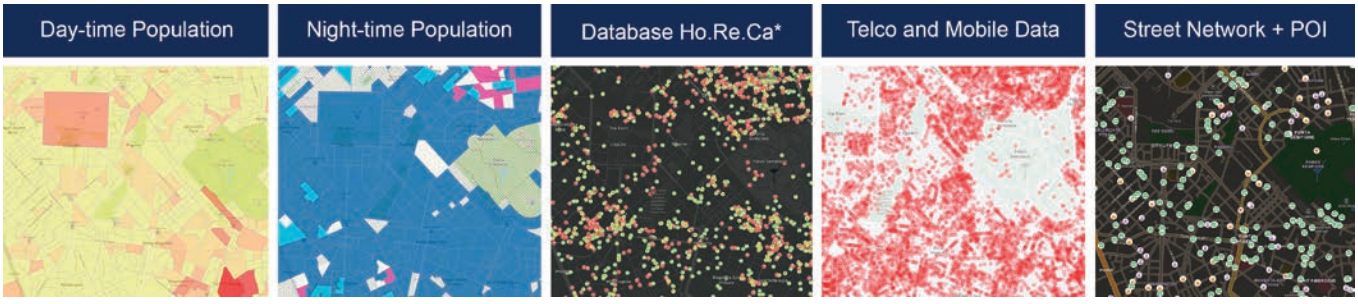
JAKALA also found that GeoAnalytics Engine helped streamline the overall process. Using GeoAnalytics Engine in the Databricks environment improved staff's ability to automate and scale analysis. They were able to analyze large volumes of data in a more efficient manner and could adjust the scale of resources based on the complexity of the analysis. Maintenance of the system was also simplified, as GeoAnalytics Engine is cloud based and requires minimal manual updates.

"Performing monthly data analysis is a recurring task for us, and each month we have a consistent set of operations to perform. Having an automated solution is crucial for us to streamline the analysis process and eliminate the need for manual analysis, ensuring efficiency and accuracy in our operations," said Angarano.

Using GeoAnalytics Engine to drive the analysis workflow has allowed JAKALA to offer new services to its customers, such as additional movement analysis and the ability to bring in larger amounts and longer time spans of data for improved context and forecasting. In the future, JAKALA will add new data sources, such as vehicle-generated data, to complement the data from personal devices it uses. Incorporating these new data sources will provide richer analyses about human movement and patterns.

"We are excited about the network analysis capabilities offered by GeoAnalytics Engine. The ability to leverage network-based service areas and closest facilities opens up new possibilities for us to incorporate additional metrics and enhance our analysis," said Angarano.

↓ JAKALA analyzes people movement data for daytime and nighttime populations; hotels, restaurants, and café businesses; telecommunications; mobile devices; street networks; and points of interest to better understand consumer behavior and drive informed decision-making for its clients.



Save a Stalled Strategy

By Matthew Lewin

Crafting a compelling and engaging geospatial strategy is no easy task. You can spend weeks identifying business needs, brainstorming GIS solutions, and designing the necessary processes and governance mechanisms. After launching the strategy with great excitement, it may still stall out weeks or even months later. Sadly, this can be a common issue for managers. In fact, I was asked about it just this week. So, what should you do when your strategy stalls? Drawing on insights from the work of Roger Martin, an influential global business thinker, and some recent guidance from the *Harvard Business Review*, I have a few suggestions.

Recognize and Diagnose the Stall

The first step in overcoming any roadblock is figuring out what's gone wrong. This requires examining both the design of your strategy and the conditions in which it operates. Often, strategies fail not because they are inherently flawed but because external conditions have changed, or internal capabilities are lacking or misaligned.

Leaders should ask probing questions: Have there been changes upstream that could impact your strategy? For instance, has there been an organizational restructuring or a new IT strategy that conflicts with critical components of your geospatial strategy? Have new business priorities emerged, necessitating a refocus on spatial data requirements or application functionality? Or is your team and organization unable to effectively execute the strategy due to lacking capabilities? A thorough and honest analysis is necessary to pinpoint the specific causes of the stall.

In one case, a city's GIS team lost its senior executive advocate for its geospatial strategy due to retirement. Accountability passed to another senior leader whose knowledge of and engagement with the strategy did not match the previous executive. As a result, projects and initiatives on the road map stalled, and budget allocation became more challenging as the strategy produced underwhelming results. Without a strong and influential advocate promoting the benefits of GIS and the geographic approach, it was unlikely that the strategy would achieve its vision.

To overcome this, we recommended that the GIS manager reengage and reeducate a group of senior leaders on the goals of the strategy and establish a level of "advocacy by committee." This would shift senior-level accountability and advocacy from one person to a few, thus relieving the pressure on the main advocate (who was feeling the burden of being the internal GIS evangelist despite being unfamiliar with the technology).

This approach worked for the most part. While it is difficult to replace a genuinely passionate and knowledgeable leader, the committee approach was sufficient to continue with critical projects and investments.

Another tactic for diagnosing the source of a stall is to examine the core components of your strategy and identify any potential issues. I have previously discussed the seven building blocks of a geospatial strategy. Review your key decisions regarding applications, data, technology, governance, delivery processes, workforce, and culture. It's possible that fundamental assumptions or strategic decisions in one building block conflict with others. For example, you might have proposed a web-based spatial open data hub without addressing data privacy and usage issues that prevent online publication. (Yes, this happens!) It is important to uncover these misalignments that will inevitably hinder progress.

Address Lingering Doubts

It's common for people to have doubts about your strategy from the beginning. There might be concerns about whether the strategy accounts for modern GIS technology trends or if it's flexible enough to adapt to industry changes. Leadership might question the realism of the forecasted return on investment (ROI). Doubts may also arise about the adequacy of resources—whether the team has the necessary skills to execute the strategy effectively. There may be confusion about team members' roles and responsibilities.

Unfortunately, many of these doubts are unspoken. That's why it's crucial that you create a safe environment for people to voice their concerns. Otherwise, inaction could stall progress. One suggestion is to conduct regular engagement surveys. If needed, make them anonymous and consider engaging a third party to compile the results to ensure honest feedback. Bring unspoken doubts to the surface and address them directly.

Engage Your Team

When a strategy hits a roadblock, it's an ideal time to connect with your team on a deeper level. Remember, the people

closest to you are the ones you depend on to bring the strategy to life. Engage them in diagnosing the problem and coming up with potential solutions. Their frontline insights can be incredibly valuable in understanding both the internal and external challenges that the strategy is facing. In addition, involving the team can help reignite their commitment to the strategic goals, thus improving execution capabilities.

Adapt and Iterate

One of Roger Martin's key tenets of strategy development is that strategy is a practice. It's something you do, not just something you say. It's not simply a document describing your intentions; it's an ongoing process of refinement and course correction in response to changing conditions or new information. The sooner you adjust the process, the better. Right from the start, ensure that you monitor progress regularly and don't be afraid to make corresponding corrections. Small, incremental changes can often lead to significant improvements in performance without the risks associated with large-scale strategic overhauls.

I understand that this advice may be coming late for some people. You may already be well into your geospatial strategy and have only recently realized you've hit a wall. For those in that situation, take note of the following advice.

Learn and Evolve

Every setback—including a stalled GIS strategy—is a valuable learning opportunity. Each setback provides a unique chance to gain deeper insights into geospatial technology, your organization, and your own leadership. By reflecting on what worked, what didn't, and why, you can gather important lessons that will inform future strategies. This commitment to continuous learning and improvement ensures that future efforts steer clear of the same organizational pitfalls, fostering a culture of optimism and forward-thinking.

When your strategy stalls, the path forward is not about discarding your plan at the first sign of trouble. Instead, it involves a thoughtful examination of your strategic assumptions, an adaptable approach to execution, and a commitment to continuous learning and engagement with your team. Don't give up! Refocus your efforts and keep going.

Let's Talk

Do you have stories from when a GIS strategy stalled, or an important initiative failed to deliver or lost momentum? Send me an email at geospatialedge@esri.ca or connect with me on LinkedIn. I'd like to hear about your experiences!

About the Author

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

Using Timestamp Offset for Analysis Across Time Zones

By Undral Batsukh

ArcGIS Maps SDK for JavaScript version 4.8 (JavaScript Maps SDK) introduced three new date-focused field types—date only, time only, and timestamp offset—to represent different levels of information when working with date and time values. The values stored in these fields adhere to ISO8601-compliant formats.

These new field types are supported on FeatureLayer and MapImageLayers, with plans to extend their support to other layers in future releases. The timestamp offset field type efficiently stores both date and time along with the corresponding time zone offset in the following format: YYYY-MM-DDTHH:MM:SS.sss+/-UTC offset.

Before the introduction of these fields, date and time values were stored as epoch values in the date field type. Epoch values represent a point in time as the number of seconds that have passed since January 1st, 1970, at 00:00:00 (the Unix epoch). For example, October 19, 2021, at midnight in UTC is represented as an epoch value as 1634630400. However, epoch values do not store time zone information, so all values stored in date fields are in the same time zone. This behavior makes it challenging to perform time-based analysis spanning multiple time zones.

This is where timestamp offset fields prove to be invaluable. They are particularly useful for mapping events that occur across various time zones. Practical applications for timestamp offset values are diverse and include data such as flight departures and arrivals, crime statistics, or whenever it is advantageous to persist the local time of an event in the data.

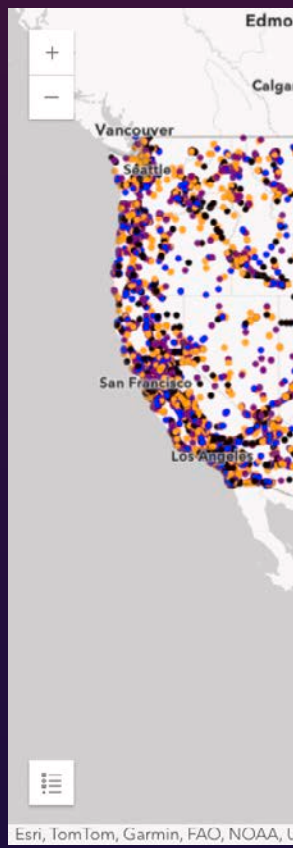
The Timestamp Offset in Action

This article explores the power of timestamp offset field values for visualization and analysis and demonstrates the advantages of using the new timestamp offset field.

Time Period	Hours
Night	12:01 AM to 6:00 AM
Morning	6:01 AM to 12:00 PM
Afternoon	12:01 PM to 6:00 PM
Evening	6:01 PM to 12:00 AM

↑ The four named time periods for this visualization

This sample application (links.esri.com/fatalcarapp) visualizes all 2021 fatal car accidents across time zones in the United States. The data is color coded by the time of day, that is, morning, afternoon, evening, and night. This data was obtained from the Fatality Analysis Reporting System (FARS) provided by the National Highway Traffic Safety Administration (links.esri.com/FARSdata). View the source code for this application at links.esri.com/carcrashappcode.



Visualizing Accidents by Time of Day

Let's examine how the unique value renderer is created for the accidents layer. It uses an ArcGIS Arcade expression to extract the local time—specifically the hour—that each car accident occurred.

The process of obtaining the local time from a timestamp offset field is relatively simple, as demonstrated in Listing 1 which uses an Arcade expression containing the hour function to extract the hour an incident occurred. For example, data captured at 8:00 AM in

Hawaii and data captured at 8:00 AM in New York would both be classified as morning because both were captured in the morning relative to their time zones. Had these incidents been stored in a traditional date field, each location's time zone would have to be inferred. For national or global datasets, this can be difficult or impossible.

Depicting the Distribution of Accidents on Charts

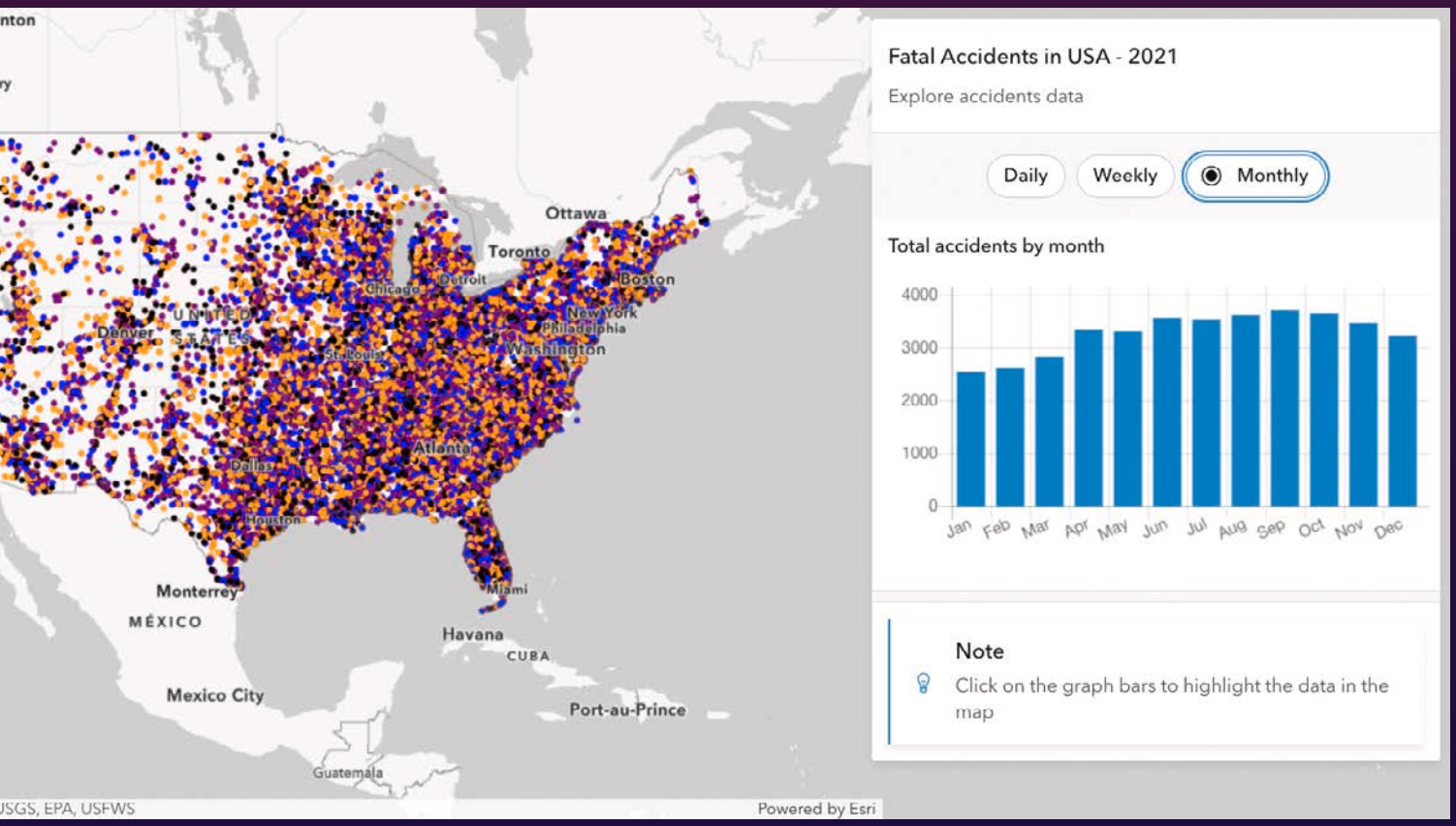
The charts displayed on the right side of the application offer a breakdown of the total number of accidents based on time of day, weekdays, and months. In the weekday chart, you can explore accident data by hours for the selected day of the week, while the monthly chart provides a breakdown of accidents by days within the chosen month. An analysis of accidents by hours on weekdays highlights the noticeable increase in accidents during late-night and early morning hours, particularly on weekends.

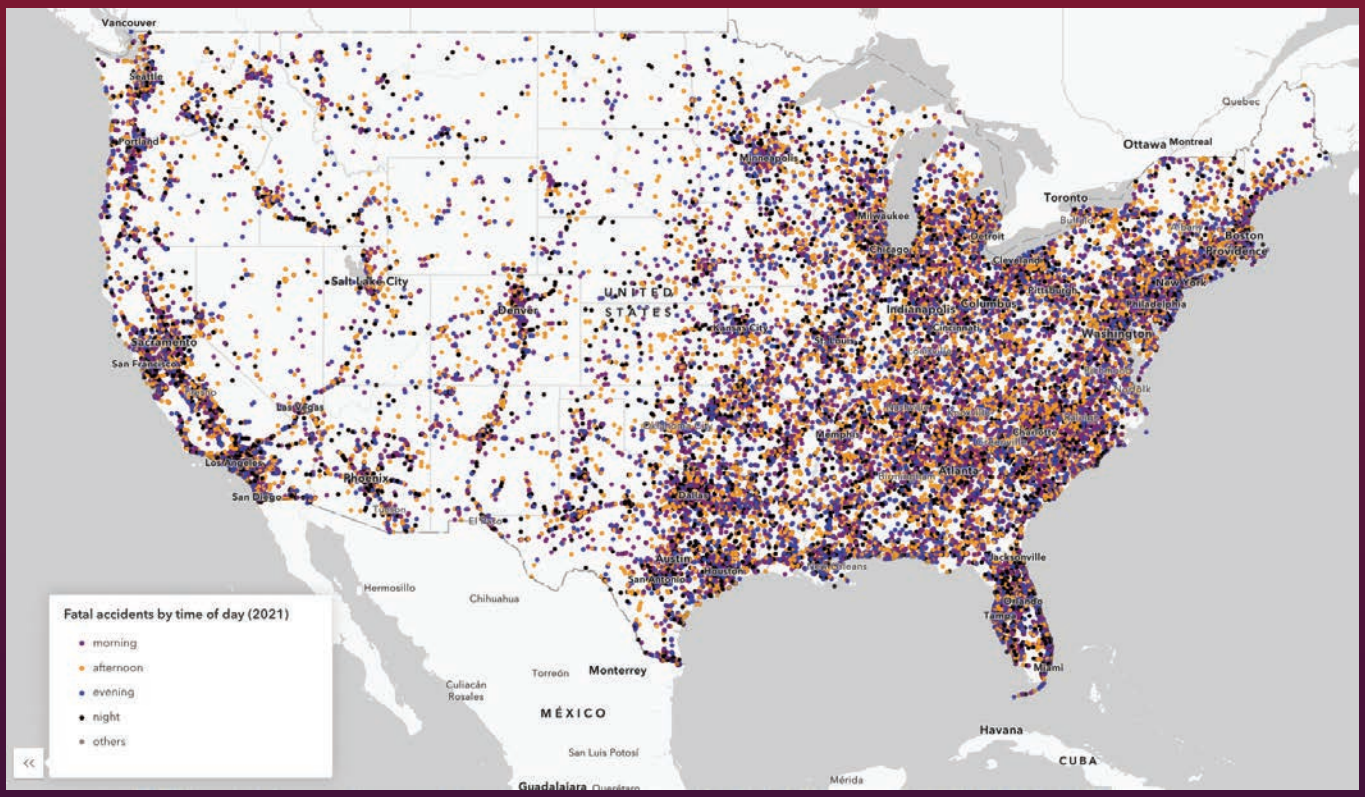
These charts are generated by querying the dataset to obtain accident counts. The query involves extracting information about the hour,

```
layer.renderer = {
   type: "unique-value",
   valueExpression: `
     var d = $feature.TSODate;
     var h = Hour(d);

     When(
       h <= 6, "night",
       h <= 12, "morning",
       h <= 18, "afternoon",
       "evening"
     );`,
   uniqueValueInfos: [
     {
       value: "morning",
       symbol: createSymbol("purple")
     },
     {
       value: "afternoon",
       symbol: createSymbol("orange")
     },
     {
       value: "evening",
       symbol: createSymbol("blue")
     },
     {
       value: "night",
       symbol: createSymbol("black")
     }
   ],
   defaultSymbol: createSymbol("gray")
};
```

← Listing 1

↓ Visualization of all fatal car accidents in 2021 across all time zones in the United States.





↑ Timestamp offset values are used to symbolize fatal car accidents categorized by morning, afternoon, evening, and night.

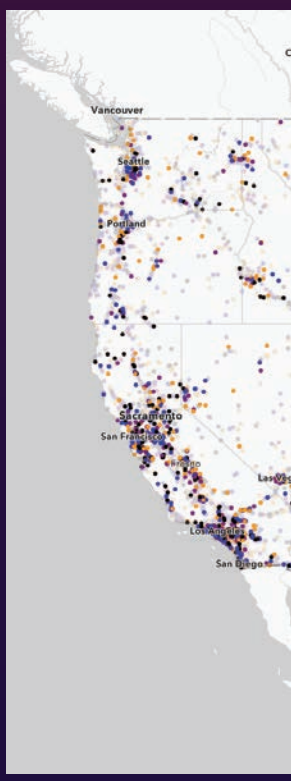
day, and month from the timestamp offset field available in the service. For example, the total accidents by time of day chart data is efficiently prepared using timestamp offset values. This approach enables seamless time-based analysis across multiple time zones. For example, data captured at 8:00 AM in Hawaii with data captured at 8:00 AM in New York can be compared because both were recorded in the morning relative to their respective time zones.

While it may have been possible to generate this information using a traditional date field, it would have required additional information, such as the state, to determine the localized time offset and ultimately the local time of each accident. This is complicated by the fact that some dates honor Daylight Saving Time while others do not. The code in Listing 2 demonstrates how the data for the total accidents by time of day chart is prepared. It involves querying the accident data, extracting the hours from the timestamp offset field values, and obtaining the total count of accidents grouped by the hours.

