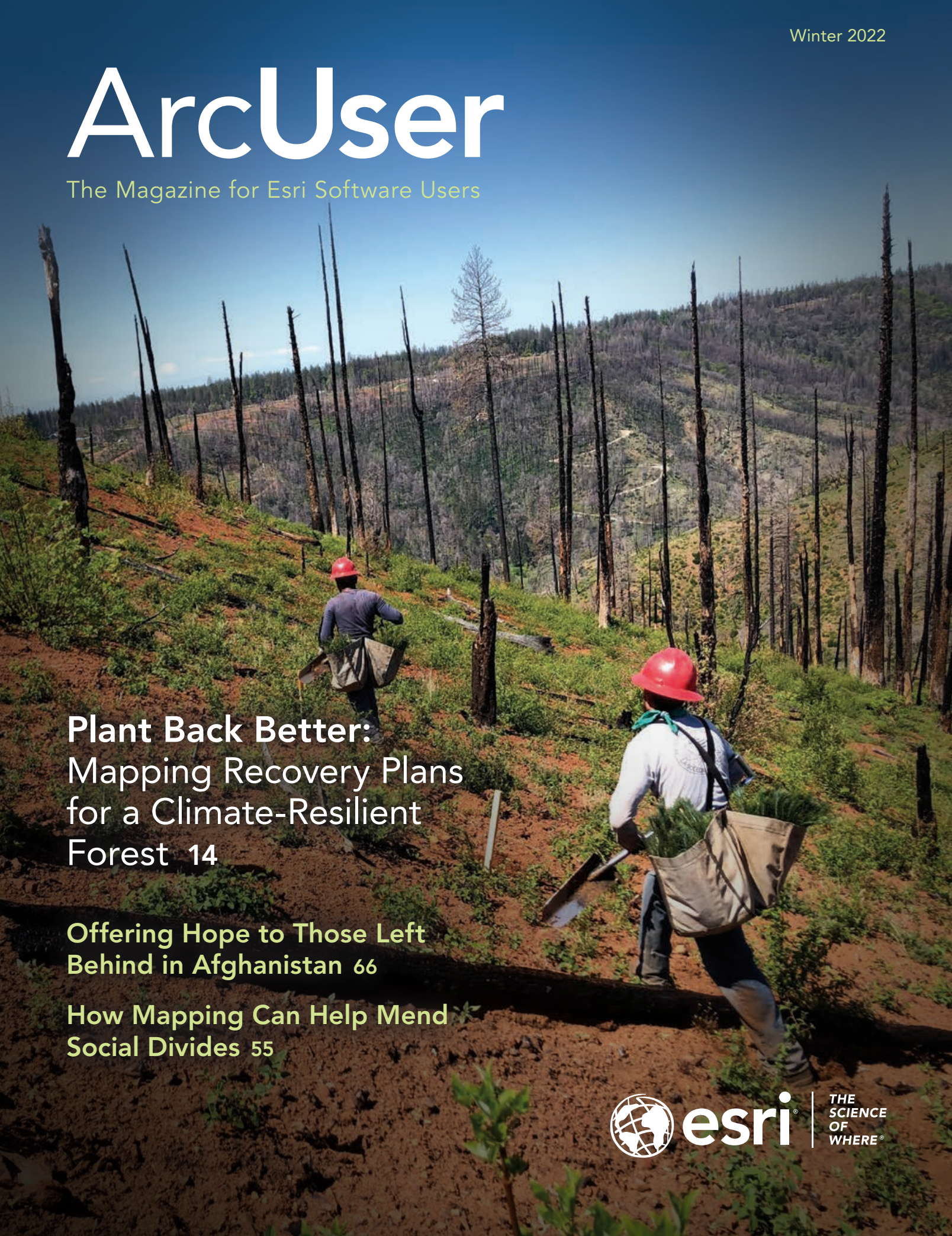
Winter 2022

ArcUser

The Magazine for Esri Software Users



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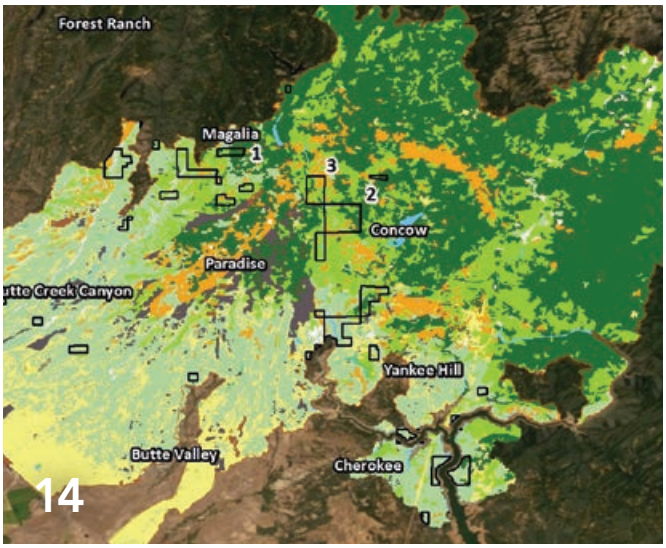
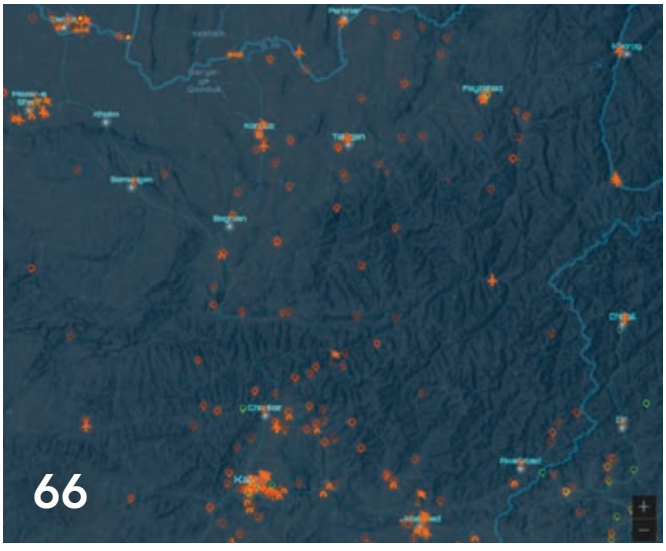


Focus

Special Section



End Notes

On the Cover

Planting crews at the Bureau of Land Management's Jordan Hill parcel in Butte County, California in spring 2020. (Photo courtesy of Austin Rempel, senior forest restoration manager for American Forests)

Understanding Where to Act

As the world deals with the devastating effects of more frequent wildfires, longer droughts, and more intense tropical storms that are attributed to climate change, the other great and interrelated challenge of our era—loss of biodiversity—is often overlooked.

Preserving the abundance and variety of life on Earth is required to support humanity and achieve the United Nations (UN) Sustainable Development Goals (SDGs). However, a 2019 report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) found that more animal and plant species are threatened with extinction than ever before in human history and that rate is accelerating. Clearly, action is needed.

Taking effective action will require not only understanding *what* must be done, but *where* it must be done. Everything happens somewhere. GIS is the technology that uses where to make strategies actionable.

The late American biologist and biodiversity champion Edward O. Wilson was acutely aware of the need to use the geographic approach to tackle massive species loss on a global scale. In a 2018 conversation with Esri president Jack Dangermond, he noted, "We still live on a little-known planet. We still have to find out what's still out there—to find out where species are exactly. We are going to have to be doing a lot of mapping to find out where the maximum of diversity exists."

Wilson advocated transforming geography into a "digitized system of thinking ecosystems that will inform where conservation is most needed to preserve biodiversity." His vision has been realized in the Half-Earth Project, an initiative of the nonprofit E.O. Wilson Biodiversity Foundation, which advocates conserving half of the world's land and sea to preserve 85 percent of its biodiversity.

Esri, in partnership with the US Geological Survey and others, has been developing a global framework—releasing the ecological land units (ELUs), the ecological marine units (EMUs), and most recently, the ecological coastal units (ECLUs). However, the creation of an ecological infrastructure of places that should be protected will require massive participation by people—not just scientists—to capture data in the detail that is needed. According to Dangermond, "It will require everybody's imagination and all of our science and technology to measure virtually everything that moves or changes in the living world."

Monica Pratt
ArcUser Editor

ArcUser

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Editorial
Editor Monica Pratt
Contributors Matthew Lewin, Jim Baumann, Carla Wheeler, Citabria Stevens
Technical Adviser Paul Dodd
Copyediting Allan Mendiola

Design
Creative Director James Hitchcock
Designer Doug Huibregtse
Illustrator Dan Gill
Photographers Eric Laycock
Print Coordinator Lilia Arias

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

Read the article submission guidelines at **https://bit.ly/3mwMRxc**.

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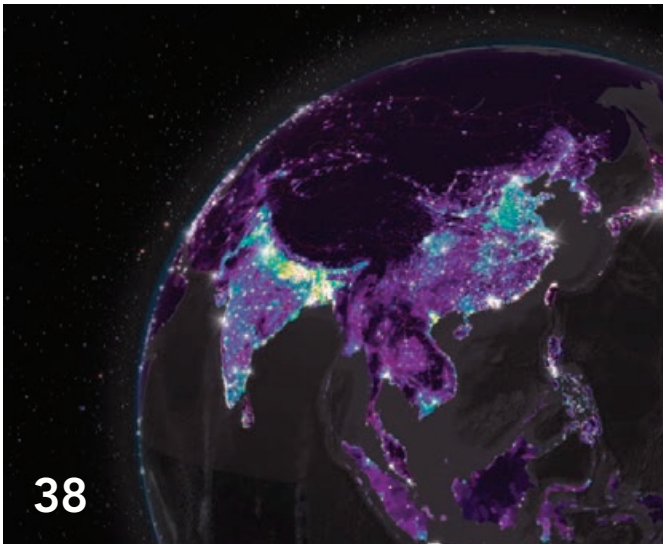


Briefly Noted

→ CDC Chooses Esri to Help Promote Confidence in Vaccines

To assist in boosting vaccine confidence across the United States, the Centers for Disease Control and Prevention (CDC) selected Esri to provide technology and services for its expanding outreach and education work. The CDC's Vaccinate with Confidence strategy will employ digital tools to give communities more resources for communicating the value vaccines hold in stopping the spread of preventable diseases.

↑ The Centers for Disease Control and Prevention (CDC) selected Esri to provide technology and services for its expanding outreach and education work to increase the rate of COVID-19 vaccination.

→ Esri North Africa Brings the Latest Technology to the Region

In partnership with Alkan CIT, Esri established Esri North Africa, LLC (Esri NA), as the sole distributor of ArcGIS technology for Egypt, Libya, Sudan, South Sudan, and Chad. Esri NA will bring the latest GIS technology to these markets, raising geospatial awareness, supporting customers in building effective geospatial strategies, providing Esri-certified training courses, and establishing a strong partner network. The focus for the region will be on national security, utilities, telecommunications, oil and gas, transportation, education, and other promising industries.

→ Esri Education Manager Receives Prestigious Geography Education Award

Esri education manager Tom Baker received the National Council for Geographic Education (NCGE) President's Award for 2021. The award, given out at the discretion of the organization's president, honors Baker's service in promoting and improving geography education, as well as his recent collaboration in creating the NCGE Resource Library (library.ncge.org), which features curated geography education content from teachers around the United States.

→ Join Your GIS Peers in Esri Community

ArcGIS users can turn to Esri Community to find solutions, share ideas, and collaborate to solve problems with GIS. Members can join groups with others who share their interests in specific products, industries, services, ideas, and other related topics. Visit community.esri.com/ to join at no charge.

→ Cloud-Hosted Geospatial Technology Makes Imagery Data Easy to Consume

To satisfy a growing demand for this data, Microsoft has teamed with Esri to rapidly analyze imagery data captured by satellite providers in space orbit. Esri's ArcGIS Image technology will provide processing and analysis on imagery hosted in Azure Orbital, Microsoft's satellite Ground Station as a Service. This enables seamless application and use of Azure services such as compute, storage, and AI fast data processing.

↑ ArcGIS Image technology will provide processing and analysis on imagery hosted in Azure Orbital, Microsoft's satellite Ground Station as a Service.

→ SAS-ArcGIS Bridge Is a Geoprocessing Tool That Runs SAS

To help integrate ArcGIS and SAS, the SAS-ArcGIS Bridge includes Python modules that make it possible to run SAS analytics directly within ArcGIS Pro. This capability can be shared with others who don't know how to write SAS procedures by creating a script tool that calls SAS statements and will run like any other geoprocessing tool in ArcGIS Pro.

→ Biodiversity Champion Edward O. Wilson

Edward O. Wilson, world-renowned ant researcher, university research professor emeritus at Harvard University, and a pioneer of modern biodiversity conservation, died at age 92. For his research and environmental activism, he received many of the world's leading honors including two Pulitzer Prizes. Wilson was a great supporter of GIS and spoke at the Esri User Conference in 1994 and 2019. The goal of his Half-Earth Project, an initiative of the nonprofit E.O. Wilson Biodiversity Foundation, is to protect half the earth's lands and seas to preserve 85 percent or more of the planet's biodiversity and reverse the current species extinction crisis.

↑ Renowned naturalist and Harvard University emeritus professor Edward O. Wilson spoke at the Esri User Conference in 2019.

A Guide to Sharing Imagery and Raster Data

By Mallory Delgadillo and Shea Shelby

Imagery is so much more than a pretty picture. It is purchased, collected, or acquired with the goal of extracting information from it, whether that is through visualization or analysis. However, imagery must be shared before it can be used. Even after finding a place to host imagery, it can be challenging to decide how to share it. Within ArcGIS, there are three ways to share or stream imagery and raster data: map tile cache, tiled imagery, and dynamic imagery. This article outlines the advantages and disadvantages of each method.

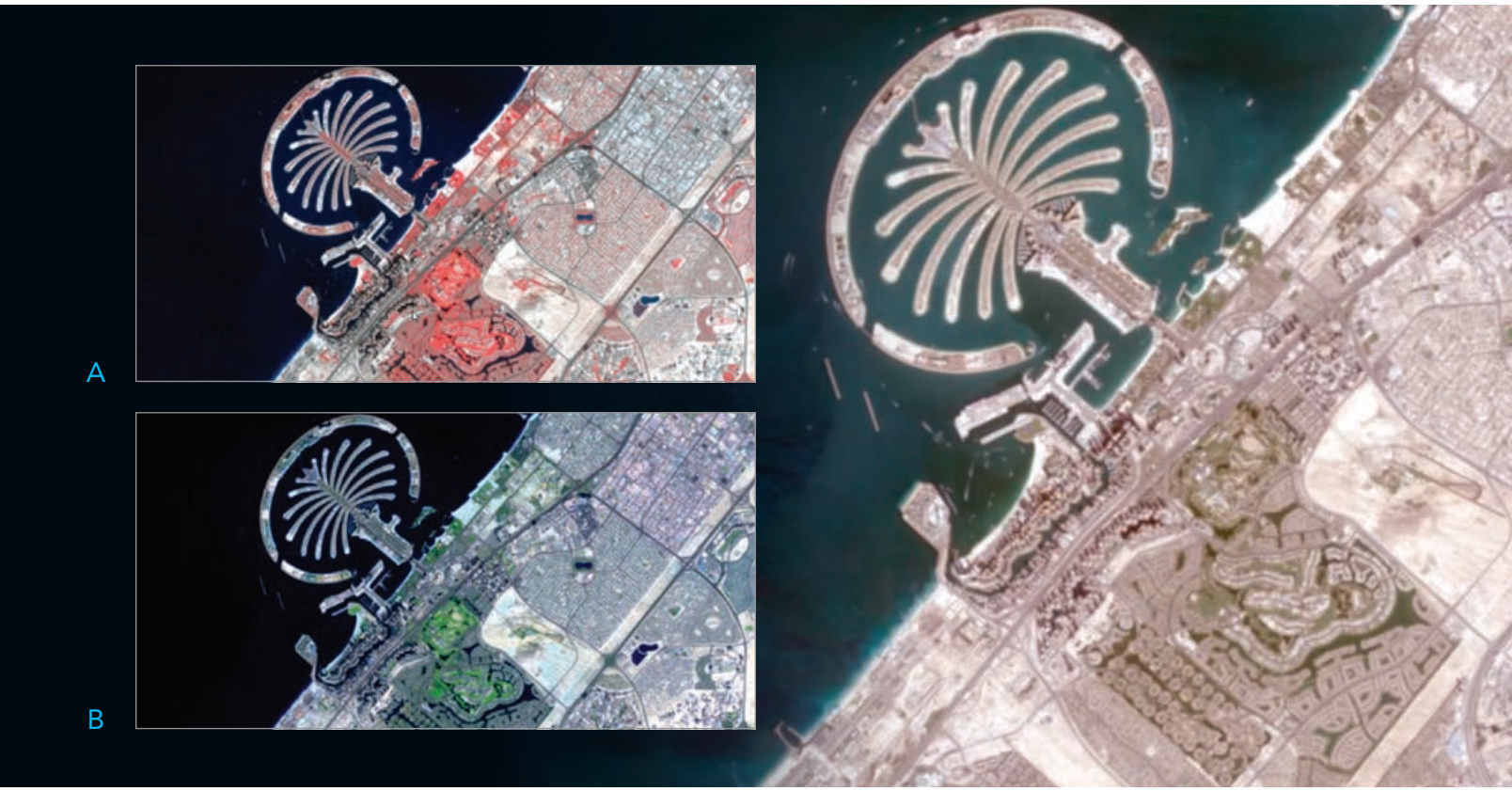
What Is Map Tile Cache?

Think of a map tile cache as a collection of images that have been tiled together to create a pretty picture that is often used as a basemap. This picture is optimized for performance and designed to scale. What makes this tile service fast is that preprocessing and compression are performed before it's served. Because each tile is cached and optimized for display, the tiles are drawn immediately after panning and zooming the map.

Advantages

Map tile cache is highly performant, which makes it ideal for visualization. When imagery or elevation data is solely intended to serve as a backdrop or basemap, streaming imagery as map tile cache is the best choice.

↓ Map tile cache is highly performant, which makes it ideal for visualization when imagery is used as a backdrop or basemap.



↑ Tiled imagery layers provide an experience that's just right for visualization and analysis with no loss of pixel fidelity. It provides more than a single image. Band colors can be manipulated. (A) Color infrared (B) Short-wave infrared.

Disadvantages

Although map tile cache receives high marks for performance, note that it is streaming "dumb," compressed image tiles. The rich information typically contained within imagery is lost. The map tile caching process automatically saves imagery as 8 bit and projects it to a single projection—typically Web Mercator. This means that minimal analysis can be performed on this imagery. A map tile cache doesn't provide access to spectral bands, image metadata, or the ability to reproject the imagery. If stakeholders in the organization need to do more with imagery than basic visualization, use streaming tiled imagery or dynamic imagery layers.

What Are Tiled Imagery Layers?

Like map tile cache, tiled imagery layers bring a collection of images together to create a single service or carpet of imagery. However, unlike a map tile cache, the images do not have to be compressed or projected, so more information from the original imagery is retained by the streaming service.

Advantages

Tiled imagery provides an experience that's just right for visualization and analysis. It's fast and performant, like map tile cache, but the tiles render on the client side, so no work is required on the server side. However, the rich content within the imagery is preserved, and no pixel fidelity is lost. This means the number of bands streamed isn't limited, the bit depth stays true to the original imagery, and pixel values can be obtained for any location, which allows for analysis, set renderings, and visualization of different band combinations using a single analysis-ready imagery layer.

Disadvantages

Tiled imagery is not ideal for overlapping, multiresolution, or multitemporal imagery. Because tiled imagery layers treat data like a carpet of imagery with a preset projection and pixel size. Streaming dynamic imagery layers is the best choice for stitching together imagery in real time from different sensors or for different days for a given area.

← Dynamic imagery is an image collection that's dynamically mosaicked/stitched together on the fly by the server. It is great for use cases that require stepping through time or dynamically sorting imagery based on attributes such as cloud cover, date of acquisition, or nadir angle. (A) Imagery with cloud cover (B) Imagery with different acquisition dates that show change over time (C) Imagery showing moisture index data (D) Imagery providing data on vegetation health

What Are Dynamic Imagery Layers?

Dynamic imagery is an image collection that's dynamically mosaicked/stitched together on the fly by the server. During panning and zooming, the imagery that covers the specific extent required is fetched from the server. For the area of interest, a call is made to the server to pick all the imagery in that area, process that imagery (if required), stitch the imagery together, and then send it to the client's view. This process results in a dynamic view based on specified mosaic rules that is extracted directly from the source imagery.

Advantages

Use dynamic imagery layers to analyze overlapping and multitemporal imagery. This image service is great for use cases that require stepping through time and dynamically sorting imagery based on attributes, such as cloud cover, date of acquisition, or nadir angle.

For scenarios in which cloud cover is an issue, available imagery without clouds can be dynamically chosen. To perform a change detection workflow, use a dynamic imagery layer to query two images of the same extent captured on different dates. And if that wasn't enough, dynamic imagery layers can process imagery on the server using raster functions before streaming the

pixels back to the client. In essence, a dynamic imagery layer can finely control the imagery that is received.

Disadvantages

Because the data is processed on the fly and dynamic imagery layers provide additional capabilities, they tend to be slower and slightly more expensive than either map tile cache or tiled imagery. Dynamic imagery layers also require processing power from the server. If hosting imagery via ArcGIS Image for ArcGIS Online, these services can only be streamed within an organization and cannot be streamed publicly. Alternatively, dynamic imagery layers can be streamed publicly via ArcGIS Image Dedicated, Esri Managed Cloud Services, or ArcGIS Image Server.

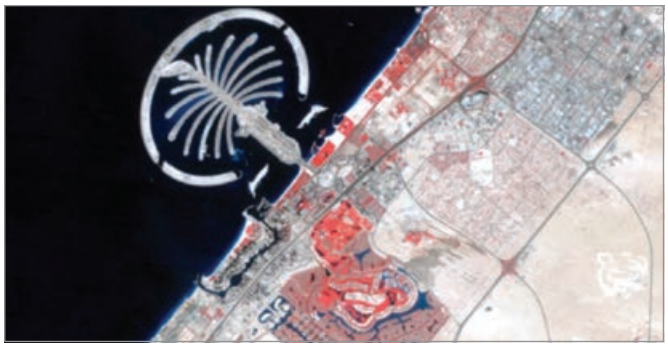
Take the Next Step

For a quick way to host and share imagery and raster data try ArcGIS Image on ArcGIS Online. Learn more at https://bit.ly/3y3LuNn. For more information on sharing imagery and raster data, see the Esri Imagery Workflows site at https://bit.ly/3Iy0K9W.

About the Authors

Mallory Delgadillo, who joined Esri in 2015, is the lead product marketing manager for Esri imagery and spatial data science products. She received a bachelor's degree in business administration, marketing management, and international business.

Shea Shelby is a senior product manager on the imagery and remote sensing team. Before joining Esri in early 2021, he spent six years as a product manager in the satellite imagery industry. Shelby received a bachelor's degree in geography from the University of Oklahoma.



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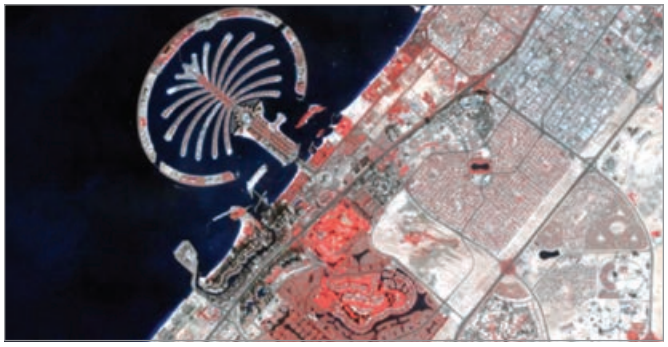


B

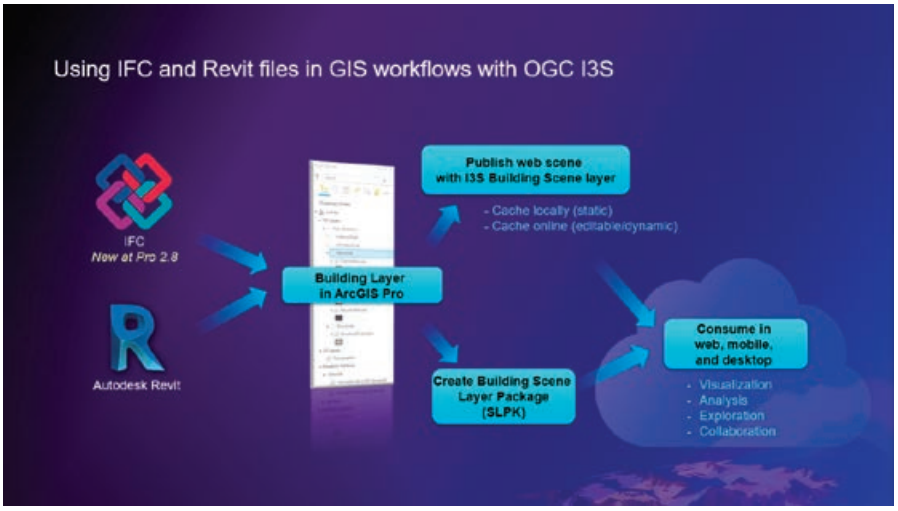
↑ Use dynamic imagery layers to analyze overlapping and multitemporal imagery. It is great for use cases that require stepping through time as shown in these two images from 2006 (A) and 2017 (B).

↓ This table summarizes the advantages and disadvantages of each method for sharing imagery in ArcGIS.

	Map Tile Cache	Tiled Imagery	Dynamic Imagery
Performance	Fast	Fast	Slower
Ideal Use	Visualization	Visualization and Analysis	Dynamic Visualization and Analysis
Share	Private and Public	Private and Public	Private with Public supported only in ArcGIS Image Dedicated and ArcGIS Image Server
Overlapping Imagery	No	No	Yes
Serve Using	ArcGIS Online	ArcGIS Image for ArcGIS Online, ArcGIS Image Dedicated, and ArcGIS Image Server	ArcGIS Image for ArcGIS Online, ArcGIS Image Dedicated, Esri Managed Cloud Services, and ArcGIS Image Server

Making More BIM Content Available

By Steven P. Santovasi, GISP



↑ ArcGIS Pro can directly read BIM files in IFC using the same workflows used with Revit files.

Esri's continued focus on the integration of building information modeling (BIM) and CAD with GIS has created some exciting results. As the divisions between GIS, BIM, and CAD workflows continue to fade, great opportunities are emerging. Ultimately, these advances help project collaboration, critical stakeholder engagements, and innovative project delivery solutions.

With the release of ArcGIS Pro 2.8 in May 2021, Esri introduced new capabilities for CAD and BIM integration that make more BIM content available for ArcGIS workflows. ArcGIS Pro can now directly read BIM files in Industry Foundation Classes (IFC) format in addition to Autodesk Revit (.rvt) and Autodesk Civil 3D (.dwg) files.

IFC is a standard for openBIM data exchange. It is used for transferring model data between software systems. This widely used schema helps designers share BIM content from any source that supports the standard. Many BIM software vendors export to IFC. Adding this capability brings a powerful method to share data between those applications, directly with ArcGIS. Currently, ArcGIS Pro supports Building IFC 2×3 and 4x and will expand as future standards are adopted.

New BIM Format with the Same Workflows

This new direct IFC integration uses the same BIM workflows already familiar to those who have used Revit files with ArcGIS Pro. These workflows encompass

- Direct read and conversion into a building layer.
- Conversion to geodatabase and I3S building scene layers.
- IFC file access through ArcGIS Pro BIM Cloud Connection to BIM 360 or the Autodesk Construction Cloud.
- Attributes and BIM categories, which are preserved during the process.

The Foundation for Digital Twins

Bringing an IFC or Revit BIM model into ArcGIS Pro empowers GIS professionals, who can incorporate and share BIM in context with other projects and geospatial data. By bringing the model into ArcGIS, it can become part of the overall project delivery strategy. The model can be directly viewed in context with all project data, including geospatial data, construction and environmental inspections, information on safety issues, and reality capture data. This is the foundation for building a digital twin to help manage the success of the project.

Publishing BIM content to ArcGIS Online or ArcGIS Enterprise helps get the data into the hands of all project teams. Creating out-of-the-box end-user web mapping applications with ArcGIS Experience Builder or ArcGIS Web AppBuilder changes the game for project delivery. This allows highly technical content to be leveraged by nontechnical users for greater stakeholder insight and collaboration.

↓ Autodesk Civil 3D Entities

Autodesk Civil 3D Objects	Esri Geometry Type
Alignment	Polyline
Alignment Profile	Polyline
Appurtenance	Point
Catchment	Polygon
COGO Point	Point
Feature	Polygon
Fitting	Point
Parcel	Polygon, Polyline
Pipe	Polyline
Site	Polygon
Structure Point	Point
Surface Point	Point

Autodesk Revit and Civil 3D Support

In addition to IFC support, ArcGIS Pro 2.9 builds on existing Autodesk Revit integration by supporting versions 2017–2022. The Revit files are upgraded to the latest version in memory while loading. Direct support for Autodesk Civil 3D has expanded and includes alignment, parcel, and pipe objects. Now site designs, GIS data, and building models can all share the same space. In addition, this can give valuable insight to office staff and field crews. The bottom line is that all project teams can streamline their project workflows, which can save time and money. Ultimately, this enables greater opportunities for project success.

BIM Cloud Connection

The BIM Cloud Connection in ArcGIS Pro allows users to directly connect to Autodesk BIM 360 or Autodesk Construction Cloud. This BIM and CAD content connection helps to manage models, versions, and collaboration efforts between design and GIS teams. Because users can go directly to the source of truth for BIM and CAD designs, they manage versions being represented in ArcGIS over multiple iterations.

ArcGIS GeoBIM—The Next Step in BIM Integration

The other big news in GIS and BIM integration is the release of ArcGIS GeoBIM. After leveraging ArcGIS Pro to establish BIM content and publish the models, powerful new web applications can be created. These applications can include direct links to Autodesk Construction Cloud or BIM 360 content with ArcGIS GeoBIM. Connecting the ArcGIS cloud directly with the Autodesk cloud means design teams can interconnect and collaborate directly. The result is an easy-to-use, cloud-to-cloud solution to help project teams make coordinated, informed decisions.

The ability to tie GIS features directly to the corresponding BIM element gives powerful insight to stakeholders beyond the GIS and design teams. Linking data from multiple systems and configuring ArcGIS GeoBIM web applications simplifies communication and collaboration. Viewing issues and linking to drawing sheets and other records has never been easier.

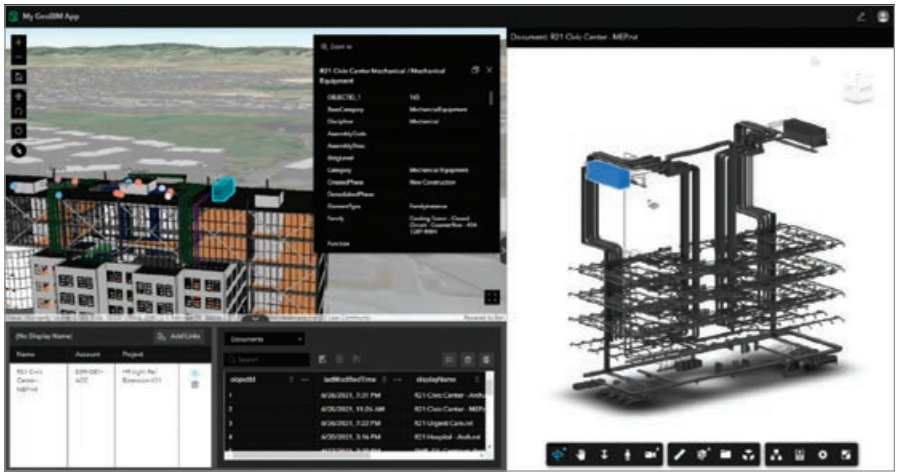
The initial October 2021 release of ArcGIS GeoBIM supports ArcGIS Online. ArcGIS Enterprise support will follow in 2022.

About the Author

Steven P. Santovasi is a senior product manager for architecture, engineering, and construction (AEC) and smart assets. He focuses on the alignment and development of ArcGIS products to help improve collaboration, transparency, and sustainability throughout the life cycle of infrastructure assets, including the planning, design, construction, and operation phases of projects for the AEC industry and owner/operators. His work in BIM and CAD integration continues to push ArcGIS forward in project delivery and digital twins. Santovasi has more than 25 years of experience in developing geospatial solutions for the AEC, government, and utility sectors.

↓ ArcGIS Experience Builder allows highly technical content to be leveraged by nontechnical users for greater stakeholder insight and collaboration.

↓↓ ArcGIS GeoBIM is a solution for exploring BIM models, engineering documents, and project management issues in a geographic context to analyze risks, costs, and timelines.



← Wolfy Rougle of the Butte County Resource Conservation District surveys replanting plans. (Photo courtesy of Austin Rempel, American Forests)

PLANT BACK BETTER

Mapping Recovery Plans for a Climate-Resilient Forest

By Mike Bialousz

In 2018, an enormous California wildfire claimed 85 lives and consumed the entire town of Paradise. Ever since, experts have been devising ways to safeguard against another tragedy and rebuild the forest destroyed by the Camp Fire. Rather than simply replant what was there, the Bureau of Land Management (BLM) set out to map a climate-informed restoration plan.

"We want to plant it back better to withstand wildfire and future climate, so the community is not vulnerable like that again," said Coreen Francis, California and Nevada state forester at the BLM.

During her more than a 20-year forestry career, Francis has seen shifts in forest health from drought, insects, disease, and climate. The pace of change in the forests around Paradise has forced everyone to reexamine their understanding and try to catch up. To create a smart restoration plan, she convened experts to combine their knowledge about the land and forest using GIS to build a sustainable plan.

In less than a decade, several fires had burned across the same area that was devastated by the Camp Fire, which burned 153,336 acres. Since 2018, more megafires have hit, including the North Complex Fire that consumed 318,935 acres in 2020, and the Dixie Fire that burned 963,309 acres in summer 2021. Together, these fires have left few trees untouched in this corner of Northern California.

Because the climate has changed, the types of trees that should be used in replanting the area have also changed, according to Austin Rempel, senior manager of reforestation at the nonprofit American Forests. "For instance, sugar pine is everyone's favorite tree because they grow big and look nice, but climate models say they don't want to live here anymore. Low-elevation sugar pine is going to be a thing of the past."

Assisting Tree Migration

Trees can't just pick up their roots and move, and a natural migration could take centuries. It's up to foresters to plant for what the forest wants to become, a practice known as "assisted migration."

"Assisted migration is a no-brainer for our organization, knowing that forests need to adapt," Rempel said. "In the Camp Fire area, because of its low elevation, it's quickly turning from dense mixed conifer forest into a place that wants to be more oak and grassland and chaparral and gray pine."

Analysts at American Forests apply models that use spatial analytics to consider species tolerances and soil types, along with climate forecasts about heat and rainfall, to predict what plants will want to live in a place, far into the future.

This level of climate action requires a detailed map to understand what exists, the conditions best suited for each plant, and where similar conditions can be found elsewhere. GIS is used to perform this suitability analysis, with predictions that improve with more data.

For Francis and other foresters, ArcGIS Online became a

repository where they could combine data, plan collaboratively, and view a shared map on portable devices as they roamed the burn scar. Checking the map in the field is called ground truthing, and it provides the opportunity to adjust and add more details.

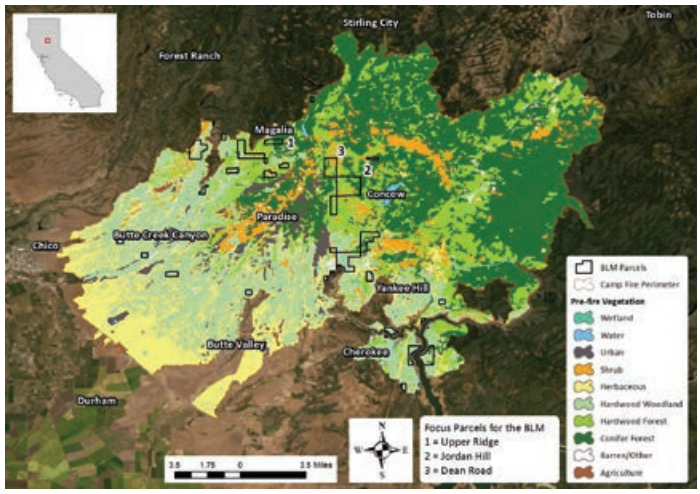
"Some data we had was wrong," Francis said. "Being able to see it right there allows us to build knowledge and make our plan a little more accurate. We take scientific concepts, and we look at them on the ground, and then we compare them with what we see on the map," she said. "We can scroll and look at different layers while we're walking to inform us of things that we can't readily see. Knowing the soil type is serpentine, for example, explains why those trees look scrawnier."

Planting and Planning Simultaneously

In California, the BLM manages 15 million acres. Much of this land is inaccessible to crews replanting trees. The number of seedlings available is limited, so they must be planted carefully where they will thrive.

"Based on capacity, resources, and access, we can only hope to reforest about 10 percent of the Camp Fire burn scar, and that's if everyone is working together," Rempel said. "That's another place where GIS comes in handy, because we have to be extremely strategic and know we're doing the right things in the right places."

Much of BLM's management practices are guided by shared



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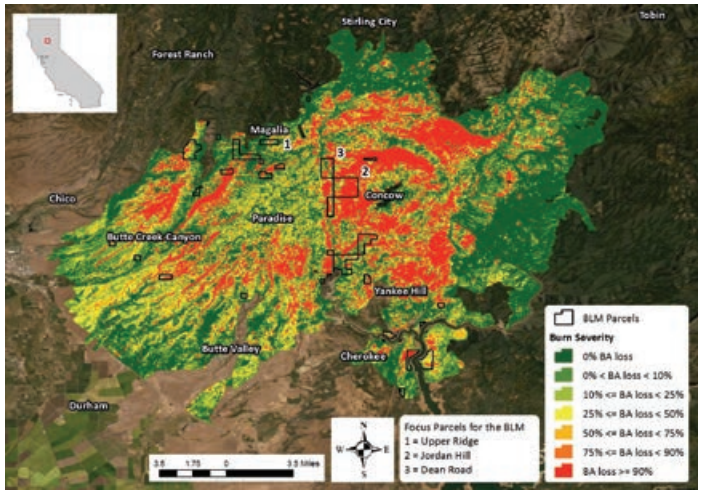

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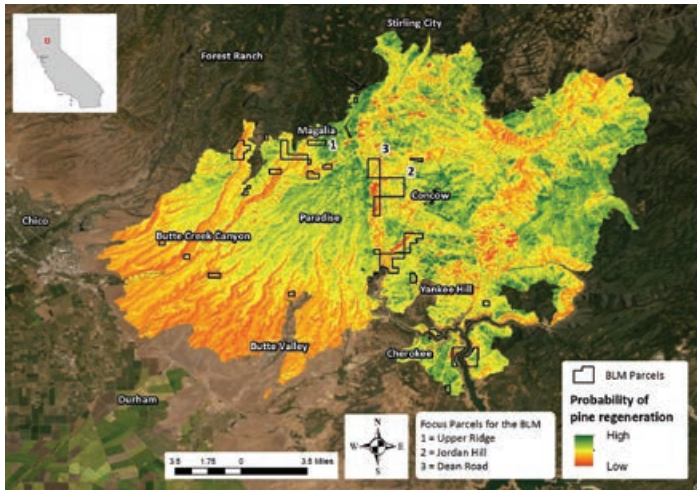

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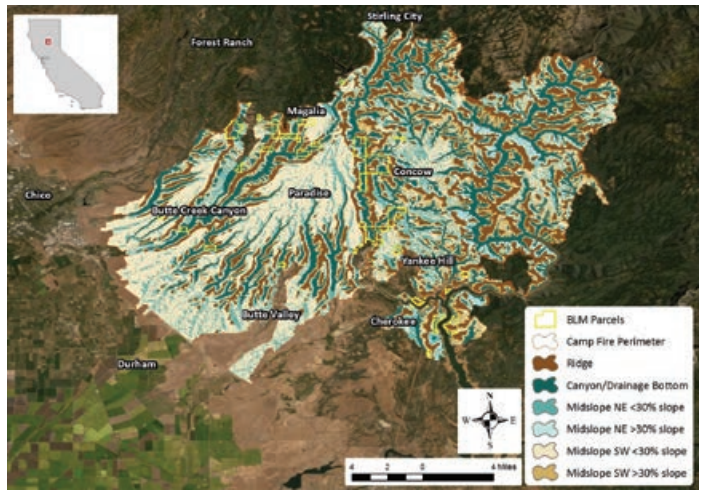

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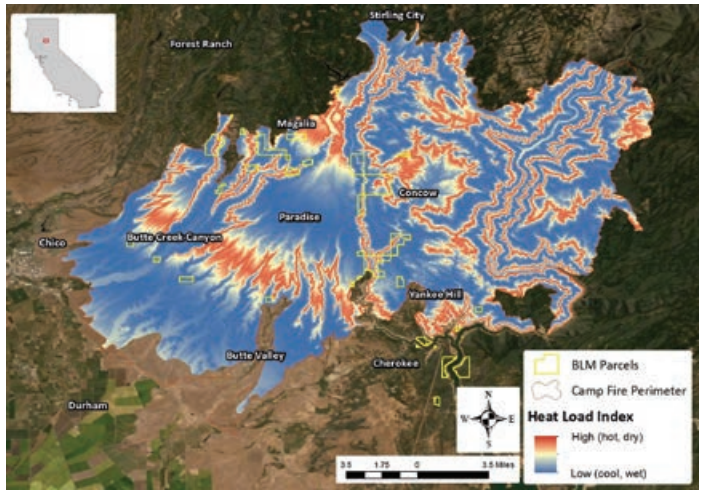

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← Analysts at American Forests apply models that use spatial analytics to consider (A) prefire vegetation, (B) burn severity, (C) probability of pine regeneration, (D) fire perimeter, and (E) fire heat load as well as soil types and other characteristics that predict the survival rate for plants.

↑ Comprehensive analysis of the environmental aspects at a site guide replanting plans to maximize success.

maps. GIS is well suited to landscape-level planning because it contains details on the topography—ridges, rock outcroppings, slopes, water, and valleys. Foresters must consider multiple locational factors that influence seedlings' success. Among them: north-facing slopes are cooler, south-facing slopes are drier, and valley bottoms have the deepest and best soils.

"Mapping the landscape is a starting point," Rempel said. "It shows us what the forest should look like and what we should plant there."

The map pinpoints the places that will be climate stable and ideal for planting specific species.

"We know where trees live now, and we can model the climates they're comfortable with," Rempel said. "We can use GIS to map the soil productivity and where trees would be most successful."

The model and map include ecology, with data to analyze and explore the pieces of the environment that contribute to a tree's survival. GIS has become a repository of information about the earth's processes and a way to query and model data so that nature-based solutions can be applied.

"We've talked about the concept of island plantings, where you put a diversity of species into a small plot, maybe a quarter of an acre, and grow those in clumps or islands across the landscape," Francis said. "Eventually trees will produce seed, and the seed will burst into the surrounding area, and it promotes more diversity on the landscape."

GIS also was used to plan and create natural fire breaks to reduce the intensity of future fires. The map helped speed reforestation by identifying strategic areas for initial planting.

Commons for Collaboration

Multiple stakeholders and participants were involved in making the climate-informed restoration plan. BLM guided the effort with the help of American Forests and participation from the US Forest Service, Plumas National Forest, Butte County Fire Safe Council, Sierra Pacific Industries, and others.

Having a timber company at the table is unusual, but so is what happened to Sierra Pacific's part of the forest that burned in 2012. Company staff diligently replanted it in hopes of harvesting lumber, and then just six short years later, everything they planted was burned in the Camp Fire. "That was enough for them to say, 'This is not a place where we can do production forestry anymore,'" Rempel said.

All the stakeholders came to the planning sessions with ideas, maps, and open minds. The evidence was clear: everyone was wasting their time by doing the same things that had been tried before.

"Permaculture ideas—nature-based approaches—are starting to enter into forestry," Rempel said. "It takes a very long time to convince old-school foresters that this is the way, but it is happening slowly."

Species name	Common Name	Climate Temp	Climate Precip	Fire Sensitivity	Germination Agents	Dispersal Mode	Reproductive Lifespan	Sensitivity Score	Fire	Recruitment Mode /Fecundity	Seed Longevity	Adaptive Capacity Score
Pinus aristata	Bristlecone pine	4	3	1	4	5	2	3.2	5	4	5	4.7
Pinus ponderosa	Ponderosa pine	3	3	5	2	4	5	3.7	4	4	1	3.0
Pinus sabiniana	Gray pine	4	3	2	4	5	3	3.5	1	4	4	3.0
Quercus chrysolepis	Canyon live oak	3	3	4	3	2	5	3.3	5	3	1	3.0
Quercus wislizeni	Interior live oak	4	3	4	3	2	3	3.2	5	4	1	3.3
Calocedrus decurrens	Incense cedar	3	3	5	2	3	5	3.5	1	5	1	2.3
Pseudotsuga menziesii	Douglas fir	3	3	5	3	4	5	3.8	1	3	1	1.7
Quercus kelloggii	California black oak	3	2	3	3	2	5	3.0	5	3	2	3.3
Quercus lobata	Valley oak	3	3	5	3	2	5	3.5	5	1	1	2.3
Lithocarpus densiflorus	Tanoak	3	3	4	3	2	5	3.3	5	1	1	2.3
Pseudotsuga macrocarpa	Bigcone Douglas-fir	3	3	4	2	3	5	3.3	5	1	1	2.3
Pinus lambertiana	Sugar pine	3	3	5	2	4	5	3.7	1	2	1	1.3
Quercus garryana	Oregon white oak	3	2	4	3	2	5	3.2	5	1	1	2.3
Pinus jeffreyi	Jeffrey pine	2	3	4	2	3	5	3.2	1	3	2	2.0
Quercus douglasii	Blue oak	4	4	3	3	2	4	3.3	3	1	1	1.7
Abies concolor	White fir	2	2	2	2	4	5	2.8	1	5	1	2.3
Acer macrophyllum	Bigleaf maple	2	2	4	3	3	2	2.7	5	1	1	2.3
Juniperus californica	California juniper	3	3	1	2	2	3	2.3	5	2	2	3.0
Arbutus menziesii	Pacific madrone	2	2	2	2	2	5	2.5	2	1	3	2.0

↑ This table ranks the sensitivity and adaptive capacity of species, ranging from red for species that are highly sensitive and have low adaptability, to green for species that are less sensitive and have high adaptability. (Image courtesy of American Forests)

ArcGIS Online became the place where everyone could work and iterate together. For those not familiar with GIS, they could view the maps and agree or disagree with what they were presented.

"The sharing platform was central to our collaborative approach and our climate conversations," Rempel said. "We had these sessions during different versions of the draft where we got all the land managers and foresters together to go over what they were seeing or if other tricks of the trade should be added to the report."

Replanting Wisely

The foresters who crafted the Camp Fire restoration plan hope that climate-informed strategies become more common. This approach is practical because it makes the most of limited resources by pinpointing the places where the forest can thrive.

"Many of the climate plans just offer big-picture ideas—about techniques that could be applied," Francis said. "Our plan takes those large concepts to the ground level. Predictions of what the climate is going to be informs our implementation plan."

According to research at American Forests, 81 percent of reforestation needed on national forest land is now due to wildfires rather than logging. To replant wisely, new models must factor in future climate.

"This is a recovery plan," Francis said. "It's about using the best science to replant."

About the Author

Mike Bialousz is a senior consultant and practice lead for state and local government environment and natural resources customers at Esri. Bialousz has more than 27 years of experience working in GIS and mapping, including management positions in the private sector and Pennsylvania state government. All his experience has involved implementing GIS for natural resources challenges. He has also taught GIS at several Pennsylvania colleges and universities for the past 13 years.

Site Suitability Modeling for Locating Tidal Buoys

By John Doroba

Editor's note: The author developed a suitability model that allows users to determine suitable anchorage locations for National Oceanic and Atmospheric Administration (NOAA) Global Navigation Satellite System (GNSS) tide buoys located in the US Exclusive Economic Zone (EEZ).

Identifying the anchorage of NOAA GNSS tide buoys is an important component that supports one of NOAA's primary missions: charting depths for safe and efficient navigation via its nautical chart suite. Deploying GNSS tide buoys to update vertical datums is the principle reason that this anchorage suitability model is important. *[According to NOAA, "A geodetic datum is an abstract coordinate system with a reference surface (such as sea level) that serves to provide known locations to begin surveys and create maps. Horizontal datums measure positions (latitude and longitude) on the surface of the earth, while vertical datums are used to measure land elevations and water depths."]*

GNSS tide buoys allow NOAA to collect ellipsoid heights and water level data, evaluate the measurements, and empirically determine the vertical difference between the ellipsoid and tidal datums. *[A tidal datum is a standard elevation defined by a certain phase of the tide.]* Equipped with accurate information derived from tide buoys, NOAA hydrographers and cartographers can properly chart soundings (or depths), which use vertical transformations between the ellipsoid and tidal datum to convert in situ sonar depth data to the appropriate tidal datum such as Mean Lower Low Water (MLLW), which is the tidal datum used for the majority of US nautical charts. *[MLLW is the average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch (NTDE). NTDE is a 19-year period established by the National Ocean Service for collecting observations on water levels and calculating tidal datum values.]*

As the quantity and density of measurements increases, vertical transformation models, also known as separation (SEP) models, increase in accuracy. Therefore, more buoys are needed to acquire more accurate data.

After extensive testing and validation of the anchorage suitability model, the use of GNSS tide buoys will be expanded to support NOAA field operations. This will require predetermining suitable locations to anchor the buoys. Buoys must maintain position for long durations under defined environmental conditions. It is equally critical that suitable anchorage locations for the buoys are established throughout the entirety of waters within the US EEZ. This is the area where the US government assumes jurisdiction over the exploration and exploitation of resources 200 nautical miles offshore from the nearest shoreline maritime boundary point.

The main objective of this project is to allow users to determine suitable anchorage locations for NOAA GNSS tide buoys in the US EEZ based on depth, slope, seabed, current, and wave characteristics using Python scripts that utilize GeoPandas *[an add-on for the open-source Pandas library]* to manipulate tables and ArcPy, a Python site package, to create custom ArcTools that run suitability analysis and geoprocessing. The following steps were taken to facilitate the determination and evaluation of suitable anchorage locations for NOAA GNSS buoys:

1. Develop a manual suitability model to determine appropriate anchorage locations.
2. Implement the suitability model using ArcPy and GeoPandas Python scripts to create custom toolboxes for parameter, conditional, and suitability raster creation.

3. Run suitability models for Alaska, conterminous United States (CONUS) East/Gulf/West, Hawaii, and Puerto Rico EEZs.
4. Evaluate the impact of each characteristic on the suitability model using sensitivity analysis.

ArcGIS Pro was used to develop, implement, and run the suitability model. GeoPandas Python scripts were used to modify tables and prepare raw data for the ArcPy Python scripts that created the custom tools. With these custom tools, rapid and standard workflows were developed.

In the rapid workflow, the user creates a raster for each parameter from raw data, then creates a suitability raster from the parameter raster using the raster calculator that runs inside the tool. The user creates only parameter and suitability rasters.

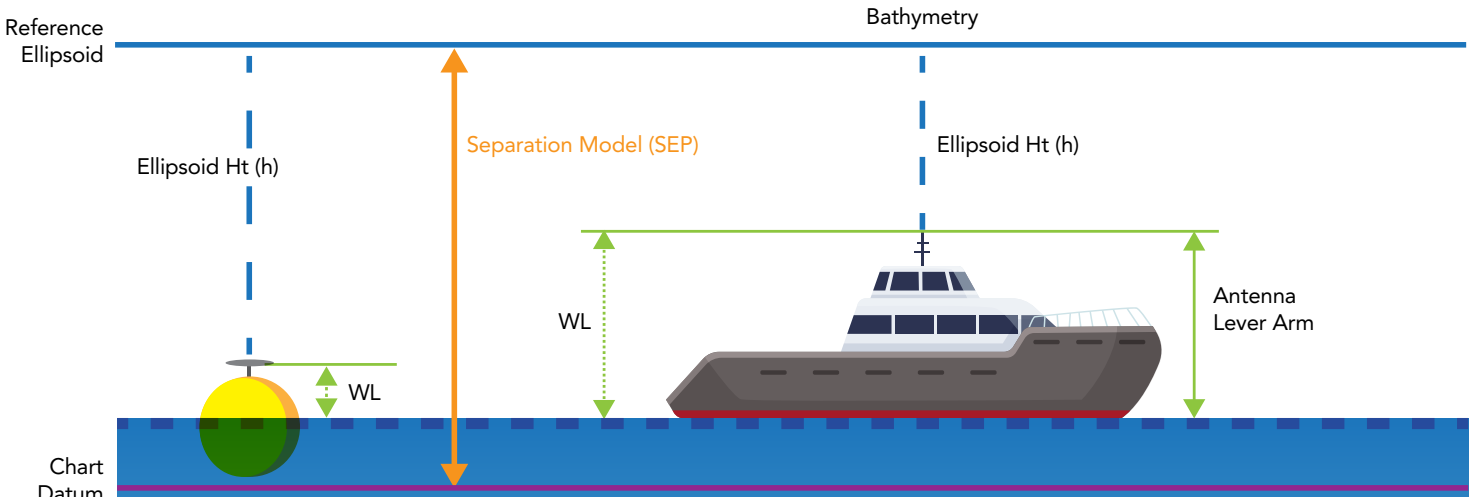
In the standard workflow, the user creates a raster for each parameter from raw data, then creates a conditional raster from a parameter raster, then creates a suitability raster from the conditional raster. The user can create visual aids for each parameter, condition, and suitability.

A sensitivity analysis tool was also developed using ArcPy. It creates a text file for 16 suitability model tests. A baseline uses parameters for the conditional value of each characteristic in the documented workflow. Three tests for each characteristic use different values for those parameters. The text file is imported into Microsoft Excel and used to create graphs for analysis. The final suitability pixel count for each model is graphed relative to the user-defined parameter values. This process is repeated for all suitability parameters for a given EEZ. Each is analyzed, and the sensitivity of each is ranked. Final sensitivity analysis showed that depth and wave height have the largest impact on suitability in all EEZs except CONUS East, where seabed is the most significant characteristic followed by depth and wave height.

In total, there are nine tools: four parameter tools, two condition tools, two suitability tools, and one sensitivity analysis tool. ArcPy scripts for customized tools further allowed the user to define the resolution and projection of outputs, raster mask feature classes, required inputs, and output names and directories.

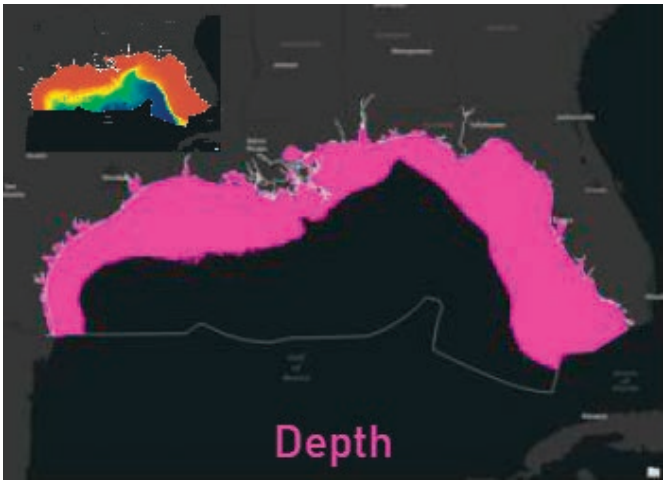
The tools can be easily manipulated to include additional publicly available data, such as Automatic Identification System (AIS) or Dangers to Navigation data, or use alternative sources of seabed data or data in other formats. The custom tools also foster repeatability but still provide agility. By using compartmentalized modules, one can rerun parts of a process instead of one long process or tool that burdens the user with far too many inputs if variables change or an error is made. The tools provide ease of use and improved workflow efficiency via user-friendly interfaces for a task that is time-consuming and needs to be performed for more than one area.

Although the project focuses on locating NOAA GNSS tide buoys, the model can be used for any floating platform, such as another buoy type or a ship. It could also be used for a fixed platform, such as an

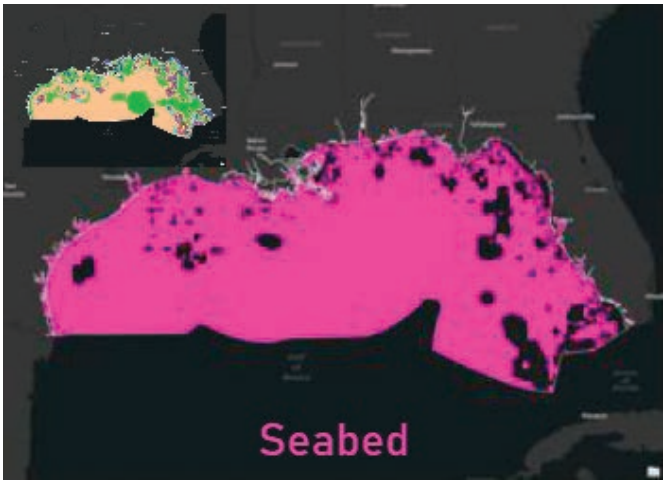


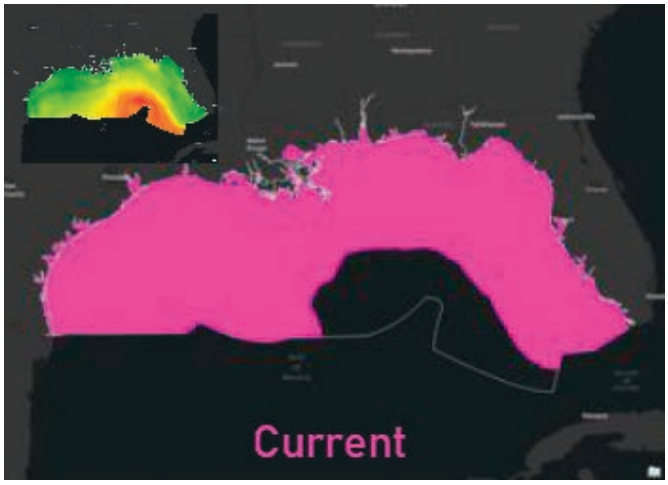
GNSS Tide Gauge Buoy Datum Development

This diagram shows the relationship between the reference ellipsoid, antenna, waterline (WL), and chart datum. NOAA surveys are referenced to the ellipsoid. The ellipsoid height is established averaging high-accuracy GNSS positioning techniques. These surveys are transformed to tidal datum via vertical separation (SEP) models derived from buoy data.

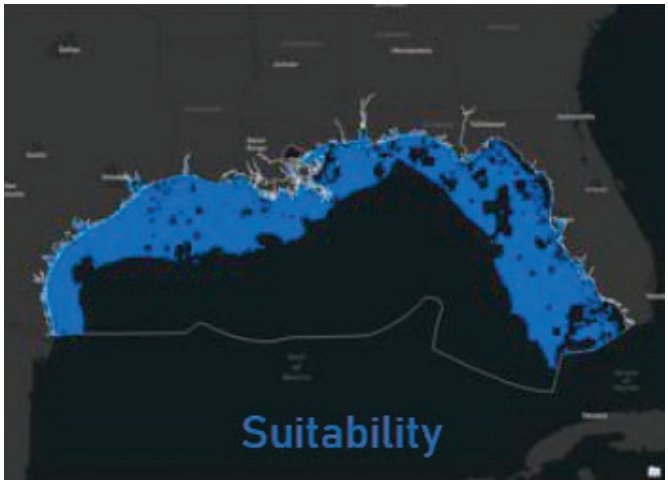

Depth

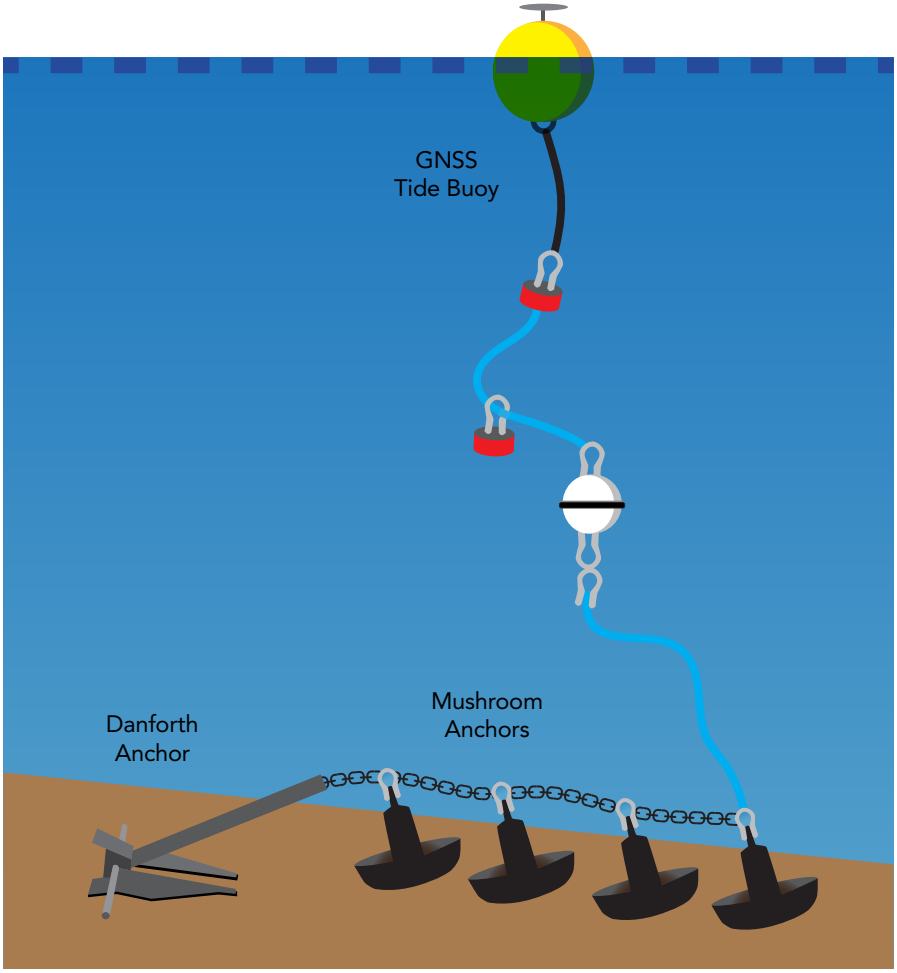

Slope


Seabed


Current


Wave Height


Suitability



← NOAA GNSS tide buoy and anchorage configuration.