Aggregation Based on Timestamp Offset Field

In the example in Listing 2, a unique value renderer is assigned to the accidents layer to show what time of day accidents occurred. The visualization can be changed by aggregating the accidents based on time of the accident.

The application demonstrates how accident data can be presented as clustered pie charts. This demonstrates the benefit of using timestamp offset with data that spans multiple time zones. Chart size corresponds to the overall number of fatal car incidents and the size of each slice illustrates when during the day or night the accidents occurred.



The size of each pie can be varied based on data with any other field value or Arcade expression using visual variables. The total accidents by time of day chart automatically updates as the user zooms or pans the map. The chart updates dynamically by reprocessing in-memory data without requesting additional content from the server. This technique is called client-side query. View the app at https://codepen.io/U_B_U/pen/bGzEwae.

Summary

If you are working with temporal data spanning multiple

time zones, then timestamp offset may be advantageous for certain time-based queries and answering specific questions.

For example, what time of day has the most accidents across the US? This would require trans-time zone comparison. Storing event instances in timestamp offset fields allows for easy inter-time zone comparison and analysis. For another example, what are the best operating hours for a new coffee stop in Los Angeles? Analysis of national store transactions could provide the answer.

If a coffee chain wanted to know which store sold the most on Christmas day, aggregating data irrespective of time zone would show higher-level trends but would unfairly base statistics in a specific time zone. Instead, temporal aggregation uses the local time zone of each store and data aggregated by local hour, day, week, and month. This shows the advantage of timestamp offset over traditional storage as epoch values in the date field type.

About the Author

Undral Batsukh is a product engineer at Esri who works on ArcGIS Maps SDK for JavaScript.

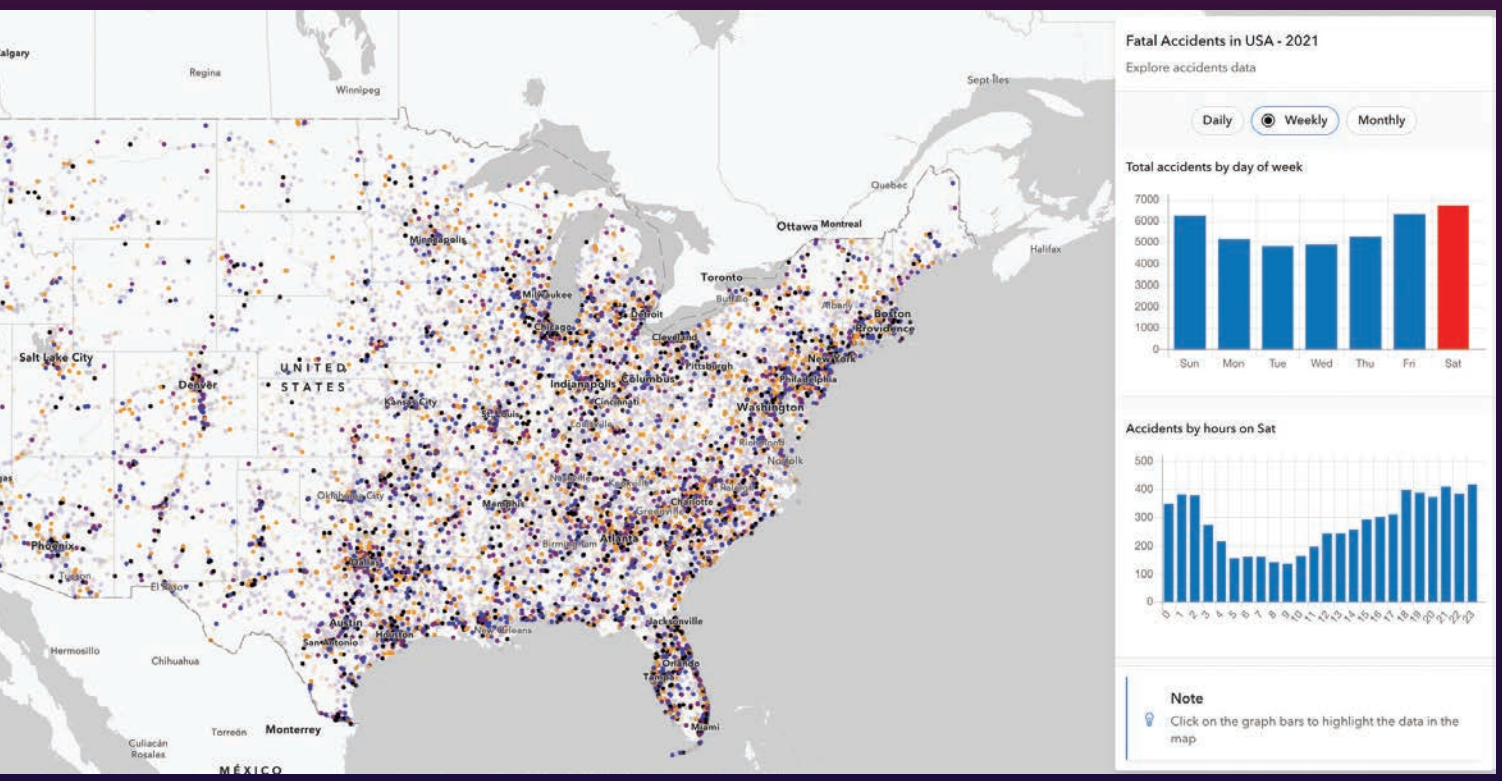
```
const query = layer.createQuery();
query.where = "1=1;
query.outStatistics = [
  {
    statisticType: "count",
    onStatisticField: "*",
    outStatisticFieldName: "count"
  }
];
query.groupByFieldsForStatistics = ["extract(hour from tsodate)];
query.orderByFields = ["extract(hour from tsodate)];
const hourResult = await layer.queryFeatures(query);

for (let feature of hourResult.features) {
  hourData.push(feature.attributes["count"]);
  hourLabels.push(feature.attributes["EXPR_1"]);
}
// create a bar chart showing total number of accidents by time of day
updateChart("chart-day", hourData, hourLabels, false, 3000);
```

Resources

- "Time Is on Your Side with New Field Types in ArcGIS Online" (links.esri.com/timefields).
- "8 ways to style point clusters on the web" (links.esri.com/8ways).
- "Turbo charge your web apps with client-side queries" (links.esri.com/clientqueries).

↑ Listing 2

↓ Charts offer a breakdown of the total number of accidents based on time of day, weekdays, and months.



Good Governance in Minnesota Starts with Geospatial Data

Minnesota has been making headlines recently for its data-driven policies impacting energy, employment, and education. Behind the scenes, a portfolio of GIS maps and dashboards support decision-making, communication, and collaboration while enabling the state to achieve important economic milestones and drive efficiency. In this interview, Alison Slaats, Minnesota's chief geospatial information officer, discusses the state's innovative approaches to visualizing and analyzing data with GIS, and making data more accessible.

Q: The Minnesota Executive Map Portfolio has attracted a lot of attention. What made these maps possible?

A: The state has done a good job of aggregating authoritative data together in a uniform way for bigger analysis across the landscape. The Minnesota geospatial community, over time, has worked together to build up a great data-sharing environment. These data serve the broader community, all levels of government, nonprofits, the private sector, and our Tribal nation partners.

> "Many questions that we face in Minnesota are similar everywhere. They have a geographic component. If you have solid geospatial data and GIS tools, you can really empower people to see the answer, with the goal of improving people's lives."
>
> **Alison Slaats**
> Chief Geospatial Information Officer
> for the State of Minnesota

GIS at the state started back in 1977. Since then, the state agencies have collaborated. Counties and local government have been responsible for a lot of the data creation and maintenance, like parcel data, addresses, road centerlines, and so on.

The Minnesota Geospatial Commons, our state data clearinghouse, provides access to anyone. We have 48 publishers—including state agencies, counties, and other groups—that have shared more than 1,000 resources. We're working to modernize the site to make datasets accessible through web services so they can be directly included in web or desktop applications for analysis, ensuring people have the most up-to-date data.

One of the things that has been very important to Minnesota is metadata *[data about the data, such as who created it and when, and at what scale and frequency of update]*. We even have our own metadata guidelines. I think it has really served us well because no matter what dataset you find on the Commons; it must have a good metadata record.

Q: How will advances in AI impact the work you're doing?

A: We know that AI is coming, and we know that natural language AI is going to incorporate geospatial data in the future. We know metadata is needed to do that well, so you can be assured that the answers come from authoritative data sources. The great tradition of having good metadata in Minnesota is setting us up well for the future of GIS and geospatial analysis to help us make better decisions. I'm excited to see how that plays out.

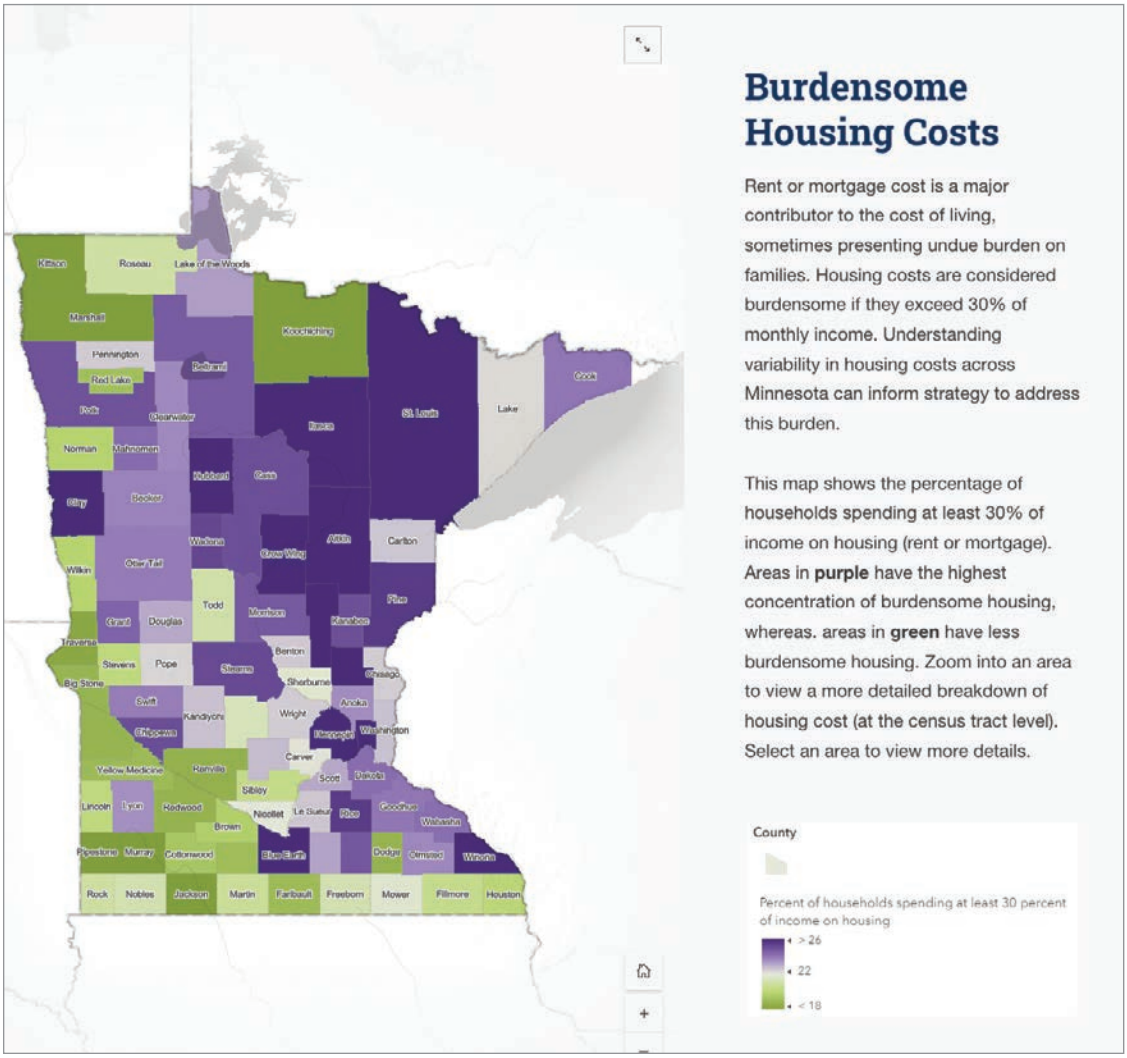
Q: How does GIS foster communication and collaboration around important policy decisions in Minnesota?

A: We're all seeing the same map…and we're able to understand the topic in the same way. I'm seeing that more and more with state agencies as we're considering things like social equity, access to resources, and how that relates to policy decisions.

One recent initiative is Minnesota's Broadband Equity, Access and Deployment program. The goal is to provide border-to-border high-speed internet access. We partner with the Department of Employment and Economic Development to create and use maps to identify areas in the state that are underserved. We can agree on where the gaps are, and then decisions can be made about mitigating that and providing funding to solve that problem.

Q: What are some other examples of Minnesota using data and technology to address important issues?

A: There has been a return on investment that is tangible. For example, we recently helped the Department of Transportation create an equity map for the suitability of active transportation—for pedestrians and cycling. And we worked with the Department



← This map showing areas with burdensome housing costs is part of a collection of maps curated to understand and combat current challenges facing children, youth, and families in Minnesota.

↑ Alison Slaats

of Revenue on hosting and updating their sales tax map so anyone can see where and why sales tax is different in different cities.

With COVID, we were one of a couple of states that used mapping to look at vulnerable populations so we could better deliver vaccines. That proved to be successful to get people vaccinated, which reduced the rate of transmission and lessened the incidence of severe illness in Minnesota.

With avian influenza, starting in 2015 when it first became an issue, I supported the Department of Agriculture and the Board of Animal Health. We were very active in that response, working with local and federal agencies. The first question was, "Where are the impacted farms?" If poultry needed to be moved, we had to understand the boundaries of the impacted farm. One of the neat things we did is to create a custom view of the data for the poultry industry to look at the same maps the state and federal agencies were looking at. We were all looking at the same map and understanding the issue together.

Q: What's one tactic that has made your leadership effective?

A: Throughout my career, I've been focused on creating great data and sharing great data. To share great data, you need to build relationships. You need to have relationships with the data producers, with the data users, and then, of course, have the tools to share data in ways that are useful for analysis, in both web-based apps and desktop analysis tools.

Q: How does Minnesota benefit from a statewide use of GIS through its Geographic Information Office (GIO)?

A: Our office supports all agency partners. That's one of the benefits of having a centralized GIO office within the state IT department. When there are available federal funds, such as for broadband, our agency partners work with us to accomplish their results. They receive funds and we help them fulfill their needs. It works well, because they are the subject matter experts, and we apply our technical skills to support their work.

I think agency work and the support of GIS experts and the GIO office come together, and honestly improve our daily lives in Minnesota. By making data available and processes more transparent, we are showing people that we're delivering good services and value to the people of Minnesota.

Q: Do you have a favorite map?

A: Someone recently asked us the question, "Where in Minnesota is 'up North.'" It comes up often in chat rooms and local media. It's funny for us because it's an imaginary map. It's your own mental map of what you value. For me, it's where I can start to smell the pine trees, hear the loons, and be by a lake.

I know it's a strange answer, but I think we can all relate. Maps help us understand the way we exist in our landscape, how we're part of a community, and part of our environment.

About the Author

Patricia Cummens is the director of government strategy and policy solutions at Esri where she provides guidance on state and national government initiatives and emerging policy issues. The digital divide has been an area of focus for her for some time. She works with executives including governor's offices, the White House, and US Congress. Previously, she was the GIS director for the New Jersey Department of Environmental Protection and a project manager for the State of Minnesota Land Management Information Center. Her skills bridge the gap between policy and technology, helping governments understand the value of geospatial data and GIS technology for efficient, smart government.

View the Minnesota Executive Map Portfolio at links.esri.com/MinnPortfolio.

This interview has been edited and condensed.

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A Personal Approach to Making Maps

By Andy Skinner

I have more than 50 years of experience as a cartographer, and a large part of that time has been spent designing and building complex reference maps. Over time, I've developed my own techniques for handling this work.

Thanks in part to my commercial background, I'm a reactive cartographer. I tend not to dream up new ideas myself. (I leave that to the innovative Esri cartographers around me, particularly my colleagues on the ArcGIS Living Atlas of the World team.) My background is in developing concepts based on the requirements of a customer and I'm skilled at it!

Defining the Concept

This may be the trickiest part of the whole process, particularly if you are developing a map for someone else. You need to be a good map designer, but you will also need to be a collaborator, a teacher, and a diplomat. Some people see cartography as just another design exercise and others see it as a form of alchemy. You need to be ready for both possibilities.

The customer could be a book or map publisher, website developer, or just a colleague—anyone who is coming to you for some help. If the product is part of a larger presentation, you will find that cartographers tend to be towards the bottom of the food chain. For example, a book will have an author, a publisher, and a designer, and all of them will have opinions about how the map works with their content.

Usually, I would try to identify the key player and ask them what they want to achieve with the map or maps. They may have a very clear idea of what this is, but frequently they are not too sure themselves! They may say "You're the cartographer—you tell me." It will require some discussion. Almost certainly it will require some tact and diplomacy. It may require two or three blind attempts that result in reactions, such as "Oh…that's not what I imagined at all," before you get them to provide clear direction.

If you have the time, try to come up with more than one approach and present them as alternatives. You have a better chance of getting inside your customer's head if you have something for them to look at. You don't need to develop the ideas fully, but you may find that your customer has problems seeing your efforts as a draft, so be careful.

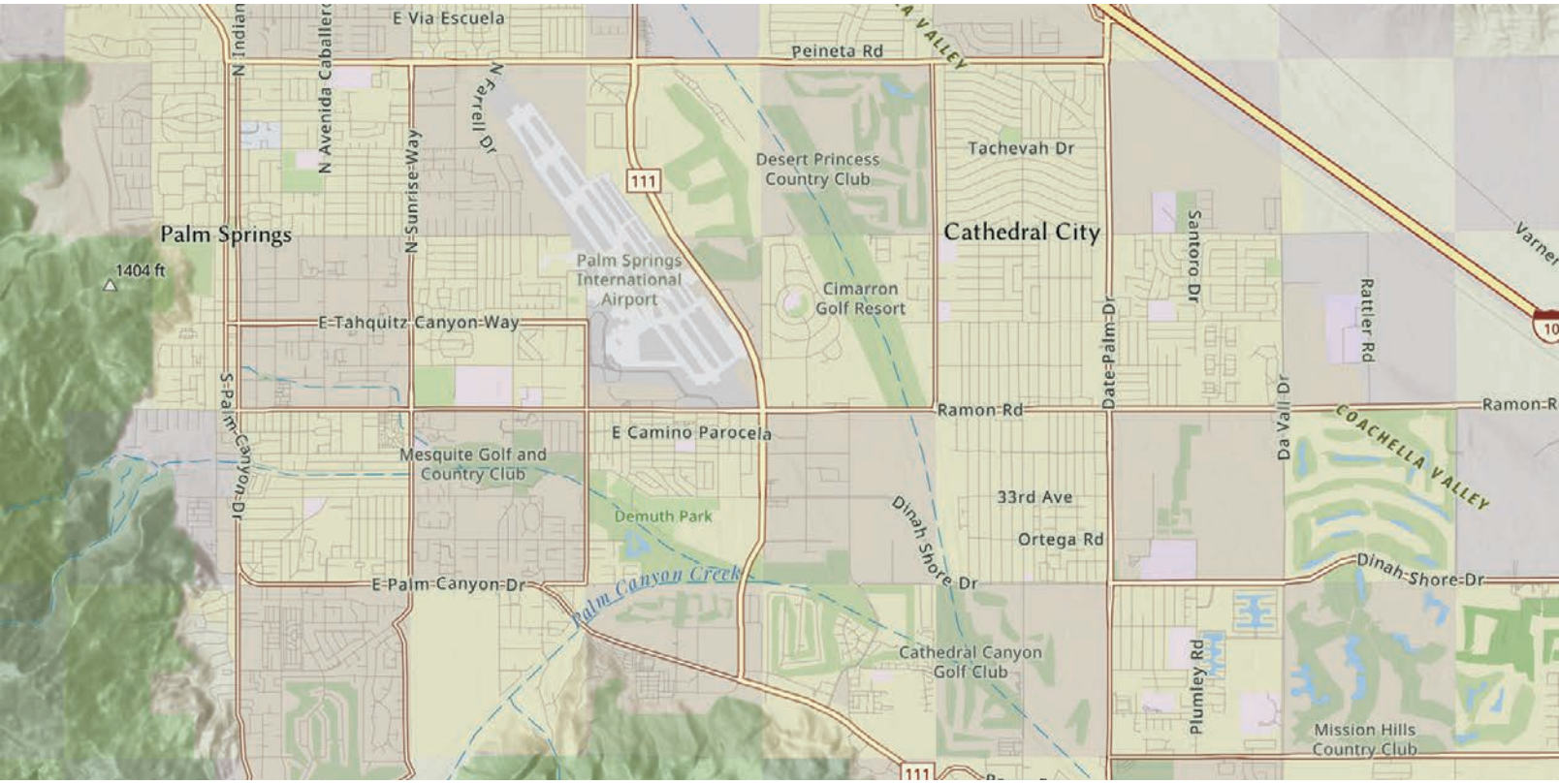
And try not to get too frustrated! Whether the customer is internal or external, they are looking to you to bring some clarity to *their* concept. Whatever *you* think about the agreed result, they will be proud of it. They may want to take credit for it as well! It happens, and you will need to develop a thick skin.