About the Author

John Doroba, who currently works at the NOAA Hydrographic Systems and Technology Branch (HSTB), has 15 years of experience in the hydrographic survey industry. After graduating from the University of Delaware in 2006 with a degree in geography, he went to work on NOAA's navigation response teams and was part of emergency response to hurricanes, the emergency landing of US Airways Flight 1549 in the Hudson River, and several other special projects. He moved to the NOAA Marine Chart Division (MCD) as a cartographer working on nautical charts and then as a survey tech. Doroba left NOAA to work for the dredging industry and then returned to NOAA as a hydrographic survey technician before moving to his current position. Doroba recently completed his master's degree in GIS at the University of Maryland and hopes to increase his focus on drones for shoreline verification and GIS programming.

offshore wind farm. By modifying its scope, the application could be used to build other tools for studies based on the model's adaptability, modularization, and workflow.

NOAA hydrographic surveys require planning but can require quick changes in location or platform, depending on budget and survey requirements. Simple changes in location can result in complicated, on-the-fly modifications that cost time and money. Automated, binary suitability analysis allows for simple solutions to what could become complicated, time-consuming tasks. The suitability analysis is a cost-efficient, easily deployable solution that helps NOAA scientists quickly decide where to anchor GNSS tide buoys in conjunction with hydrographic surveys for nautical chart updates.

For more information, contact John Doroba at John.doroba@noaa.gov.

Conditional and suitability rasters in the Gulf of Mexico

← Each inset graphic shows the parameter rasters. The values used to define conditional parameters were depth, less than or equal to 175 meters (m); slope, less than or equal to 15 degrees; seabed equal to sand, mud, and clay; current less than or equal to 1.5 m/second; and wave height less than or equal to 2.5 m. (Courtesy of John Doroba, NOAA)

Small Team Makes a Big Impact with Enterprise GIS

By Suzanne Boden

The City of Aspen, Colorado, is a world-famous ski resort and a vacation spot for celebrities. Aspen's GIS team has been working to make its enterprise GIS more accessible to users.

To support the GIS needs of internal staff, the team leveraged ArcGIS Enterprise.

Led by GIS program manager Bridgette Kelly, the three-person team (including Kelly) is responsible for developing and maintaining the city's GIS platform and applications. While the team is located in the engineering department, it supports all departments.

Aspen has a Small Government Enterprise Agreement and is a member of the Esri Advantage Program. Citywide, there are about a dozen individuals in other departments who use ArcGIS for their work. More than 200 city staff are light users, who consume GIS content.

Until recently, the GIS team was also fielding requests for maps and data from community members. To manage these requests, Kelly's team used a fee-for-service model for both internal staff and the public.

"They would call us up, request something, we'd take their payment, and then send *[the GIS product]* out. We realized that wasn't efficient for either side," said Kelly.

A new GIS delivery model was needed.

Embracing the Portal Paradigm

The team decided to replace fee-for-service delivery with a self-service environment.

As Kelly explained, "Because our GIS program is very small, we knew that we wanted to enable all of our users within the city to utilize the GIS resources themselves instead of calling us."

To facilitate easy access to the city's GIS maps and data, Kelly's team launched an ArcGIS Hub open data site called Map Aspen (https://mapaspen-cityofaspen.opendata.arcgis.com/). Kelly, with team members Joshua Zeeb, a GIS analyst, and Rachel Eyler, GIS project assistant, provide GIS resources to the public through the site. These resources include imagery, transportation and zoning data, 3D basemaps, and web maps and web apps. Site users can download data and create and print their own maps. The site is popular with developers as well as community members.

To support the GIS needs of internal staff, the team leveraged ArcGIS Enterprise. In 2019, the team used Advantage Program credits to engage Esri Services experts and launched an enterprise portal website to share useful GIS resources.

Enabling Self-Service GIS

With the city's enterprise portal website operational and populated with resources, it was time to engage city staff.

"Once we put up the GIS portal, we needed to start getting people in there and getting trained," said Kelly.

Initially, the team recommended that staff take Esri's free web course for new ArcGIS Online users. That course introduces high-level portal concepts that are also relevant to ArcGIS Enterprise users. However, this course wasn't a perfect solution for all city staff.

Aspen's users were working with sample datasets and portal tools and workflows in ArcGIS Online that didn't quite match those in the city's portal. While talking with Esri training consultant

Tosca Hoffman, Kelly learned that Training Services could tailor the ArcGIS Online web course specific to the experience that Aspen's enterprise GIS portal users have.

Kelly immediately saw the value of that option. "We wanted to have a customized experience where our users were entering our portal, utilizing our content, and using our workflows in order to learn the technology," Kelly said. "So, we came up with a custom course that did just that."

Kelly used Advantage Program credits to commission the custom web course. From inception to delivery, the project took five months. The course is hosted on Esri Academy (esri.com/training) but visible only to Aspen staff.

Course exercises are designed so that staff directly access and navigate through the GIS portal content. When an individual accesses the portal for the first time, their portal user account and profile are automatically created. The user profile defines the user type and privileges. By default, all new users are viewers. With a portal account and privileges, staff can complete the training and get comfortable using the portal to support their work.

Forging an Adoption Strategy

Launching the portal and providing effective training were key elements to establishing a city-wide self-service environment for GIS, but Kelly realized more needed to be done.

Department staff were used to coming to her team for GIS support. Seeking out GIS information on their own would require shifting from these entrenched habits. During their Advantage Program annual planning meeting, Kelly and Zeeb learned about Esri's people-focused change management practice. They attended the Preparing for Change workshop. Change management consultants Lyndal Brookhart and Chris Vokaty taught that workshop. It emphasized the importance of sponsorship and communication to successful change initiatives.

The concepts resonated with Kelly, who felt that Aspen's department heads might be unaware of all the support the GIS team provides to their staff. To ensure sustained adoption of the self-service portal, the GIS team would need leadership's support. After the workshop, Kelly used Advantage Program credits to retain Brookhart for one-on-one consulting. The two

↓ The custom web course uses images of the Aspen GIS Portal and hands-on exercises that guide learners through the steps to access the portal and explore the city's GIS content.

↑ GIS project assistant Rachel Eyler used ArcGIS to create 3D basemaps that depict Aspen's built and natural environments.

With more than 200 active members, the Aspen GIS Portal is supporting staff GIS needs as Kelly hoped it would.

focused on a strategy to gain sponsorship.

Kelly leveraged Brookhart's communication expertise in developing a presentation she delivered to city leaders that highlighted how GIS work was directly supporting the city's strategic goals and solving problems for each department. She also shared how GIS drives better customer service and other benefits to the community. Kelly's strategic focus was well received by leaders. Building on that success, she and Brookhart mapped out a four-phase adoption strategy dubbed the GIS User Expansion campaign. The campaign has Learn, Explore, Leverage, and Innovate phases.

For the first two phases of the strategy, Learn and Explore, the GIS team focused on raising awareness and participation across city departments. "We wanted it to be fun," Kelly said. Prizes were offered and a pizza party given for the department with the most new portal users.

The strategy has worked. With more than 200 active members, the Aspen GIS Portal is supporting staff GIS needs as Kelly hoped it would. New users are happy when they discover all the portal resources available to them.

"I don't think a lot of people realized how much content is in there," said Kelly. "They love that they can get in there and get the information to answer community member questions without bringing it to us."

Freed Up for Priority Projects

The third phase, Leverage, will focus on encouraging users to create their own GIS content in the portal. To help with that, a second custom web course will train users how to make web maps and apps. Like the first course, this one will be tailored to Aspen's enterprise GIS portal and content shared there.

Details of the final phase, Innovate, are still being planned, but Kelly would like to establish a GIS "superuser" point of contact in each department. "These users would have the necessary skills to take the platform to the next level by incorporating analytics into their projects," she said. The insights produced by superusers would support data-driven decisions across the city.

With the growth in portal adoption, Kelly, Zeeb, and Eyler have more time for projects that leverage more advanced GIS capabilities themselves. Eyler created a 3D basemap of the city, which is used for visualization and analysis support.

The team also focuses its work on priorities defined by Aspen's city council that include

transportation and climate action. To support those priorities, Zeeb conducted an analysis of the city's electric vehicle (EV) infrastructure.

"We created an *[ArcGIS]* Insights page with parking transaction data and EV charging transaction data," said Zeeb. "We used it to create an analysis and provide insight into EV viability and usage within the city, mainly built upon the idea that EV usage and production will only increase, so how can we keep up with it?"

Aspen's Clean River Program to reduce pollution in stormwater runoff from developed areas is managed by the engineering department. The GIS team is helping share information on actions that the city and residents can take to decrease pollution.

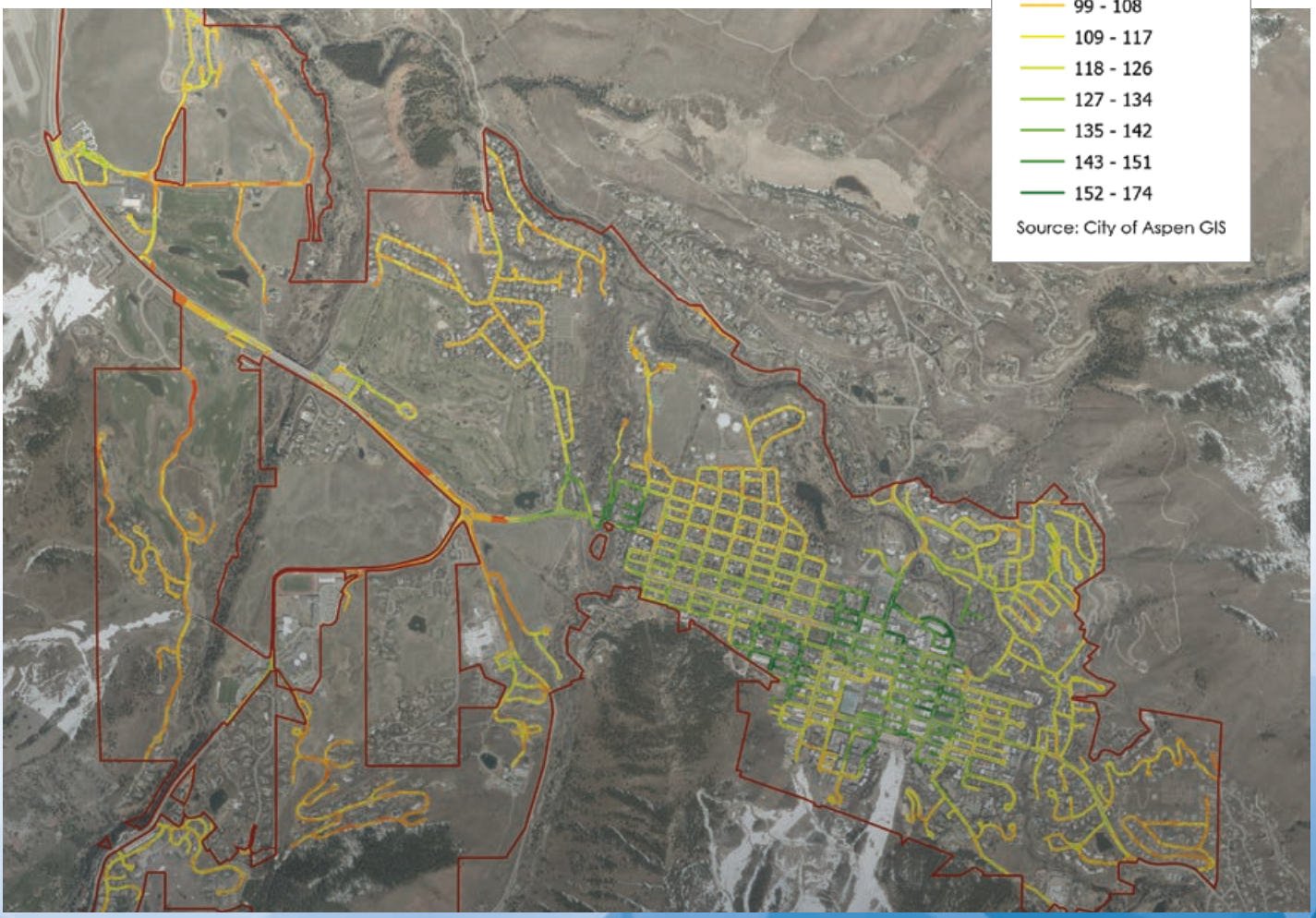
"We want to help *[them]* understand not only our stormwater infrastructure, but many of the policies, projects, and programs that will help improve the health of our river," said Kelly.

With the successful launch of their self-service GIS delivery model, the team of three is poised to make an even bigger impact with GIS-driven location intelligence.

For more information on the City of Aspen's self-service GIS initiative, contact gis@cityofaspen.com.

About the Author

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



↓ Joshua Zeeb's analysis of parking transaction data will help city leaders determine suitable locations for stations to help the public keep their electric vehicles charged.

The Role of Change Management in Strategy Development

By Matthew Lewin

Based on feedback I've received from previous articles, a common challenge for people tasked with developing a new strategy is understanding where change management fits into the process.

It's a great point, because invariably when you create a new strategy, you impose a raft of changes on your organization. So, at what point in the development process should you start managing change? And what are some tactics to address change effectively? Since I haven't seen this topic discussed elsewhere, I thought I'd tackle it here.

To be clear, I don't intend this as a dissertation on specific change management methodologies. There are countless volumes of material that cover that topic in depth. My intention is to discuss why change management is essential for strategy development and the key factors to address to ensure change is managed effectively. I also review a set of tactics to help you improve how you manage change across the entire strategy development process.

When Strategy Meets Change

Strategy development, by its very nature, is an exercise in change. In most cases, you're making decisions that significantly alter where and how your business pursues its goals. This is true for a full corporate strategy where you're making choices about the fundamentals of the business model itself, such as product and services mix, customer segment, and geographic focus. It's true of a line of business strategy such as a city's transportation strategy, where you determine the portfolio of transportation investments required to optimally route residents through the growing community. It's also true of a horizontal capability strategy, such as an IT strategy or a geospatial strategy, where you decide on the best combination of people, process, and technology to advance the business agenda through new tech innovations. All strategies impose a change of some degree, and that change needs to be managed.

What are the specific change factors you should consider during strategy development? And how should you address them?
To answer these questions, I devised a simple model that aligns the three main stages of strategy development with a set of empirical change factors. The result is a set of tactics to help you address change at each step of the strategy development process.

The change factors included in the model—called the DICE factors—were developed by Boston Consulting Group (BCG), a global consulting firm. They are based on decades of research with different organizations. Collectively, the factors represent the four areas that have the greatest impact on success when implementing any kind of change-based undertaking. They are a simple and tangible way to focus change activity during strategy development, and I have consulted them during many geospatial strategy engagements that I've supported. The DICE factors are duration, integrity, commitment, and effort.

Duration—the total length of time of the change program, or the time between reviews

Integrity—the quality of your implementation team in terms of its ability to execute the changes

Commitment—the support of influential leadership and engagement of people directly impacted by the change

Effort—the amount of additional work required of people tasked with implementing changes

While the DICE factors are not the only factors to consider when implementing a change program, they make evaluating the likelihood of success easier. In this way, they serve as a convenient checklist of change best practices to focus on during strategy development. When devising a new strategy, you've got enough to do already, so having a simple way to test if the change side is on track can greatly expedite the process.

To understand how to use the DICE factors during strategy development, I've separated the process into three distinct stages: formulation, planning, and execution. While specific methods vary, most strategies generally progress in this fashion.

Strategy Formulation

Strategy formulation is where strategy development begins. It's also where change management begins. At this stage, you typically start by defining your business goals and aspirations. Next, you perform market analysis to determine the demand for products and services and to gauge opportunities with your customers. Then, you review internal processes and systems to understand if and how they could support these new opportunities and where gaps exist.

You might also conduct external and internal consultation to understand the needs and interests of different stakeholders. Based on this information, you and your strategy team will generate options regarding where to focus your efforts and how you'll capitalize on emerging business opportunities. Then you make a clear choice about your direction. By the end of strategy formulation, you should have a clear picture of where your business is going to share with everyone.

At this stage, change management is primarily about creating buy-in. You're making fundamental decisions about your business's future, so it's critical that you build awareness and cultivate support for the proposed direction. That means ensuring key influencers are engaged early and often and that key contributors are freed of other commitments to invest time and energy in the process. Also, it's critical that you address the concerns of those who would resist a new strategy and the changes it implies. When handled well, strategy formulation is a process that creates enthusiasm and early buy-in for the strategy. The following are specific actions to take during strategy formulation related to DICE factors:

Duration—Engage key stakeholders as soon as possible and minimize the time between engagement sessions. This means starting the engagement process early, at the inception of the strategy. Then, continue to socialize findings and recommendations regularly as strategy formulation progresses.

Integrity—People often fall into two camps during strategy formulation: naysayers and change seekers. Naysayers act as blockers to change, preferring the comfort of the current situation over change. On the other hand, change seekers want to upend things and can run roughshod over what's already working well. Assign leads to the strategy development process who are adept at respecting and balancing both tensions.

Commitment—Clearly communicate the motivation for the strategy and directly address feedback or concerns. Formally involve influential stakeholders by creating a steering committee of senior leaders and working groups of cross-functional subject matter experts (SMEs).

Effort—Ensure key contributors have sufficient time to commit to strategy formulation by allocating a set number of days a month to the strategy effort. Help to balance their schedules by supporting the deferral or rescheduling of competing projects and finding backfill support for daily work.

Strategy Planning

Once the strategy is formulated, the next step is to plan it out. This means estimating the work needed to execute the strategy. During this stage, the strategy team drafts up initiatives, identifies resourcing and funding requirements, and develops risk mitigation strategies. This is usually documented as an action plan that, once executed, delivers on the goals of the strategy. All in all, the intention of your strategic plan is to transform your strategy concept into a concrete, actionable road map.

The change factors you face during strategy planning relate primarily to people's perception of how feasible the strategy is to implement. Few things can kill a strategy quicker than a poorly designed plan. The vision that got people excited during formulation looks like a fantasy when matched with a plan that has no practical basis. Avoid this fate by carefully and inclusively planning out your strategy.

Ensure you consult those with significant knowledge in their subject area to map out initiatives and adopt an objective and diplomatic approach to setting priorities. Above all, ensure the plan is realistic in terms of the additional work required of people. Your strategy depends on your people's level of commitment. You must get this right. Specific actions to take during strategy planning include the following:

Duration—Develop a plan that incorporates clear, measurable milestones that trace back to your strategic objectives. This ensures stakeholders understand the timing and contribution of key outcomes to the overall strategic vision.

Integrity—Incorporate SME input into initiative planning. Tap those with the most pertinent knowledge to provide their opinion on effort and risks. Avoid planning activities where you have a limited understanding of their complexity.

Commitment—Prioritize initiatives using a transparent and objective value-risk-cost matrix to minimize individual biases and competing interests. People will tend to favor initiatives that directly address their interests. Adopting an impartial prioritization methodology will help people see the value of other initiatives outside their purview and encourages a "for the common good" mentality.

Effort—Assume no more than a 10 percent increase in workload for key contributors to strategy execution. This comes directly from the BCG research and is healthy advice to avoid overtaxing employees. Where more than 10 percent is needed, start planning for backfill. This could involve temporary staffing or capable staff drawn from other areas of the organization.

Strategy Execution

After strategy formulation and planning comes the real work. Strategy execution is where your strategy becomes a reality. At this stage, resources are mobilized, initiatives are launched, and (hopefully) goals are achieved. During execution, all eyes are on the strategy team. Leadership monitors progress closely, with a keen eye on the status of major milestones. Delays and setbacks are heavily scrutinized.

The key to successful strategy execution is ensuring stakeholders remain engaged in the process and are well supported when changes impact their daily lives. Ensure rigorous program governance to track, monitor, and communicate progress to the rest of the organization. Open and honest communication is essential to maintaining support for the strategy. It can be the difference between a winning strategy and one that fails to launch. Specific actions to take during strategy execution include the following:

Duration—Regularly review the progress and impact of the strategy and reformulate or replan if it's off the mark. Some aspects of your strategy might be flawed. In that case, alter course, but make sure you catch issues early by frequently tracking and monitoring outcomes and performance.

Integrity—Establish delivery teams responsible for specific initiatives. The idea here is to assign a portfolio of projects and activities under the banner of an initiative to a focused team to ensure a cohesive effort. This is instead of assigning projects in a piecemeal fashion, resulting in poor coordination.

Commitment—Deliver early and ensure visible wins. The last thing you want is a strategy that takes years to deliver any tangible results. Stakeholders will lose interest, and your strategy will be a memory, filed away as a failed experiment. It's critical to maintain momentum by delivering early and regular wins, even if they're small wins in the overall scheme of your strategy.

Effort—Continually monitor morale among key contributors and address early indicators of burnout or loss of motivation. Regularly check in with the people responsible for implementing the key initiatives that drive the strategy. Are they still on board, or is belief starting to wane? Listen to their concerns and work relentlessly to remove the barriers causing frustration.

Key Takeaways

Change management is a large and complex topic, and I encourage you to explore it further. That said, when it comes to strategy development—particularly the early stages of strategy formulation and strategy planning—simplifying your focus to a subset of empirical change factors (i.e., the DICE factors) will greatly improve your odds of a smooth execution. After all, developing and implementing a new strategy is hard enough. Keep change management front and center, but keep it manageable.

Here are some points to keep in mind when implementing a development strategy:

- Strategy is an exercise in change.
- Change begins when a strategy is formulated, accelerates through planning, and reaches a peak during execution.
- To simplify change management, focus on the outcomes of effective change management. These outcomes are encapsulated in the change framework called the DICE factors.
- Use the DICE factors to ensure you address change at each stage of strategy development, from formulation to execution.
- Integrate the tactics described in this article into your formal change management methodology when developing strategies. And if you haven't adopted formal change management in your organization, look into it!

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.

Configure Feature Display Order in Web Apps

By Kristian Ekenes

The September 2021 release of version 4.21 of the ArcGIS API for JavaScript introduced the ability to use field values to control the drawing order (or sorting) of overlapping features. Feature sorting is configured on the orderBy property of the FeatureLayer, CSVLayer, GeoJSONLayer, or OGCFeatureLayer. Controlling feature sort order is important if you want to establish a clear visual hierarchy of overlapping features within the same layer. An example is shown in Listing 1. Sorting features can be useful when you want to

- Render small symbols on top of large symbols so that all (or most) of the data can be seen at a glance.
- Display features with large symbols on top of small symbols to hide irrelevant features.
- Use a date field to ensure more recent features are drawn on top of older features.

Let's explore a few examples showing how drawing order can be applied.

```
layer.orderBy = [{
  order: "descending", // or "ascending"
  field: "Population",
  // or alternatively...
  valueExpression: "$feature.Poverty / $feature.Population"
}];
```

↑ Listing 1

Annual Average Daily Traffic

The first example visualizes the annual average daily traffic (AADT) on Florida highways. This is a graduated symbol map of polyline features where the value of the AADT field determines the width and color of the symbol, and layer.orderBy is set to null. By default, features are rendered in the order they are received by the client. Visually, feature order in this default scenario may appear random. Notice that some smaller features, such as ramps and surface streets, are rendered on top of the high-traffic highways.

Ascending Order

By controlling feature sort order in proportional symbol maps, you can establish a clear visual hierarchy. In many cases, seeing all the data at once is preferred. To maximize the amount of data in view, order features with small values on top of features with large values. This is done by sorting features based on the field used by the renderer in ascending order, as shown in Listing 2.

```
layer.orderBy = [{
  field: "AADT",
  order: "ascending"
}];
```

↑ Listing 2

↓ Average annual daily traffic on Florida roads. Dark, thick lines indicate high-traffic roads, whereas light, thin lines are roads with less traffic. Some smaller road features draw on top of the larger ones. This may have the appearance of random rendering artifacts.

Descending Order

Perhaps you want to achieve the opposite scenario and render large features on top of small ones to ensure that they are always the most prominent. This is accomplished by setting the order property to descending, as shown in Listing 3.

```
layer.orderBy = [{
  field: "AADT",
  order: "descending"
}];
```

↑ Listing 3

Above and Below Visualizations

You can leverage ArcGIS Arcade expressions for visualizations of diverging data by ordering features based on symbol size. Sorting by data value is different from sorting by symbol size. The orderBy property currently does not allow sorting by symbol size, but because small symbols typically represent small values, and large symbols represent large data values, using orderBy will usually produce a visualization that appears to order features by symbol size.

However, this doesn't apply to graduated symbols that represent data above and below a meaningful middle value. For example, the expression in Listing 4 calculates the change in the percentage of homes built with one bedroom in 2010 versus 2020.

```
var oneBed2010 = $feature["pvph_1dor_1"];
var oneBed2020 = $feature["pvph_1dor"];
// Change in one-bedroom homes from 2010-2020
return oneBed2020 - oneBed2010;
```

↑ Listing 4

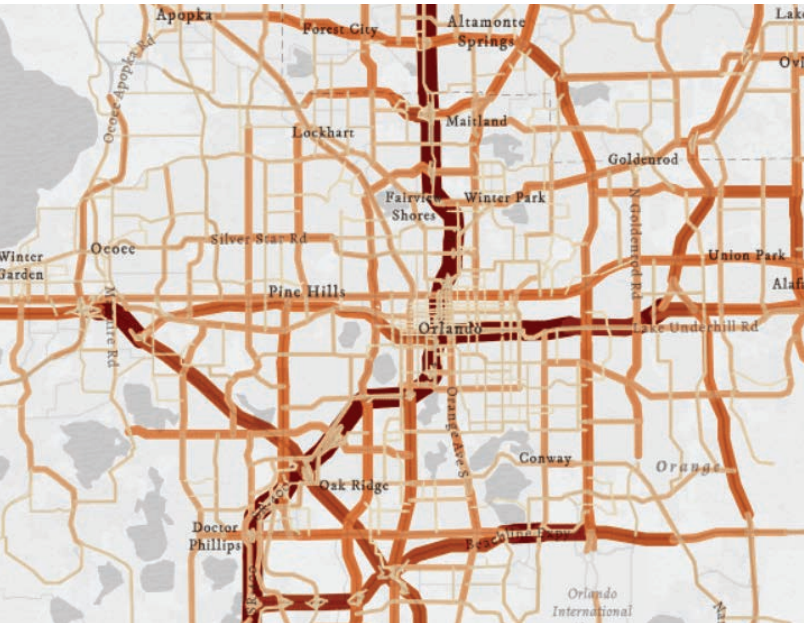
Notice how the smallest symbols represent values close to a center value, and the features with very small or very large values have large symbols.

Look at how Listing 5 sorts the layer's features based on an ArcGIS Arcade expression that matches the renderer.

```
const valueExpression = `
  var oneBed2010 = $feature["pvph_1dor_1"];
  var oneBed2020 = $feature["pvph_1dor"];

  return oneBed2020 - oneBed2010;
`;

layer.orderBy = {
  valueExpression,
  // small values on top
  order: "ascending"
};
```

↑ Listing 5

↓ Sorting features based on the renderer's field in ascending order displays small features on top of large features, allowing all or most of the data to be viewed at once.



↓ Sorting features based on the renderer's field in descending order displays large features on top of small features. This creates a clean visual hierarchy that shows high-traffic highways on top of smaller roads.

All features in the red "below" category dominate the map because they represent negative values. If we flip the order to descending, then the features in the "above" category will be given more importance. Since the goal is to see both above and below patterns clearly, both visuals fail.

Use Arcade to Generate a Sequence That Orders by Symbol Size

To sort by symbol size in any above and below visualization, take the absolute value of the difference between the rendered value and the middle value (or inflection point).

```
Abs(fieldValue - midValue)
```

In expressions that calculate change over time, the middle value is always zero, so just take the absolute value of the final calculation, whether it represents total change or percent change, as shown in Listing 6. Now all small symbols render on top of features with larger symbols.

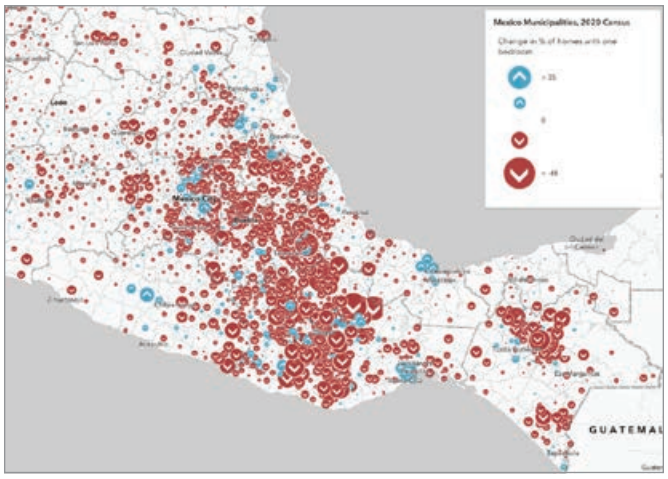
```
const valueExpression = `
  var oneBed2010 = $feature["pvph_1dor_1"];
  var oneBed2020 = $feature["pvph_1dor"];

  return abs(oneBed2020 - oneBed2010);
`;

layer.orderBy = {
  valueExpression,
  // small values on top
  order: "ascending"
};
```

↑ Listing 6

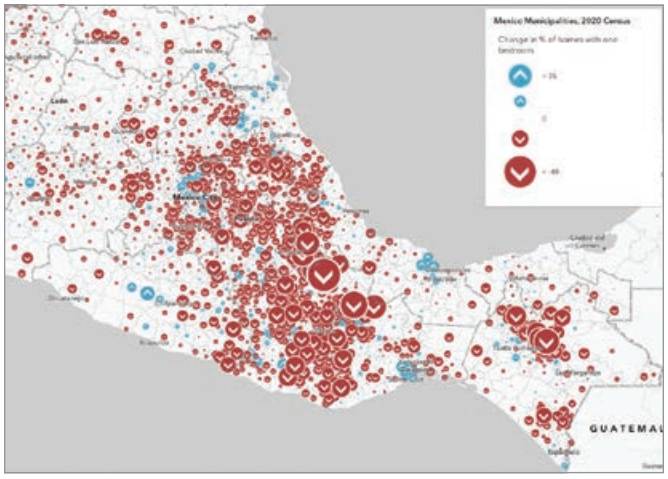
While this rendering makes it easier to see more points, the extremes communicate where the most change happened in the given time frame. To show this information, keep the modified expression and switch the order to descending, as shown in Listing 7.

```
const valueExpression = `
  var oneBed2010 = $feature["pvph_1dor_1"];
  var oneBed2020 = $feature["pvph_1dor"];

  return abs(oneBed2020 - oneBed2010);
`;

layer.orderBy = {
  valueExpression,
  // Emphasizes the extremes (large symbols)
  order: "descending"
};
```

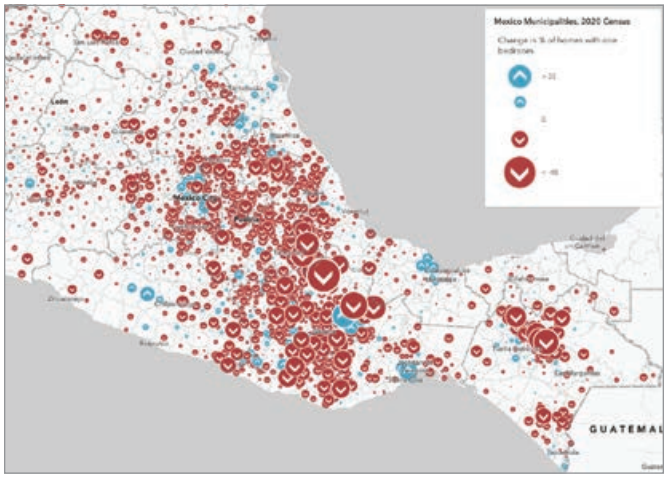
↑ Listing 7



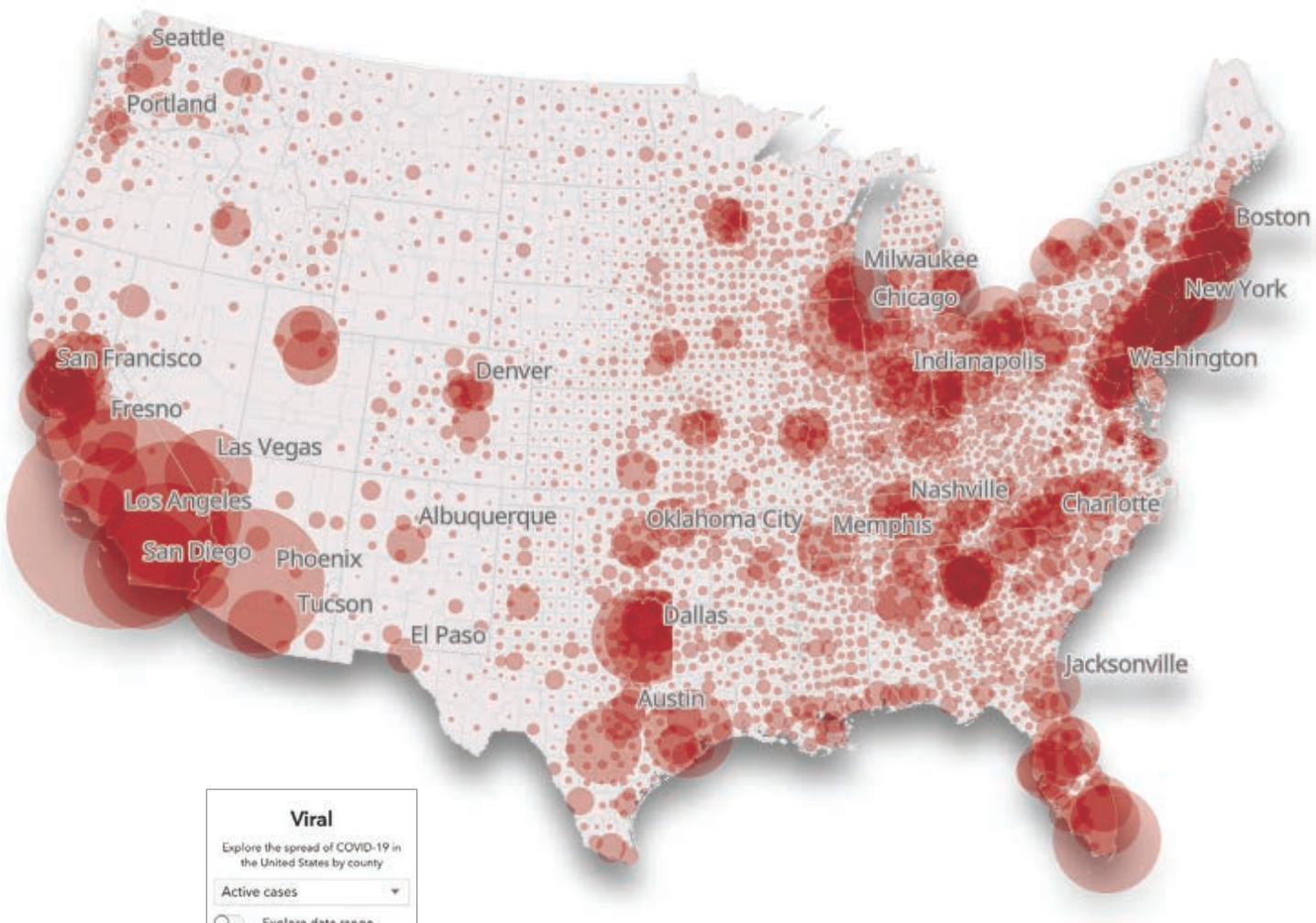
↑ Change in the percentage of homes with no more than one bedroom (2010–2020), which displays features with small symbols on top of larger figures, ensuring more data is visible to the user at this scale.

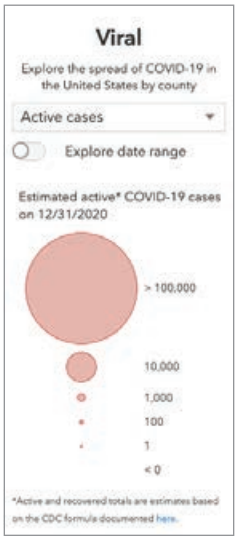


↑ Change in the percentage of homes with no more than one bedroom (2010–2020), which displays large features drawn on top of smaller symbols to make them more prominent.



↑ Change in the percentage of homes with no more than one bedroom (2010–2020), which renders features with small values on top, but since small values have large sizes, this may not be desirable.





↑ Active COVID-19 cases displayed using graduated symbols that are very transparent, making it easier to see symbols that overlap in dense areas.

When configuring feature display order in ArcGIS Online, sorting by using an ArcGIS Arcade expression is not an option available in the UI. However, use ArcGIS Arcade to sort features by calculating a new field with an expression and selecting that field in the UI.

Now the map clearly communicates that there was generally a larger decrease in one-bedroom homes, though some municipalities still had a significant increase.

Alternatives to Visualizing Overlapping Features

The orderBy property helps establish visual priorities. However, prioritizing feature order isn't necessary or relevant in some cases. For example, using opacity to see through a stack of features clearly communicates relative density.

Alternatively, depending on feature density, hollow rings can be easier to read than opacity. If displaying all features isn't required, consider alternative methods, such as clustering or heat maps, for visualizing overlapping and dense datasets.

About the Author

Kristian Ekenes is a senior product engineer on the ArcGIS API for JavaScript team. His work focuses on mapping, visualization, and ArcGIS Arcade integration. Prior to joining Esri, he worked as a GIS specialist for an environmental consulting company. He enjoys cartography, GIS analysis, and building GIS applications for genealogy.

Social Equity Analysis Solution Supports Better Policy Decisions

By Michael Brown

Governments across the globe struggle to ensure residents have opportunities to continue their education, secure a well-paying job, find healthy foods, access affordable health care, and locate housing options in safe neighborhoods. They recognize many people face challenges due, in part, to systematic and structural barriers that constrain access to opportunity.

Social equity aims for a just and fair social policy. Many governments are making a commitment to social equity, seeking to make investments aligned with the severity of needs in their jurisdictions. They want strong, equitable communities that provide opportunities and benefits to all.

To do this, governments first must understand patterns, conditions, and outcomes that impact various groups. Being able to aggregate, disaggregate, and analyze community conditions is crucial to understanding how to allocate resources by knowing where they are abundant and where they are lacking.

The Social Equity Analysis solution (https://bit.ly/3oFdTWV) delivers a set of capabilities that help state and local governments understand community characteristics, analyze community conditions and actions, and generate an equity analysis index that can be used to educate internal and external stakeholders.

Evaluate Conditions

Equity offices want to understand where community condition rates are high or low so programs and investment can be appropriately adjusted. The Social Equity Analysis solution provides tools that help analysts assemble data on assets, conditions, and outcomes; aggregate the data into a geographic reporting area; and calculate a community condition rate for each given geography. Any numeric, address, or spatial data can be used to focus on

specific statistics. The resultant *Community Condition Rate* map allows departments to see where condition rates are high or low.

Identify Community Characteristics

Equity offices also need to know where concentrations of focus community characteristics are located. The solution is configured to identify demographics and focus variables that are common inputs in equity analysis. These variables are added using the Enrich tool and apportioned by geographic reporting areas.

Analysis can be directed on any focus variable to ensure the condition that is being analyzed is equitable. This stand-alone map produced can be useful for visualizing where the specified focus community characteristics have the highest concentrations. The *Community Characteristics Index* map shows areas of highest and lowest focus based on the input focus variables.

Create an Equity Analysis Index

The *Community Condition Rate* and *Community Characteristics Index* maps are produced by previous steps in the Social Equity Analysis solution. Combining these two key pieces of information produces an equity analysis index map, showing where need is the highest and lowest relative to the other reporting areas. The resultant equity analysis index map can be used to identify where the highest need exists for the specified community condition and focus community characteristics variables.

Evaluate Asset Locations

The Social Equity Analysis solution determines how many people are within a specified travel time of existing asset locations. If necessary, travel modes and times can be adjusted to reflect local conditions and ultimately used to visually evaluate where gaps in coverage exist. If existing asset locations are not meeting community needs, the Social Equity Analysis solution can be used to select the best candidate asset locations from a set of potential locations provided.

The selection process weights each reporting area as a point of need, so that areas that have greater need have a nearby location. This ensures that new asset locations will be selected in or near areas that are in need.

Share Results with Stakeholders

After refining the equity analysis, results can be shared with both internal and external stakeholders. The maps of indexes and chosen asset locations can be shared via ArcGIS Online or ArcGIS Enterprise organizational accounts. The Equity Analysis Index application is designed to share these results, so stakeholders understand where equitable, or inequitable, conditions exist.

Additional Resources

Learn more about racial equity solutions and how to quickly deploy them by going to the ArcGIS Solutions site (https://bit.ly/3dHlqOE). For questions and feedback, contact members of the ArcGIS Solutions team on Esri Community or contact Esri Support Services.

Esri provides resources via the Racial Equity GIS Hub (https://bit.ly/3dFQbDD) to help organizations address racial inequities. When using this data, please reference "The Role of the GIS Professional in Issues of Equity and Social Justice" (https://bit.ly/31TNUC3), an article that ran in the January/February 2019 issue of *GIS Professional,* a publication of the Urban and Regional Information Systems Association (URISA).

About the Author

Michael Brown is a product engineer and member of the ArcGIS Solutions team.

← The risks of homelessness have been exacerbated by the COVID-19 pandemic.

ArcGIS Solutions Helps Communities Assist People Experiencing Homelessness

By Jeremiah Lindemann

Homelessness is a complex problem that is typically brought on by personal hardship, unemployment, and the lack of affordable housing or mental health services. It is a human tragedy that has been exacerbated by the COVID-19 pandemic.

ArcGIS Solutions has been developed to assist communities dealing with homelessness. These solutions provide industry-specific configurations for ArcGIS that are designed to meet key business requirements and support common workflows in an organization. Each solution includes one or more applications, surveys, maps, feature layers, and ArcGIS Pro projects.

Conducting Point-in-Time Counts

The Department of Housing and Urban Development (HUD) requires each Continuum of Care (CoC) community to conduct a Point-in-Time (PIT) count each year during the last 10 days of January. *[CoC is a regional or local planning body that coordinates housing and services funding for homeless families and individuals.]* This count of sheltered and unsheltered people helps communities understand the extent of homelessness and provides a foundation for social programs and funding. Many communities did not perform the counts during the height of the COVID-19 pandemic, which made the count in 2021 extremely important.

An updated version of the Homeless Point-in-Time Counts solution (https://bit.ly/3lrwPGu), an ArcGIS Solution, was released in November 2021. This was a relatively minor update, but it did include updated choices for demographics, ethnicity, and gender in the Homeless Count Survey and to align with the *FY 2022 HMIS Data Standards Data Dictionary* published by HUD.

Conducting these counts on one night can take a lot of resources, thus in many cases volunteers are used to help canvas the area and perform the surveys. Volunteers interviewing people experiencing homelessness can use a series of questions provided by HUD to guide the process. If a person cannot be interviewed, observation data can be collected. This survey can be easily extended with community-based questions, such as awareness about local resources. Communities wanting to track volunteer progress and ensure data is not exposed can utilize ArcGIS Hub Premium, with community users to grant access to the survey.

Some CoC communities activate their Emergency Operations Center on the night the count occurs. This helps managers track the progress in real time and can help ensure areas that are not being canvassed can be covered before the night is over. The solution provides a Homeless Count Dashboard so that managers can visualize this information in real time. After the count, the dashboard values, such as gender or age, can be selected to see how the geography changes.

HUD has specific guidelines that govern how CoC communities must report the results of their point-in-time counts. After the assessment, the program manager can then generate reports that meet the HUD requirements using the HUDReport Notebook, an ArcGIS Notebooks app.

Assessing Homeless Risk

Homelessness counts are typically conducted on a single night in January. However, this doesn't necessarily reflect the extent of ongoing homelessness activity in a community. The Homeless Risk Reduction solution (https://bit.ly/3EejzfS) can be used by local officials to leverage continual reports of homeless individuals and encampments in the community and identify which areas are at risk for generating homelessness.

The solution enables a collaborative approach between the public and local government agencies to determine where resources can be deployed, offer services to homeless persons, and determine any additional steps required. Homeless Risk Reduction

← The Homeless Point-in-Time Counts solution provides a Homeless Count Dashboard so that managers can visualize this information in real time. After the count, dashboard values, such as gender or age, can be selected to see how they are distributed geographically.

is typically implemented by health and human services agencies to proactively address homelessness and connect homeless individuals with available resources.

The Homeless Risk Reduction solution includes an ArcGIS Survey123 form, crowdsourcing app, dashboard, and ArcGIS Pro project that deliver a set of capabilities that help users understand where homelessness originates and actively monitor regular reports of homelessness so assistance can be offered to individuals in need.

Resources for People Experiencing Homelessness

The Homeless Outreach solution (https://bit.ly/3dgDq21) can be used educate the public and help individuals experiencing homelessness find available resources. This solution helps manage information about homelessness in a community and community services available to homeless persons. It also assists public health agencies in maintaining information about homeless populations.

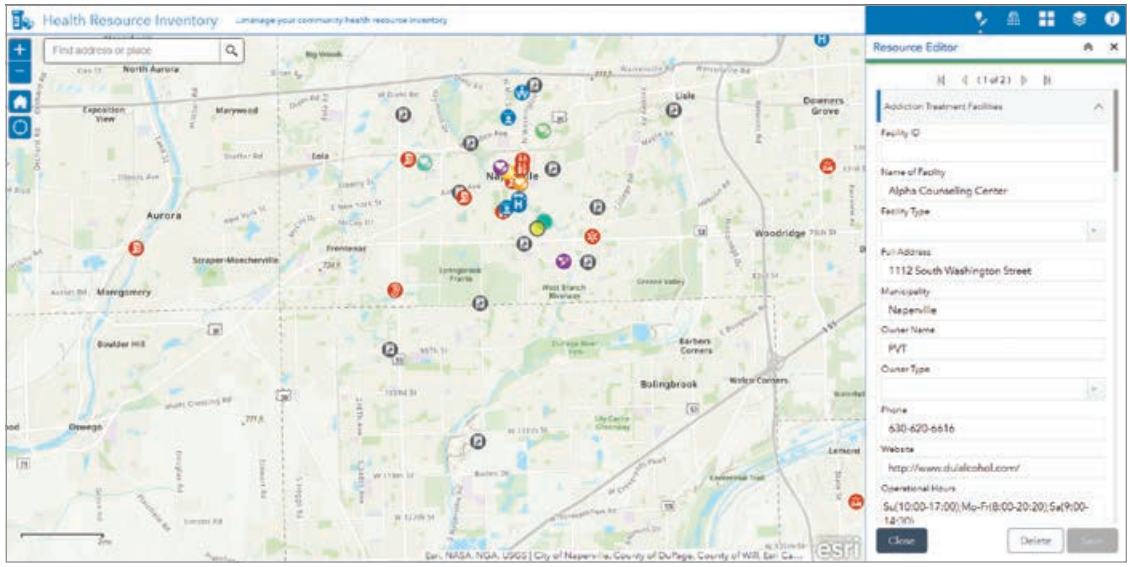
Promoting a collaborative approach helps ease the burden on communities that are dealing with increasing service demands, limited access to technology, and real-time data. Homeless Outreach is typically implemented by health and human services agencies that want to take an active role in reducing homelessness.

The Homeless Outreach solution delivers a set of capabilities to inventory available services for people experiencing homelessness, communicate the extent of the homeless challenge to the public, solicit volunteers to help deliver these services, and share resources with those experiencing homelessness.

About the Author

Jeremiah Lindemann is a product engineer on the ArcGIS Solutions team. He has more than 20 years of experience with Esri, beginning as an instructor and working for several years as a solution engineer on the state and local government global business team. For the last few years, he has been supporting workflows for public safety and health with ArcGIS Solutions.

→ The Homeless Outreach solution delivers a set of capabilities to inventory available services for people who are experiencing homelessness and communicate them to the community.



How to Choose Your Map's Medium

By Mark Harrower and Heather Smith

Knowing how your map will be shared before you start mapping helps with important design decisions.

We've never had so many ways to share our maps with the world, from full, interactive stories to photocopied brochures, from videos on smartphones to giant posters. The problem is that a map that works brilliantly for one medium might be a complete mess in another. Interactive maps are great for deep exploration, but they're not a good choice if people need to print a copy, or if the map needs to be embedded on another platform. Print maps are great for fine lines and lots of labels, but those details might be illegible on a smartphone.

How to Choose a Medium

We recommend choosing your map's medium as early in the mapping process as possible. To make this choice, consider these four questions:

1. Who is your target audience?

Your boss? Teenagers? People who live in your city? Potential customers of your business?

2. How and where is your audience most likely to read a map?

On a billboard? On your website? In a legal report? On Twitter? Through a projector?

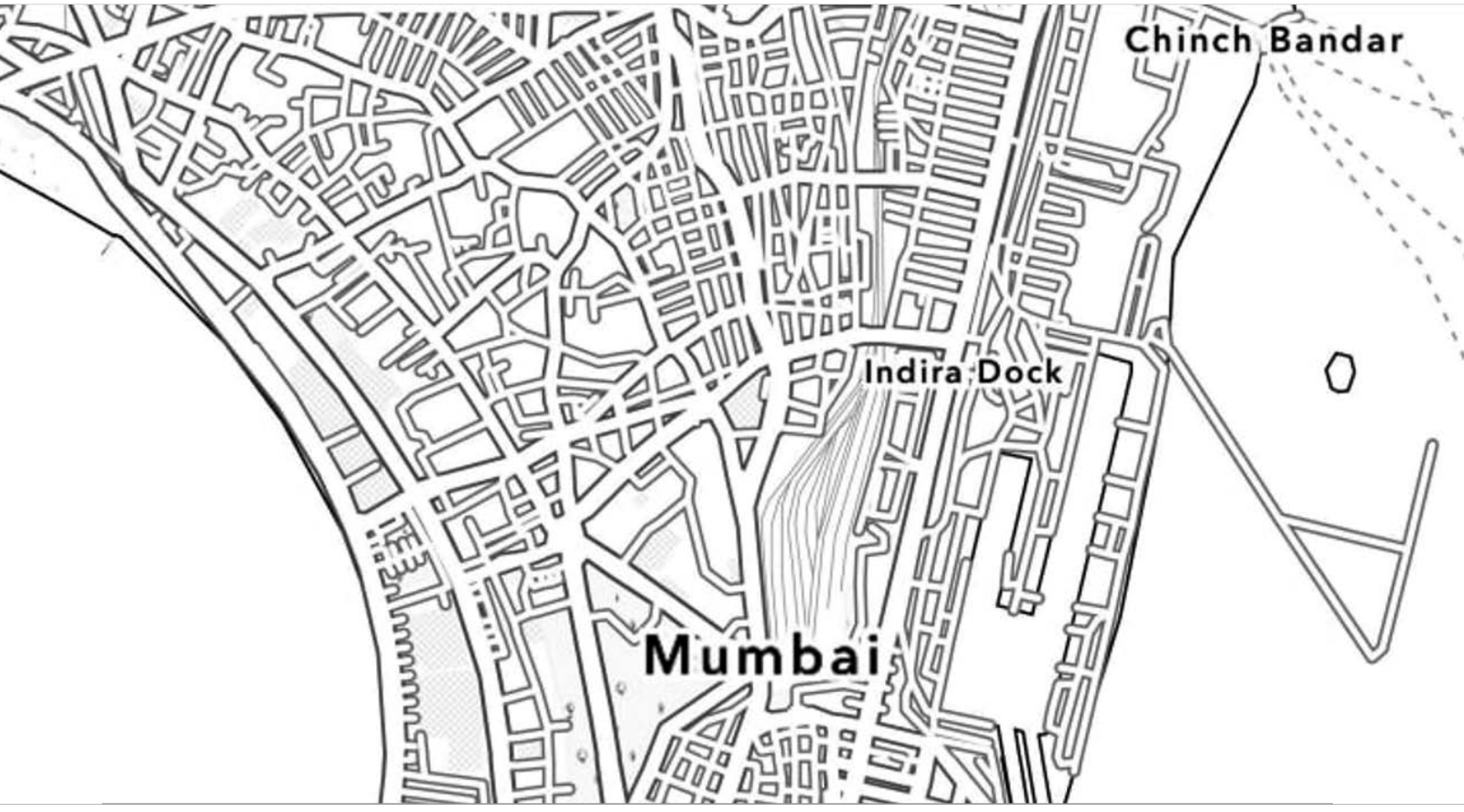
3. What does your audience need to do with the map?

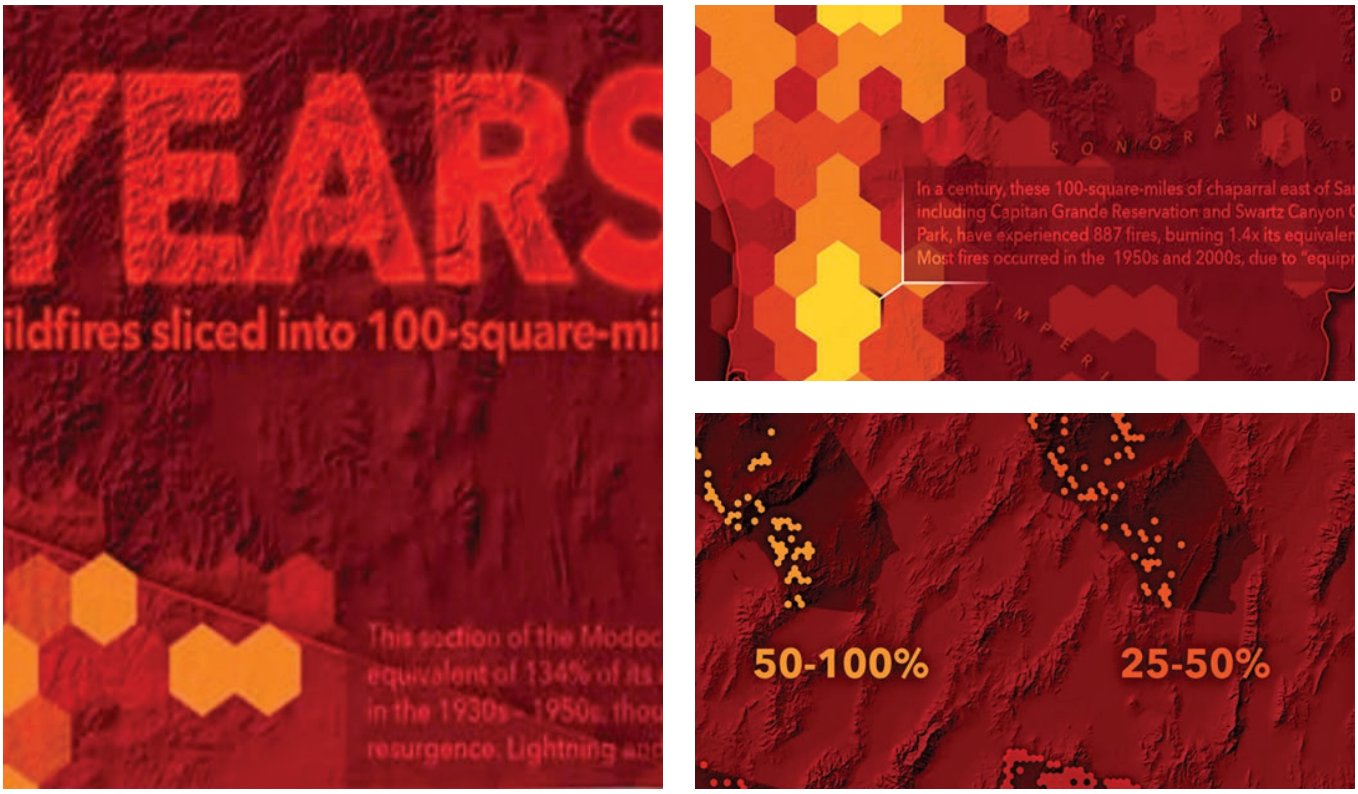
Do they need to print it and write on it? Do they need to add features and attributes? Do they need to be able to search the map?

4. What medium best supports your map's message?

If your map's message is complex and nuanced, a series of interactive maps presented with ArcGIS StoryMaps might serve you best.

↓ This is an example of the coloring book maps created by Esri staff member Cindy Prostak, who chose PDF for the output medium so people could print them at home.





↑ Rather than trying to fit his large and detailed map of California wildfires into a post on Twitter, Esri cartographer John Nelson shared thumbnails. Read more at https://bit.ly/3okwF60.

If you want to show the location of an upcoming event, a single static image shared on social media may be more effective.

Often you will not have a choice of medium. Ask the person who is requesting your map before you begin. It's best to think clearly and early in the mapping process about how you want your readers to access your work.

How to Design for Your Chosen Medium

Pick your medium early and keep its limitations in mind as you design. Every mapmaker has experienced the regret of designing without first considering the output medium. The result is more work: either redesigning or retrofitting the map or searching for a suitable medium that matches what you've made.

Every reader has experienced the frustration of trying to use a map that was designed for one medium but displayed in another. For example, a large print topographic map that becomes a pixelated JPEG on a smartphone. These six tips will help you avoid those outcomes.

1 Proof Your Work Often

As you work, frequently check how your map appears in your intended medium. Your map likely looks beautiful on your big display, but how will it appear when it's in your reader's hands? Seeing your work for the first time on a tiny smartphone screen or printed with a low-quality printer can be frustrating if you wait until the end to view it. Proofing it can help you make smart design decisions if you do it early and often.

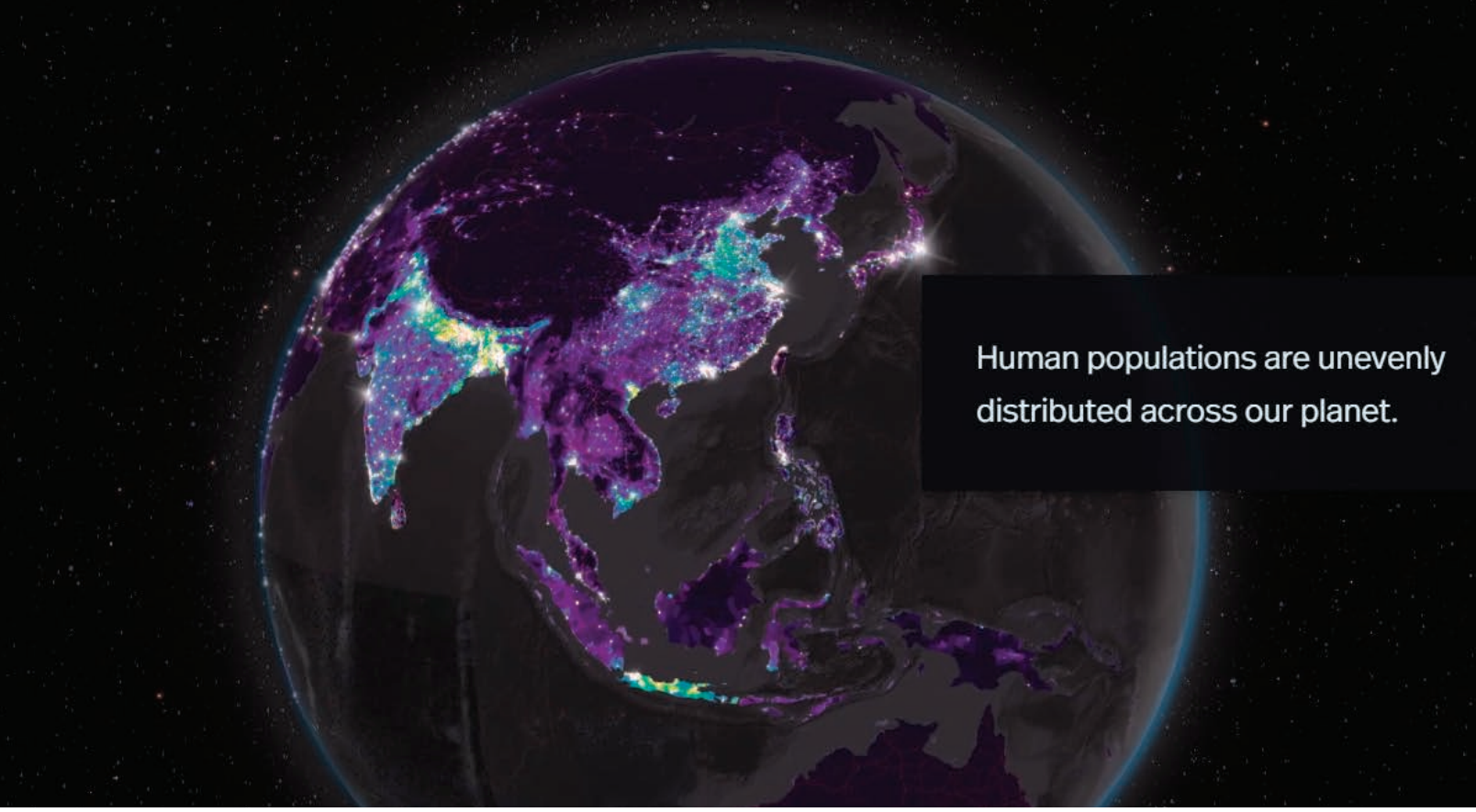
2 Consider Making Multiple Optimized Versions

If you'll only be creating one version of your map, design it for the platform you consider primary or most popular with your audience. But if you need to make a map that works well nearly everywhere, your safest option is to make multiple versions of the same map and optimize each for a different medium. Top-tier news outlets tailor the design of their maps for print, smartphone, tablet, and desktop. Most of us don't have the resources to do this. But you can work in the same frame of mind by preparing a thumbnail version of your map to share on social media.