If your map is going to be part of a larger presentation (a book or magazine, or a

↓ An example of a typical Esri basemap visual hierarchy (left) as compared to the layer order for that map.

Hierarchy	Item	
Bottom	Open water	
	Land	
	Urban Area	
	Indigenous	
	Military	
	Generic forests and parks	
	National Parks	
	Land Use polygons	Large scale only
	Airport	
	Water Lines	
	Rail lines	
	Roads	Local
		Minor
		Major
		Highway

Hierarchy	Layer item	
Bottom (Draws first)	Land/Not Ice	
	Land/Ice	
	Urban Area	
	Openspace or forest	
	Military	
	Admin0 forest or park	National Parks etc
	Admin1 forest or park	State/Provincial parks etc
	Land Use 1	Zoo, Port, Transportation, Industry
	Indigenous	USA only
	Land Use 2	Golf Course, Retail, Education
	Airport	
	Land Use 3	Medical, Water and wastewater, Freight, Cemetery, Landmark, Finance, Government, Emergency, Pedestrian
	Park or Farming	



↑ A portion of the Esri National Geographic Style basemap for Palm Springs, California, displaying a complex pattern of polygons showing urban areas, an airport, courses, and Indigenous ownership. Layering this data requires careful consideration.

website), it's possible you will be working with a graphic designer who has the responsibility for the overall look of the product. There is the potential for some tension here.

The graphic designer will be focused on how the map fits into their work, and that is important. They may, justifiably, want to have a say in some of the components of the map (such as color palettes and font treatments). Our focus as cartographers is the successful depiction of the map's message, but we have a responsibility to do that in a way that fits comfortably in the map's surroundings. Be willing to follow the designer's guidelines but be ready to push back if you feel that the effectiveness of the map is compromised by their requirements.

How Many Maps?

Is this one map, designed by you, or is it one of a series? This has important implications.

If it is one map, then dive in! You are probably designing and building it, so you can go where you (or your customers) want.

If it is part of a series, you will need to establish a common style, which will probably involve standardizing map furniture (e.g., titles, frames, scales, pop-up styles) and font treatments. It may involve some common symbols within the map. Are your boundaries dashed lines with a tint band behind? Can you stick with dashed lines for the entire set without having it clash with other symbols? Do you need to make subsets of designs based on themes? If so, how do these themes hang together?

Who Is Doing the Work?

There may be more than one person working on the maps. If you are the cartographic designer, you will need to provide other people with a template and/or a list of common specifications and guidelines so that the whole set has a unified look and feel. Building specifications or templates can be tedious, but as a designer you will need to accept that as the less-fun part of a fun job.

If you are working to another cartographer's design, you will need to be objective. You may not like what you are building, or you may think you can improve on it. That may be true, but the designer has the responsibility for holding the whole set of maps together, so don't be a maverick.

Executing

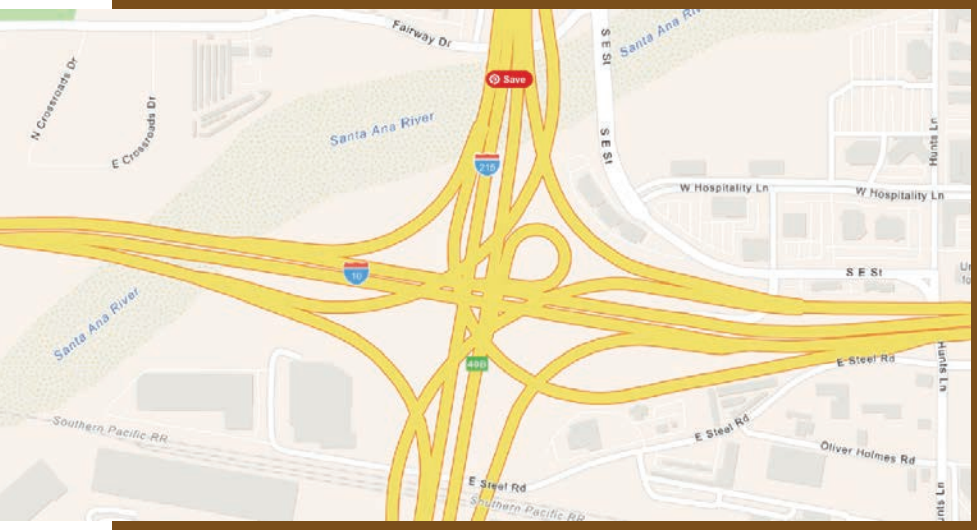
How do *I* go about starting a map design? I'm focusing here on the type of detail-rich reference map that I used to build, and the basemaps that I now build.

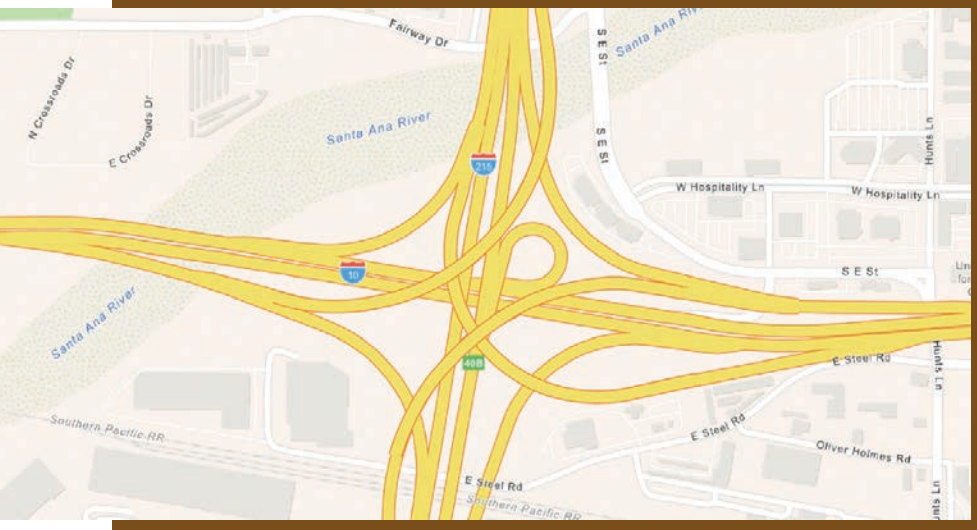
Establishing a Hierarchy

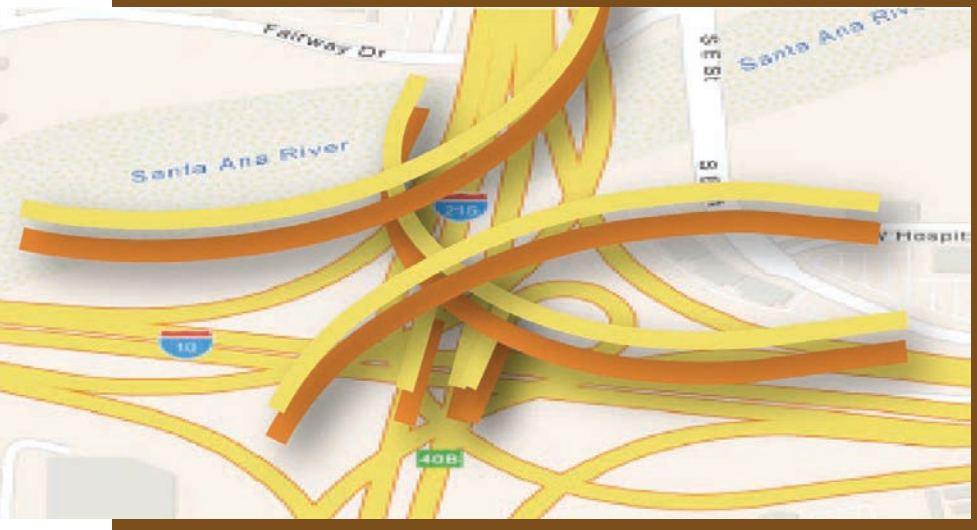
A visual hierarchy (as distinct from a layer order) is the key to making a map work. That is doubly true with a complex reference map. A starting point might be to build a quick and generalized list of what you think is that hierarchy. This depends to some extent on the map's subject. It may be a reference map, but it's going to focus on roads or boundaries or physical features *or* whatever you decide. (An admission: As I've become more experienced, I find I tend to just dive in, and work it out as I go. If you are starting out though, a bit of structure is not a bad thing.)

Printed or Static Maps

A static reference map is basically a huge puzzle. The first job is to decide how many pieces it has, so get everything in there!







↑↑↑ Flat road system for handling intersections and bridges.

↑↑ Layered method for handling intersections and bridges.

↑ Building this interchange correctly required new data and six new layers of information.

Start the design work by establishing that hierarchy with color and symbolization, then start moving symbols—particularly labels—around.

If you are in a GIS environment, a lot of the label placement can be done automatically using the labeling rules in ArcGIS Pro. It does a pretty good job if you take the time to set it up properly, and it's very possible that you will not have the time to do more than that.

If you do have the opportunity for some manual adjustment, don't ignore it. A skilled cartographer should be able to transform a GIS map from adequate to exceptional. The changes may be invisible to the user, but they sharpen up the map. A user may not know why the map is working better, but they'll know that it does.

Multiscale Online Maps

A multiscale map gives you the opportunity to develop the symbolization across more than 20 scales or zoom levels. It's the reverse of a static map. Rather than packing everything into one view, some details can be introduced at more appropriate scales.

The map appears empty when compared to the static version, but in fact it has far more information as you zoom in. That makes things easier to work with at each scale, but the transition between scales needs to be seamless. We spend a lot of time working on those transitions so that they happen in a way that doesn't draw attention. We're not always successful. Sometimes we are limited by the data available, but in most cases we cartographers do a pretty good job.

The Approach

If you have used Esri basemaps, you know they contain a massive amount of information, so this is a complex issue. I've always been interested in the concept of separating information by reversing some of it out. Esri does this to some extent with Canvas basemaps, which have reversed roads, but those are kept subdued so that they are part of a pale background. As a challenge, I wanted to build an online basemap/reference map that separates

boundaries and administrative data visually from the rest of the content without oversimplifying the map.

As a starting point, I look at the broad-brush items of the map, such as land, and set the agenda for the rest of the map information from there. I may change these items as the map progresses, but this gets the work off the ground. The reversed information would be a feature of the map. It required that the land color be in the mid-tones, between 30 to 60 percent, which is not something ordinarily done with a basemap. The goal is for the reversed features to be the background. My source was the Streets basemap, so I opened that into the Vector Tile Style Editor (www.arcgis.com/apps/vtseditor/en/#/styles), saved a copy, and made the adjustments to the land and water.

Working the Detail

Usually, I work from small scales in, adjusting the increasing content as I go. It's not a linear process though. I am constantly zooming out and back in as I come up against more items or symbols. It can be frustrating! Just as you feel the map is coming together, you will find something new that forces you to rethink the map.

Others prefer to work out from the largest scales, establishing the full range of symbolization available, then figuring out how to thin it out at smaller scales. Neither is the correct way. Do whatever you are most comfortable with.

One compromise is to find some key scales to set up, then transition between them. For example, Esri Basemap symbols tends to transition to large-scale data sources around Zoom 11, so it may be worth establishing a design at this scale, then working in both directions.

Nitpicking

With the basic concept established, the work really starts. Zooming in and out across the whole world, looking for combinations of features that don't work together, then tweaking them, then checking again. It's the least enjoyable part of the process, but also the most critical. This is where the product moves from being a concept (what an old manager of mine called a map-like object) to a fully functional map.

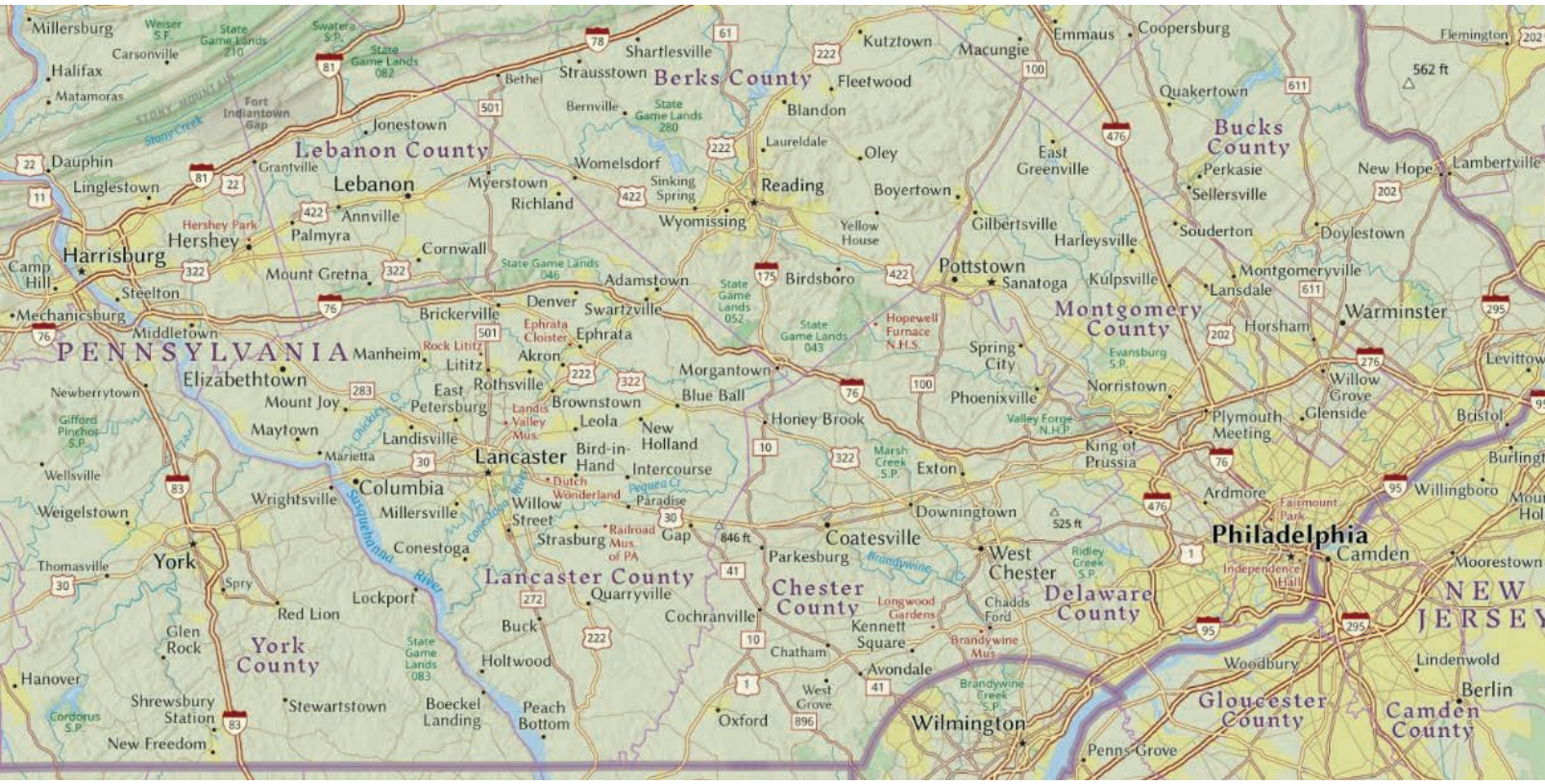
Review

Never trust your own judgment 100 percent! Once *I'm* happy with the map, I'll send it to a few trusted colleagues for review. It's almost guaranteed that they'll find something I've missed. While I'm waiting for the reviews there are some other tasks to do.

Layering the Map Online

Usually I'm working on a single-layer version of the map while I'm designing it. At this stage I decide if I want to use the sandwich option—separate out layers and/or other information into a reference layer. If I'm building a basemap, I'll bring in some sample map content to see how the whole concept hangs together. This may lead to a little bit of redesign around label haloes and the like.

↓ The Esri National Geographic Style basemap reconfigured as a static print map of southeastern Pennsylvania with additional information from larger scales.



a user will interact with first, so it needs to be filled out. Not just for a web map version, but for each of the component layers.

Letting Go

So, the reviews are back, you've made some adjustments, and you've finished the metadata—but there's just that one thing you noticed that you want to change. This is the dangerous stage of the project. You can spend days sitting on the map, trying to make it perfect. I'm not immune to that.

The most important skill you can learn is how to decide when the map is good enough. Let it go! There is other work waiting for you! Publish the map, then decide if you need to get the word out about it, and how.

In my print days, it was a literal letting go. Once a map has gone to press there's nothing more you can do about it. Partly for my own sanity, I learned to forget about a job after it was done, to the extent that I had very little interest in it when the published version came back.

↖ Reversed information is a feature of this map, which required that the land color be in the mid-tones (between 30 to 60 percent). This is not something ordinarily done with a basemap.

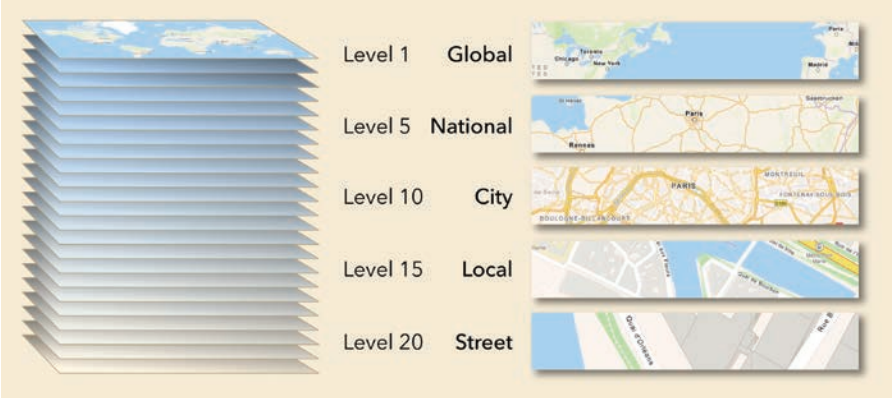
← The Esri Streets basemap shown in transition to the Mid-Tone basemap (left to right).

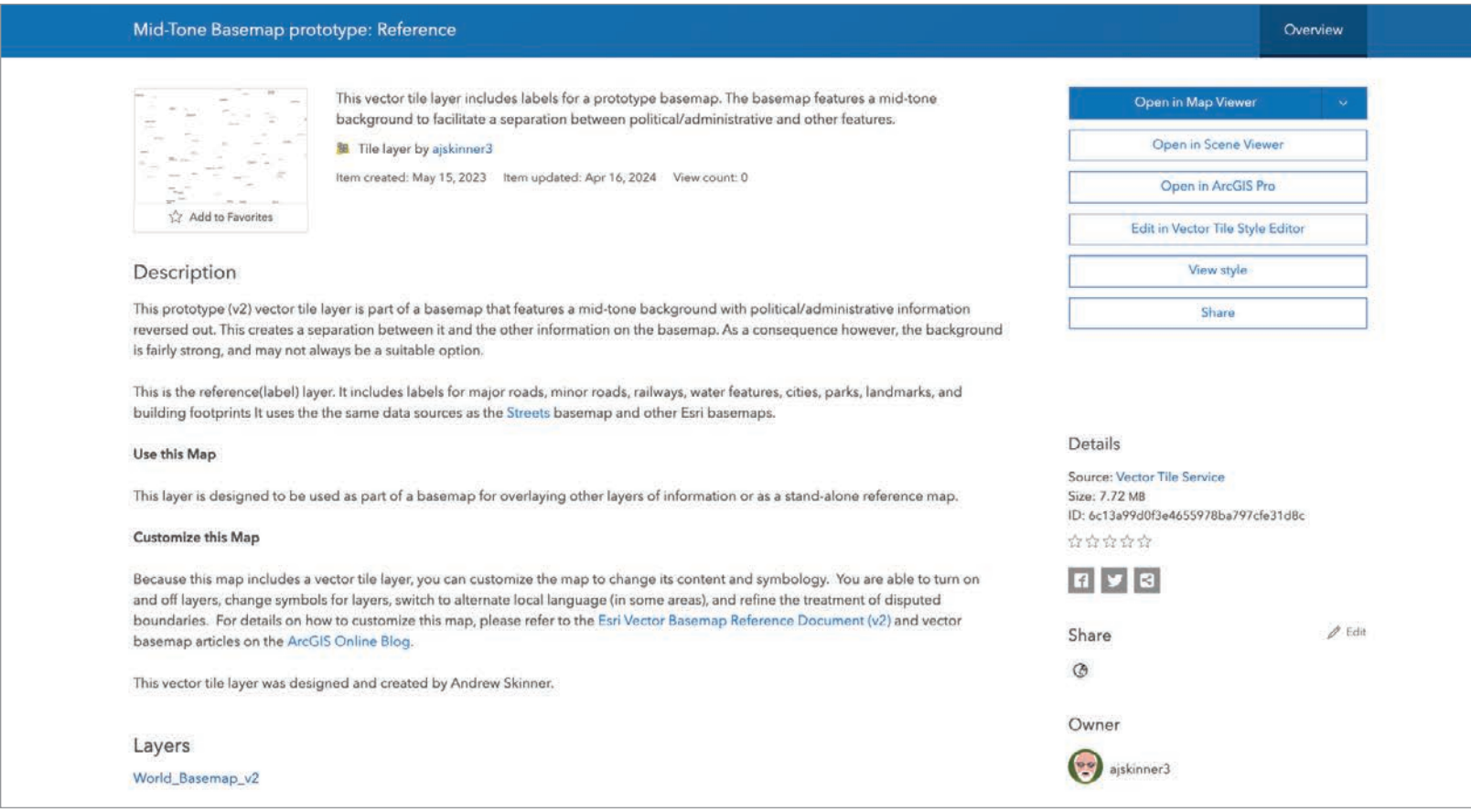
↓ With a multiscale map, you can develop symbolization across 20 or more scales or zoom levels. Details can be introduced at appropriate scales.

For my map, I decided to use a base layer, a label reference layer, and a separate reference layer with the boundaries that are the feature of the map. I needed to adjust the boundary lines so that they will work over any content. The best way to do that is to give the line light and dark components. In this case that is a light line with a dark casing.

The Details Page

This is tedious, but critical. It's likely that the information in the details page is what





That is not as true with online maps. You want the first release to be as presentable as possible, but it's easy enough to make revisions later. But that doesn't mean redesigning! Correct and improve, but the map is in use, and you don't want to make changes that affect the way it interacts with a customer's content. As for me, I've had to learn to reengage, so that I'm able to maintain my maps going forward.

Building Experience

As I stated at the start, this is my personal approach to planning. It's a model that you may want to try out but expect to develop it into something that suits your way of working.

If you are just starting out as a production cartographer, the chances are that you've come from a college environment where you were encouraged to innovate. You were given plenty of time to develop your ideas, and you may have been very successful at it.

Now, you are building maps for customers. That may be a paying customer or your manager or a colleague. While you still want to innovate, there is now a decision-maker who might have their own ideas of what the deliverable might be, and there is a cost involved. The treadmill aspect may be a bit daunting at first, but with time and experience you will learn how to hone-in quickly on those great ideas, turn them around on time, and do it to the satisfaction of you *and* your customer.

About the Author

Andy Skinner is a cartographic designer who has been building maps for 50 years. He has been working with Esri in Redlands for 14 years. Recently, he worked creating some of Esri's vector basemaps, and then developing color ramps for ArcGIS Online. Before coming to Esri, he was the manager of cartographic design at Rand McNally, and a senior cartographer at GeoSystems/MapQuest. Originally from England, he worked for several years at what is now the University of Derby before moving to the United States.

↑ Fill out the details page for the map's layers as well as the web map.

Successfully Migrating Parcel Fabric to ArcGIS Pro

By Jack Chen

Jack Chen is a GIS developer in the Geospatial Information Services (GIS) division of the Mecklenburg County Land Use and Environmental Services Agency in North Carolina. He was tasked with migrating the county's ArcMap parcel fabric from to ArcGIS Pro parcel fabric and performing data verification. This article, describing how he accomplished the migration, will be helpful to GIS managers in other counties who plan to migrate to a newer parcel fabric version. It will also benefit GIS administrators, analysts, and developers who might participate in the migration and are familiar with SQL.

Mecklenburg County, North Carolina, had been using the ArcMap parcel fabric since October 2019. In July 2023, the goal of migrating the county's parcel fabric from ArcMap to ArcGIS Pro was set. The migration was one of the first steps that would let the county take full advantage of ArcGIS Enterprise for different data-driven enterprise applications to support the county's business activities.

Just a year later, Mecklenburg County's parcel fabric had been migrated from ArcMap to ArcGIS Pro. Immediately following the migration, data verification was carried out via a SQL script to confirm that parcel fabric migration was successful. Migration allowed the county's GIS division to continue providing high-quality parcel data and facilitate the use of ArcGIS Pro and ArcGIS Enterprise.

Preparing for Parcel Fabric Migration

Before beginning the migration process, Chen studied online Esri documentation for the data models for both ArcMap and ArcGIS Pro parcel fabric. By September 2023, he had conducted several tests using the Upgrade ArcMap Parcel Fabric geoprocessing tool to upgrade a sample ArcMap parcel fabric to an ArcGIS Pro parcel fabric in a file geodatabase.

After completing two other GIS projects, Chen refocused his work on the parcel fabric migration from March to June 2024. On June 6, 2024, both the county's testing and production ArcGIS Enterprise implementations were up and running. These included all the ArcGIS Enterprise components including Portal for ArcGIS, ArcGIS Server, and ArcGIS Data Store.

To complement both the testing and production in ArcGIS Enterprise, he worked with a database administrator from the county's IT department to create a testing enterprise geodatabase and a production enterprise geodatabase on two different remote SQL Server database servers. Chen refined his workflow using ArcGIS Enterprise and a testing enterprise geodatabase.

```
SELECT OBJECTID FROM aq.MC_ParcelFabric_Parcels
WHERE Type = 7  -- 402,336 ArcMap Tax.
INTERSECT
SELECT OriginalFeatureOID FROM lr.Tax;  --
402,154 ArcGIS Pro Tax.
-- 402,154
```

```
SELECT OBJECTID, Name, StatedArea, Shape.STArea()
Area, Shape.STLength() Length
FROM aq.MC_ParcelFabric_Parcels
WHERE OBJECTID IN (
  SELECT OBJECTID FROM aq.MC_ParcelFabric_Parcels
WHERE Type = 7  -- 402,336 ArcMap Tax.
  EXCEPT  -- 182.
  SELECT OriginalFeatureOID FROM lr.Tax  -- 402,154
ArcGIS Pro Tax.
);
```

↑↑ Listing 1

↑ Listing 2

Emma Rosenthal from Esri also provided technical support for this process.

Processing the parcel fabric locally fully utilized Chen's powerful workstation computer. It took eight hours to complete the workflow. In the final step of this workflow, he copied the ArcGIS Pro parcel fabric from a file geodatabase on his workstation to the testing enterprise geodatabase on the remote SQL Server.

Preparing for Data Verification

When Chen was preparing for the migration, he was asked how to determine if the parcel fabric migration was successful. To verify migration success, he needed to answer three questions:

- How many plans, points, lines, and parcels were migrated from the ArcMap parcel fabric to the ArcGIS Pro parcel fabric?
- If all elements did not migrate, which ones did not migrate and why?
- Did the plans, points, lines, and parcels that were migrated keep their original geometry and attribute values?

While ArcGIS Pro might be used to manually compare plans and records, points, lines, and polygons before and after migration, that approach is not practical when checking millions of features.

While the Spatially Enabled DataFrame in ArcGIS API for Python could be used to verify data, Chen believed that SQL was a more efficient way to verify not only the number of objects migrated, but also their geometry and attributes. First, he illustrated the relationships among tables. Then, he copied both the ArcMap and ArcGIS Pro parcel fabric from an experimental test of parcel fabric migration conducted in June 2024. He put the ArcMap parcel fabric into a database schema called aq, and the ArcGIS Pro parcel fabric to another database schema called lr. Both database schemas were located in the same testing enterprise geodatabase in the remote SQL Server.

With both the ArcMap and ArcGIS Pro parcel fabric in the same testing enterprise geodatabase, Chen wrote SQL statements to compare the plans, points, lines, and polygons in ArcMap parcel fabric to their counterparts in ArcGIS Pro parcel fabric. Running SQL statements enabled him to perform data analysis and validate the success of the migration.

It took two weeks for Chen to complete the SQL script. After answering specific questions about the migration with this table, he expected that the parcel fabric migration would be successful.

Chen's scripts validated the parcel migration. Running three different portions of the SQL statements shown in Listing 1 in Microsoft SQL Server Management Studio returned:

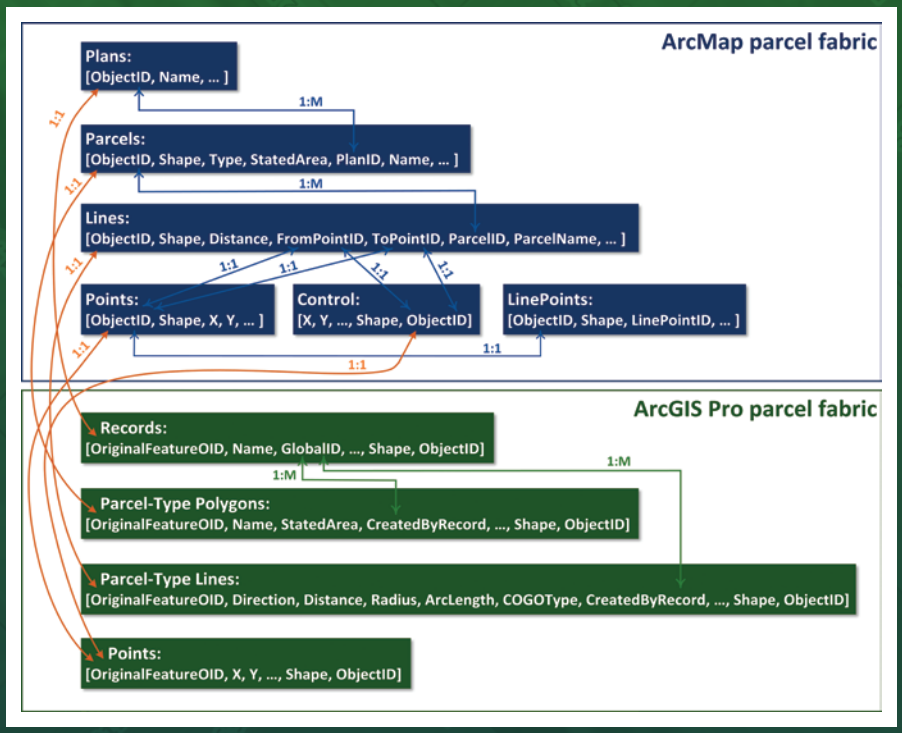
- 402,336 parcels (the number of tax parcels in ArcMap parcel fabric)
- 402,154 parcels (the number of tax parcels in ArcGIS Pro parcel fabric)
- 402,154 parcels (the number of tax parcels migrated)

The difference between the number of ArcMap and ArcGIS Pro parcels was 182. Why didn't these parcels migrate? He ran the SQL statement shown in Listing 2 and found that all 182 tax parcel polygons had zero area and perimeter length so that they did not migrate.

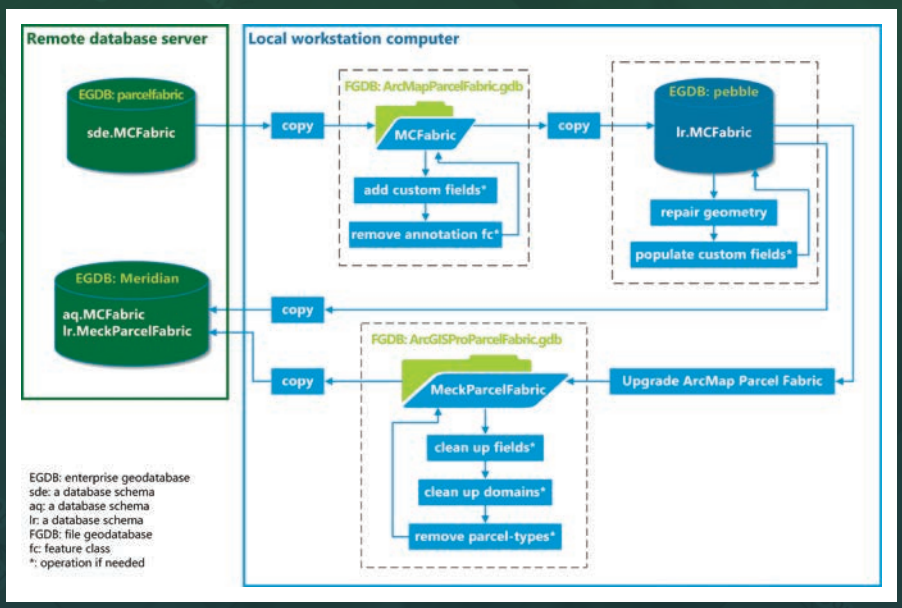
```
SELECT COUNT(*)
FROM aq.MC_ParcelFabric_Parcels AS map
INNER JOIN
(
  SELECT Shape.STAsText() geom, OriginalFeatureOID,
Name, OriginalStatedArea,
       Accuracy, LegalStartDate, LegalEndDate,
created_user, last_edited_user,
       last_edited_date, Parcel_X, Parcel_Y,
PARCEL_TYPE, CONDO_TOWN_FLAG, Unclosed
  FROM lr.Conveyance_Division  --  57,643 ArcGIS
Pro conveyance division.
  UNION
  SELECT Shape.STAsText() geom, OriginalFeatureOID,
Name, OriginalStatedArea,
       Accuracy, LegalStartDate, LegalEndDate,
created_user, last_edited_user,
       last_edited_date, Parcel_X, Parcel_Y,
PARCEL_TYPE, CONDO_TOWN_FLAG, Unclosed
  FROM lr.Tax                  -- 402,154 ArcGIS
Pro tax.
  UNION
  SELECT Shape.STAsText() geom, OriginalFeatureOID,
Name, OriginalStatedArea,
       Accuracy, LegalStartDate, LegalEndDate,
created_user, last_edited_user,
       last_edited_date, Parcel_X, Parcel_Y,
PARCEL_TYPE, CONDO_TOWN_FLAG, Unclosed
  FROM lr.Encumbrance          --    3,785 ArcGIS
Pro encumbrance.
) AS pro                       -- 463,582 ArcGIS
Pro parcels.
  ON pro.OriginalFeatureOID = map.ObjectID
WHERE Type IN (9, 6, 7)        -- 463,832 ArcMap
parcels.
  AND (map.Shape.STAsText() <> pro.geom OR
       map.Name <> pro.Name OR map.StatedArea <>
pro.OriginalStatedArea OR
       map.Accuracy <> pro.Accuracy OR
map.LegalStartDate <> pro.LegalStartDate OR
       map.LegalEndDate <> pro.LegalEndDate OR
map.CreatedBy <> pro.created_user OR
       map.ModifiedBy <> pro.last_edited_user OR
map.ModifyDate <> pro.last_edited_date OR
       map.Parcel_X <> pro.PARCEL_X OR map.Parcel_Y
<> pro.PARCEL_Y OR
       map.PARCEL_TYPE <> pro.PARCEL_TYPE OR
map.CONDO_TOWN_FLAG <> pro.CONDO_TOWN_FLAG OR
       map.Unclosed <> pro.Unclosed);
-- 0.
```

↑ Listing 3

Next, Chen ran the SQL statement in Listing 3 to find out if—after migration—all parcel polygons kept their original geometry and attribute values. No parcels were returned, which showed him that after migration the parcel polygons' original geometry and attribute values were preserved.



← Chen illustrated the relationships among tables when preparing for the migration.



↑ After thoroughly testing the parcel fabric migration and data verification workflow in the testing environment, Chen used the same workflow to complete the county's parcel fabric migration in the production environment in a single day.

Implementation

After thoroughly testing the parcel fabric migration and data verification workflow in the testing environment, Chen used the same workflow to complete the county's parcel fabric migration in the production environment in a single day, July 27, 2024. The production environment consisted of the production ArcGIS Enterprise and the production enterprise geodatabase. The next day, Chen ran his SQL script and summarized the data verification in a table that proved that the county's parcel fabric migration was a success.

Editing ArcGIS Pro Parcel Fabric Data in ArcGIS Enterprise

During his experiments in the testing environment in early June 2024, Chen created a map for staff in the county's Land Records Agency to use when editing parcel fabric data in ArcGIS Pro. He first published the ArcGIS Pro parcel fabric in the testing enterprise geodatabase as a web feature layer. Then he worked with the land records staff to design the map with the web feature layer and other supplementary layers.

Chen wrote an ArcGIS Arcade script to create attribute rules for the critical fields in ArcGIS Pro parcel fabric feature classes. He also modified an Arcade script provided by Esri to intelligently label the length values of parcel-type line features in the ArcGIS Pro parcel fabric's web feature layer. He intended to let the land records staff use the map to get familiar with ArcGIS Pro and its record-driven editing style as early as possible.

Meanwhile, the county's GIS department had the land records staff take Esri training classes on ArcGIS Pro and the parcel fabric. This training would help them avoid a transition shock when they began editing the parcel fabric in ArcGIS Pro in the production environment.

After successfully migrating the parcel fabric, Chen published the ArcGIS Pro parcel fabric in the production enterprise geodata¬base as a web feature layer to the production ArcGIS Enterprise portal. Then, he copied the map which he previously created for the testing environment, changed the data source of ArcGIS Pro parcel fabric's web feature layer from the testing ArcGIS Enterprise portal to the production ArcGIS Enterprise portal. Finally, he gave the updated map to the land records staff. This ensured a seamless transition from ArcMap to ArcGIS Pro. They were instantly using ArcGIS Pro and the map to edit ArcGIS Pro parcel fabric in the production environment, beginning on July 28, 2024.

Support for Parcel Migration Efforts

It took Chen five months to complete the parcel migration. To help others still using the ArcMap parcel fabric migrate to the ArcGIS

ArcMap parcel fabric								ArcGIS Pro parcel fabric	
Objects	Input	Subtract						Output	Objects
		Zero Area	Zero Length	Null X	Standalone CenterPoint	To Connection	Multipart Parcel Connector		
Plans table: MC_ParcelFabric_Plans	12,845							12,845	Records polygon feature class: ParcelFabric_Records
Parcel polygon feature class: MC_ParcelFabric_Parcels									Parcel-type polygon feature class:
Type = 6 (lots and units)	57,709	66						57,643	Conveyance_Division
Type = 7 (tax parcels)	402,336	182						402,154	Tax
Type = 9 (encumbrance)	3,787	2						3,785	Encumbrance
Parcel line feature class: MC_ParcelFabric_Lines									Parcel-type line feature class:
Parcel Type = 6	561,806		124,991			27,839	1,974	407,002	Conveyance_Division_Lines
Parcel Type = 7	3,498,891		799,073			35,617	9,339	2,654,842	Tax_Lines
Parcel Type = 9	149,741		65,782			68	126	83,765	Encumbrance_Lines
Parcel Type not in (6,7,9)						12		63,536	ParcelFabric_Connections
Parcel point feature class: MC_ParcelFabric_Points	1,698,289		335,366		190			1,362,733	Point feature class: ParcelFabric_Points AdjustmentConstraint = 1
Parcel control point feature class: MC_ParcelFabric_Control	1,337							1,337	AdjustmentConstraint = 2
Parcel line point feature class: MC_ParcelFabric_LinePoints #									

← Chen ran his SQL script and summarized the data verification in a table that proved that the county's parcel fabric migration was a success.

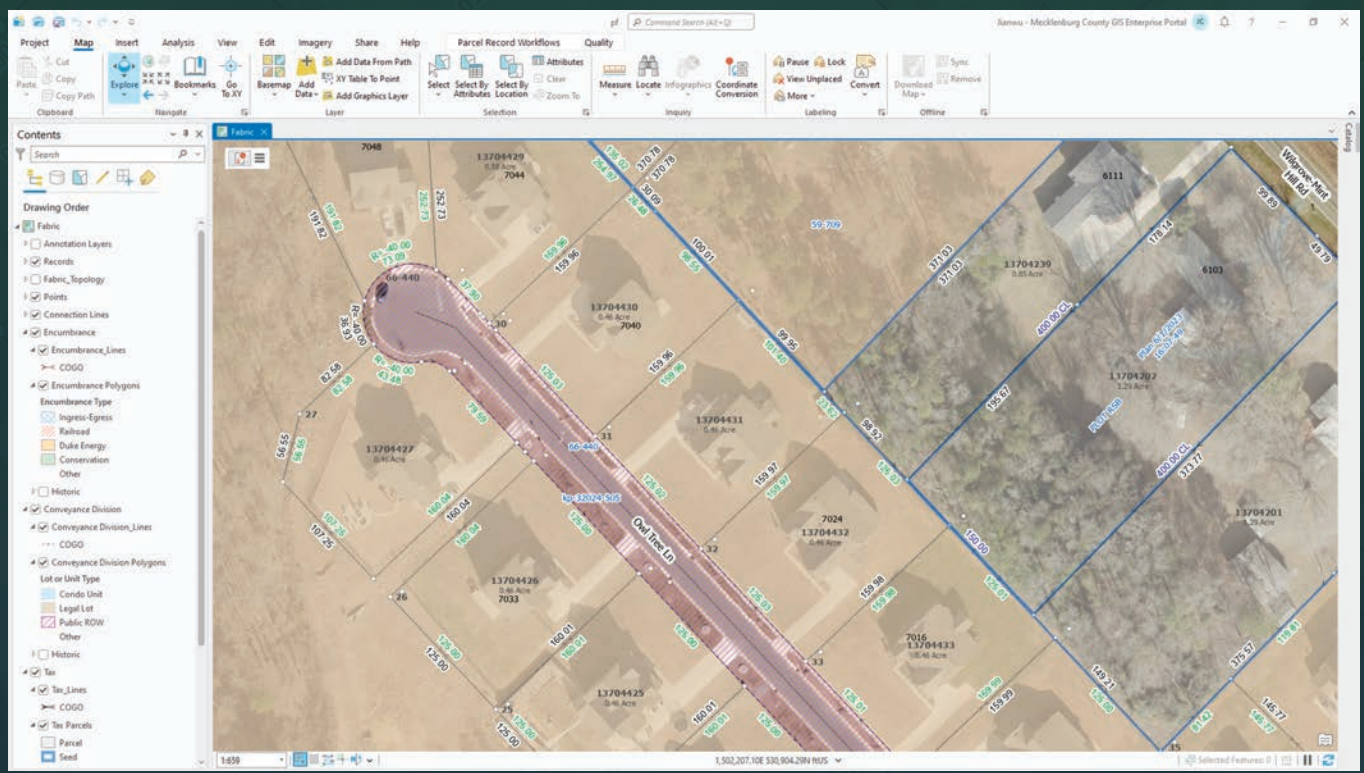
↓ Chen created a map for staff in the county's Land Records Agency to use when editing parcel fabric data in ArcGIS Pro.