3 Social Media Isn't Always Kind to Maps, So Keep It Simple

Social media is a powerful way to reach an audience, but it comes with some restrictions:

- Interactivity is often not possible.
- Images will be downsampled and compressed, which doesn't leave much room for small text and fine line work.



↑ *The Human Reach* (https://arcg.is/08LOHO) is an ArcGIS StoryMaps story with gorgeous cartography by David Asbury and Cooper Thomas.

- Each platform will crop your image to a different aspect ratio.
- Sometimes social media platforms automatically serve different versions depending on the device, so it's hard to know in advance how your maps will look.
  - **Facebook:** 1200 x 630 pixels
  - **Twitter:** 1024 x 512 pixels
  - **Instagram:** 1080 x 1080 (square), 1080 x 566 (landscape), 1080 x 1350 (portrait)

If you begin your design with these limitations in mind, you won't have to make compromises later. One of the authors, Heather Smith, designed a map of the Lena River in Siberia for Instagram. Up to 10 images can be included in a post that the user can swipe through horizontally. To capitalize on this format, she designed a map that was 10 times wider than it was tall and divided the map into squares so they would appear as one continuous map when viewed on a phone. Learn more by reading the blog at https://bit.ly/32QJDAn.

If you want to share an interactive map on social media, test it before you get too invested in your design to determine how it will respond.

Will it appear in-line, as an embedded item that you click to activate, or with a card placeholder that links to the original?

Test your static maps, too. Will people be able to rotate your map or zoom in?

It can be frustrating to see your high-quality images get cropped, compressed, and resized without your control. But social media platforms must optimize for performance if they are to continue providing you with such an enormous audience. The visibility is great, but not if it leaves your gorgeous, detailed map looking pixelated, shoddy, and with the edges cut off, so test often.

Need help? Here's a cheat sheet guide (https://bit.ly/32LL6rb) for publishing content on major social media platforms from Falcon.io.

4 ArcGIS StoryMaps Is the Best Choice for Interactive and Animated Maps

Given all of these frustrations, ArcGIS StoryMaps is a format designed by cartographers who are all too familiar with the limitations of sharing work online. It will let you coordinate and combine maps, narrative content, and other media. StoryMaps treats maps as a unique type of content, instead of treating maps like photos or videos. ArcGIS StoryMaps stories can handle full-screen maps, 3D scenes, interactivity, and map actions (like zooming in) that are choreographed with the accompanying text. This is much better than a low-resolution placeholder JPEG of your map that opens in a new window when clicked.

5 Design for the Smallest Screen It'll Be Consumed On

On mobile devices, everything needs to be done by scrolling, pinching, or tapping with fingers that are sometimes clumsy. To account for this, use fewer labels with larger text, and fewer layers with simpler symbology. Leave out any complicated UI elements because they won't work as well on a smartphone screen as they do on a large monitor.

6 Be Careful with Color

The colors you choose will look different on every screen and on the output of every printer. The printing process is incredibly complex, and it's unreasonable to expect even a high-end plotter to create something that looks exactly like your screen. A richly or subtly colored map—one containing satellite imagery, for example—will display in all its luminous glory on most digital displays, but it will seem darker, muddier, and less vivid once it is printed. Your best defense is to proof often and keep the colors simple. One of our favorite reliable techniques is to design in gray scale with one or two spot colors for punch.

In Conclusion: Keep It Simple

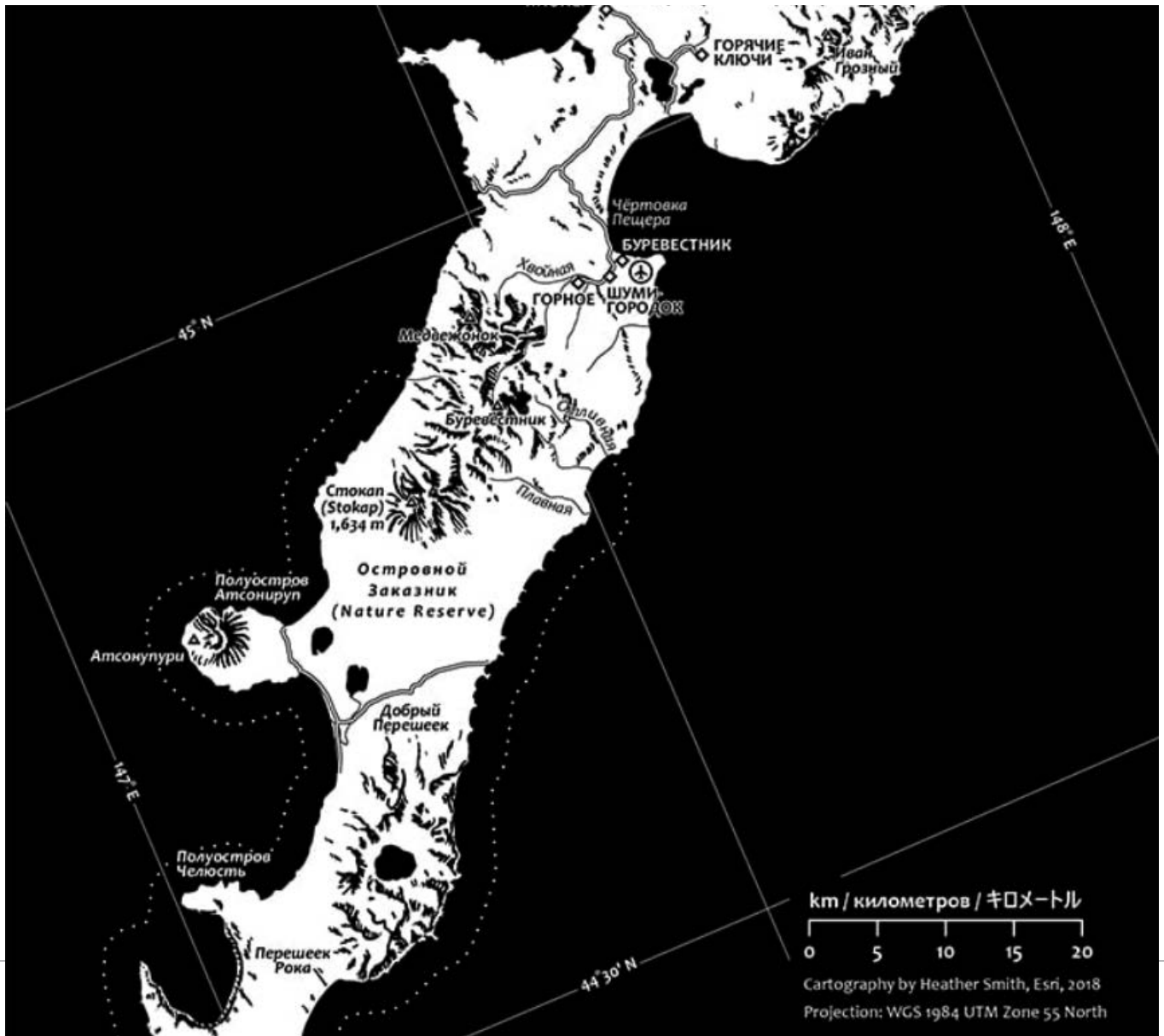
The choice of medium should dictate your design choices from the beginning, so don't wait until the map is done before you give it any thought! Often, your map will be shared and consumed via different media, and you won't have a lot of control. The best way to prepare your map for this reality is to keep it simple. Use few colors, layers, and labels; eliminate fine details or textures; and omit interactivity in most cases. However, if your map demands highly detailed and interactive cartography, ArcGIS StoryMaps offers you a way to share it without compromise.

About the Authors

Mark Harrower is a map nerd who is passionate about great design, teaching, and doing cool things with data.

Heather Smith is a cartographer and artist who mixes both practices to express and understand landscapes. She writes and edits lessons for the Learn ArcGIS website. View more of her work at www.heathergabrielsmith.ca.

↓ Heather Smith, one of the authors, designed this map to be easy to print on standard-size paper and limited the color scheme to black and white.



Automating Everyday Workflows Using Custom ModelBuilder Tools

By Michael Rochelle

Author's note: I work for WRA, Inc., an environmental consulting firm in the San Francisco Bay Area. The firm has slightly fewer than 100 employees, and I am one of six full-time GIS staff members who support the company's GIS efforts. WRA receives about 200 new projects each year and continues to work on many existing projects for years, even decades.

With so many active projects that often require the same GIS tasks, automation is key for operational efficiency. In this article, I'm going to share some of these automation tools. All these tools were built within ModelBuilder, a visual programming language for building geoprocessing workflows, using simple geoprocessing tools and feature template domains. None required any scripting.

Workflows that are repeated—whether several times a month or week or every day—are perfectly suited for automation. Although these workflows may not be very exciting when compared with complex GIS analyses, they are arguably the most used and often the most useful.

Create Workspace Model

The essential model is the Create Workspace model. This tool is run for every new project to set up the entire workspace for all GIS work. This model sets up folders, creates geodatabases and feature datasets, and then imports premade and empty feature classes and their domains. To run the tool, the only model parameters required are the root folder by year on the server, the new project number, the project name for name of the main geodatabase, and the project's state plane coordinate system.

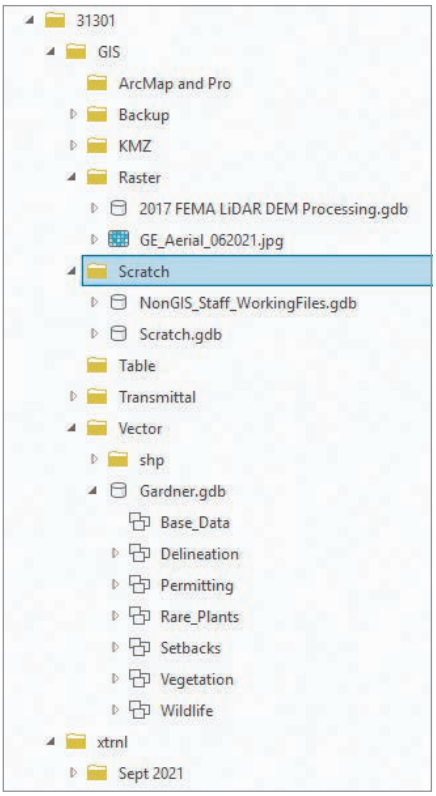
The model not only creates a space for GIS work, it also creates a highly organized space for implementing a database management system so that data and GIS products can be easily managed and located. In addition, the main project geodatabase already contains empty feature classes and fields that are ready to use. For most projects, these feature classes are all that is needed to complete the project. Table 1 describes each folder in the directory structure and its use.

The main geodatabase is organized by feature datasets for base files, delineation, permitting, rare plants, setbacks, and wildlife. Each feature dataset has empty feature classes ready for editing, and pertinent fields with domain constraints. For example, the feature dataset for rare plants has feature classes for rare plant points and polygons with fields for code, common and scientific name, count, and a dropdown for jurisdiction.

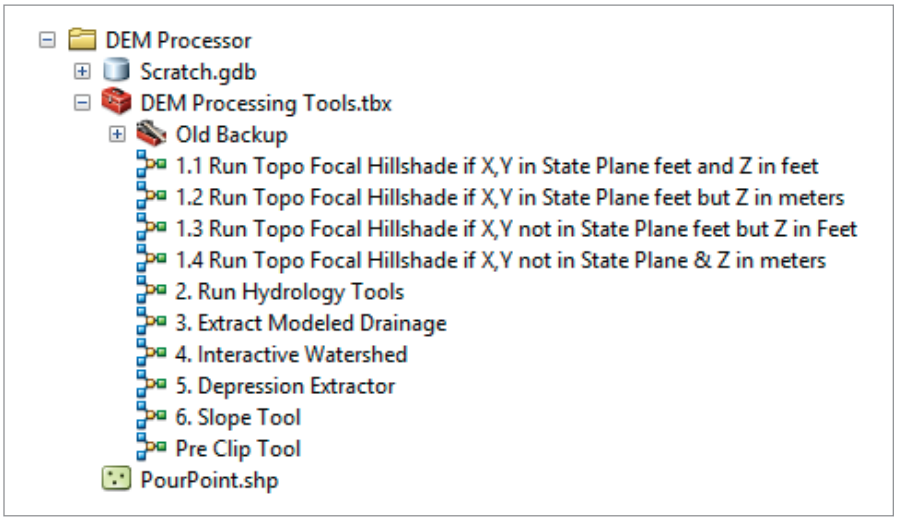
DEM Processor Tools

As an environmental consulting firm, WPA requires field efforts to map out biological resources, and the biggest component is aquatics resources (i.e., wetlands, waters, riparian areas). WPA biologists need field maps—either hard-copy or web maps—to help delineate features while on-site. Topographic information is extremely helpful to them because aquatic features are topography driven. With the availability of high-resolution lidar projects covering much of the earth, high-quality topographic work products can be automated using the DEM Processor toolbox to support field efforts.

The Run Topo Focal Hillshade tools (1.1 to 1.4) in the DEM Processor toolbox simply create the DEM geodatabase where all products will be stored and named



↑ The folder organization generated by the Create Workspace tool.



→ The DEM Processor toolbox automates the production of GIS products to support on-site work.

by the associated lidar project. The Run Hydrology tool creates contours and a hillshade. It then performs a focal analysis to produce a more smoothed DEM, contours, and hillshade. Intervals and the focal neighborhood are parameterized, and there are four variations of the tool to ensure that all x, y, and z measurements are in feet.

Run Hydrology Tools include all hydrology tools—Fill, Flow Direction, and Flow Accumulation—if more products are desired.

The Modeled Drainage tool produces possible stream vectors based on the size a watershed needs to be before the stream begins. The only parameters are the cell size of the DEM and the size in acres (with a default set at three acres).

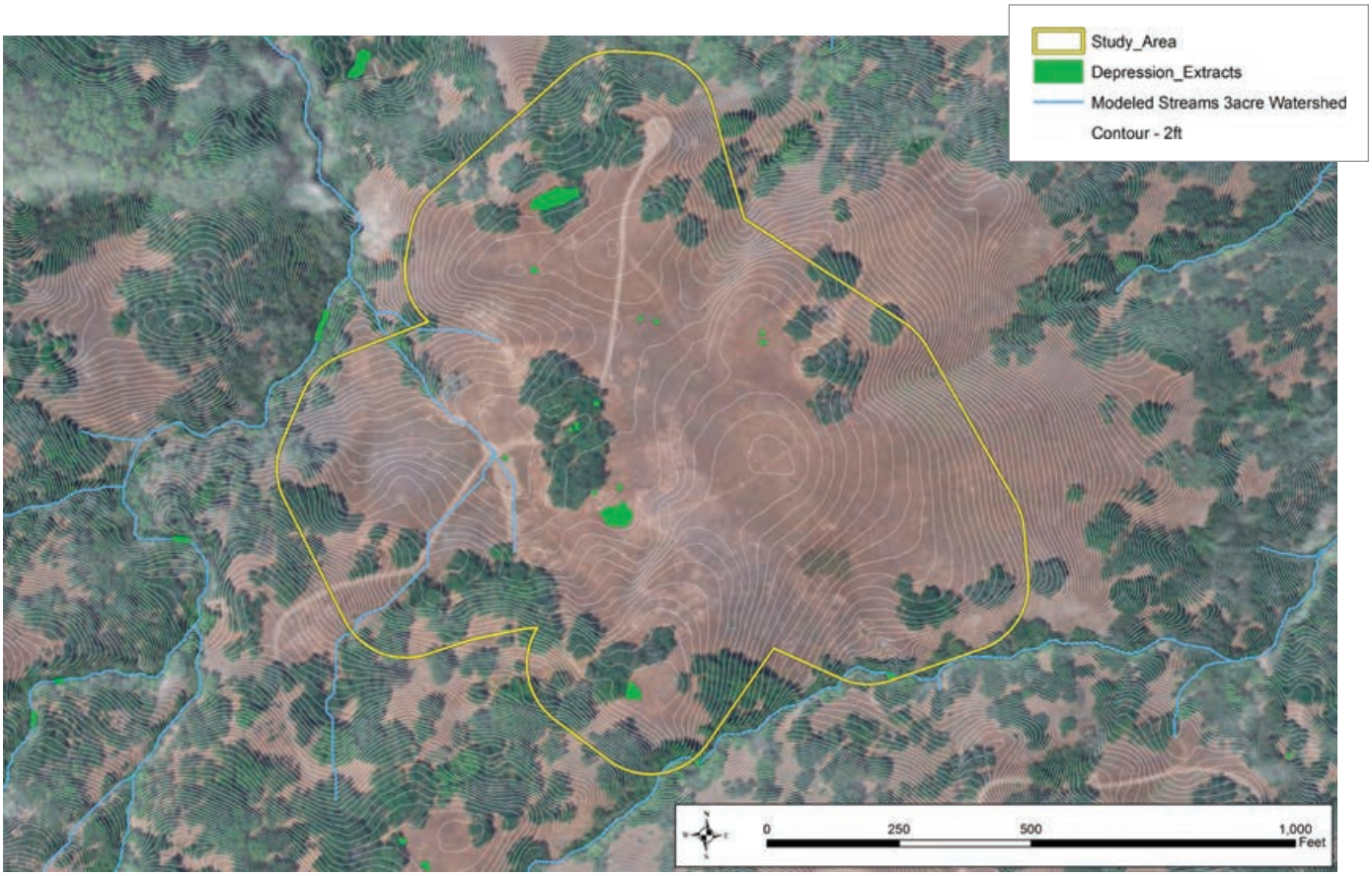
The Interactive Watershed tool is a simple tool that uses a feature set to drop pour points on the map to then derive watersheds.

The Depression Extractor tool subtracts the filled DEM from the nonfilled DEM, extracts all positive values, and converts the output to polygons.

The DEM Processor toolbox also

Folder	Description
XTRNL	All external files received by engineers, architects, clients, and others. Create subfolders for date received.
ArcMap and ArcGIS Pro	All MXD map documents and ArcGIS Pro projects. Create subfolders for different reports and analysis or different projects in ArcGIS Pro.
Backup	A dumping ground for older versions of data that have been updated. Old data is retained in this folder in case it is needed. Active data folders contain only pertinent and current data, and there aren't multiple versions. Update the active version while dumping the previous version in the backup folder with the date.
KMZ	Dumping ground for Google Earth files and their geodatabase conversions.
Raster	All raster files, including aerials, digital elevation models (DEMs), project scans, and any raster-based analysis.
Scratch	Intermediary and other random data that is not brought into the main data folders. It can occasionally be cleaned out. This also contains an empty geodatabase that non-GIS staff can use. GIS staff can perform QA/QC work before it is brought into the main project geodatabase.
Table	All table outputs for map inserts, collections of acreages, overlay information, and other items.
Transmittal	For every GIS transmittal package sent to a client, agency, or other recipient, a folder is deposited here with date.
Vector	The main data folder with the project geodatabase and a subfolder for shapefiles.

↑ Table 1: Directory structure and folder use generated by the Create Workspace model.



↑ Field map created using several DEM Processor Toolbox tools shows the focal version for smoothed contours and hillshade backdrop behind the aerial image and the three-acre modeled drainage. Depression Extractor was used on the map to help target flat areas that may be wetlands.

contains Slope and DEM Clip tools.

Since the tools derive the raw and focal-smoothed contours, the GIS staff member or biologist can decide which to use. The Depression Extractor was used on the map to help target flat areas that may be wetlands.

The following tools have also proved very useful. *[These tools were developed by the author, who will share them.]*

Sample Point Tool: For every aquatic delineation submitted to the US Army Corps of Engineers, sample points must be taken in the field and a form filled out for each point. Because many of these fields are geographic, the data input can be automated using GIS. Once the sample point feature class is complete, it merely needs to be plugged into the tool, and a Microsoft Excel table is exported for the delineator. The tool calculates the points' coordinates, then goes through a series of spatial joins to add information for township and range, soil type, NWI-CARI *[National Wetland Inventory-California Aquatic Resources Inventory]* intersects, major land resources, and slope (obtained from the DEM Processor Tools).

SURGGO Soils Extract: Takes a Natural Resources Conservation Service (NRCS) soils layer file (with useful table joins already executed in the layer file) and clips it to a project's study area, then adds a field for the legend that combines soil type with the label identifier.

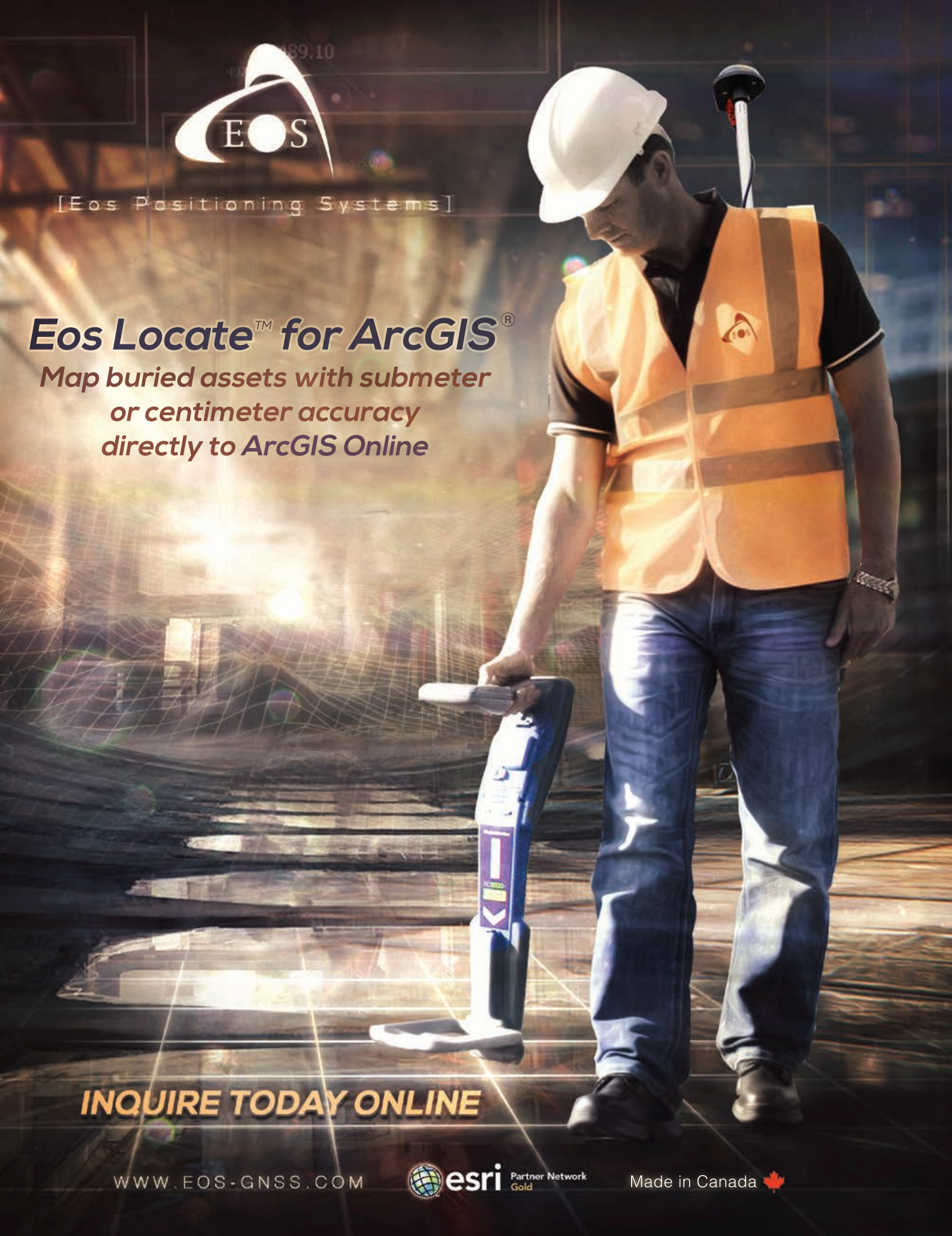
CNDDB Extract: Generates a five-mile buffer around a project then selects out all intersecting California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB) occurrences separated by wildlife and plants. Additional dissolve and explode operations are performed for cartographic purposes.

I've briefly described several tools that WPA employs regularly because they have proven very useful. I've also developed several other tools that I use regularly or might use only a few times a year. If it's something repeatable and has more than a few steps, I immediately begin considering if it is a process that should be automated in ModelBuilder. WPA has just started using arcpy.mp for ArcGIS Pro to automate map production, and I see a lot of future modeling efforts to be implemented.

For more information, contact Michael Rochelle at rochelle@wra-ca.com.

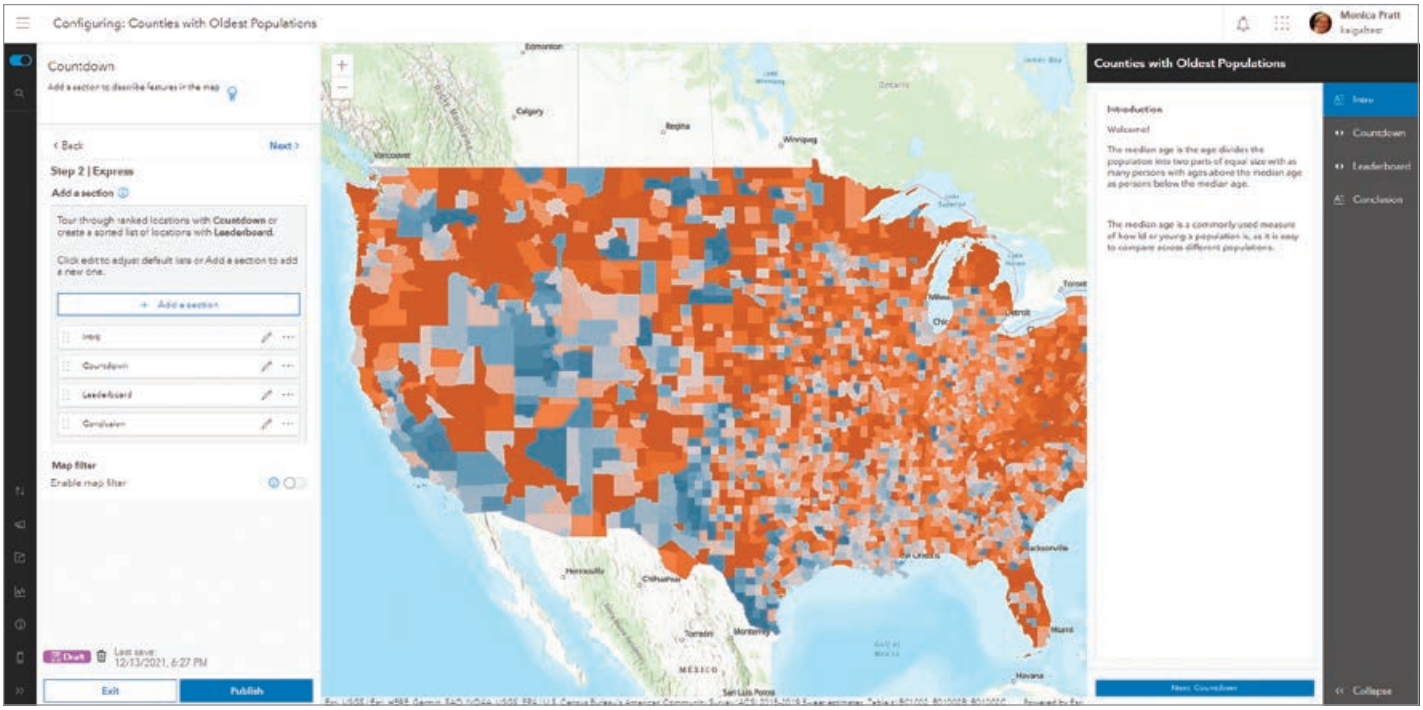
About the Author

Michael Rochelle is a GIS analyst for WRA, Inc., a California environmental consulting company with offices in San Rafael, Emeryville, Petaluma, and San Diego. In his 15 years at WRA, Rochelle has managed the GIS workload for hundreds of projects and developed several workflows and models for both advanced spatial analysis and automating everyday GIS tasks. He graduated from San Francisco State University with bachelor's degrees in environmental science and geography.