Pro parcel fabric, he detailed his parcel fabric migration process in a Microsoft Word document and made ArcMap and ArcGIS Pro parcel fabric data in two file geodatabases, and his SQL script in two text files available at https://tinyurl.com/mrxhuma3.

The folder contains a ReadMe.txt file describing how to use the data and SQL script. His SQL script worked for an enterprise geodatabase in SQL Server 2016 or newer version. With minimal modification in SQL spatial data type methods that would entail changing from Shape.STArea() for SQL Server to ST_Area(shape) for PostgreSQL with PostGIS and Oracle, his SQL script should work for an enterprise geodatabase in PostgreSQL with PostGIS or Oracle.

About the Author

A GIS developer in the GIS division of the Mecklenburg County Land Use and Environmental Services Agency in North Carolina, **Jack Chen** has worked in the GIS field for city, county, and state governments for 20 years. He started as a GIS technician and has held positions as a GIS analyst, a GIS administrator, and an applications developer, before moving to his current position. Chen is passionate about using ArcGIS technology with SQL, Python, and other programming languages to develop GIS-related applications for business activities. In 2006, he obtained a master of science degree from the geography department at the University of South Carolina, Columbia. For more information, contact him at jack.chen@mecklenburgcountync.gov.



Design Service Areas with ArcGIS

By Diana Lavery

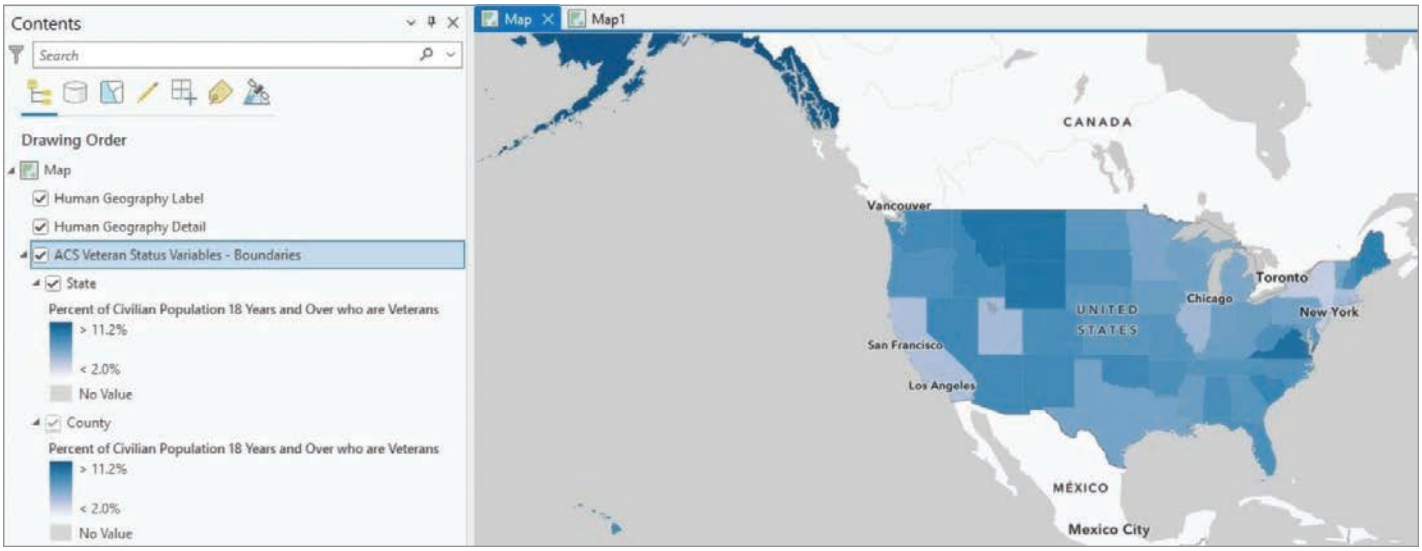
Defining boundaries is a popular use case for GIS.

These boundaries go by many names: service areas, sales territories, attendance areas, caseloads, wards, legislative districts. This article will walk you through a simple workflow designing areas in the state of Virginia to serve the veteran population. To follow along, start a new project and a blank map in ArcGIS Pro.

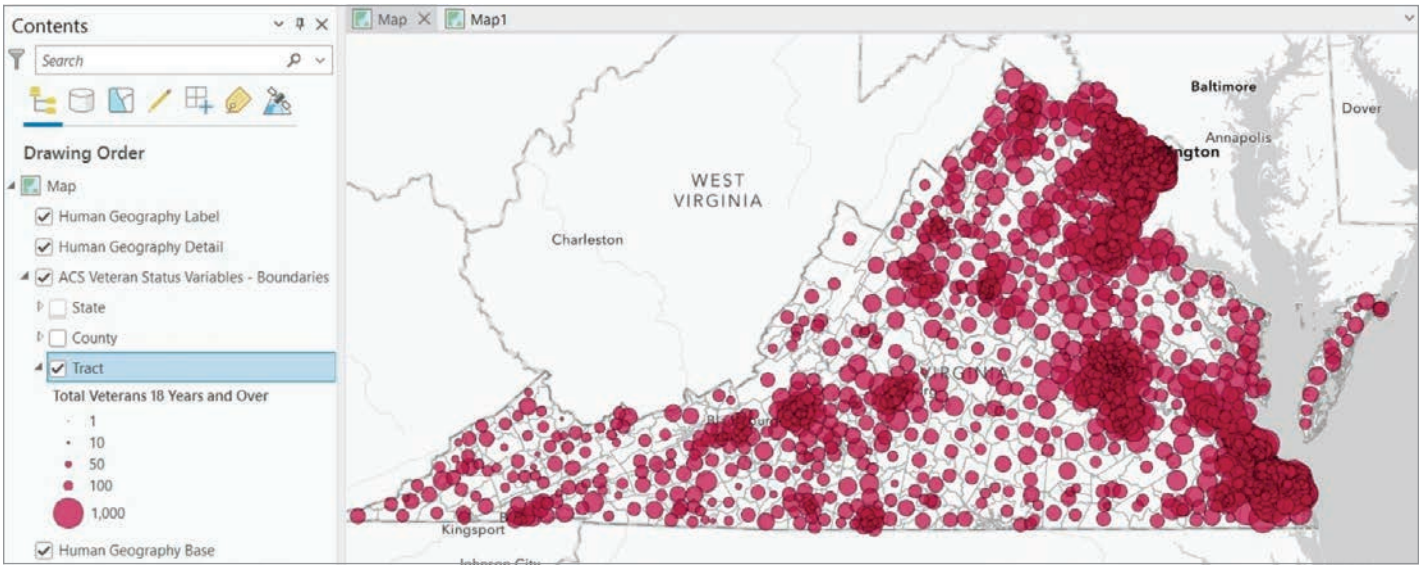
1 Add Layers from ArcGIS Living Atlas of the World

First, you need some baseline data about where veterans live. The US Census Bureau does an excellent job maintaining data about this important topic. Fortunately, ArcGIS Living Atlas has many preconfigured layers containing data from the US Census Bureau to get you started. You'll add one of these layers to your map.

From the Map tab, click the top half of the Add Data button to bring up a dialogue window. In the window that appears, under Portal, click Living Atlas, and type "veterans" into the search bar. Click the first item in the search results, the layer named ACS Veteran Status Variables–Boundaries (www.arcgis.com/home/item.html?id=891153ed7a4c4e978b2ca63ad7fb2435) to add it to your map.



↓ Use the Human Geography and Light Gray Canvas basemap, which will more clearly show the percent of the population that served in the US military. Notice that the state of Virginia has a large percentage of veterans.



2 Explore the Spatial Data

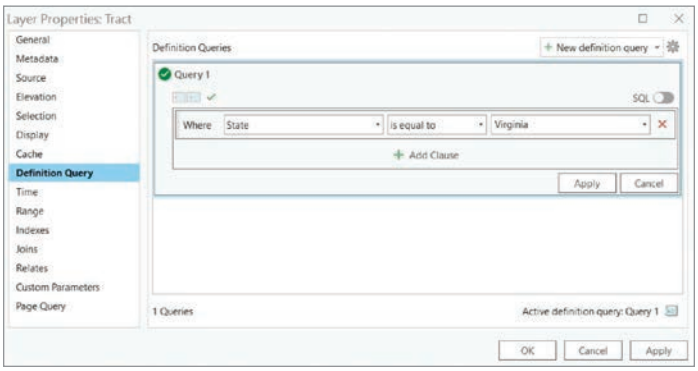
This is a multiscale layer containing data for three levels of geography: state, county, and census tract. It has visible scale ranges set so that appropriate geography levels are shown and hidden as users zoom in and out. Zoom out to see data at the state level. Then zoom in to see data at the county level. Zoom in further to see the data at the tract level.

This layer is also symbolized to show the percent of the adult population with veteran status. Darker blue areas have a higher percentage of adults who have formerly served in the US military. Notice that the state of Virginia is one of the darker blue states, indicating a large percentage of veterans.

On the Map ribbon, switch the basemap to Human Geography or Light Gray Canvas. These neutral basemaps help to make your map easier to read, since they don't compete visually with your thematic data. The Human Geography basemap also places city/state labels on top.

↑ The map now only shows tracts for Virginia. In the Contents pane, the legend shows that each symbol can represent between 1 and 1,000 veterans.

↙ Filter all US census tracts to show just those in the state of Virginia by using the definition query "Where State is equal to Virginia".



3 Use a Definition Query to Show Only Virginia Tracts

Zoom to display Virginia in your map. To design your service areas, you will want to start with the most granular level of geography. In this case, the finest level of geography is tracts. Turn off the State and County layers by unchecking them in the Contents pane. Now filter all the tracts in the US to show only those in the state of Virginia. In the Contents pane, right-click Tract and click Properties. Add a definition query that reads "Where State is equal to Virginia."

Before closing the Layer Properties window, click the General tab and choose the Show layer at all scales option. This will always show tracts no matter the zoom level. The map now only shows tracts for Virginia.

4 Symbolize by Count Rather Than Percent

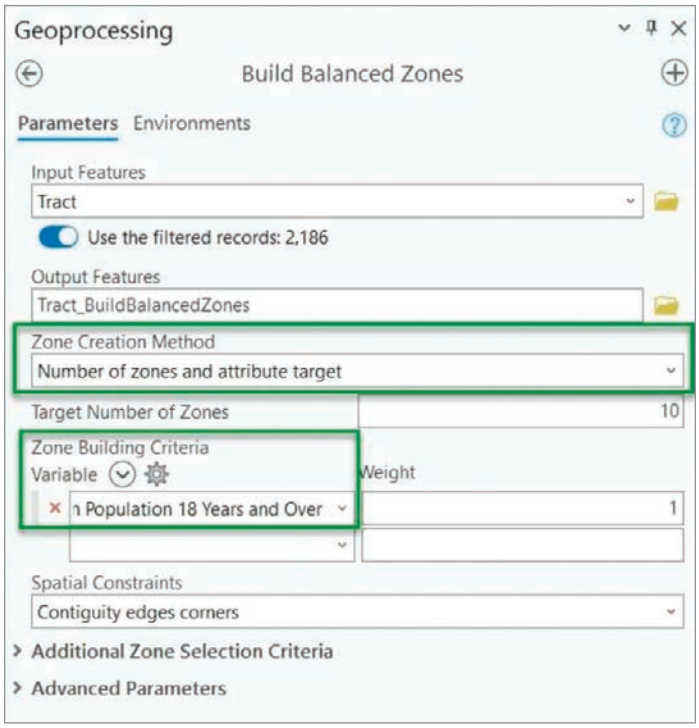
To design service areas, you will work with the count of individual veterans. By default, the layer is symbolized by the percent, but you can modify this. Right-click on the Tract layer in the Contents pane and click Symbology. The Symbology pane appears. It shows that the layer is currently symbolized with the Unclassed Colors method and a percentage field. The unclassed colors symbology method is a great way to display percentages and rates, but not so great for showing counts. Change the Primary symbology to Proportional Symbols. This type of symbology uses size rather than color, which is more intuitive for depicting differences in counts.

Change the field to symbolize to Total Veterans 18 Years and Over. The symbols on the map are currently too large and crowded. You will adjust the symbology settings to get a clearer visualization. The goal is to see where veteran counts are high and low. Change the minimum size to 1 pt and see the symbols get smaller.

Next to Template, right-click the circle symbol and click Color Properties. In the Color Editor window, increase the transparency to 30 percent. Changing the transparency helps reveal overlapping symbols that represent where data values are large. This visualization shows large groups of veterans around Norfolk and Arlington.

In the Contents pane, the legend shows that each symbol represents between 1 and 1,000 veterans. In the Symbology pane, the histogram shows that the minimum value is 3. This means that there's a tract somewhere in Virginia with only three veterans. On the other side of the distribution, the maximum value is 1,642, so there's also a tract with 1,642 veterans. Note: This layer is updated every year, so exact counts may vary.

Now that you understand how Virginia's veteran population is distributed across space, you can use two geoprocessing tools in this workflow—Build Balanced Zones and Dissolve—to perform analysis.



5 Set Parameters and Run the Build Balanced Zones Tool

From the Analysis ribbon, click Tools. This will open the Geoprocessing pane. Search for and open the Build Balanced Zones tool. Set the Input Features to the Tract layer. Make sure that Use the filtered records: 2,186 is toggled on so that the tool runs on tracts in Virginia, rather than all tracts in the entire US.

Point to Zone Creation Method and click the i button that appears next to it. Read the detailed information about this parameter in the window that appears. Here's where you input whether you want an attribute target (e.g., as balanced as possible for a specific attribute), or a defined number of zones (e.g., 10 zones and only 10 zones), or both. The defined number of zones option is helpful when you have a fixed number of resources, such as regional directors, campuses, or field offices. For this exercise, change the drop-down option to Number of zones and attribute target. For Target Number of Zones, type in 10.

The Zone Building Criteria is where you'll tell the tool which attribute(s) you want it to consider. In the drop-down under Variable, select Total Veterans 18 Years and Over. The tool will now generate zones that are balanced with respect to the sum of veterans from all the tracts. The result should be 10 zones containing roughly equal numbers of veterans. Click Run. This operation should take a few minutes.

↗ The Zone Building Criteria tells the tool which attribute(s) to consider. In the drop-down under Variable, select Total Veterans 18 Years and Over to generate zones that are balanced with respect to the sum of veterans from all the tracts.

→ In this example, 10 zones are generated. The sum of veterans in each zone ranges from 508,630 to 771,260.

6 Examine Output

This tool will complete with warnings. Click View Details. These details are the messages that you would get in a log file if you were running this programmatically. The main message is that some zones are disconnected groups and not contiguous. That is okay. Virginia contains some island and peninsula areas. You will have output that you can evaluate.

Note: It's possible you could get 10 zones that look a little different than the output shown. It's also possible that it could complete with a warning and results containing 9 or 11 zones.

Let's look at the output. A layer and two charts were added to the map. Turn off the Tract layer so that the Tract_BuildBalancedZones layer can be seen more clearly. Open the first chart whose title starts with Sum of Variable.

Because this tool is run using a random seed, the results will be slightly different each time. In the example illustrated, there are 10 zones, and the sum of veterans ranges from 508,630 in Zone 9 to 771,260 in Zone 3. The number of tracts in each is listed in the Contents pane. For example, Zone 2 contains 200 tracts.

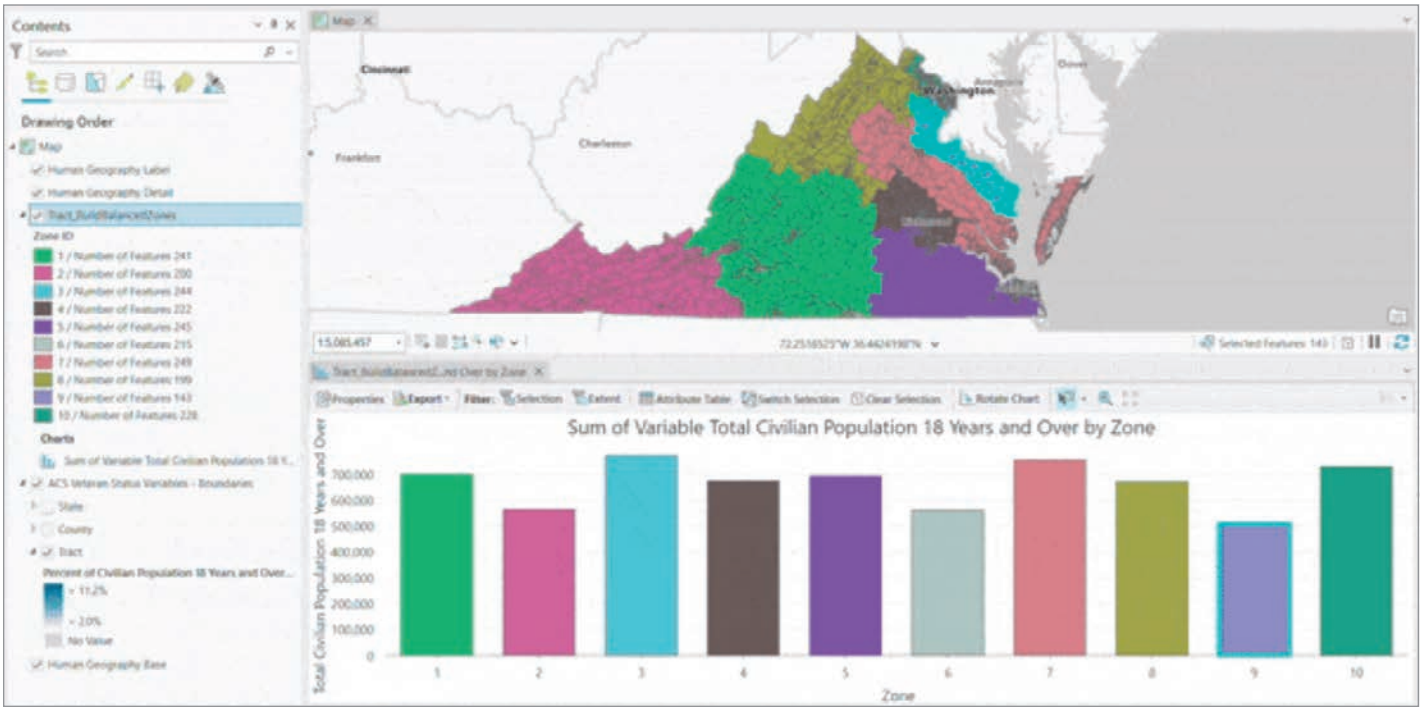
Turn the Tract layer back on and explore the map. Notice that the smaller zones (near Norfolk and Arlington) have the largest groups of proportional symbols. There are more veterans in these areas than in other places within the state. The tool has generated zones based on the veteran population, while at the same time keeping the zones as contiguous as possible.

In the Contents pane, right-click Tract_BuildBalancedZones and click Attribute Table. There are 2,186 tracts in this layer. A field called Zone ID assigns each of them a value of 1 through 9.

Optional: Fine-Tune Your Zones

Experiment with different parameters in the Build Balanced Zones tool and rerun the tool. You can see that some zones are not compact—they are elongated and stretched out. Zones that are more compact can help with canvassing, improve drive times, and aid in administration. If you want, run the tool again and choose the zone selection criteria for compactness.

There are many more options available with this tool, particularly the spatial constraints. Read the ArcGIS Pro help for more information (links.esri.com/BBT). Feel free to fine-tune your zones as much as you'd like.

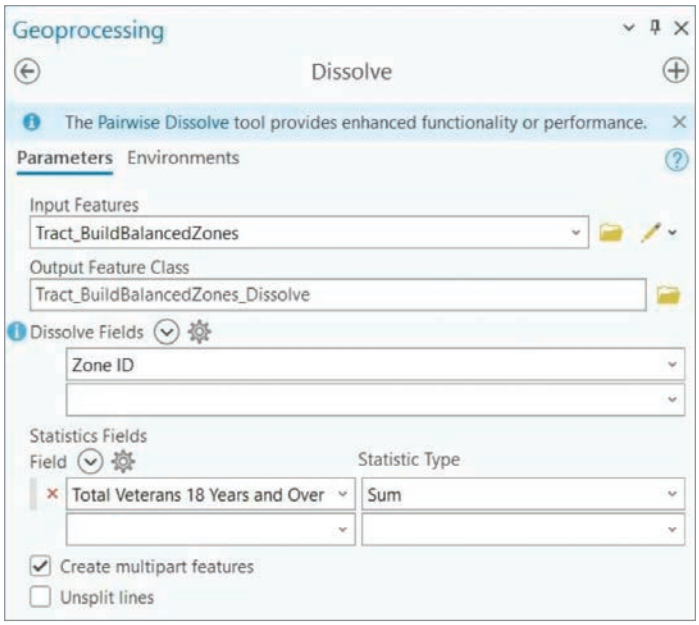


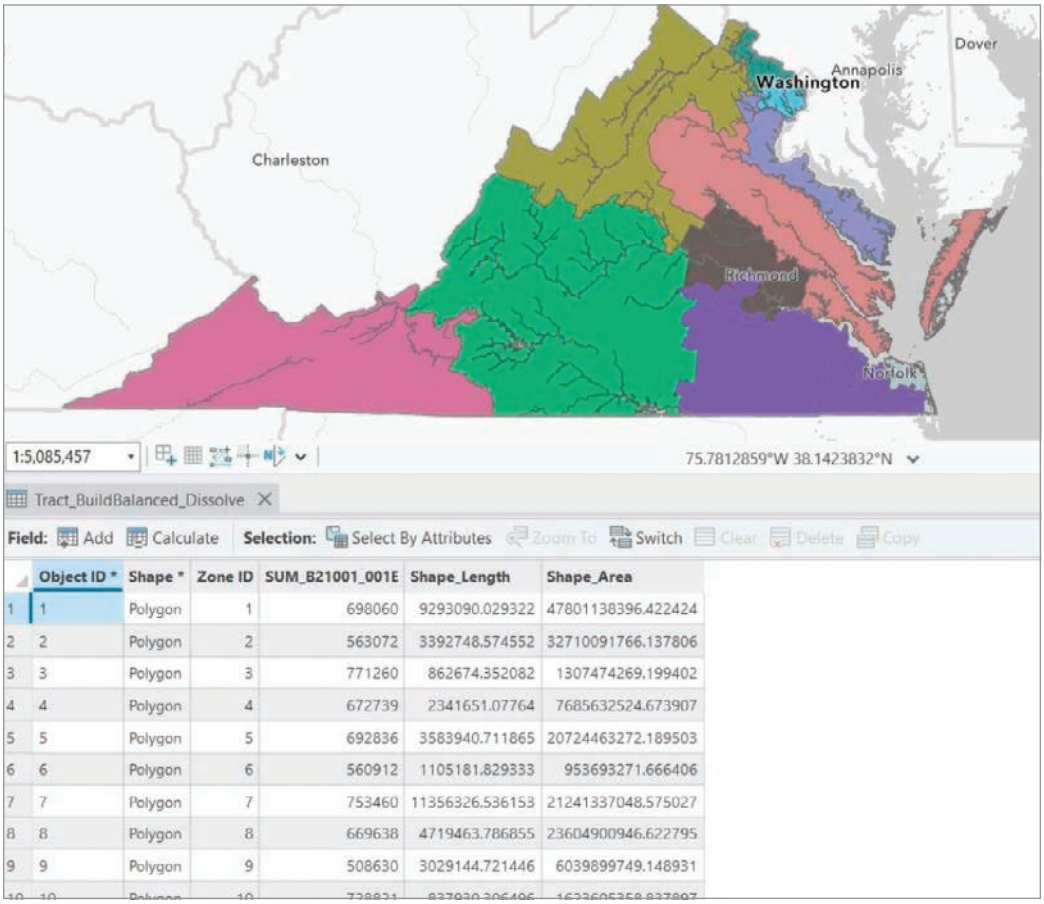
7 Dissolve the Zones into New Polygons

Your final desired output is a new polygon layer of balanced service areas. In this case, you will end up with a layer containing nine polygons. In the Geoprocessing pane, click the Back arrow. If you closed the Geoprocessing pane, click Tools on the Analysis ribbon to reopen it. Search for and open the Dissolve tool. This will dissolve the 2,186 tract polygons into 10 zone polygons.

Set the Input Features to your finalized results from the previous step, Tract_BuildBalancedZones. For Dissolve Fields, choose Zone ID. The tool will create output polygons that group together input polygons based on their Zone ID values.

Finally, set the Statistics Fields. We want the the output layer to include a field that shows the total number of veterans in each zone. To achieve this, set Field to Total Veterans 18 Years and Over and set Statistics Type to Sum. Click Run. This analysis runs in a few seconds. The result is a layer with 10 polygons, and a field named SUM_B21001_002E that stores the total veteran population for each.





	Object ID *	Shape *	Zone ID	SUM_B21001_001E	Shape_Length	Shape_Area
1	1	Polygon	1	698060	9293090.029322	47801138396.422424
2	2	Polygon	2	563072	3392748.574552	32710091766.137806
3	3	Polygon	3	771260	862674.352082	1307474269.199402
4	4	Polygon	4	672739	2341651.07764	7685632524.673907
5	5	Polygon	5	692836	3583940.711865	20724463272.189503
6	6	Polygon	6	560912	1105181.829333	953693271.666406
7	7	Polygon	7	753460	11356326.536153	21241337048.575027
8	8	Polygon	8	669638	4719463.786855	23604900946.622795
9	9	Polygon	9	508630	3029144.721446	6039899749.148931

↗ Set Input Features to the results from the previous step, Tract_BuildBalancedZones. For Dissolve Field, choose Zone ID. Set the Statistics Fields to Total Veterans 18 Years and Over and Statistics Type to Sum.

→ The result is a layer with 10 polygons, and a field named SUM_B21001_002E that stores the total veteran population for each.

Take It Further

You have used ArcGIS Living Atlas content and geoprocessing tools in ArcGIS Pro to design custom service areas. From here, there are endless possibilities. With this knowledge, you could create a map series of reference maps of each zone using highways and county boundaries layers with the Human Geography basemap. Then, export and publish a feature layer of these zones to ArcGIS Online and share it within your organization. You could combine this layer with your organization's data on the locations of facilities, assets, and places of interest. You could also enrich this layer to bring in even more demographic, consumer spending, or psychographic data specific to your cause or your business needs. Finally, you could create infographics using ArcGIS Business Analyst.

Have you designed service areas for your work? Visit the Geoprocessing and ArcGIS Living Atlas of the World Esri Community pages.

About the Author

Diana Lavery loves working with data. She has more than 15 years of experience as a practitioner of demography, sociology, economics, policy analysis, and GIS. She holds a bachelor's degree in quantitative economics and a master's degree in applied demography. She is a senior GIS engineer on ArcGIS Living Atlas of the World's Policy Maps team. She enjoys strong coffee and clean datasets, usually simultaneously.

The Power of Maps to Influence Decisions

Anna Riling is a geologist-turned-cartographer who owns Four Corners Mapping, based in Durango, Colorado. Her business creates custom cartography for policy advocacy campaigns and print media, designs interactive web mapping applications and ArcGIS Story Maps stories, and produces geologic and topographic trail maps. In this interview, Riling talks about her move to mapmaking, her work updating the Multimodal Transportation Plan for Durango, and the power of maps in influencing decisions that matter.

Q. How did you become a cartographer? And what do you enjoy about it?

A: I worked as a professionally licensed geologist in geotechnical engineering, oil and gas, and environmental consulting for a long time. As much as I loved fieldwork, it became harder to do after I had kids. After a slew of particularly brutal days in the field, I realized I needed a change. I wanted to do more with mapping and GIS, so I got my master's from the University of Denver and started Four Corners Mapping as a side gig. In 2021, I went all in with my business, and it's been one of the best career decisions I've made.

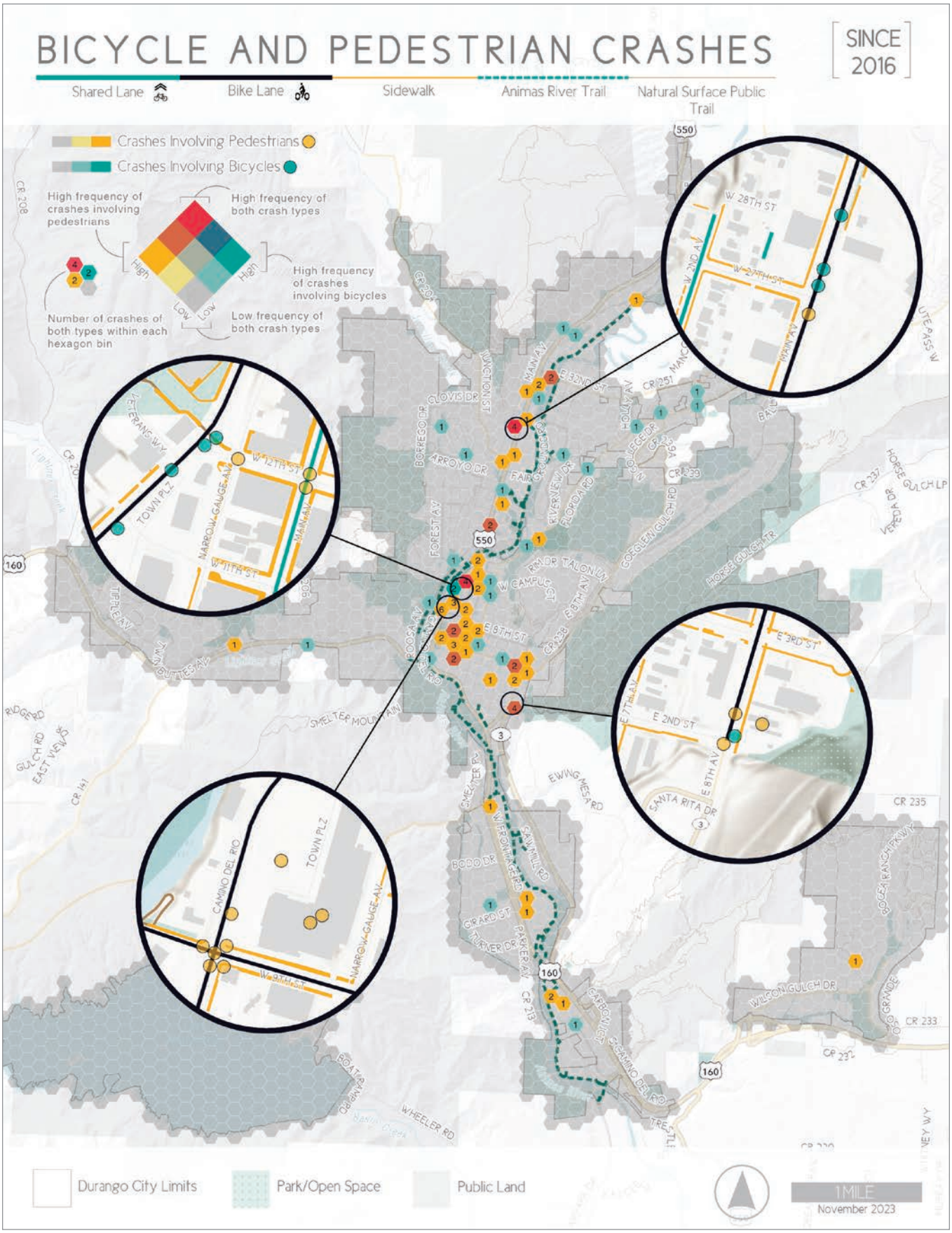
I'm lucky to love what I do. I get to be creative, which wasn't a big part of being a geologist. I still love geology, but now I apply my creativity to mapping. I get to choose projects and work with awesome clients, many of whom are environmental conservation nonprofits making a big difference in protecting and conserving endangered landscapes, water resources, and Indigenous rights. It feels good to know that my maps help with such important causes.

Q. How did you get involved in creating the updated Multimodal Transportation Plan maps for Durango?

A: Durango is a small city in a valley, which limits growth. We value clean air, walking, and biking but as a mountain town with a big tourist economy, there's also a focus on affordable housing and safe multimodal transportation. Safety is a huge concern, especially with the mix of pedestrians, cyclists, and heavy traffic. This issue is compounded by the fact that our main thoroughfare is a highway, increasing the potential for crashes and negative interactions.

Devin King, the city's multimodal manager, hosted many public meetings on this topic and received 500 comments on what the community felt were the most important multimodal transportation needs, and the concerns around each. Since there was a major mapping component, PST Engineering, the company that won the project, subcontracted *[with]* me to do the maps. I then worked closely with Devin to ensure the plan reflects the community's needs.

Anna Riling



↑ Riling applied her cartographic skills to updating Multimodal Transportation Plan maps for the city of Durango, Colorado.

Q. What was your design process for the Durango map, and how did you collaborate with the city's multimodal manager?

A: The city's multimodal manager shared examples of maps he liked from other municipalities *[that were]* streamlined, simple, and consistently formatted. I then worked closely with him and the city's designer to create a cohesive color palette and font that matched the transportation theme. We ensured a consistent color scheme across the map series; for example, yellow sidewalks and teal shared lanes appeared uniformly on all maps. For the bivariate symbology—instead of relying on default color gradients—I chose accessible colors that created a consistent look and feel. We also standardized all the maps in portrait orientation to improve readability.

Q. What was the primary message you wanted to convey with this map, and how did you approach the design to ensure it told the right story?

A: The city's outreach before this update identified safety as a major concern, so I wanted this map to tell a story not just about where crashes occurred but also the frequency and types of crashes. When I first got the data, I noticed many crashes were recorded at the same location—most likely due to how the police geocoded the data. This resulted in overlapping points that didn't clearly convey the frequency of crashes.

That's when I decided to use bivariate symbology, a method I hadn't tried before, and aggregated features into bins, creating a honeycomb pattern. For certain areas with frequent crashes, I used the disperse markers tool to separate coincident locations by at least 10 feet. I then drew attention to these spots using inset maps that function like magnifying glasses. This approach allows the map to show where incidents happen while also highlighting the transportation infrastructure in those areas.

I think the legend really helped because bivariate maps aren't the easiest symbology for everyone to instantly pick up on, but the legend walks you through everything. In this case, that was crucial to making the map understandable and effective.

This interview has been edited and condensed.

Q. What challenges did you encounter while creating this map, and how did you overcome them?

A: One challenge was creating a map series in ArcGIS Pro before it had support for thematic map series. I figured out a workflow that allowed precise adjustments without leaving the software, but it was cumbersome. I had to manually group all my graphic elements and features by map, and with dynamic text changing from map to map, I had to manually toggle layers and graphics for each page.

Another challenge was creating the graphic legend to explain the bivariate symbology, which took a lot of experimentation to get it just right. Finding the right size hexagonal bins was important. They had to be large enough to capture key details at intersections but not so small that they became visually overwhelming.

Q. What lessons from this project will you carry forward into your future work?

A: I learned a lot about working with legends during this project. It's a continuous learning process, and I'll probably try something different next time, but in this case, the dynamic legend wasn't an option. I had to tease out the information, convert it to graphics, and ensure everything was clearly labeled and laid out. Aside from the bivariate legend, I used another legend as a separator between the title and the map. It shows the symbology for the linear and point features in the map, like the shared lanes, bike lanes, sidewalks, and trails.

Q. What has the feedback been for this project?

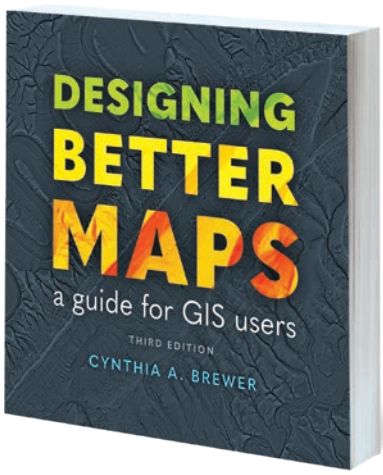
A: The map directly led to identifying key intersections with frequent crashes, especially along the main US 550 highway which runs through the town. The analysis showed that the highway was a barrier for pedestrian and bike crossings, resulting in proposed projects like underpasses, overpasses, and shared lanes. There were also land use development code recommendations, which will have a lasting impact on the community.

Maps have power. How we present and visualize data can significantly influence decisions. If the data isn't clear or lacks context or just plain isn't nice to look at, it won't be as effective as a communication tool.

Bookshelf

Designing Better Maps: A Guide for GIS Users, Third Edition

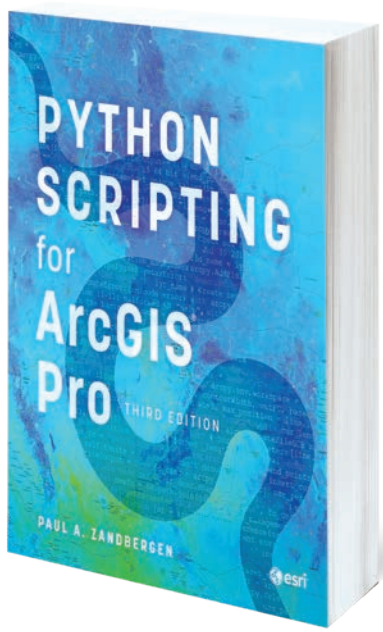
By Cynthia A. Brewer



For more than 18 years, *Designing Better Maps: A Guide for GIS Users* has been essential reading for all mapmakers who use GIS. The third edition—updated with new and revamped design practices—continues that legacy, emphasizing core cartographic concepts. With more than 400 full-color illustrations, this book applies map design best practices to both reference and statistical mapping. Readers learn how to plan maps, use basemaps, employ scale and time, explain maps, share maps, apply type and labels, understand and use color, and customize symbols. October 2024, 272 pp. Ebook ISBN: 9781589487833 and paperback ISBN: 9781589487826.

Python Scripting for ArcGIS Pro, Third Edition

By Paul A. Zandbergen



Python Scripting for ArcGIS Pro, Third Edition, teaches readers how to write Python scripts to automate tasks in ArcGIS Pro. The book begins with the fundamentals of Python programming and then dives into how to write useful Python scripts that work with spatial data in ArcGIS Pro. With step-by-step instructions and practical examples, it reveals how to use geoprocessing tools; describe, create, and update data; and execute specialized tasks. June/September 2024, 414 pp. Ebook ISBN: 9781589488021 and paperback ISBN: 9781589488014.

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

The Importance of Building a GIS Portfolio

By Ugochukwu Okonkwo

As a student or emerging GIS professional, what can you do to stand out from others in this dynamic field? One of the most powerful tools you can leverage is a well-crafted GIS portfolio. A GIS portfolio is more than just a collection of your work—it's a showcase of your skills, a reflection of your professional journey, and a crucial component in building a successful career in GIS.

Something More than Just a Resume

A resume provides a snapshot of your education, skills, and experience, but a GIS portfolio offers a deeper dive into what you can actually do. It's the difference between telling and showing. While a resume might list "proficiency in ArcGIS" as a skill, a portfolio can demonstrate this proficiency through detailed examples of projects you've completed, maps you've created, and problems you've solved using GIS technology.

Your GIS portfolio should include a variety of work samples that highlight your capabilities across different areas of GIS. These samples might include:

Maps and Visualizations: High-quality maps that demonstrate your ability to analyze spatial data and present it in a clear, compelling manner.

Project Descriptions: Detailed write-ups of the projects you've worked on, including the challenges you faced, the solutions you implemented, and the impact of your work.

Data Analysis: Examples of your ability to analyze and interpret spatial data, using tools such as ArcGIS or other GIS software.

Programming and Automation: If applicable, include scripts or code snippets that show your ability to automate GIS tasks or perform advanced spatial analysis.

By including these elements, your portfolio becomes a powerful tool that not only highlights your technical skills but also tells the story of your professional journey in GIS.

Building Your Portfolio

Creating a GIS portfolio might seem daunting, especially if you're early in your career and don't yet have a wealth of experience to draw from. However, with a strategic approach, you can build a portfolio that effectively showcases your potential.

1) Start with What You Have

Don't wait until you've accumulated years of experience before you start building your portfolio. Start with the projects you've completed during your education or any internships you've done. Even classroom assignments can be valuable portfolio pieces if they demonstrate your skills and your ability to solve real-world problems.

2) Choose a Platform

Your GIS portfolio needs a home, and there are several platforms you can use to create it. Websites like GitHub, Behance, or even a personal website can serve as a platform for your portfolio. Esri's ArcGIS StoryMaps, ArcGIS Experience Builder, or ArcGIS Hub are excellent tools that allow you to create interactive, visually compelling narratives that showcase your work.

3) Showcase a Variety of Skills

When selecting projects for your portfolio, aim for diversity. Include projects that demonstrate your proficiency with different GIS tools and techniques, from spatial analysis and geocoding to data visualization and programming. This not only shows potential employers the breadth of your skills but also your adaptability in different areas of GIS.

4) Provide Context

A map or a data visualization on its own might look impressive, but without context, it's just a pretty picture. For each project in your portfolio, provide a brief description that explains the problem you were trying to solve, the methods you used, and the results you achieved. This context is crucial for helping potential employers understand the impact of your work.

5) Keep It Updated

Your portfolio should be a living document that evolves as your career progresses. Make it a habit to update your portfolio regularly with new projects and skills. This not only keeps your portfolio fresh but also serves as a reminder of your growth and accomplishments in the field.

Leveraging Your Portfolio

Once you've built your GIS portfolio, the next step is to leverage it in your job search and career development. These strategies will help you make the most of your portfolio.

- **Use it in job applications.**

When applying for GIS positions, include a link to your portfolio in your resume and cover letter. This allows potential employers to see firsthand what you can do, rather than just reading about it.

- **Bring it to interviews.**

In an interview, your portfolio can be a powerful tool for demonstrating your skills and experience. Consider bringing a tablet or laptop to the interview so you can walk the interviewer through your portfolio and discuss the projects in detail.

- **Share it on professional networks.**

Platforms like LinkedIn are great for sharing your portfolio with a wider audience. Post updates about new projects you've added to your portfolio and include a link to your portfolio in your LinkedIn profile. This increases your visibility and can attract potential employers or collaborators.

- **Use it for networking.**

When networking at conferences or industry events, your portfolio can serve as a conversation starter. Whether you're talking to potential employers or peers in the industry, being able to show them your work can leave a lasting impression.

Real-World Results from a GIS Portfolio

A close friend of mine, Mathew Ugwuanyi, is an example of a GIS professional who used his portfolio to successfully land a full-time GIS technician position at Highlands County Board of County Commissioners in Florida. His work, skills, and expertise were captured and presented in an ArcGIS StoryMap story and YouTube video. He updated his portfolio with projects that showcased his ability to analyze and visualize data related to health, crime, emergency response, and urban expansion potential. His portfolio demonstrated his versatility and ability to apply his GIS skills in a new context, which helped him stand out in the job market.