EOS
[Eos Positioning Systems]
Eos Locate™ for ArcGIS®
Map buried assets with submeter
or centimeter accuracy
directly to ArcGIS Online
INQUIRE TODAY ONLINE
WWW.EOS-GNSS.COM
esri Partner Network Gold
Made in Canada

Try the Newest of the Instant Apps—Countdown

By Diana Lavery



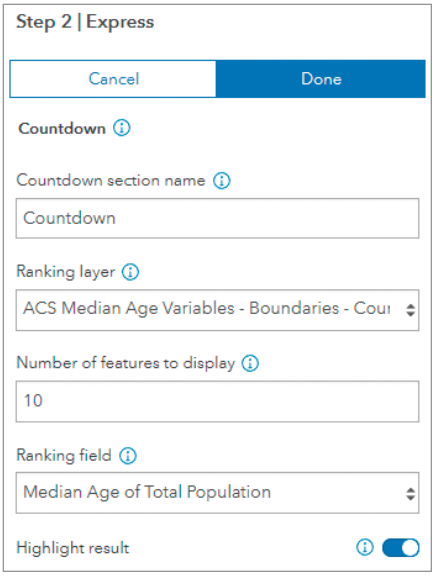
Countdown, the newest app template in ArcGIS Instant Apps, shows a specified number of top or bottom features in a map, sorted by a particular attribute. With it, data journalists, decision support analysts, and others can deliver an interactive, data-driven tour of specific features. Countdown was out of beta as of the December 2021 release of ArcGIS Online. Like all Instant Apps templates, you can easily place your web map in an app from within the new Map Viewer.

In addition to the countdown functionality, an interactive Leaderboard (sorted list) section provides an at-a-glance view of multiple features. The Details section helps orient viewers and tell a complete story by providing context alongside the map. There are three major section types: Details, Countdown, and Leaderboard. Adding and reordering these sections is simple to do in the configuration panel.

In the app itself, the sections appear in the side toolbar. People viewing the app can experience each section and click Next at the bottom to navigate through or click the sections on the side toolbar for a self-directed experience.

Details

The Details section is text based and designed to help provide context alongside the map. Give the Details section a name, such as Introduction or Conclusion, and it will appear on the side toolbar of the app. Details sections can be used to tell a narrative story around the trends and geographic differences presented in the app, along



↑ The Countdown app template creates a list based on a chosen attribute and a specified number of features.

with some key takeaways. These sections are also a great place to provide definitions, sources, and more information.

Countdown

The Countdown section is the bread and butter of the Instant Apps experience. It's a guided tour of the top (or bottom) features of the map. Sorting is based on the attribute chosen. The information displayed on the side comes directly from the web map's pop-up, including any charts, images, or other media. In this example app, 10 was chosen as the number of features, and Median Age of Total Population as the attribute to display the top 10 counties with the highest median age.

Leaderboard

Accompanying the map-based countdown experience is an optional list-based Leaderboard section. The Pin to Compare button allows the app's viewers to pin a particular feature to compare with others on the list. Up to two pop-ups can be docked for comparison. The Leaderboard section does not need to have the same number of features as the countdown. With more features listed, there is a greater potential for ties. The numeric rankings on the list honor ties in the data.

In this example, the leaderboard has a list of the top 15 oldest counties, whereas the countdown goes through the top 10. For example, there are two counties in the United States with a median age of 57.4 years. These two counties are both ranked 13th, and the next ranking displayed is 15th because there is no county ranked 14th.

Express versus All Settings

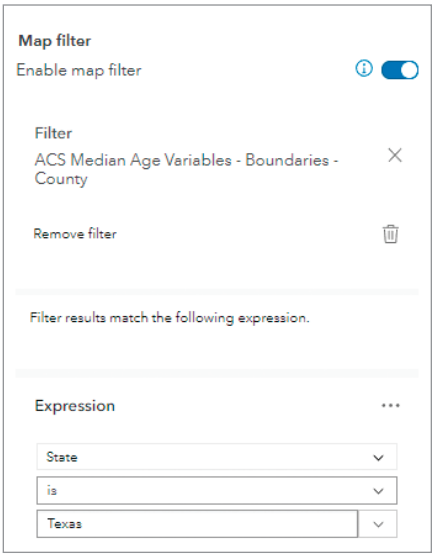
Upon entering app configuration in Instant Apps, Express Setup is the default mode. It is a quick way to get started by only configuring the core options. For more control over the app, enter All Settings.

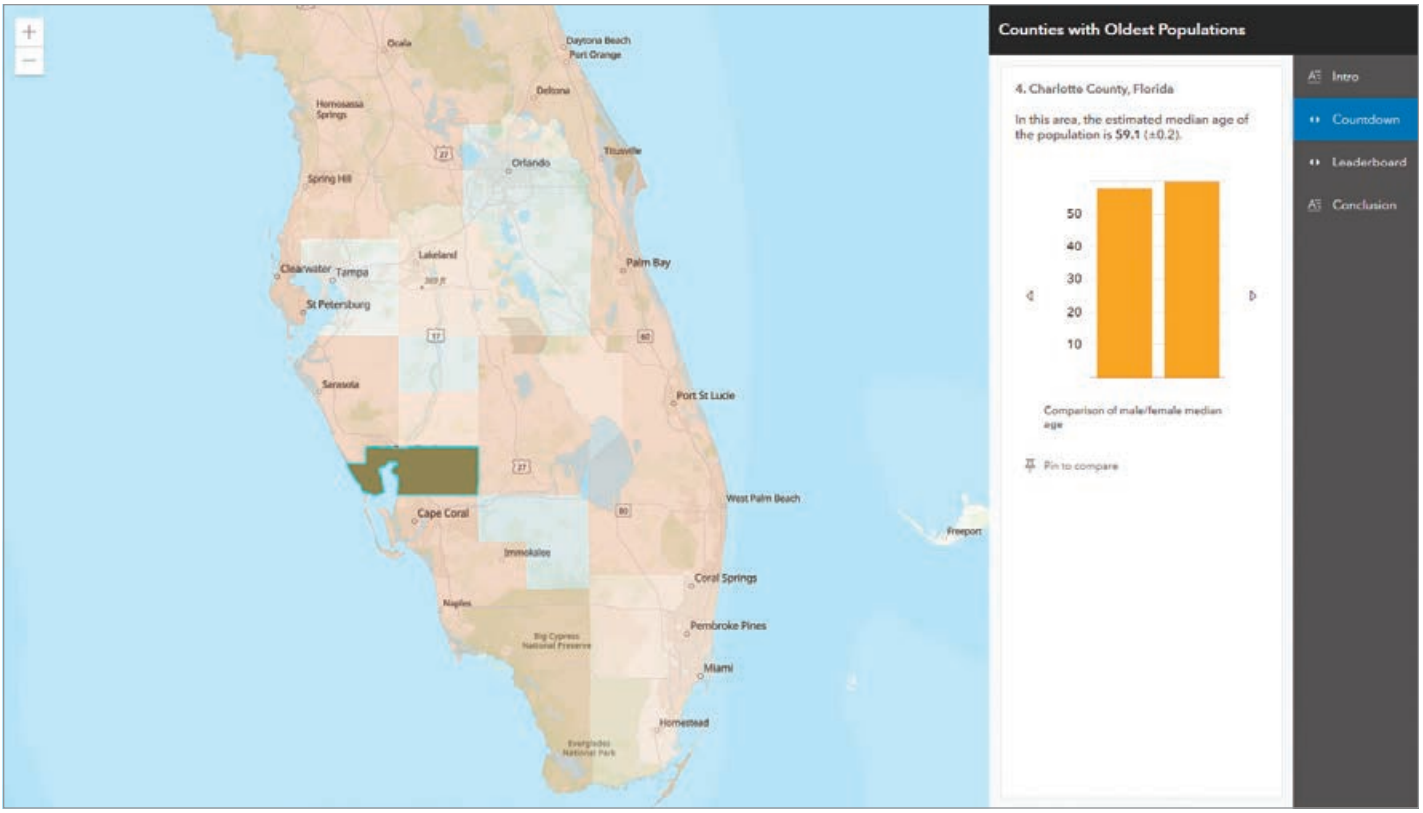
All Settings includes options such as the following:

- Having the legend show up when the app loads
- Changing the placement of app widgets

↓ With the new Map Filter capability, a nationwide map can be filtered within the app configuration experience. In this example, the filter limits the geographic extent to the state of Texas.

↓↓ Users can interact with any feature in the map highlighted in the Countdown or Leaderboard sections.





through the Position Manager
- Choosing a Light or Dark theme or shared theme to take advantage of branding colors set by your ArcGIS Online organization's administrators

Interactive Viewing Experience

Those viewing your app can interact with any feature in the map, not just those highlighted in the Countdown or Leaderboard section. This allows viewers to see and dock the pop-up for their own feature of interest, such as their own county, school district or other boundary layer and compare it to those highlighted in the app.

Release Enhancements

This app is now out of beta as of the December 2021 release. The main enhancement with this release is the ability to apply a map filter. Most maps available in ArcGIS Living Atlas of the World have nationwide or even worldwide coverage. Many users have told Esri that they need to filter these maps to the state or county level. Previously, this was done by filtering in the Map Viewer itself and saving a filtered map to use in Instant Apps. With the new Map Filter capability in Countdown, a nationwide map can be filtered within the app configuration experience.

In this example, in step 2 of the Express Setup adding sections, a map filter can be applied to the county-level layer such that the attribute called State is equal to Texas. Now, although the web map still covers the nation, the app counts down and maps only counties in Texas.

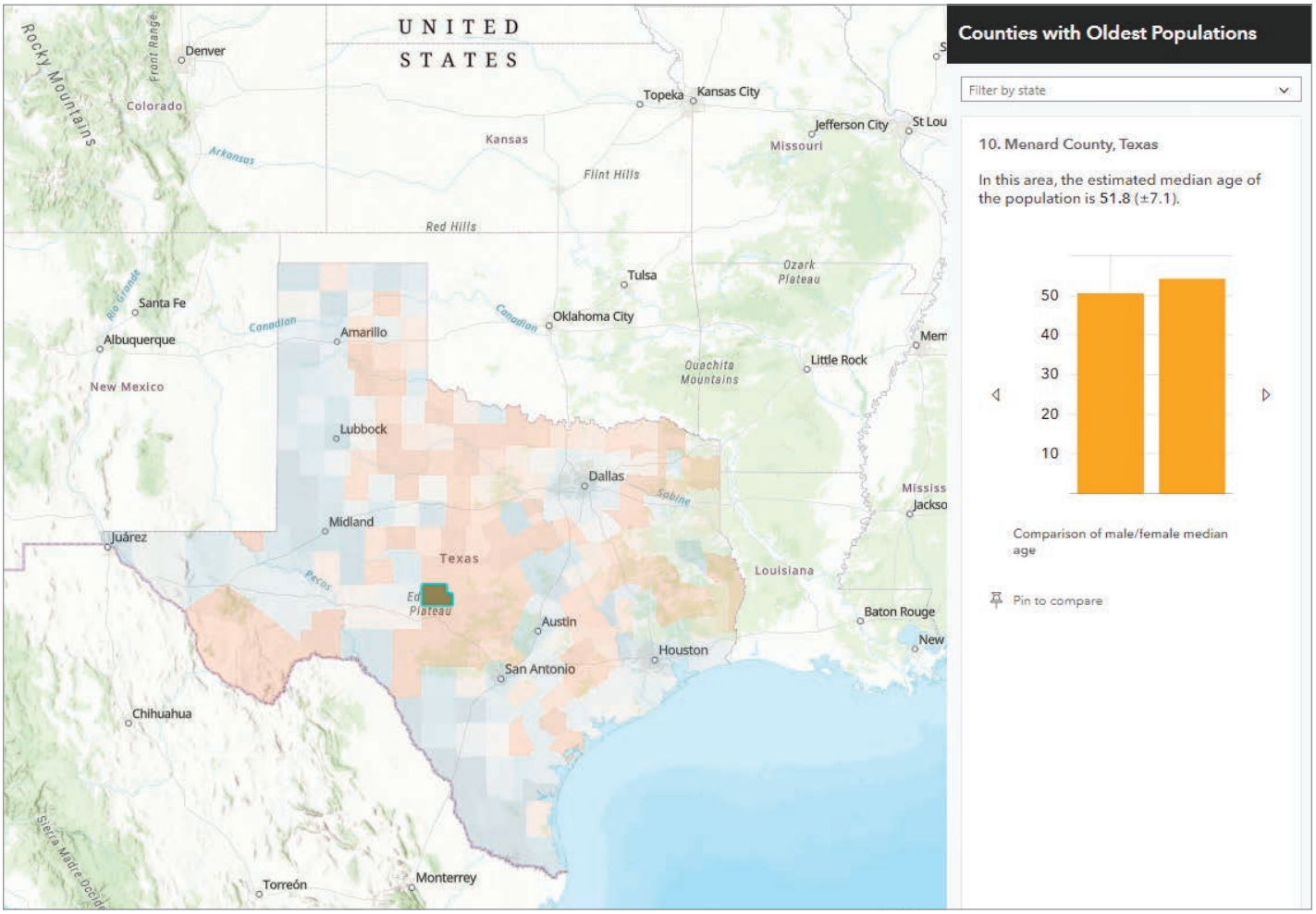
Other Enhancements

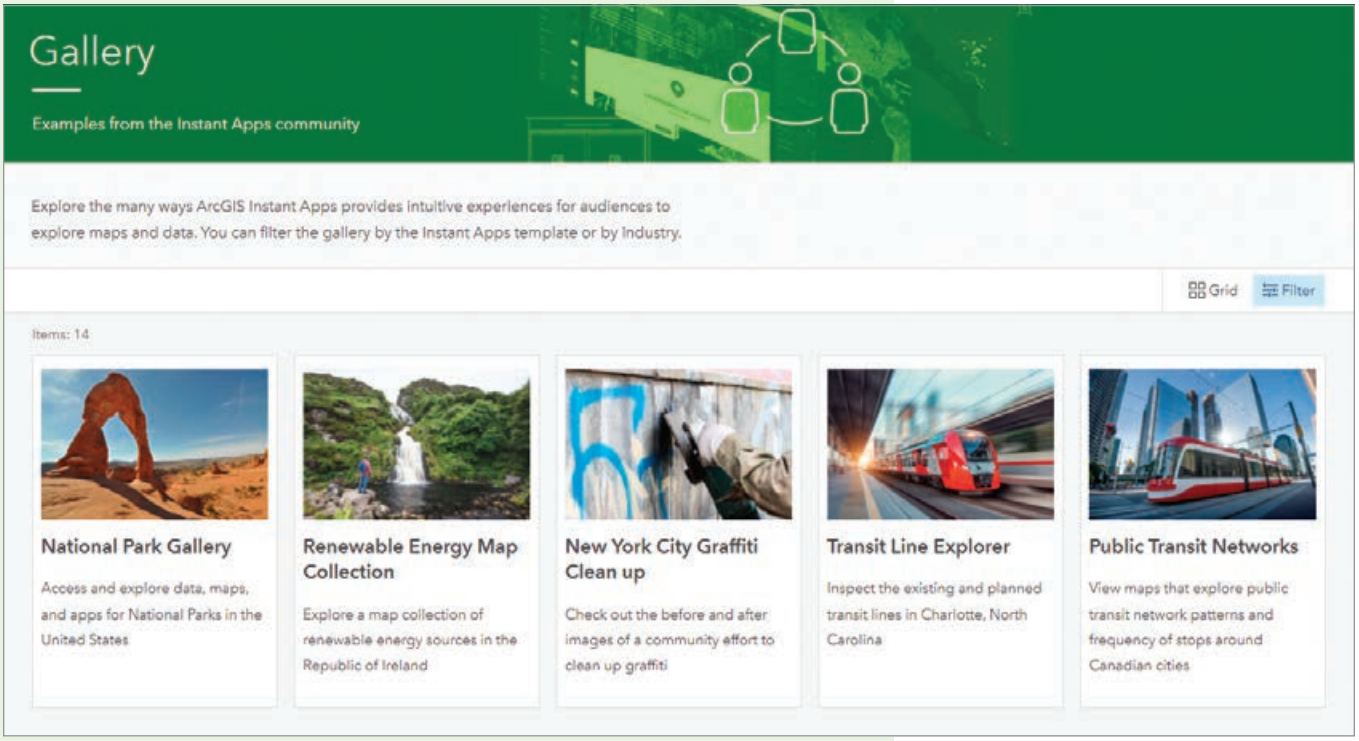
In addition to Map Filter, other capabilities, such as Navigation Boundary and Custom Theme, are now available in Countdown along with improvements for mobile viewing.

About the Author

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

↓ The Countdown and Leaderboard sections will only show Texas counties once the filter has been applied.





↑ Countdown is the newest Instant Apps template. This gallery shows other Instant Apps templates such as 3D Viewer, Attachment Viewer, Category Gallery, Imagery Viewer, Interactive Legend, Media Map, Minimalist, Nearby, Portfolio, and Zone Lookup.

Focused Interactive Experiences with Maps and Data

ArcGIS Instant Apps, available in ArcGIS Online with the June 2021 release, provides focused interactive experiences with maps and data quickly by applying app templates available from a library.

Those templates can be accessed from three locations in the ArcGIS Online interface: under the Content page, on the map item details pages, and in Map Viewer. All methods of accessing the ArcGIS Instant Apps go to a template library that guides the user through the app selection process and highlights templates that are popular, updated, or new. Use the My Apps tab to configure, copy, or delete existing apps. Each template has a specific purpose such as comparing two things, getting directions, viewing a gallery, or finding something nearby.

Two configuration experiences—Express Setup and All Settings—are available. With the Express Setup option, a useful app can be configured within five minutes. The All Settings option gives additional capabilities. Either choice provides a responsive app that will work on mobile phones, tables, and desktops. Apps are localized to support multiple languages and are accessible to people using assistive technologies.

Countdown is the newest template to join the Instant Apps gallery, which also includes 3D Viewer, Attachment Viewer, Category Gallery, Imagery Viewer, Interactive Legend, Media Map, Minimalist, Nearby, Portfolio, and Zone Lookup. Instant Apps offers the ease of fast, intuitive creation workflows along with the flexibility to build a custom app that is designed to share a map through a focused experience. The apps are developed to detect the locale settings configured in the browser and translate all text to the appropriate language. All apps are designed to be responsive for use in browsers on desktops, mobile phones, and tablets. The apps have been developed with support for keyboard-only navigation and screen reading software.

Want inspiration? Browse Esri Community (community.esri.com) to see what others are doing with Instant Apps or share apps.

DESIGNING FOR ACCESSIBILITY

By Katie Thompson and Klara Schmitt

Creating accessible web content matters to everyone. If your organization uses ArcGIS Hub or ArcGIS Enterprise to create sites and pages, understanding and applying the principles of accessible web design will help you provide the best experience for all visitors to your site, including those with situational, permanent, or temporary disabilities.

What Is Accessibility?

It is imperative to provide equal access to website content. Many countries seek to improve the accessibility of their web content by adhering to the Web Content Accessibility Guidelines (WCAG) at https://www.w3.org/WAI/standards-guidelines/wcag/. This set of international standards has been used to define regulations in Canada, Germany, New Zealand, and other countries with the goal of improving inclusivity.

In this article, *accessibility* is used as an umbrella term to refer to WCAG 2.1, Section 508, and Title III of the Americans with Disabilities Act (ADA). In the United States, WCAG sets the foundation for Section 508, a federal regulation that applies to all federally produced web content, as well as being the recommended practice for ADA compliance.

Accessibility and the Site Builder

The site builder in ArcGIS Hub lets you feature a range of content types—web maps, images, video, and text—using drag-and-drop cards. Although ArcGIS Hub works behind the scenes to ensure WCAG 2.1 AA compliance, there are still several guidelines that you should consider as you customize your site.

Site Settings and Theme

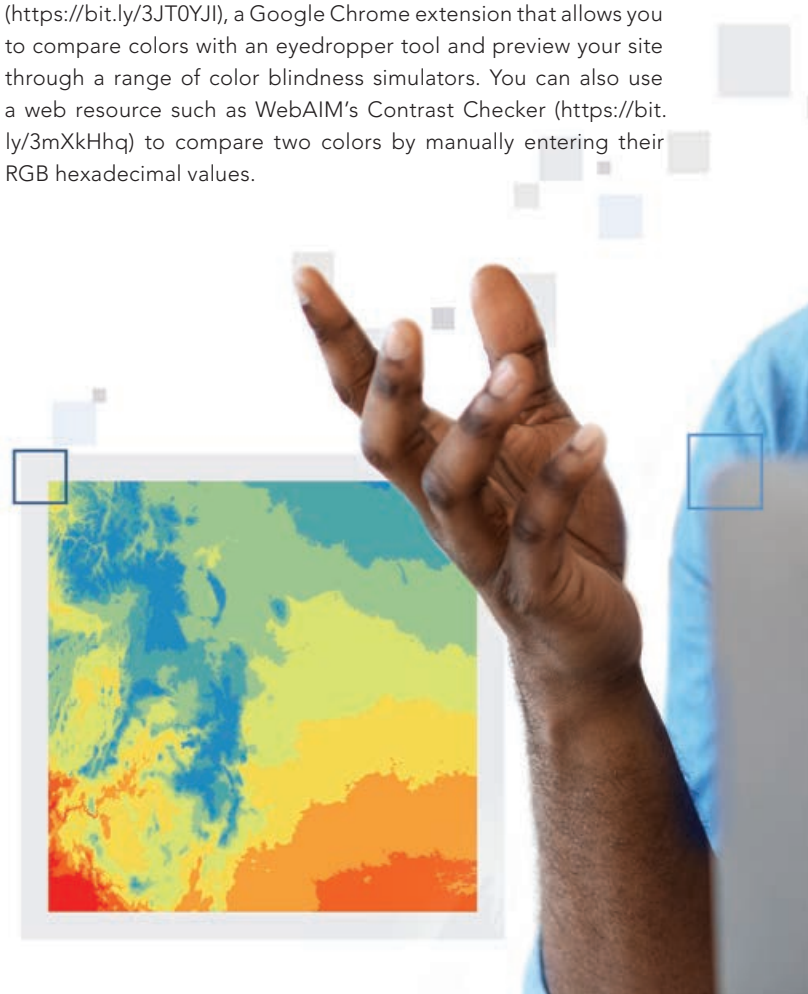
Underlined Links, enabled by default for all newly created sites, helps your site pass the WCAG 2.1 1.4.1 Use of Color guideline, which requires a noncolor visual distinction for body links. This benefits individuals experiencing partial sight, color blindness, or those using text-only displays.

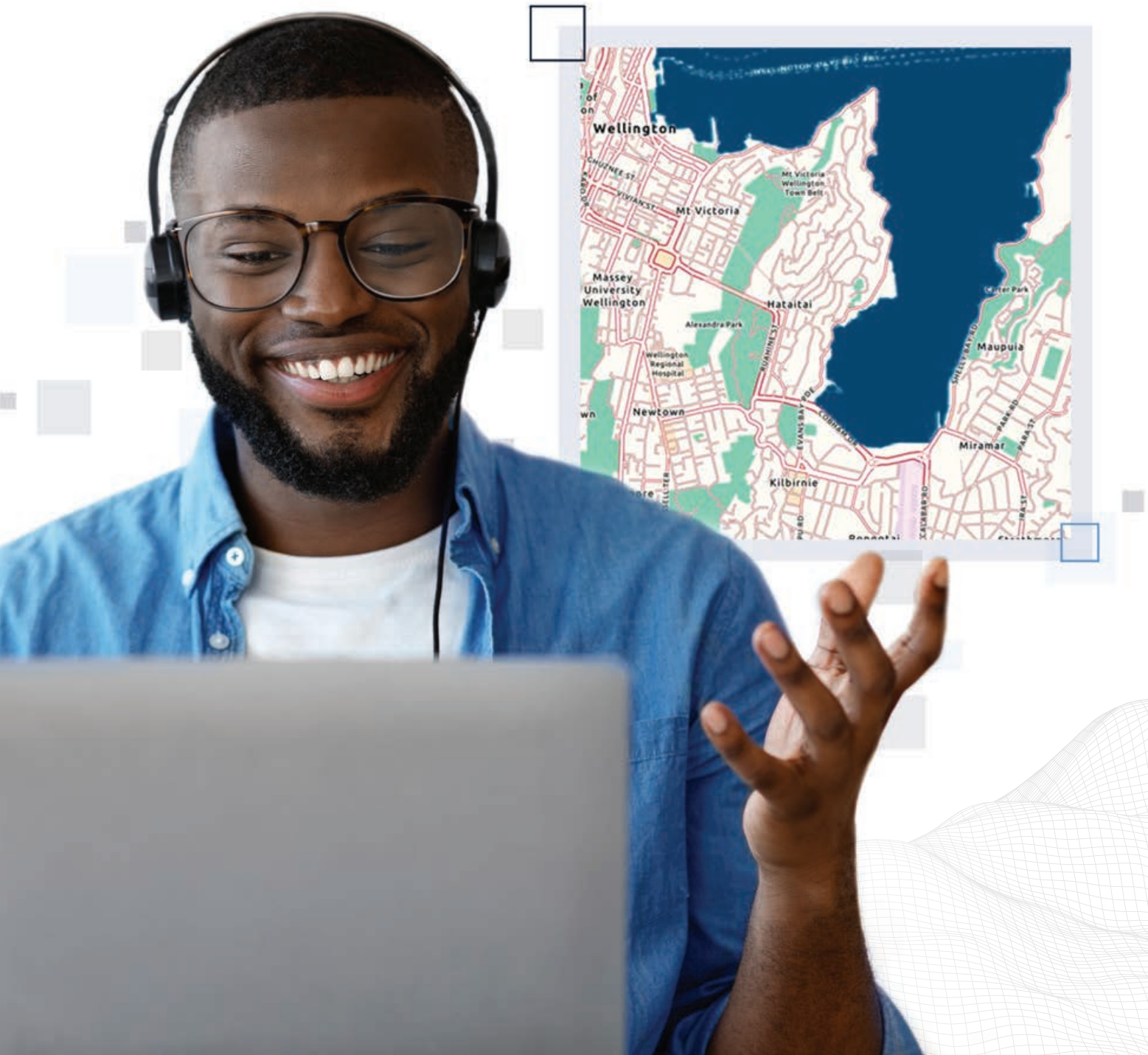
Using an ArcGIS Online shared theme allows you to compare contrast between foreground and background colors, and any sites created with Hub or ArcGIS Enterprise Sites will automatically import the shared theme. Contrast is important, as it helps individuals with varying visual abilities access your information.

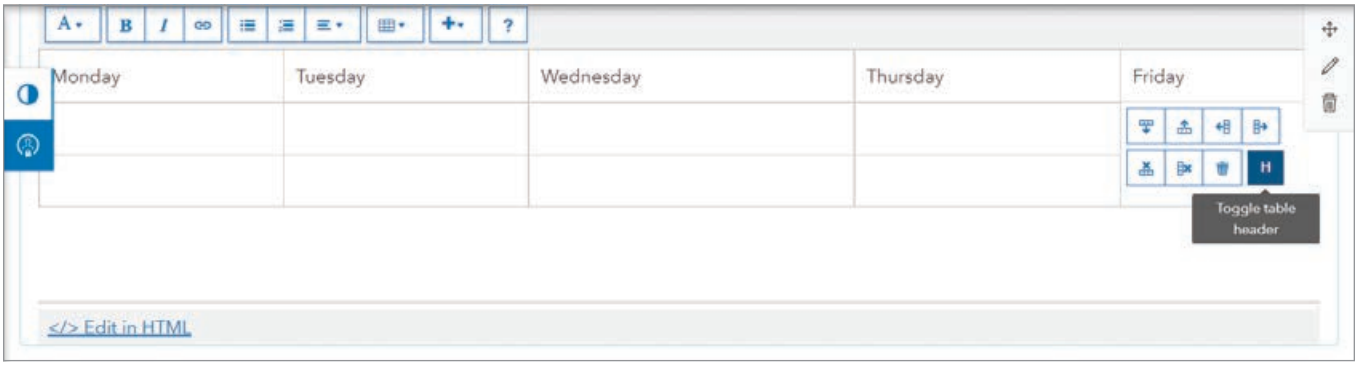
According to the WCAG guideline 1.4.3 Contrast (Minimum), color luminance contrast between text and background color should be greater than or equal to 4.5:1 for small text and 3.1 for large text.

WCAG guideline 1.4.11 Non-Text Contrast extends the 3:1 contrast ratio to icons and graphic elements.

If you are setting the theme within the site theme panel, you may want to verify the contrast of your selected colors with an external tool. A number of free color contrast analysis tools can be used online, such as the WCAG Luminosity Contrast Ratio Analyzer (https://bit.ly/3JT0YJI), a Google Chrome extension that allows you to compare colors with an eyedropper tool and preview your site through a range of color blindness simulators. You can also use a web resource such as WebAIM's Contrast Checker (https://bit.ly/3mXkHhq) to compare two colors by manually entering their RGB hexadecimal values.




Wellington
Mt Victoria
Massey University Wellington
Hataitai
Alexandra Park
Wellington Regional Hospital
Newtown
Kilbirnie
Miramar
Maupuia



↑ Avoid using tables to structure your layout. Tables should be reserved for basic data. Use the Table header toggle (H) option that comes with the text card table to structure your tables to provide an optimal experience for users of assistive technologies.

Organize an Accessible Content Structure

As you use the cards available in the layout builder, consider the WCAG guidelines 2.4.4. Link Purpose (In Context) and 2.4.6 Headings and Labels to create a structured narrative that's easy to navigate. Each page you publish should have at least one <h1> heading to provide visitors with context.

Row Card

Row cards are the building blocks of your site. They can be filled with any combination of additional cards, such as web map, video, image, text, and chart cards. When configuring the settings for a row, you can set a background color or upload an image. Whichever you choose, make sure that there is sufficiently high color contrast between the background and any content displayed by other cards, such as the text or category cards. If you are not sure whether a row background image provides enough color contrast, then add a light or dark background color to the row and adjust the color's transparency.

Text Card

Sharing narratives connects your audience with the information that users need to understand your message and take necessary action. When using the text card, there are several ways you can create an accessible content structure.

Structure your narratives with sections to make it easier for screen readers to navigate text. Be sure to use the correct hierarchy of header levels, and don't skip heading levels. Do not use headings decoratively to increase font size.

If you link to additional resources, such as external sites and pages, ensure that your text is descriptive. Rather than saying, "click here," invite people to follow the link with phrasing like, "to learn more about x…" This strategy helps assistive technologies that may use shortcuts to rapidly jump through all the links on a page without having to read the text around those links.

As part of WCAG guideline 3.2.2 On Input, Technique G201 recommends avoiding opening links in new tabs or windows unless you provide the user with advanced warning.

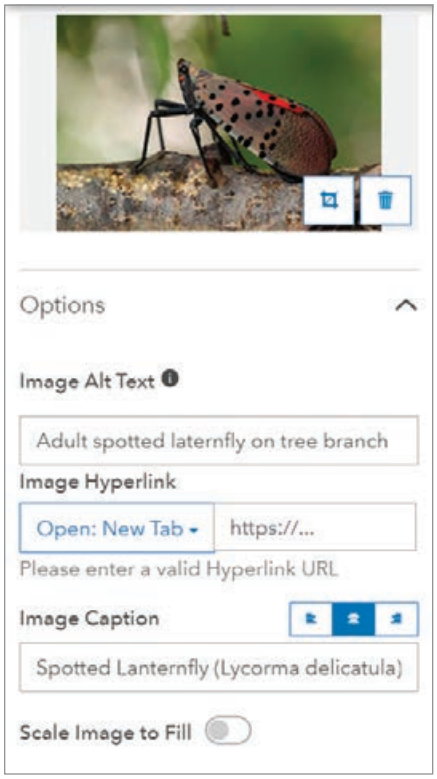
Avoid using tables to structure your layout. Tables should be reserved for basic data. Use the Toggle table header (H) option that comes with the text card table to structure your tables to provide an optimal experience for users of assistive technologies.