As a recent GIS graduate, I have used my GIS portfolio to land multiple awards, assistantships, and leadership roles. My portfolio included detailed maps, analyses, scripting/coding snippets, media coverage/representation, and publications that I had completed during my academic work, research, and profession. I can confidently say that recruitment managers have been impressed with the quality of my work and the way I have documented my problem-solving process.

I have always included my GIS portfolio in every application package I submit. This has paved the way for opportunities, such as working as an Esri User Conference student assistant and serving as a judge and reviewer for competitions held by the Ohio Academy of Science and the Virginia Junior Academy of Science. You can take a look at my GIS portfolio at https://bit.ly/ugochukwuokonkwo.

In the competitive and ever-evolving field of GIS, having a well-crafted portfolio is not just an option—it's a necessity. It serves as a powerful tool for showcasing your skills, telling your professional story, and navigating your career path. Whether you're just starting out or looking to make a career transition, your portfolio can help you stand out, demonstrate your value, and open doors to new opportunities in the geospatial industry.

As you continue to build your career in GIS, remember that your portfolio is a reflection of your journey. Keep it updated, use it strategically, and let it be your compass as you navigate the exciting world of GIS.

I hope you find this article exciting and motivating. If a GIS portfolio helped you navigate your career trajectory, feel free to connect with me on LinkedIn.

About the Author

Ugochukwu "Ugo" Udonna Okonkwo received a master's degree in geography and GIS from Southern Illinois University Edwardsville (SIUE), where he worked on the use and application of remote sensing and GIS technologies in monitoring vegetation cover, phenology dynamics, and land temperature over 20-year spans in the Mark Twain National Forest. While obtaining his first master's degree, he discovered the need for geographic information management in secured databases. This caused him to enroll in a master's program in the Department of Computer Management Information Systems at SIUE to integrate geography, GIS, and information systems technology while working as an expert in the GIS community. He is currently in the first year of that program.

The author has always included his GIS portfolio in every application package he submits.

COLLEGES DRIVE SOCIAL AND ECONOMIC MOBILITY WITH SPATIALLY ENABLED DATA

A core mission of California community colleges is providing access to educational programs and workforce opportunities for every learner. The nine community colleges and school of continuing education in Orange County (OC), California, serve a diverse student body that includes adult learners seeking general education diplomas, individuals who are reskilling, veterans, high school students in dual-enrollment programs, foster youth, and low-income first-generation students.

A project led by one of those colleges, Coast Community College District (CCCD), uses GIS to synchronize academic offerings with labor market needs and help equip students with the skills and credentials they need to succeed in the regional workforce.

Vision 2030, an action plan adopted by California Community Colleges, seeks to increase the number of students who can earn a living wage after completing their studies. However, students often lack accessible, reliable data on the economic outcomes of their educational choices. Complex labor market data, organized into spreadsheets, was not accessible or easily sharable.

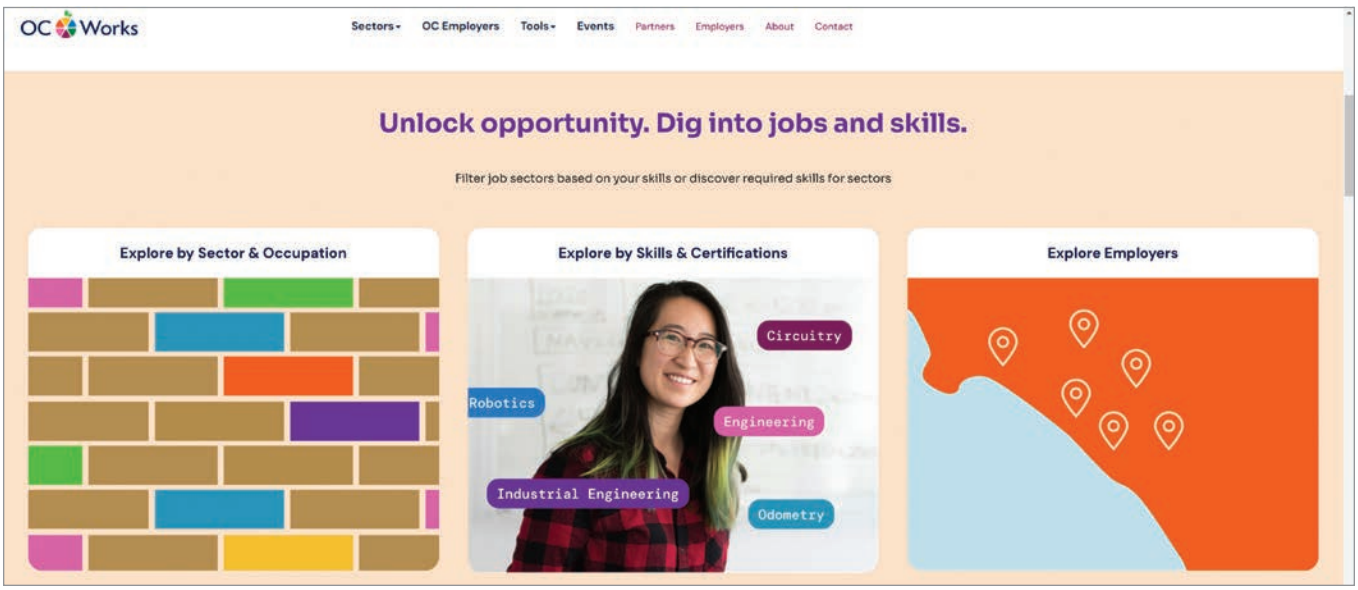
To address this challenge, CCCD is utilizing geospatial tools and data that visualizes labor market information in a way that empowers students to reach their career goals. CCCD used GIS-enabled tools embedded in an ArcGIS StoryMaps story, "TalentED—Geo-enabling the Student Journey," (www.talentedcareerpathways.org), a resource that more effectively communicates this information.

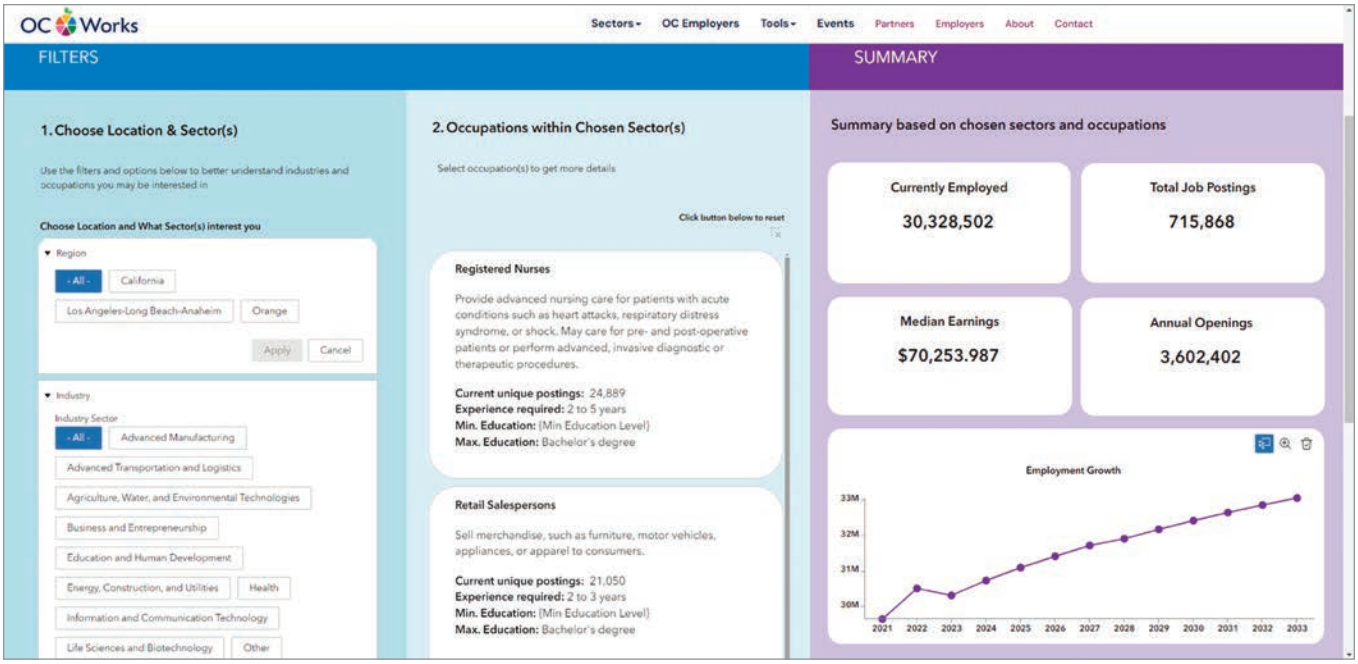
EXPANDING GIS TOOLS TO BETTER SERVE STUDENTS

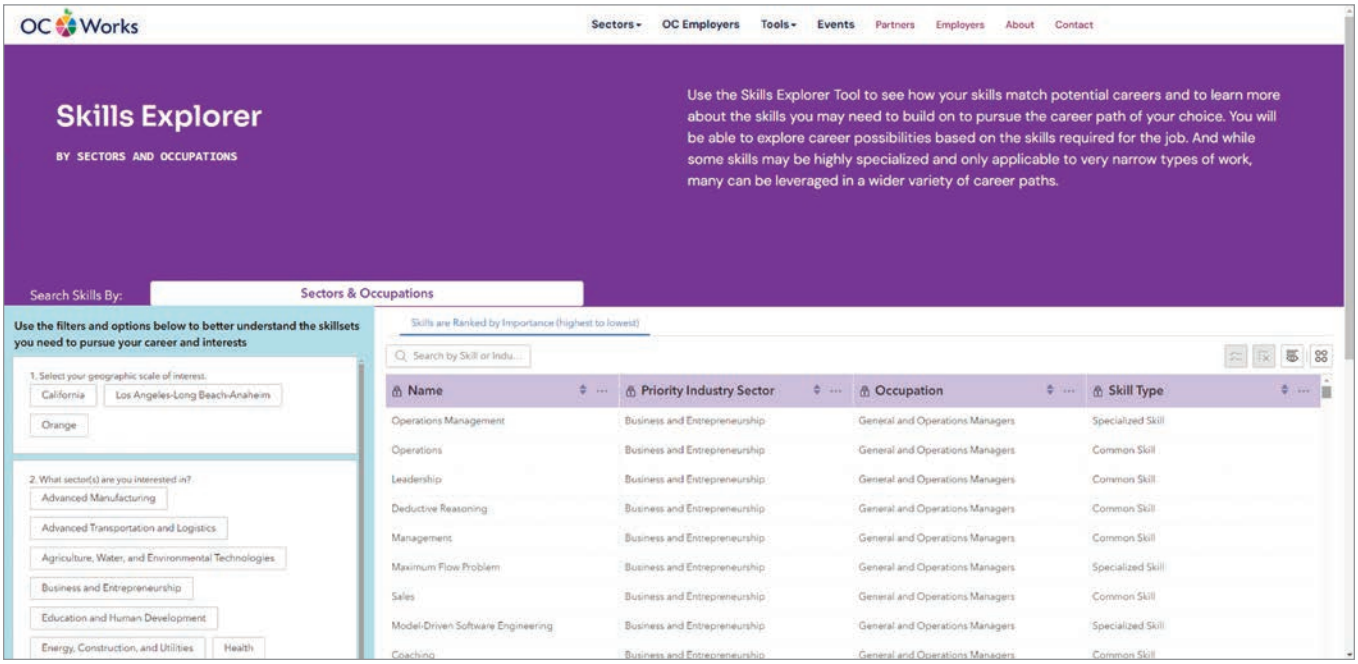
Community colleges have significant limitations on how they collect and share labor market information with students, especially priority sectors such as advanced transportation; biotechnology; business; digital media arts; energy; construction; utilities; nursing and allied health; information and communications technology; and retail, hospitality, and tourism.

Information that had been presented in tables and spreadsheets on the locations

↓ Using ArcGIS Hub, labor-market-informed applications are presented within the OC Works gallery.







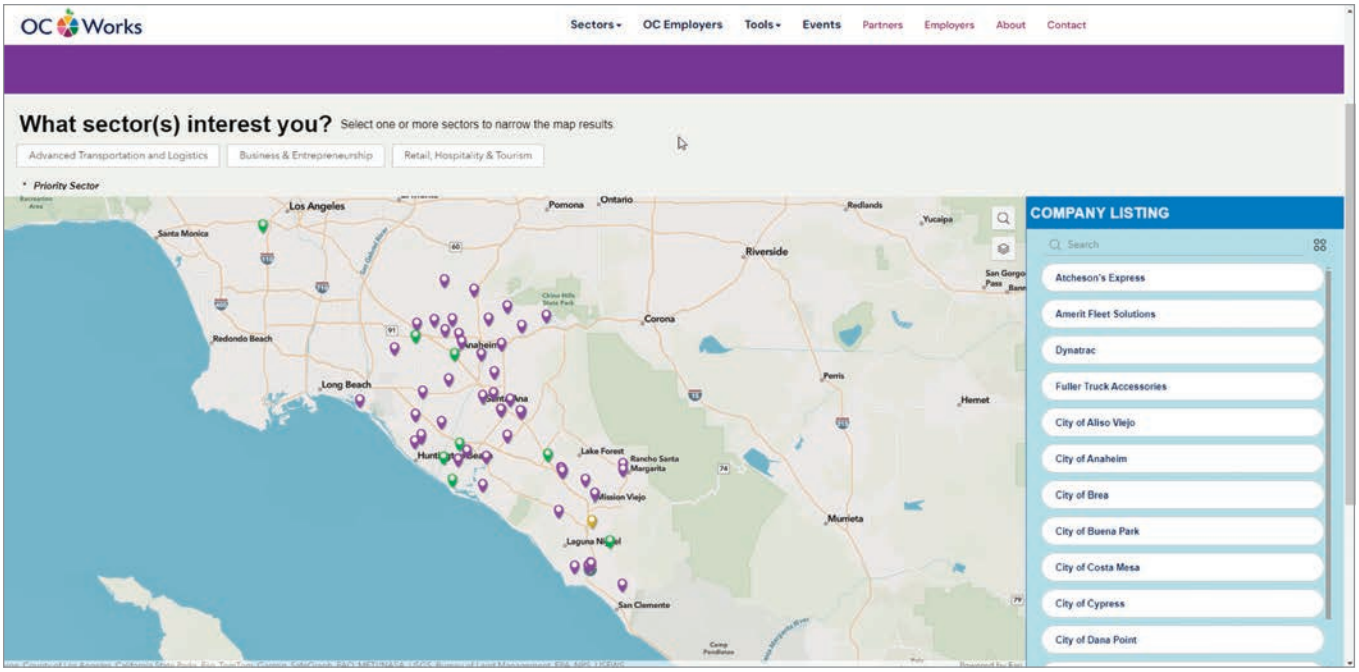
of businesses that are hiring, salary information, and the skills required was months or years old. This information wasn't easily accessible or understandable, and not updatable. Studies show that lack of access to reliable and credible data about expected labor market outcomes, not surprisingly, minimizes how students weigh this information in making programmatic decisions.

"Navigating labor market information can be daunting for job seekers. We thought 'there has to be another way,'" said Stephanie Feger, a program director for career education and workforce development at Coast Community College District. "That's when we decided to map the information spatially."

CCCD deployed TalentED, which turns geographic data into interactive content that helps students visualize labor market information for different occupations. It provided direct access to current information on businesses that were hiring, where they were located, what these jobs pay, and

↑↑ Developed using ArcGIS Experience Builder and informed by a Lightcast API, the Sector Explorer application provides users with detailed occupational data based on region and selected industry.

↑ This ArcGIS Experience Builder application highlights the top 10 skills for occupations as ranked according to importance by employers.



↑↑ This map highlights employer partners by industry. Each employer is searchable by industry or by the search bar. The pop-up data provides key information about the employer.

↑ Utilizing MIT's Living Wage Calculator, this application allows job seekers to identify by location and family size the livable wage in both annual and hourly earnings.

what skills are required. As CCCD expanded partnerships with community-based organizations and workforce development agencies, the team also wanted to include more real-time data to identify living-wage careers and career pathways.

One way to achieve that was by implementing a more comprehensive tool that would appeal to a larger audience. CCCD senior research analyst Dr. C.J. Bishop expanded his GIS analytical skillset and received additional training on GIS tools. He employed his new knowledge and skills to build out a strategy for implementing mapping software.

TalentED was initially launched as a resource to promote career exploration, but he sought to do more. Working with real-time data using a Lightcast API, and assisted by Esri partner Blue Raster, CCCD has tapped into tools including ArcGIS Business Analyst, ArcGIS Hub, ArcGIS Experience Builder, ArcGIS Survey123, and ArcGIS Pro to develop better career road maps for students.

"*[GIS]* has helped us communicate in ways that we haven't been able to previously do," said Bishop.

With GIS tools in place, the community colleges are launching OC Works. This job seeker data tool is a resource for college administrators, students, guidance counselors, and workforce development partners. By providing a shared understanding of labor market information, students and those entering the workforce can make better-informed decisions about education paths and outcomes.

"We're able to look at labor market data based off key partnerships in the region… to show not only key industries that we know will help people move up economically, but also what skills are needed," said Bishop.

"Having geospatial tools where we can identify potential partners in this work is really a game changer for understanding populations in our region where we can do outreach and where we can build partnerships," said Feger.

Community college program directors can view up-to-date information on skills and certifications and understand how their program offerings match workforce needs. Through the suite of tools and information, students can explore interactive maps and data visualizations that display the location of jobs, public transportation information, median salaries, skills, and educational requirements for jobs in each priority sector.

In the K–12 education sector, guidance counselors can access online maps and workforce data from different employment sectors to help younger students with college and career exploration. Throughout California, OC Works has been presented to a variety of community college districts.

These districts have seen the value the tool brings to their regions and its potential to increase collaboration with workforce development partners. A regional version of OC Works has been incorporated into job centers that assist those seeking employment or additional skills that would improve their earnings.

LAUNCHING THE WORKFORCE OF TOMORROW

To help identify shared solutions to challenges such as enrollment, equity, and employment, CCCD is now leading a regional consortium effort that includes four community college districts, college administrators, and district offices to educate institutional researchers on employing Esri software. Working with Dr. Cecilia Rios-Aguilar from UCLA, CCCD is exploring Esri's Social Equity Analysis solution for mapping areas where gaps exist in educational attainment and earnings so that colleges can develop targeted outreach strategies.

Information from consortium partners has led to CCCD working closely with adult schools to understand where gaps exist in high school education for people seeking a general education diploma (GED).

"This has given us a good opportunity to think collectively about the high-priority sectors with living-wage jobs and target areas of where students are and what *[specific]* populations need," said Feger.

Feger and Bishop continue refining their work and hope it inspires other educational institutions and institutional researchers to incorporate GIS into their work. As Bishop noted, "The work demonstrates the value added of researchers being able to better understand key metrics of enrollment, equity, success, and upward economic mobility in new and more accessible ways that inform colleges and their partners in the region."

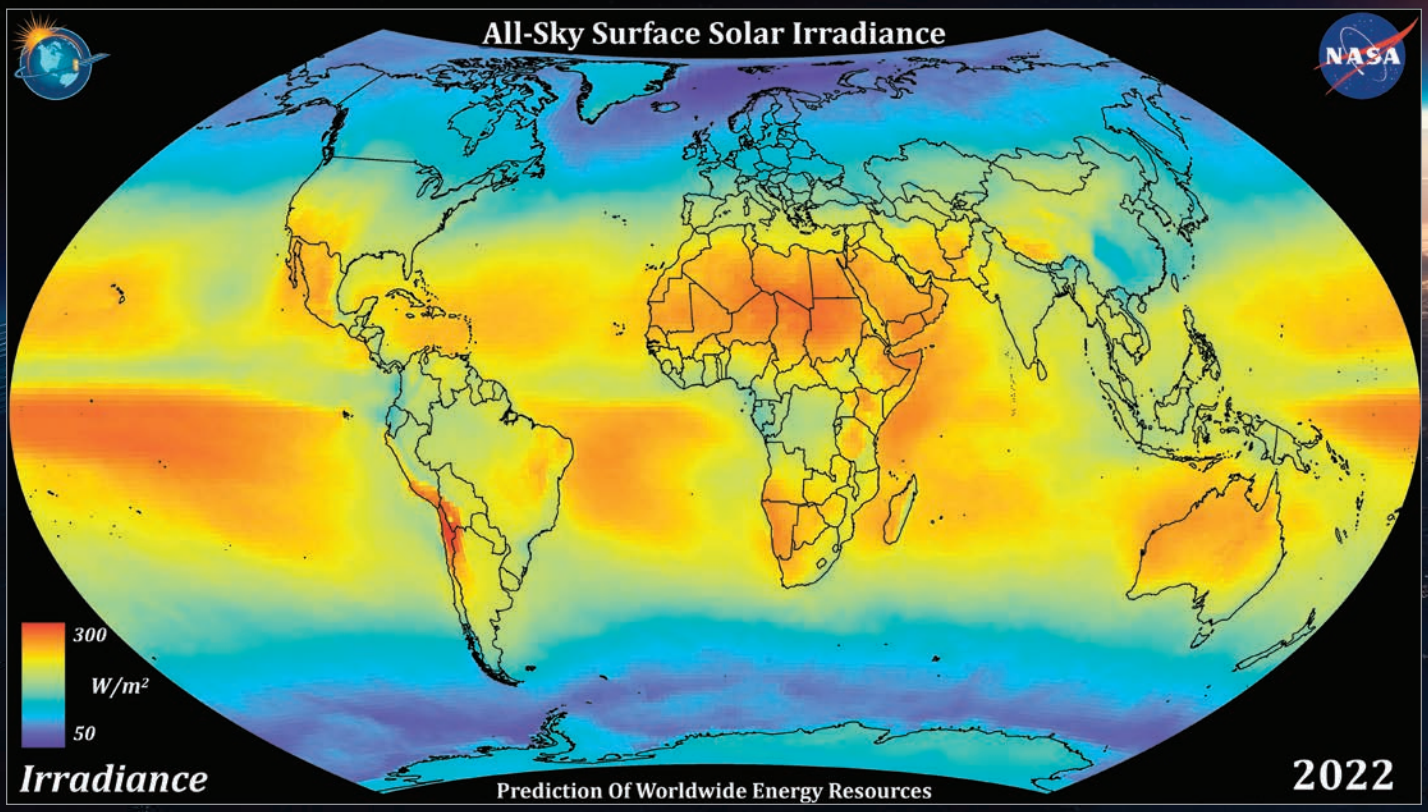
NASA Provides a Valuable Source of Earth Observation Data

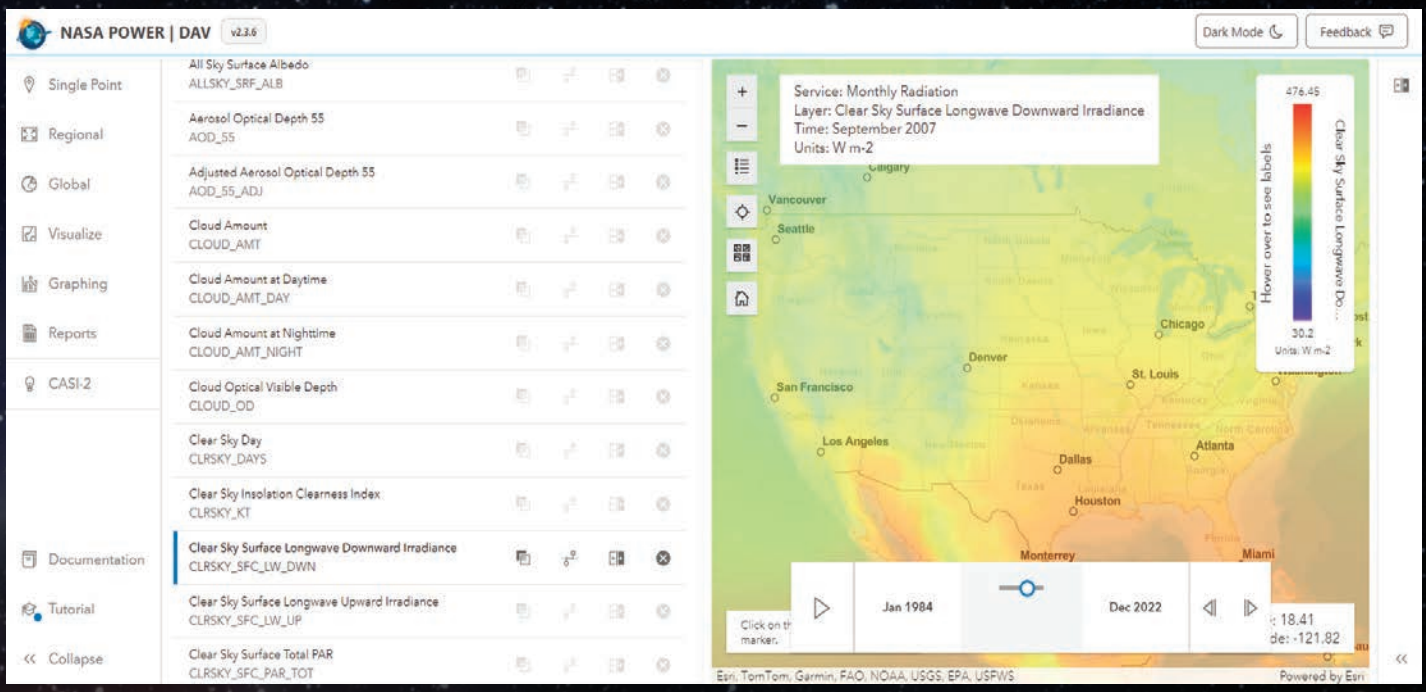
By Zoe Waring, Madison Broddle, Paul Stackhouse, and Falguni Patadia

Humans face the challenge of understanding, adapting to, and mitigating the impacts of a changing climate while continuing to thrive on Earth. While NASA is known for unfolding the mysteries of the universe, many may not know that for decades NASA has been focusing on Earth. It has flown satellites and developed models that have enlarged the collection of Earth science data. These data products are being used to study Earth's climate systems and impact strategic decisions. They have increased the understanding of renewable energy resources and future conditions that affect access to affordable and efficient use of energy worldwide.

In the last five years, NASA has grown its catalog of GIS-focused tools and services, which make it easier to discover, access, and download NASA Earth Observation (EO) data. For example, NASA maintains a public-facing ArcGIS Online organization account where users can discover resources pertaining to Earth science fields, such as water resources and atmospheric composition. The data

↓ This is a global visualization of average annual solar irradiance in watts per square meter.
Credit: Christopher Higham, NASA POWER Team





↑ The Data Access Viewer (DAV), a web-based tool, allows access to POWER data in GIS- friendly formats.

supporting these resources is hosted in NASA's ArcGIS Enterprise, the Earthdata Geographic Information System (EGIS), which serves as a centralized hub for NASA EO data, services, and resources that are cloud native and GIS friendly.

The Prediction Of Worldwide Energy Resources (POWER) Project is one of many NASA Earth science projects hosted within the EGIS. POWER is a cornerstone project for NASA's Earth Action Program. POWER's goal is to provide communities tackling energy and infrastructure challenges access to free, geospatially enabled NASA solar and meteorology datasets via ArcGIS image services that are hosted on EGIS.

The GIS community can benefit from POWER's geospatial services, which offer data in an easily accessible, GIS-friendly format. The POWER Project has worked continuously for 26 years, innovating its GIS-based tools and services and supporting the GIS community.

For example, POWER's Data Access Viewer (DAV) (links.esri.com/DAV_NASA) and PaRameter Uncertainty ViEwer (PRUVE) tool directly utilize the project's image services and serve as an example of how users can use POWER's services in the backend for developing their own tools. Applications, like the DAV, provide users direct access to POWER's Application Programming Interfaces (API) while enabling them to create plots. DAV and PRUVE were developed using the Esri Calcite Design System.

Products That Make EO Data Accessible

The POWER Project strives to make EO data easily accessible to users. More than 500 million data requests have been fulfilled since the project's inception. To attract a diverse usership, POWER offers a suite of tools that provide GIS-friendly, community-specific data that can be easily and efficiently integrated into GIS services and platforms.

DAV, a web application mapping system, provides visualization tools, charting, and data download capabilities. DAV products can be easily downloaded or integrated into custom applications and software. Subset datasets can be obtained by selecting location, time period, file type, and other parameters that enable users to acquire just the data that is relevant to their purposes.

Currently in development, PRUVE is slated for release in late 2024. This tool works as an online, dynamic validation application that utilizes statistical analysis and visualization. It will compare in situ surface site data with POWER data. The comparison data for solar radiation comes from the Global Energy and Water Exchanges (GEWEX) program and the Global Climate Observing System (GCOS) and Baseline Surface Radiation Network (BSRN). Meteorological comparison data is acquired from the National Oceanic and Atmospheric Administration (NOAA). The PRUVE tool will allow users to assess data in a web framework, which improves accessibility and eases the complexity of assessing data uncertainty.

Geospatial services, DAV, and the PRUVE tool are all POWER services that help users address geospatial challenges and create

opportunities. This past year, POWER released 16 updated and new multidimensional ArcGIS image services that the GIS community can leverage for its projects and research. POWER's geospatial services allow users to visualize and explore POWER data as well as enable the data to efficiently interact with GIS applications and tools.

POWER geospatial services include data on:

- Monthly and annual climatology solar and thermal radiation.
- Monthly and annual climatology meteorology.
- Monthly and annual U and V wind components *[i.e., geographic wind coordinate system Ugeo, Vgeo]* as well as monthly wind speed.
- Tilted surfaces irradiance, horizon (solar geometry), azimuth (solar geometry), and battery sizing for grid independent facilities climatology.
- Thermal climate zones and build thermal moisture climate zones for the period 1981–2021 and difference maps for both types of zones are derived for the most recent 15-year period (2007–2021) minus the earliest 15-year period (1981–1995) to illustrate variability.

With these geospatial services, which are hosted within the NASA EGIS Enterprise, users can access data via the enterprise's web browser, NASA ArcGIS homepage, or by searching ArcGIS Living Atlas of the World. POWER's geospatial services can also be directly accessed using ArcGIS Pro.

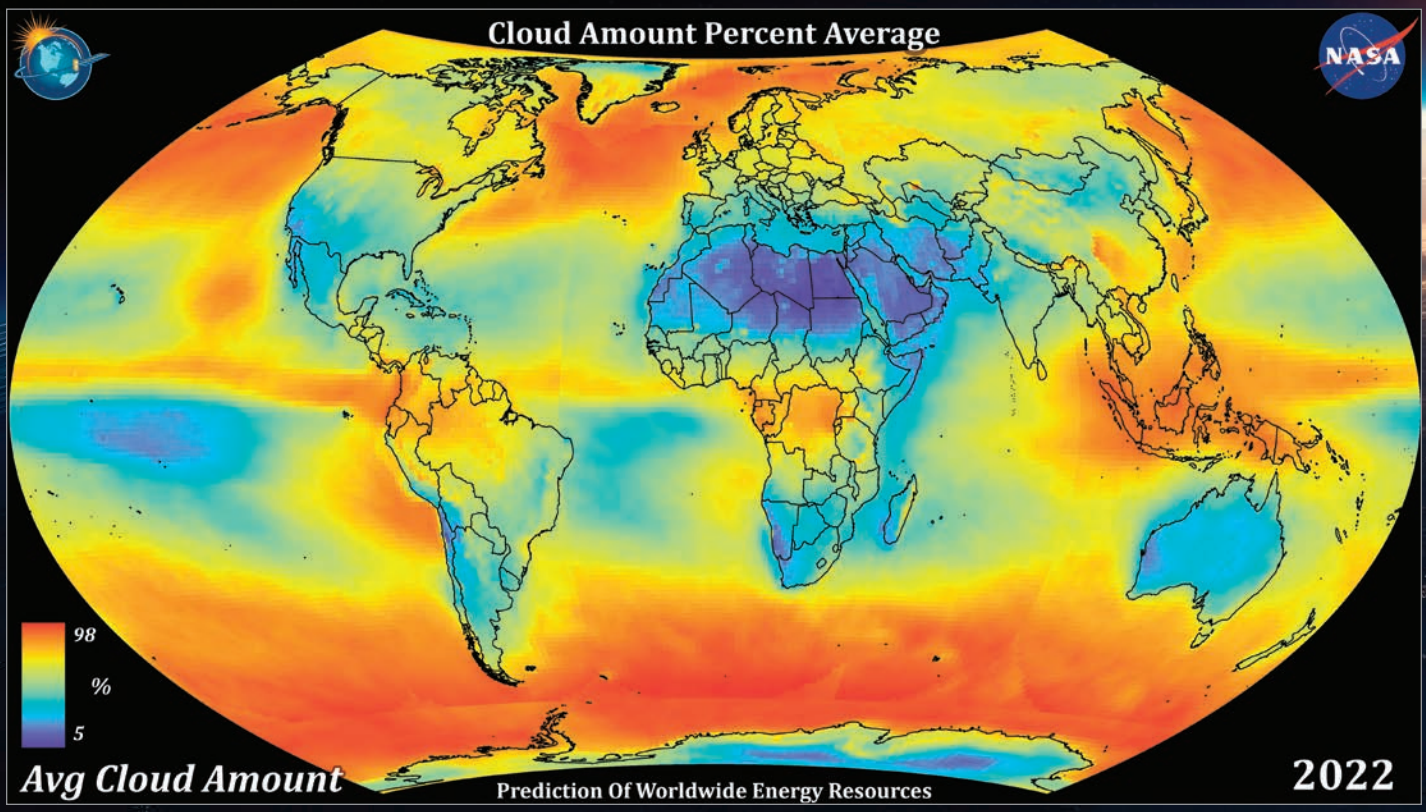
A Key Data Provider

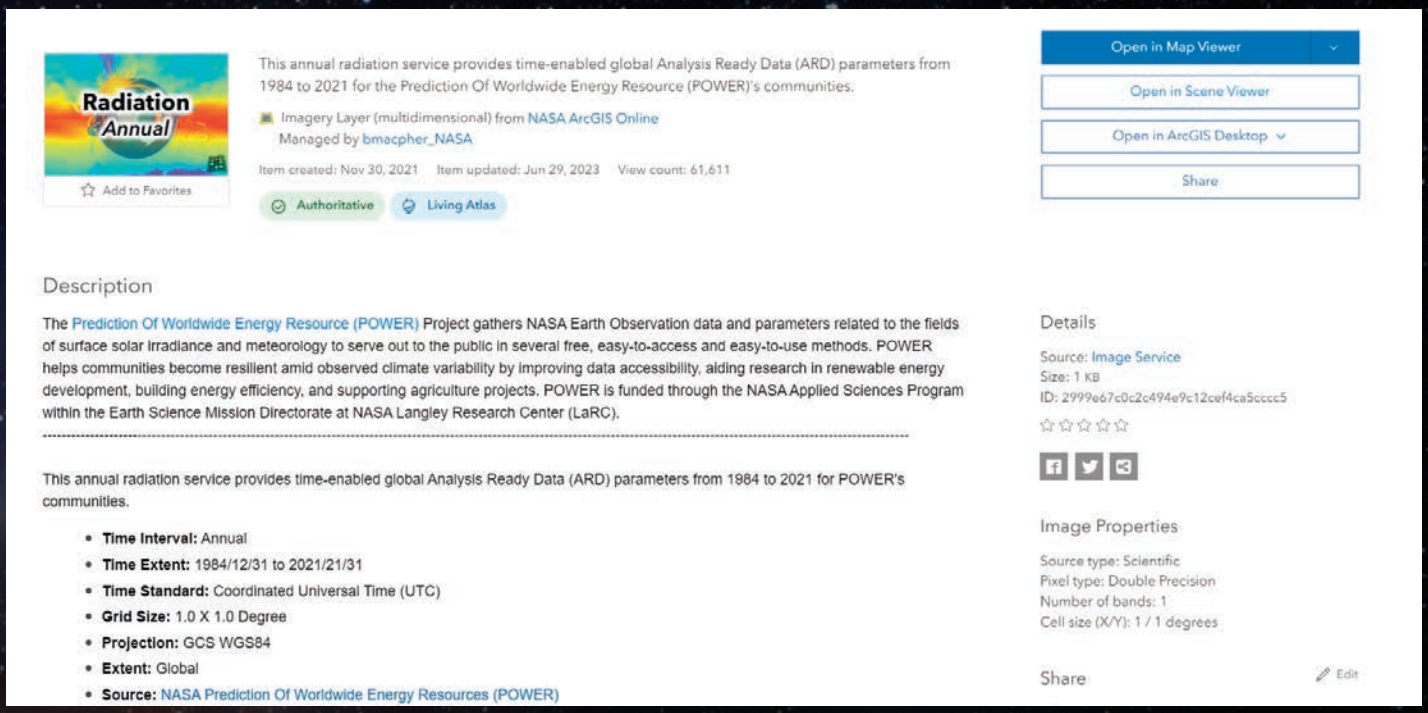
The POWER Project is uniquely positioned to support users in three areas: renewable energy, sustainable infrastructure, and agroclimatology. POWER serves as a key data provider to these communities by offering customized NASA EO data products that can be used to meet the demands and needs of these unique markets. POWER addresses market necessities by providing application-ready formats, long time series, globally gridded data, low-latency parameters, and community-specific, value-added data parameters.

Utilizing information from NASA's Clouds and the Earth's Radiant Energy System (CERES) project and Global Modeling and Assimilation Office (GMAO) Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) data products, POWER provides more than 400 parameters. Surface solar irradiance data dates back until 1984, with meteorology data since 1981, which enables users to compare how the Earth's climate functioned, previously and currently. POWER offers data in hourly, daily, monthly, annual, and climatology time periods.

The POWER Project values input from its diverse user community and takes their

↓ This is a global visualization of average annual cloud amount coverage.
Credit: Christopher Higham, NASA POWER Team





↑ POWER data can be accessed via ArcGIS Living Atlas of the World.

needs into consideration. The user community ranges from government agencies to nonprofits to industry, both domestic and international. They have found POWER data products and tools to be instrumental in their work due to its near real-time data distribution and global availability for all parameters offered. Many research projects study remote regions of the world where data acquisition is difficult or impossible. The project's array of tools and services can meet the needs of many groups with various technical, investigative, and developmental backgrounds.

Finding Sustainable Solutions with POWER Data

POWER GIS data has had an impact on a global scale when it comes to finding sustainable energy solutions in areas such as renewable energy, wastewater treatment, agroclimatology, and assessing energy budgets.

At Arunai Engineering College in Tamil Nadu, India, Dr. Saravanan Vasudevan, with the support of his team, installed a 10-kilowatts peak (kWp) solar photovoltaic microgrid system on the college site. The team used DAV to acquire solar and meteorological data, which allowed it to forecast solar power generation. As of June 12, 2024, the system has generated close to 30,000 kWp of electrical energy. The system saves about $100 per month, or 5 percent of the school's total budget. It is not only used for sustainable energy, but also for education. The system provides an opportunity to educate future scientists and engineers and discuss the importance of solar energy sustainability in accordance with the United Nation's Sustainable Development Goals.

Produced Water Ecoservices (PWES), a company based out of Colombia, uses a mechanical evaporation process for treating and returning wastewater to its original purity on-site for industrial facilities. Treating water on-site saves transportation costs, shortens the water treatment cycle, and reduces the risk of environmental spillage. PWES has successfully treated and returned more than 2.5 million barrels of water, while assisting the production of 300,000 barrels of oil.

Mechanical water evaporation is a process that is very sensitive to surrounding meteorological conditions, so PWES utilizes DAV for meteorological data. PWES vice president Hubert Borja Quintero said, "POWER's data access platform has been a very valuable resource of meteorological data, especially in an area where the weather station network is poor or absent."

The Future of POWER

NASA's POWER Project aims to introduce projected climate risk information and continue serving the missions of its unique user communities. The project plans to expand spatial coverage of its climate data products regionally and globally, enhance spatial resolution of datasets regionally across the United States, and develop data products that include new satellite datasets.

POWER is always looking for partnerships that will strengthen its impact across the world. One partner, RETScreen International of Natural Resources Canada, uses NASA POWER data to support

analyses from its RETScreen Expert Clean Energy Management Software. Using POWER data with this software, the RETScreen team plans on expanding climate prediction calculations to NASA buildings and more locations across the United States and the world.

The NASA POWER Project will continue to serve its communities and make improvements based on their needs. Earth science is vital to understanding a dynamic and ever-changing Earth. POWER provides insights that can improve renewable and sustainable practices that support a flourishing world for years to come.

> "The POWER Project has worked continuously for 26 years, innovating its GIS-based tools and services and supporting the GIS community."

About the Authors

Zoe Waring is a scientific and technical writer/editor who supports the NASA POWER Project team. She earned a bachelor's degree in scientific writing.

Madison Broddle is a geospatial data analyst and outreach coordinator for the NASA POWER Project team who helps develop interactive map products and apps. She holds bachelor's degrees in geographic information science and environmental sustainability: sciences and natural resources.

Paul Stackhouse, a senior research scientist at the NASA Langley Research Center, leads the NASA POWER Project. He leads work in the formulation of community requested parameters, and reviews validation, assessments, and documentation. He completed a master's and doctorate in atmospheric sciences.

Falguni Patadia is a research physical scientist at the NASA Langley Research Center who serves as the deputy lead for the NASA POWER Project. Her role involves assisting with project management, planning, and communications. She provides scientific oversight for algorithm development and data validation activities of the project. Patadia completed a master's degree in physics and a doctorate in atmospheric sciences.

For more information on the NASA POWER Project, email larc-power-project@mail.nasa.gov.

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A hub for geographic discovery, innovation, applied research, service, and community, the Institute for Geospatial Impact (IGI) fosters the use of geographic information systems (GIS) to empower people to positively impact society through thoughtful and intentional analysis of the world around them.

In continued partnership with geospatial industry leader Esri,® IGI is driven through cutting-edge application of Esri's contemporary technologies for higher education. Our students are guided by expert faculty in GIS who provide one-on-one mentoring and collaborative hands-on, real-life learning opportunities that prepare them to make meaningful impact in their organizations and communities.

Through interdisciplinary instruction and community-based internship projects, students are equipped for diverse careers that employ geospatial insights to improve organizational strategy, streamline government services, optimize non-profit operations, and more. The IGI at University of Redlands is eager to continue mentoring current and aspiring GIS professionals for this innovative and competitive field.

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Meet Dr. Avijit Sarkar, Director of the University of Redlands Institute for Geospatial Impact.

Through education pathways, partnerships, and research, Sarkar sees IGI as a forum for bringing people together through GIS and answering the complex problems our world faces today.

"We are positioning ourselves as an institution where we can authentically say that wherever you are in your geospatial journey, the University of Redlands has opportunities and pathways for you to continue to advance your education and professional development to have a positive impact on society."

—Avijit Sarkar
Director, Institute for Geospatial Impact
Professor, School of Business & Society

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