Don't forget to check color contrast of a card's link text by selecting Theme on the Customize panel and adjusting the Body Link Color.

Category Card

Category cards visualize groups of similar datasets. Choose from the library of icons for category cards that are provided as scalable vector graphics (SVGs), an image file format that can be used at different sizes without affecting image quality. Alternative text (Alt text) is automatically provided for each SVG by tying it to the link text you provide via an Accessible Rich Internet Applications (ARIA) tag.

You can also upload a custom image for your category card. If you want to use your own image, you can provide a URL for an SVG or transparent PNG file. Be sure to write alt text in the provided field so that your image is accessible to screen readers.



← Alt text should be provided for all images on your site but make sure alt text is different from the image caption.

Share Accessible Visuals and Media

Adding images and media is a simple way to enhance your sites and pages. When choosing visuals or media to add, consider content that provides value rather than redundancy.

Image Card

The image card settings provide you with several options for customizing the display of your image, including the option to provide image alt text. Alt text is a specific attribute that is attached to an image to give screen readers a description for nonsighted users. Here are some things to consider when providing alt text:

- Alt text should be provided for all images on your site.
- Descriptions should be brief but provide enough context to justify the value of the image.
- Alt text is different from an image caption. Don't copy and paste an image caption as alt text. If you do that, the screen reader will read the same thing twice.
- Refrain from using "image of" or "picture of" in your alt text.
- If you want your image to link to something, make sure that your image hyperlink is set to open in the same tab. Doing this makes things easier for a sighted user to navigate.

Gallery Card

Gallery cards are used to display a range of content types like apps, dashboards, web maps, documents, and additional sites and pages. Whether you style your gallery with icons or thumbnails, the images will automatically be marked as decorative to avoid redundant text descriptions. However, tying back into content structure, you may want to adjust the Gallery Card Title Heading. This will not change font size but can help you better order your nested headings.

Video Card

Per WCAG guideline 1.2.2 Captions, you will have to caption any video added to video cards, but YouTube, Vimeo, and Facebook videos are supported. (Note: ArcGIS Enterprise 10.7 provides support only for Facebook videos.)

Embedded content should always contain titles so that people using assistive technologies know whether or not they want to enter into that section of your page. Use the title setting on the video card to describe what will be presented in your video. The same goes for any content embedded through the iframe card. Always add a title describing what content can be found within the iframe.

Social Media Card

With the social media card, you can provide Facebook or Twitter posts in-line. Unfortunately, content being shown from either platforms cannot be controlled, so color contrast violations can occur. However, a toggle for the Twitter Dark Theme is included, which does pass color contrast requirements.

Automated Accessibility Testing Tools

There are also several tools that can run automated tests of your entire web page to check for accessibility violations. The ArcGIS Hub team uses axe by Deque (https://www.deque.com/axe/) as part of its development process. Lighthouse by Google (https://bit.ly/3JLv1CP) is also available. Both axe and Lighthouse have Chrome extensions that can be installed so these auditing tools can run in your browser.

Get Started

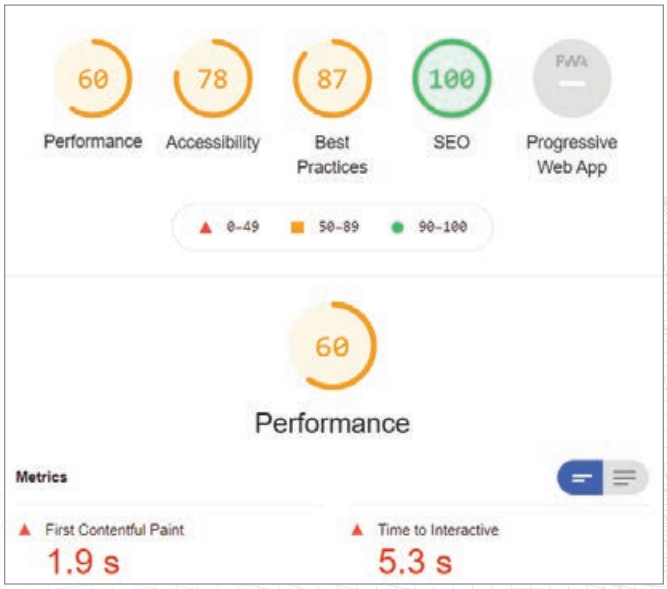
Create a new site or review existing sites for accessibility improvements. If you have any questions or comments, go to the ArcGIS Hub section of Esri Community. The ArcGIS Hub Changelog (https://hub.arcgis.com/pages/changelog) is updated regularly to reflect the changes in product accessibility. For overall product accessibility status reports, visit https://bit.ly/3qOIa5v for ArcGIS Hub or https://bit.ly/3pX5TkY for ArcGIS Enterprise Sites.

About the Authors

Katie Thompson is a writer working on ArcGIS Hub and Enterprise Sites in the R&D Center in Washington, DC.

Klara Schmitt is a UX/UI designer for Esri on ArcGIS Hub. She has a passion for web accessibility.

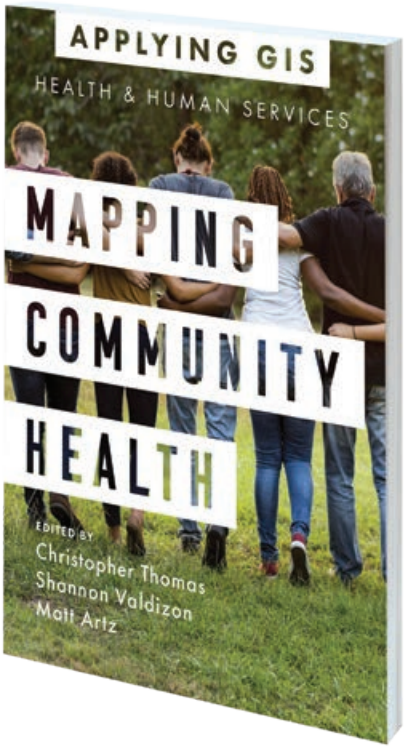
↓ Test your site for accessibility and other performance metrics using Lighthouse by Google, a free Chrome extension.



GIS Bookshelf

Mapping Community Health: GIS for Health and Human Services

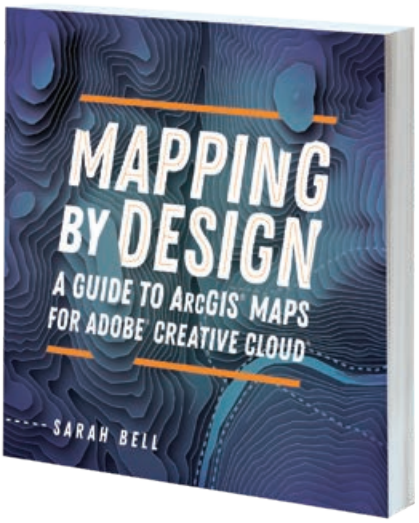
Edited by Christopher Thomas, Shannon Valdizon, and Matt Artz



Public health service agencies rely on GIS to improve health outcomes, increase access to health care, and build healthier communities. This collection of case studies demonstrates how GIS is being used to address challenges and build resilient communities and suggest ideas, strategies, and tools to jump-start the use of GIS. Supplementary online resources include additional case studies, videos, and downloadable tools and content. This is another in the Applying GIS series. Esri Press, 2021, 120 pp., print ISBN: 9781589486997, ebook ISBN: 9781589487000.

Mapping by Design: A Guide to ArcGIS Maps for Adobe Creative Cloud

By Sarah Bell



Esri cartographer Sarah Bell, author of *Mapping by Design: A Guide to ArcGIS Maps for Adobe Creative Cloud*, believes that while learning to create maps is hard work, it's also a fun and creative endeavor that is continually evolving. Besides being a cartographer, Bell is also the lead product engineer for ArcGIS Maps for Adobe Creative Cloud—a product that she uses to make beautiful, artistic maps of everything from rock climbing sites to donut shop locations. In *Mapping by Design*, she uses her knowledge of and skills with Maps for Adobe Creative Cloud to guide readers through how to use the software and Adobe Illustrator to craft informative and visually compelling stories with maps.

Readers who complete the book's tutorials will learn how to do the following:

- Work with the user interface components of Maps for Adobe Creative Cloud
- Make maps using common workflows
- Perform custom geospatial analysis
- Use automated custom symbology and map elements
- Integrate Maps for Adobe Creative Cloud into ArcGIS Pro cartographic workflows

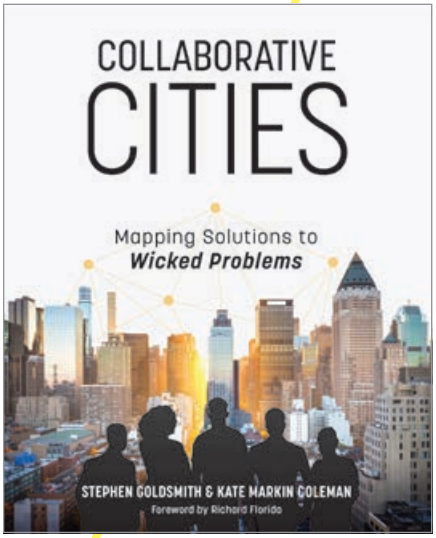
The book includes a 180-day trial license of ArcGIS software.

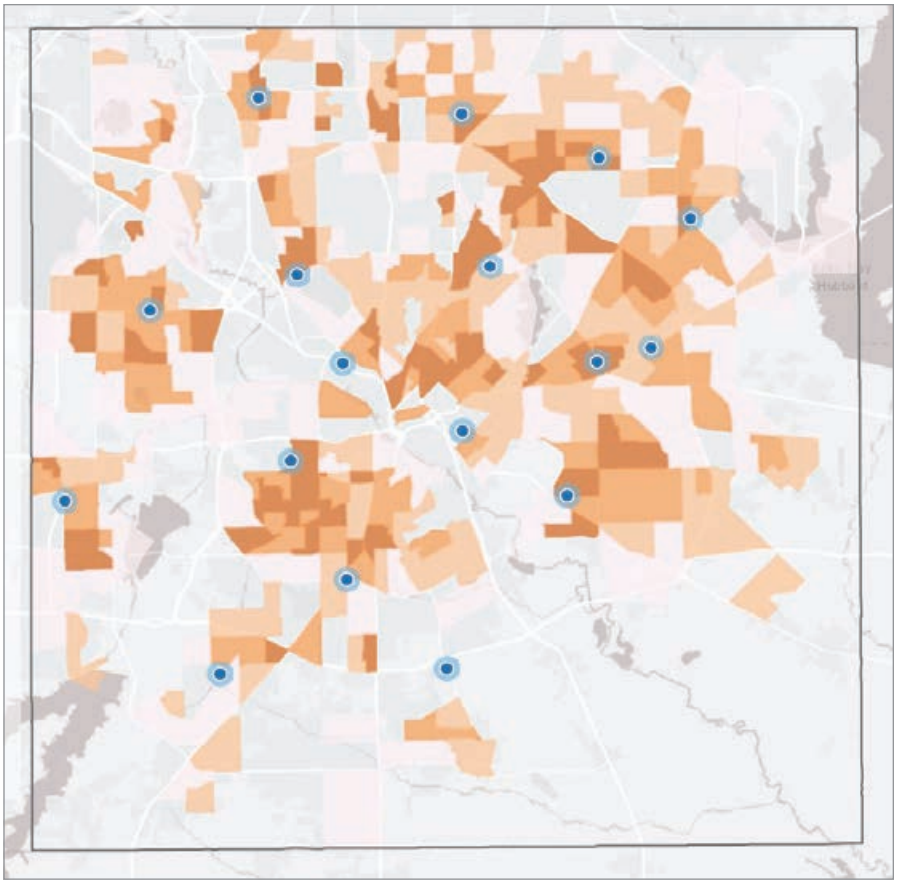
Bell has been a professional mapmaker for more than 10 years. She started her career at the National Park Service as a park ranger in North Cascades National Park in Washington State, where she also began making rock climbing maps of Mount Rainier. She earned a master's degree in geography from Western Washington University. She worked as a cartographer for a firm in Bellingham, Washington and at Western Washington University's Resilience Institute before joining Esri in 2013. Esri Press, 2021, 225 pp., print ISBN: 9781589486041, ebook ISBN: 9781589486058.

HOW MAPPING CAN HELP MEND SOCIAL DIVIDES

By Christopher Thomas

It sometimes feels as if there's little that can bridge our society's divides—but the married coauthors of a new book from Esri Press—one a Republican, the other a Democrat—are optimistic.





↑ WIC eligibility in Dallas County, Texas, is shown mapped by census tract with the location of WIC facilities indicated by a blue dot. Darker areas indicate a higher density of WIC-eligible participants.

"In city politics, you can battle about a lot of things, or you can figure out how to get food to people who don't have it. And that shouldn't be a political fight. That's just a resource question once it can be visualized," said Stephen Goldsmith, the former Republican mayor of Indianapolis and deputy mayor of New York City.

He and wife Kate Markin Coleman, a private sector and nonprofit executive who describes herself as a "very liberal Democrat," explain how one visualization tool in particular—maps—can be used to help solve persistent issues.

In *Collaborative Cities: Mapping Solutions to Wicked Problems,* the pair illustrate how a geographic approach can help communities address homelessness, climate change, and childhood poverty, all deemed "wicked" problems because of their complexity.

They're the type of problems, the authors write, that "demand the kind of creative thinking, democratized engagement, and integrated action that best happens across boundaries when government, nonprofits, businesses, and citizens work in concert."

Bringing Services to People Where They Live

Goldsmith and Coleman both have had firsthand experience in their careers by

↑ Kate Markin Coleman and Stephen Goldsmith

using the geographic approach to foster collaboration.

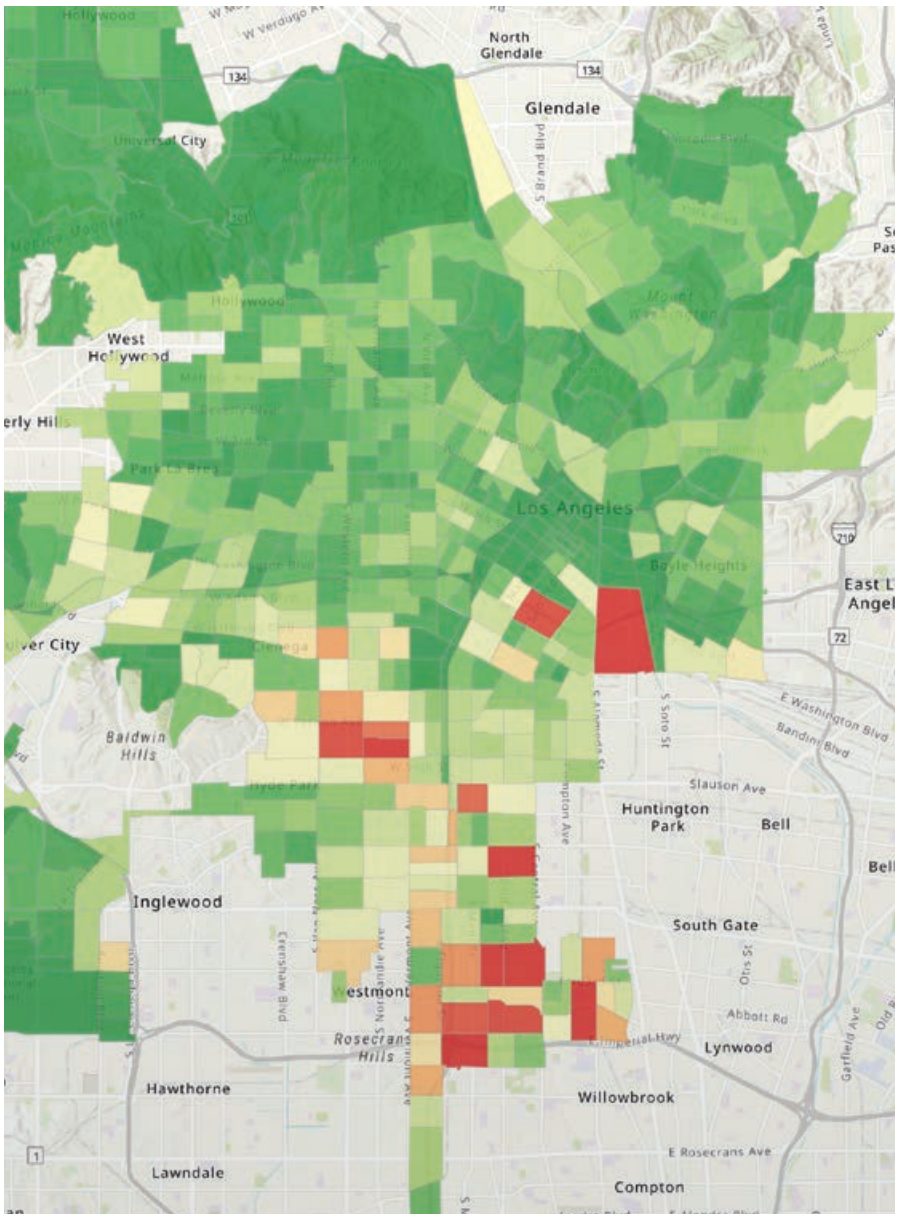
One of Goldsmith's first goals as mayor of Indianapolis was to improve the quality of life in neglected communities. He went to the lone GIS professional then employed with the city and asked for a map showing the neighborhoods most in need and the assets in those same communities. This led to a $600 million investment in improving seven neighborhoods with the Indianapolis Neighborhood Empowerment Initiative. The effort provided neighborhood and housing services, and programs for beautification, crime watch, and volunteer initiatives.

When Coleman, former executive vice president and chief strategy and advancement officer for the YMCA of the USA, was helping lead the YMCA in Chicago, she also leaned on GIS. Coleman used spatial analysis to better understand the structural barriers that made it difficult for residents to access services despite demographic data showing them to be prime candidates for participation.

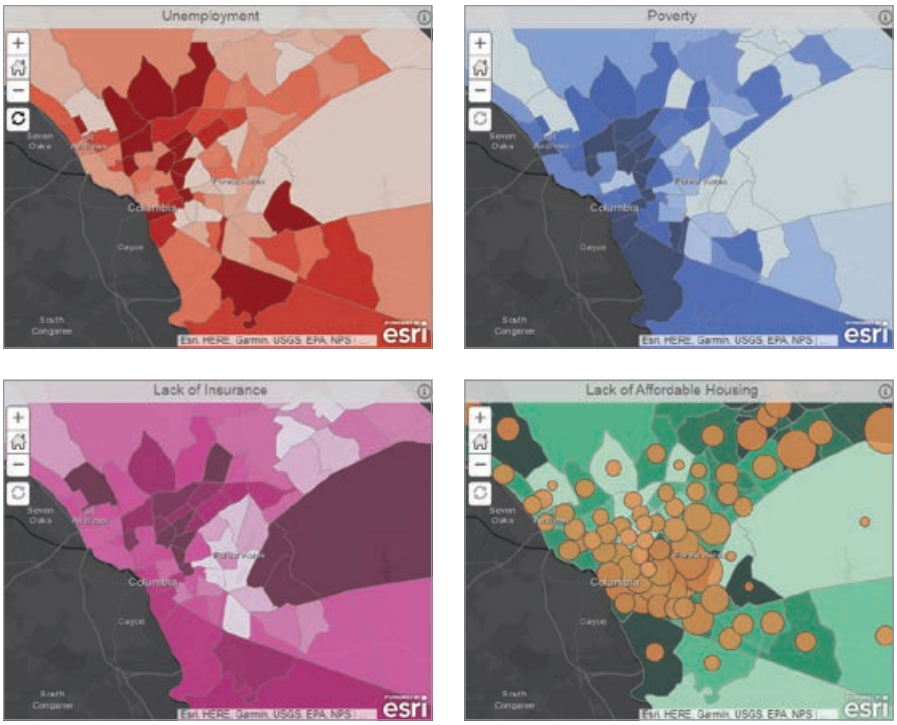
In their book, Goldsmith and Coleman point to examples across the US where a possible fix to a problem became evident through geographic awareness and collaboration among interested parties. In all cases, the focus was on the people needing to be served and not the agency providing the service.

In another case, leaders determined the reason residents were missing out on their WIC benefits. *[The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a federal program.]* A map showed that WIC offices, where individuals could apply for services, were located too far away from the homes of the people the program was meant to serve. Because the federal government entered long-term leases, it meant the offices would have to stay put even if likely clientele no longer lived nearby. A better approach would have been shorter leases nearer to the people needing services. Leaders realized that more attention should be paid to the needs of clients, not the agency.

Another example in the book comes from Richmond, Virginia.



→ This map of the city of Los Angeles highlights problem streets. The Clean Streets Index Grid 2016 symbolizes parcel condition, using color. Green parcels are in the best condition and red parcels are in the worst.



↑ GIS can be used to map and visualize common risk factors that contribute to the current rates of homelessness, such as unemployment, poverty, lack of insurance, and lack of affordable housing.

In 2018, city leaders wanted to turn around abysmally low participation rates in after-school programs. They convened a group that included Richmond Public School representatives, nonprofits, community members, and after-school program providers. Afterward, Mayor Levar Stoney launched a plan to provide "out-of-school" programs to all the city's elementary and middle school students. The group had discovered, through mapping, that at least two schools in the city provided no after-school programs at all. One of the group's members, Kimberly Bridges, told the authors that simply mapping the number of children in after-school programs and slots available by school inspired expansion.

"Just putting the information on paper, having people look at where there were and were not programs, was enough to catalyze really powerful discussion and build relationships in a way that pushed the collaboration forward," Bridges said.

Making the Time to Rethink Approaches

The book notes other efforts to colocate social services and connect like-minded organizations to team up so there is less overlap in services. Sometimes these ideas, as logical and rewarding as their results may be, have faced implementation challenges.

"When people's heads are down because they are underresourced, they don't have the bandwidth to think in bigger pictures. I saw that all the time. We so underfund the infrastructure of social service organizations that people are doing too many things and don't have the time to step back and rethink processes or approaches," Coleman said.

That's why collaboration among groups that cut across various sectors—philanthropy, government, business—can help.

"When you have all of those together, you develop tentacles that are able to reach out into the community and secure the necessary funding and enabling legislation," she said.

Even if a program doesn't formally get off the ground, the informal coalescing of different groups and ideas can provide tangible results that are carried forward.

The pair also point out that as well-meaning as government funding can be, it often encourages the kind of silos that make things less efficient for people who need services.

"Money tends to fund the solution of a problem, right? You don't have enough food; that becomes a food program. You don't have enough shelter; that's a shelter program. You don't have enough safety; one responds with policing. But of course, the proposition in the book and *[in]* life is that you don't live in a program. You live in a place and experience a multiplicity of issues. The way government funds programs aggravates the divisions," Goldsmith said.

Often, the result of geospatial analysis can be a surprise to those who may not have been fully aware of who their community members are and what they need.

"You don't really appreciate the conditions someone is living in until you can see and understand those conditions, where they're located, and how different they are from the ones you experience," Goldsmith said. By connecting with maps to show and describe those conditions, Coleman thinks leaders can build the political capital necessary to intervene in some of our most difficult problems.

The authors noted: "If you live in a world where you never see poverty, homelessness, or starvation, you don't have an accurate opinion of the challenges faced by other folks."

Read *Collaborative Cities: Mapping Solutions to Wicked Problems* from Esri Press.

About the Author

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

Building Video Games with ArcGIS Technology

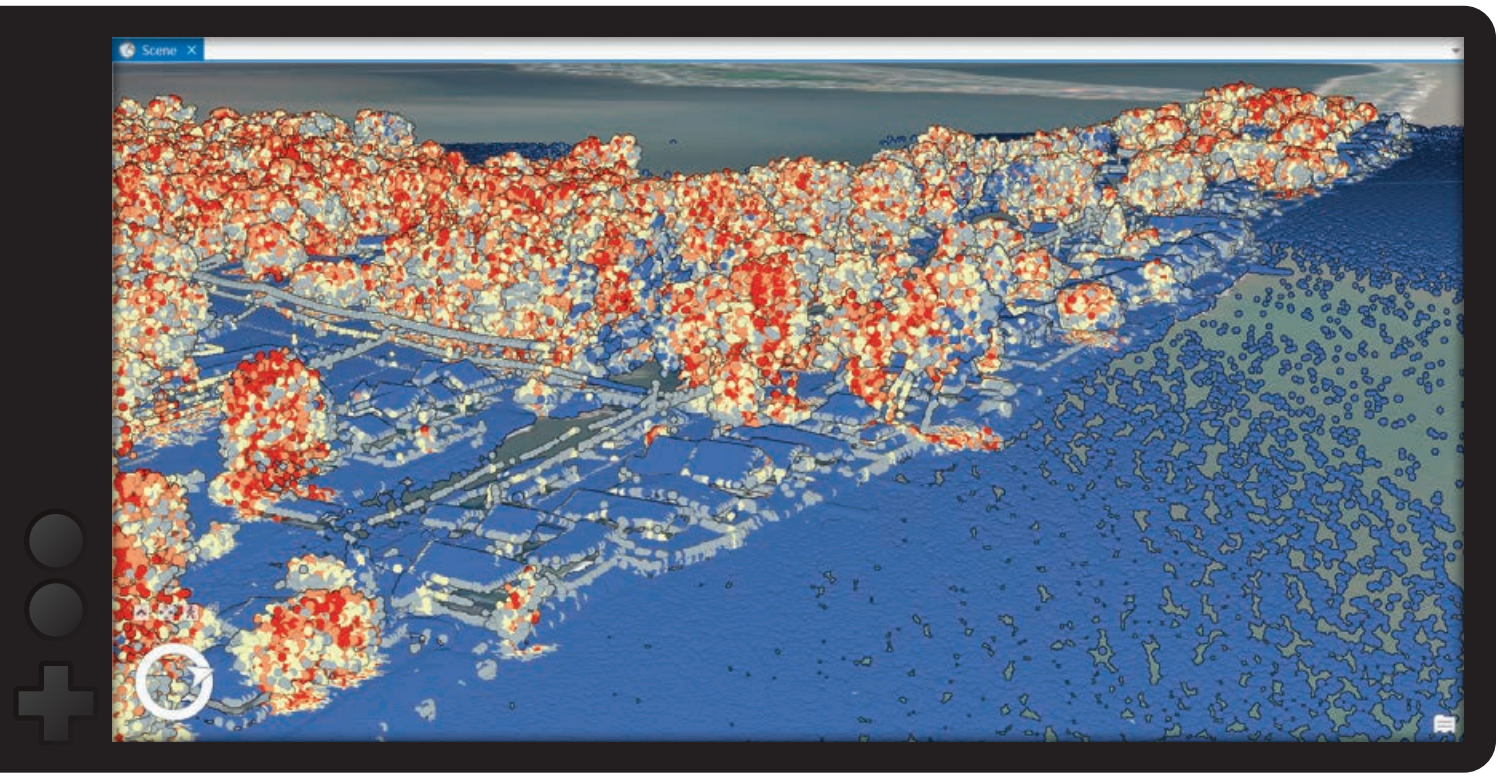
By Brian Tomaszewski, Carson Lampila, Noah Richards, Liam Andres, Chase Call, and Alex Sarnese

The intersection of ArcGIS, geospatial data, and video games is becoming more blurred as more video games are based on real-life examples. Re-creating an accurate, realistic virtual world in a video game that provides unique game experiences and interactions is a growing field. Even for entirely fictional landscapes, real-world geospatial data incorporated into a game can make the setting realistic.

For example, the action-adventure video game Assassin's Creed Syndicate is set in 1869 London. Game developers at Ubisoft worked tirelessly to create an accurate, one-to-one scale representation of London. Many players have reported that when they visited London for the first time in real life, they had already learned how to navigate the city from their gaming experiences. Although incorporating real-world geospatial data into video games is promising, many challenges still exist.

Project Background

At the Rochester Institute of Technology (RIT), the authors of this article worked as a team that explored using ArcGIS Desktop, ArcGIS Online, ArcGIS CityEngine, and ArcGIS Maps SDK for Unity to create a serious game about natural disasters. The purpose of the game was to educate people and influence policies that can impact lives during disasters. Previously, RIT created Project Lily Pad and Project EOC, both focused on events related to Hurricane Harvey in 2017, as part of a National Science Foundation (NSF)



↑ Buildings created from single return lidar data, shown in ArcGIS Pro, and compared with an ArcGIS imagery basemap.

↙ Lidar data, shown in ArcGIS Pro, was used as the basis for the Project Lake Ontario game. Multiple object types were detected—terrain, buildings, trees, and water.

Research Experiences for Undergraduate Students (REU) project. *[Read more about these games in "Serious Game Play," which appeared in the August 2020 issue of* ArcWatch.*]*

With new advancements in Esri technology that are specifically focused on game development, the team decided to use Esri technology to make a serious game and simulation called Project Lake Ontario. It is related to the flooding of Lake Ontario, which severely impacted several coastal residential neighborhoods in 2017 and 2019. A goal of Project Lake Ontario was to educate the coastal residents about Plan 2014, a water level regulation policy.

Specifically, the team wanted to use Esri technology to create a realistic simulation of how water levels would look under various scenarios. From a GIS education perspective, the team also wanted to use Project Lake Ontario to teach game development and design to students as well as Esri technology and broader GIS concepts. This would be accomplished during a 10-week undergraduate student summer research and development experience.

Video Games That Use GIS and Geospatial Data

The team started building Project Lake Ontario using ArcGIS Pro. Team members downloaded lidar data and imagery from the Monroe County, New York, website for the project area to establish accurate ground terrain for the game. One of the first challenges was that the lidar detected the trees and water in addition to the terrain and buildings.

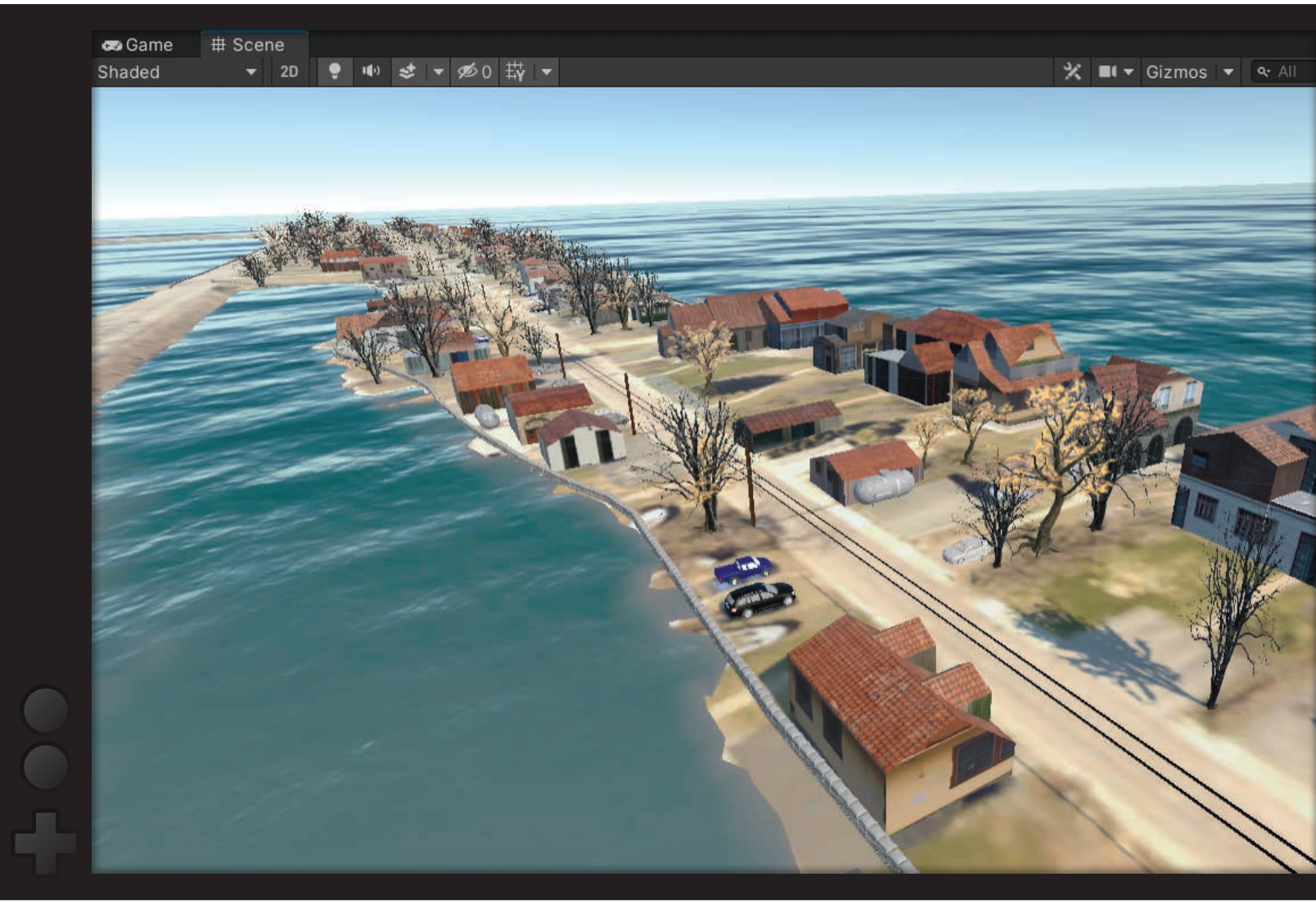
After examining the lidar data by using ArcGIS Pro, the team found it had only the ground classified so that information was extracted for the height map of the land. To get the buildings, the trees needed to be removed. To solve this problem, the lidar points were filtered by selecting only single return data points. This was done to isolate the buildings because trees tend to have multiple returned values.

With the mostly treeless lidar, it was much easier to begin to extrude and construct buildings in ArcGIS Pro. Although some of the houses that appeared in the lidar imagery did not match the imagery of the surrounding area due to differences in data collection times, the lidar data was chosen for determining which houses to display and how they would appear.

After constructing land and buildings in ArcGIS Pro as accurately as possible, the next challenge was importing that data into Unity, an industry-leading game development environment that would be used to create Project Lake Ontario. The team decided to evaluate two Esri products: the latest beta release of ArcGIS Maps SDK for Unity and then ArcGIS CityEngine.

Using ArcGIS Maps SDK for Unity

The documentation for the latest beta release of ArcGIS Maps SDK for Unity seemed to show it as an out-of-the-box tool that could easily incorporate geospatial data directly into Unity. Objects and layers were first created in ArcGIS Pro, and the layers were then exported to ArcGIS Online as scene layers. The ArcGIS Online scene layer URLs were fed into ArcGIS Maps SDK for Unity for direct incorporation into Unity. The full process involved a lot of smaller steps such as selecting settings and manually exporting/importing each time data was brought into Unity. After overcoming some



↑ The Project Lake Ontario game is shown in Unity. It was built using real-world geospatial data processed with ArcGIS Pro, ArcGIS Online, ArcGIS CityEngine, and ArcGIS Maps SDK for Unity plug-in. The combination of these technologies demonstrates an exciting new direction for combining Esri technology and video games.

initial challenges and gaining more experience with Esri tools, the landscape for the project area was imported into Unity using ArcGIS Maps SDK for Unity.

With this initial success came the next set of challenges that had to be dealt with to meet the broader goals of Project Lake Ontario. Creating the game required two things. First, features in the geospatial layers needed to become GameObjects, which are the base class for all entities in Unity scenes and the core building blocks of video games.

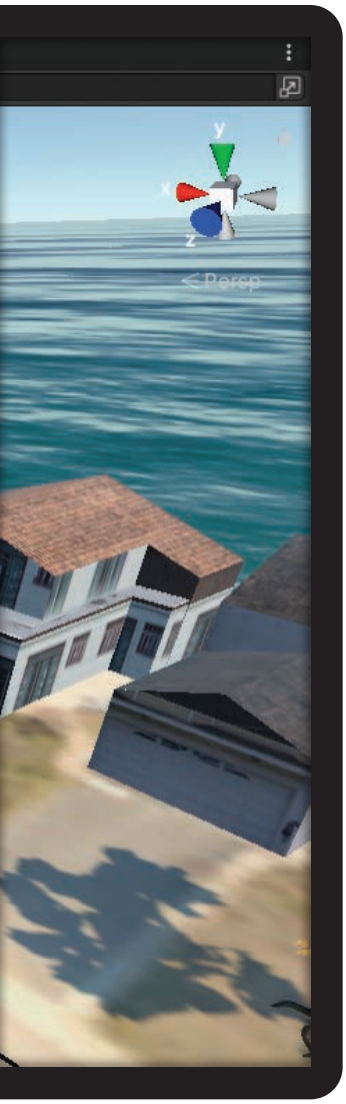
GameObjects need to respond to player interactions. In video games that have buildings, a player can't (usually) walk through a building. Colliders prevent this from happening. *[Colliders define the shape of a GameObject for the purposes of physical collisions or interactions in the game.]* For custom game interactions, GameObjects can have C# scripts attached to them.

Second, the geospatial layers must exist in Editor mode so they can be seen when building the game versus appearing in Play mode when the game is being run to test it. The team quickly realized that the ArcGIS Online layers incorporated into the game via ArcGIS Maps SDK for Unity appeared only in Play mode and were visible only in the absence of colliders.

Without geographic features from ArcGIS Online available in Editor mode, attaching scripts and colliders was much more difficult. It required that the entire workflow from its start in ArcGIS Pro to publishing layers to ArcGIS Online be redone anytime the underlying data was modified (for example, to move a building).

The team noticed another serious issue. Specifically, ArcGIS SDK for Unity had its own camera rendering in the back end, which caused conflicts when multiple cameras were implemented in the game scene. Additionally, the ArcGIS camera would exhibit strange movement if another camera was used or moved.

After some initial success and challenges with building Project Lake Ontario using the latest beta release of ArcGIS Maps SDK for Unity, the team decided to explore a different Esri technology: CityEngine.



Using ArcGIS CityEngine

With ArcGIS CityEngine, the team used the following general workflow. Layers created in ArcGIS Pro were imported into ArcGIS CityEngine. Those layers were exported from ArcGIS CityEngine as Wavefront OBJ files and opened in Unity. This workflow allowed models to be textured in ArcGIS CityEngine and modified easily without continually republishing to ArcGIS Online. In ArcGIS CityEngine, multipatch feature layers could be divided into individual models for items such as houses. These models could then be imported into Unity and modified in the Unity Editor mode.

Once the ArcGIS Pro to ArcGIS CityEngine to Unity workflow proved successful, more advanced functionality was added. For example, interactively changing water levels in the game allowed players to add sandbags to simulate flood control. Real-world objects, such as gas tanks, cars, and trees, were added to enhance the game's realism.

Reflections and Future Outlook

Creating Project Lake Ontario proved to be a challenging yet rewarding experience. Despite lacking experience with Esri technology, the team created a viable video game that incorporated advanced game design functionality using real-world geospatial data and Esri technology in the short span of 10 weeks.

In its current form, the team found that ArcGIS Maps SDK for Unity is a great tool for exploring geospatial layers and rapid prototyping in a game engine tool like Unity. Given that ArcGIS Maps SDK for Unity was still in beta, the team expects many of the challenges faced in developing Project Lake Ontario will soon be overcome.

According to Rex Hansen, the ArcGIS Maps SDK product manager, "ArcGIS Maps SDK is designed to provide developers with direct integration of live and local ArcGIS data within a game engine like Unity. As the Maps SDK moves toward its first production release in 2022, we'll continue to improve integration with game engines to support use in Editor mode; provide a geoplacement framework for more intuitive placement of cameras and game objects; enable ArcGIS data for use in ray casting or as a collision mesh; and, of course, continue to add support for additional ArcGIS data sources." *[A ray casting algorithm uses lines (rays) in virtual space to represent the path of light from an object to an observer.]*

Project Lake Ontario also represented an excellent opportunity to build unique game experiences that can be used to educate and inform the public on pressing challenges facing society. For example, the goals of the Project Lake Ontario game are related to understanding water level regulation policy.

In addition, there are great opportunities to train and educate the next generation of game development students in the use of real-world geospatial datasets and Esri technology. Ideally, there will be greater integration of game development and the geospatial field as shown in the creation of Project Lake Ontario.

For more information, contact

Brian Tomaszewski, PhD
Center for Geographic Information Science & Technology
School of Interactive Games and Media
Rochester Institute of Technology
bmtski@rit.edu

Resources

ArcGIS Maps SDK for Unity
developers.ArcGIS.com/unity-sdk/
More information about Project Lake Ontario including source code and playable executable file:
https://www.rit.edu/gccis/geoinfosciencecenter/
Overview video about combining Esri technology and video games:
https://bit.ly/3kPDoCI

About the Authors

Brian Tomaszewski is an associate professor at the Rochester Institute of Technology in New York. His research focuses on geographic information science and technology, disaster management, and serious games. He has previously contributed articles to *ArcUser* and published the second edition of his book *Geographic Information Systems for Disaster Management* in 2020. He holds a doctorate in geography from the Pennsylvania State University

Carson Lampila is an undergraduate game design and development student in the School of Interactive Games and Media at the Rochester Institute of Technology.

Noah Richards is an undergraduate game design and development student in the School of Interactive Games and Media at the Rochester Institute of Technology.

Liam Andres is an undergraduate game design and development student in the School of Interactive Games and Media at the Rochester Institute of Technology.

Chase Call is an undergraduate game design and development student in the School of Interactive Games and Media at the Rochester Institute of Technology.

Alex Sarnese is an undergraduate game design and development student in the School of Interactive Games and Media at the Rochester Institute of Technology.

↓ GIS has been integrated in the curriculum at James Madison University in Virginia.

The Top 10 Reasons to Adopt GIS in the Classroom

By Joseph Kerski

Teaching and learning with GIS technology has always been focused on higher and more noble goals than simply learning GIS skills and tools. Learning GIS is an important skill set, but the ultimate goal is to understand an issue or a problem in a deeper, more holistic way and then communicate your findings and take action.

If you are a teacher who is considering adopting GIS software in your classroom, you may be wondering how your students would benefit by using GIS technology. The following list of 10 educational benefits of working with GIS shows how GIS opens a world of possibilities for all learners.

1 Spatial Thinking

Maps have always been appealing. They convey a large amount of information in a small amount of space. In the past, this space was always constrained by physical media—stone tablets, wood blocks, silver plates, film, or paper. Today, digital maps are all around us. Increasingly, they're embedded in dashboards, interactive maps, articles, videos, and multimedia of all types. They are in 2D and 3D representations, with the fourth dimension—time—increasingly enabled through animations and space-time cubes.

Spatial thinking is crucial to understanding our increasingly interconnected, complex world, and it's key to solving the serious problems we are facing in that world. Spatial thinking is greatly enabled by using the interactive maps made possible through GIS. Through GIS, students are not only consuming maps created by others, they are also creating their *own* maps, infographics, and web mapping applications and therefore deeply connecting with the creative process.

Educators and scholars have argued as long ago as 1971 that gaining the ability to think spatially—which is sometimes called graphicacy—is every bit as important to teach at all levels in education as numeracy, articulacy, and literacy. Spatial thinking is coupled with holistic thinking, which considers the world as more than just the sum of its parts. It is also connected to seeing the world as a system of systems, including the biosphere, lithosphere, atmosphere, hydrosphere, cryosphere, and anthroposphere—the human sphere. Spatial thinking also fosters the understanding of cycles such as the carbon cycle and the hydrologic cycle.

To learn more about topics related to geography, web mapping, and the power of spatial thinking, listen to episodes of the Thinking Spatially podcast series (https://www.stitcher.com/show/thinking-spatially).

2 Critical Thinking

Critical thinking must include three aspects: data, methods, and maps. Questions to pose as you teach with GIS include the following: What difference would changing the dataset theme, resolution, or scale make in the final analysis? Can you trust this map as a source for making a decision? Is this map or layer suitable for your project? Can you trust the data that you yourself collected in the field? What are the inherent errors in data—from map projections to missing attributes—and how can you manage these errors?

3 Project-Based Learning

GIS was created to solve problems. Using GIS in education helps students frame, visualize, and grapple with problems. It even enables students to create solutions to those problems, whether they are about natural hazards, climate, urban greenways, litter, energy, social inequity, or other complex issues of our day. Project-Based Learning (PBL) is a teaching method that implies active learning, and GIS is a natural fit for it. When using GIS, students are *actively engaged* as scientists, planners, and other decision-makers. PBL students learn by participating in real-world and personally meaningful projects. Using GIS, students have flexibility to choose projects and address the serious problems that they see in their community and their world.

4 Geographic and Scientific Inquiry

Inquiry involves asking questions, gathering data, assessing the quality of that data, evaluating methods, analyzing the data and the results from each of the methods used, making decisions and recommendations, and taking action. This process usually sparks additional questions, and the process continues.

The effective use of GIS is keenly tied to this process of inquiry. At its core, GIS has always been a thinker's tool. GIS requires students to ask questions. Students aren't used to asking their own questions; they are used to instructors asking *them* questions. How can we encourage students to ask thoughtful questions of their own? Read the *ArcUser* article, "A Good Map Teaches You to Ask a Better Question" (https://bit.ly/3n0xqAd). Asking questions leads to tenacity in problem-solving. Students who ask questions will become the people who employers want to hire to help their organization achieve its goals.

5 Data Fluency

The book *Understanding the Digital Generation: Teaching and Learning in the New Digital Landscape* by Ian Jukes, Ted McCain, and Lee Crockett, stresses that to prepare students for today's workplace, there must be a shift toward teaching skills that are tied to technology. Fluencies connected to technology and digital media should be emphasized. The book uses the word *fluency* rather than *literacy* because it conveys a sense of lifelong learning. It is like becoming fluent in a language, but in this case, the language of technology.

There are five important fluencies: solution, information, collaboration, creativity, and media. Solution fluency is whole-brain thinking, including creativity and problem-solving applied in real time. Information fluency is the ability to access digital information sources to retrieve desired information and assess and critically evaluate the quality of information. Collaboration fluency is a teamwork proficiency. According to the book's authors, it is the "ability to work cooperatively with virtual and real partners in an online environment to create original digital products." Creativity fluency is, the authors say, the "process by which artistic proficiency adds meaning through design, art, and storytelling." And media fluency is the ability to look analytically at any communication media to interpret the real message, determine how the chosen media is being used to shape thinking, evaluate the efficacy of the message, and publish original digital products to match the media to the intended message.

As I have witnessed thousands of times over the past 20 years, when students use GIS and geographic inquiry to grapple with problems, they engage in all five of these fluencies. Creating interactive maps alone is key to creative fluency, and thinking critically about maps is key to success with media fluency as well as many aspects of modern life.

6 Community Connection

GIS is a tool used worldwide to help better understand global challenges such as climate, education, water, and other issues addressed in the United Nations Sustainable Development Goals (SDGs). But at the same time, GIS is a tool that students and educators can use to engage on issues at the local level, such as planning a new bike trail, nurturing public art or community gardens, or tackling traffic accidents or graffiti.

There is no shortage of data for students to examine, map, and use in understanding and engaging with local issues given the rise of community data portals such as those created with ArcGIS Hub; data on real-time indicators of what is happening on, under the surface of, and over the planet that is made available through ArcGIS Living Atlas of the World; and students' ability to collect their own data.

7 Mobile Workforces

Work being performed away from the classroom needs to include using field methods and getting outside. This type of work is essential not only for understanding our changing world and our communities but also for nurturing an Earth-focused ethic in students so that they will appreciate and want to care for the marvelous planet on which we live. Implementing successful field activities involves planning and executing the work and analyzing the results. It is keenly tied to project planning, dealing with uncertainty, working with high- and low-tech methods, and managing data. Managing data can include determining the units and variables that will be used and organizing the data tables, images, geodatabases, and maps produced.

It sometimes involves contacting others in the community for access to certain lands or to garner their support and participation. To capture data, students can use ArcGIS Survey123, ArcGIS Field Maps, or other Esri GIS apps, along with citizen science apps such as iNaturalist and apps for identifying ambient sounds or plant species. Once gathered, data can be brought into the ArcGIS environment for spatial analysis.

For example, the work of mobile teams was an integral part of a recent Data Citizens Western New York project in which students and faculty mapped storm drains and learned about the water and sewage system in their community. This type of work, even if it is just on the school or university campus, involves getting outside, observing, and using tech tools as well as one's own five senses.

8 Career Pathways

Students often ask, "When are we ever going to use this after we get out of school?" While we shouldn't use GIS in education just because it is in demand in the workplace, we should recognize that GIS does provide students with career skills that will never go out of style. Students who use GIS become valuable employees for nonprofit organizations; academia; government agencies, ranging from local to international; and private industry. They can make decisions, work with data, and see holistically. Sustainability and resilience will be in *every* organization's plan in the future, and GIS will always have a key role. Furthermore, I have seen, time and time again, how students rise to the occasion and achieve more because they know they are using a set of tools that are being used in the professional community. You can play these career videos (https://bit.ly/3D4Cbyl) and podcasts (https://www.directionsmag.com/playlist/6651) that highlight intriguing people who use GIS in their day-to-day work.

9 Content Knowledge

When you are teaching and learning with GIS, you are gaining core content knowledge. GIS was never about "buttonology"—the practice of memorizing where tools and buttons are on the GIS interface and learning how to use them. Even if you are teaching and learning in a GIS or geographic information science (GIScience) course, every procedure has real data behind it, so you are concurrently learning about plate tectonics, ecoregions, climate, the hydrologic network, transportation, energy, city zoning, or other aspects of our natural and human-built world. GIS is core to science, including social science. GIS also is rapidly expanding outside of geography and planning to fields such as health, business, civil engineering, data science, history, and the humanities. Students acquire content knowledge more rapidly than by memorizing large volumes of information because they are *actively engaging* with the data and methods as a practicing professional would.

10 Students as Change Agents

Students empowered with the skills, content knowledge, and perspectives detailed in this article have the confidence and ability to become change agents in their future workplace. Examples of GIS education available from the Esri Community site (https://bit.ly/3EZmbhz) demonstrate that students are already change agents in their own schools, universities, and beyond. GIS can also serve to help women and those who are in other underrepresented populations step into technology-based careers.

If you are a primary or secondary schoolteacher who is thinking about using GIS technology in your classroom, you should know that Esri offers the ArcGIS for Schools Bundle (https://bit.ly/3klNISF) at no cost for instructional use to individual K–12 schools and school districts in all US states. The software also can be acquired by schools worldwide at no cost by contacting one of Esri's international distributors. If you are teaching in a technical, tribal, or community college or university, chances are that your institution already has access to Esri technology. To find out, contact the Esri education team via esri.com/education.

The questions of *why* and *where* will be increasingly asked in all aspects of the workforce in the coming years. We are faced with pressure on our one single planet for which there is no spare. Teaching with GIS not only brings the benefits detailed in this article but also—even more importantly—empowers students to be effective decision-makers in our complex, dynamic world.

About the Author

Joseph Kerski is an education manager for Esri in Colorado. He served for 21 years as a geographer at the US Geological Survey and at the US Census Bureau. He has taught as adjunct instructor of GIS in traditional and online settings at Sinte Gleska University on the Rosebud Sioux Reservation and at other universities. Kerski holds a doctorate and master's and bachelor's degrees in geography. He seeks out and fosters educational partnerships, creates curricular materials focused on spatial thinking and geotechnologies in education, conducts research in the effectiveness and implementation of these technologies in education, and teaches classes and workshops in geotechnologies and in spatial thinking.

OFFERING HOPE TO THOSE LEFT BEHIND IN AFGHANISTAN

By Greg Milner

When the last of the United States' forces left Afghanistan in summer 2021, more than 120,000 people were evacuated from the country over a period of a few weeks. While it was the largest airlift in US history, it still left behind thousands who feared for their lives as the Taliban forces advanced into Kabul.

Many of those looking for a way out were Afghan nationals who had formed close ties to Americans during the 20-year conflict that started soon after the terrorist attacks of Sept. 11, 2001. Some had worked as translators and in other support positions. Most feared Taliban reprisals and an unacceptable loss of freedom.

Prompted by requests from US service members, defense mapping experts at two companies turned to GIS technology to monitor the situation and help connect people with ways out of the country. The adroit handling of maps and location intelligence by these companies is providing a solid foundation for the work of other groups extracting people from Afghanistan.

During the years spanned by the conflict in Afghanistan, mapping technology has leapt forward. Imagery and digital maps have replaced paper-based products. Soldiers have become accustomed to communicating and collaborating across teams via shared maps. These tools could be used to help those people US forces felt indebted to who still remained in the country.

GIS as a Clearinghouse

"Two weeks after the Twin Towers fell, I was in Afghanistan," said Leo Kryszewski. He was deployed to Afghanistan withthe US

↑ While the evacuation of people from Afghanistan in summer 2021 was the largest airlift in US history, it still left behind thousands who feared for their lives.

Army special forces in 2001 and did several tours there and in Iraq before leaving the service in 2009.

"I met a lot of good people and formed a lot of close relationships, so this has all been very personal for me."

Kryszewski cofounded Quiet Professionals with other veterans to provide mapping and technology support for military and intelligence organizations. Kryszewski is the company's chief of staff. *[Quiet Professionals LLC is an Esri partner.]*

As the withdrawal and evacuation proceeded, Kryszewski and his colleagues had a feeling of helplessness. Needing a break from the news and social media about the evacuation, he walked over to the office of Andy Wilson, the company's president and CEO. Wilson was also immersed in news reports.

For a while, neither said a word.

"I'm standing there watching him pull his hair out," Kryszewski recalled. "He said, 'Man, I wish there was a way to tie all these chats and information into one place.' I said, 'GIS.' And that's how it started."

Quiet Professionals decided to build an evacuation tracker dashboard to capture and display the pipeline of data about the people in Afghanistan who needed help, what kind of help they needed, and where they were located. During this tenuous time, GIS served as an information clearinghouse and a way to provide situational awareness to disparate teams and people. The dashboard came together quickly, without the slow, steady drumbeat of procedural steps that the company would typically have taken on a project.

"This was an emergency, a disaster. It couldn't be something that rolls out three months after the event is over," said Paul Bova, chief business officer for Quiet Professionals. "It needed to go up immediately, and it needed the right resources, because it was happening in real time."

Cloud-based tools provided flexibility for the geographically dispersed team to iterate dashboard versions around the clock, adding information and features as the situation unfolded. Meanwhile, the crowds at the airport in Kabul were getting desperate.

"We launched it on a Thursday, and by Sunday, we were tracking almost a thousand people," said Malachi Keddington, the vice president for strategic operations. "We knew we couldn't slow down."

Adding Clarity and Context

It soon became clear that the site's popularity warranted more context and additional data layers. The Quiet Professionals team placed a call to Esri partner Janes Group US LLC, an open-source defense intelligence provider with a 120-year history.

Janes specializes in what the intelligence community calls open-source intelligence (OSINT). All OSINT material is unclassified and available in the public domain. It encompasses newspapers, broadcasts, social media posts, and aerial imagery. Janes analysts are trained to sift through and make sense of this constant barrage of information and use Janes tradecraft to verify and validate it. The company offers clients—which include both governments and private businesses—access to assured OSINT to guide decisions. Recently, Janes has connected foundational military intelligence with high-speed data discovery.

Janes hired a new chief product officer, Ben Conklin, who has a GIS background. Conklin fielded the call from an old colleague who now works at Quiet Professionals. Conklin applied his GIS skills and used ArcGIS Online to draw a more detailed map of Afghanistan. A new topographical layer was a major improvement. It revealed the difficulties of maneuvering through the country's varied terrain.

"It helps you understand that you have a city here and city there, and it looks like you can just go over land between them, but no, there are massive mountains between the two," he explained.

Connecting the Right People

The map of Afghanistan became a map of people wanting to leave Afghanistan. The OSINT Tracker has color-coded dots that show the location of people requesting assistance and provides additional information and context. For example, anyone looking at the map can discern whether someone is in hiding, has a support network, or is in the process of being evacuated.

People in Afghanistan can register and provide updates to the OSINT Tracker via a simple ArcGIS Survey123 form accessible via a smartphone. This capability was also used to share real-time on-the-ground updates. Quiet Professionals makes that information available to government offices, such as the US State Department and Department of Homeland Security, as well as military organizations and nongovernmental organizations (NGOs).

"We're not involved with any extraction process," Bova clarified. "This is all about information gathering and information

sharing. We're providing technology that connects the right people with individuals who want to get out."

As the OSINT Tracker's reputation spread, managing it became a full-time affair, although it still was an all-volunteer endeavor. "We were working full days just on this, and at night doing our day jobs," Kryszewski said.

Augmenting the Map

Conklin brought in the team at Janes that is responsible for OSINT for real-time unfolding events, such as political unrest, invasions, and terrorist attacks. The team turned all its attention to Afghanistan and the surrounding countries and gathered data that could augment the OSINT Tracker dashboard.

Conklin, like the members of the Quiet Professionals team, realized that the unfolding situation demanded speed, but the company he was working for was not his own.

"The person who could've really been upset about it is the guy who runs our research divisions, because it was his analysts I was using," Conklin said. "But he loved it. He said it was one of the most impactful things he'd seen Janes do."

Janes analysts used aerial and satellite imagery to monitor activities at checkpoints and border crossings. They provided detailed spatial analysis about the feasibility of different landing sites for evacuation missions.

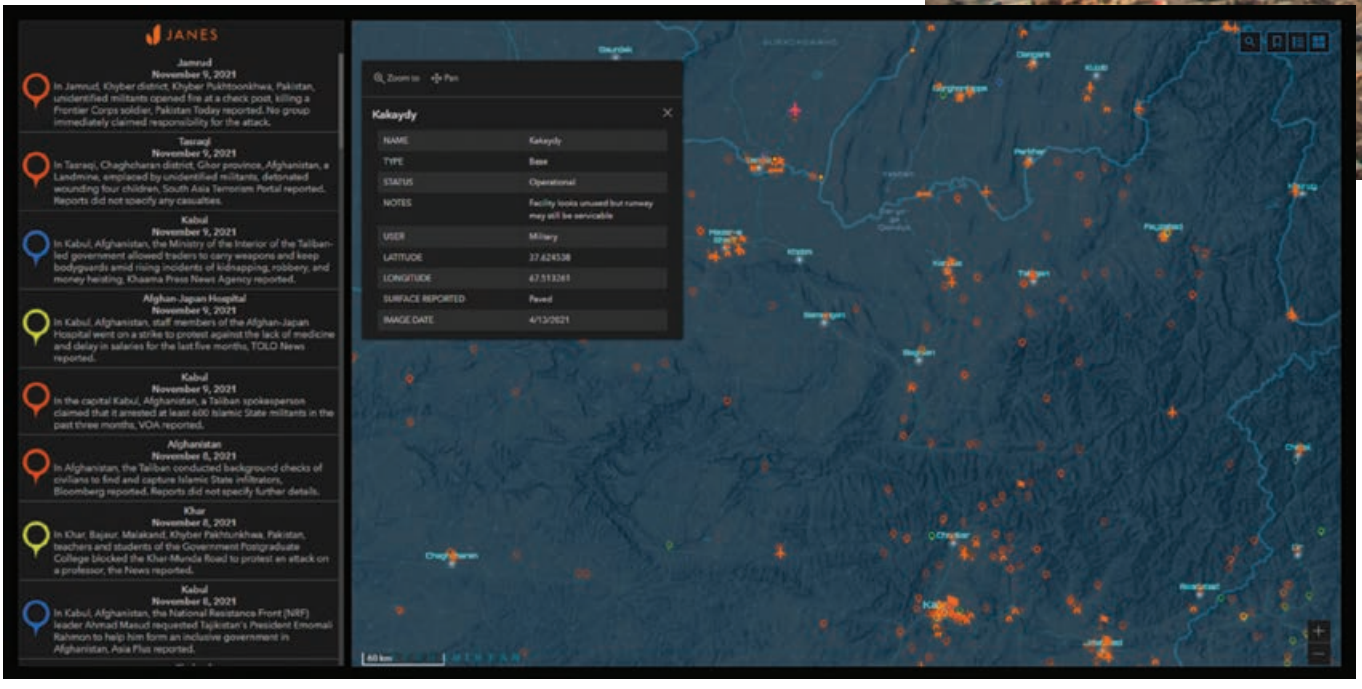
"That turned out to be superkey data," Conklin said, explaining that anyone looking at the Quiet Professionals dashboard can click on an airfield to learn more about the conditions. "For example, one of the places that has been used *[for rescue operations]* had an operational runway, but the facility itself was no longer in use. That's actually perfect, because that way, you're not disrupting normal air traffic."

Building a Better Workflow

The data Janes gathered was crucial, but it was equally important to determine how best to integrate the data into the OSINT Tracker dashboard. The Janes team began by processing the data and providing it to Quiet Professionals.

"That made it so Janes could keep our content up-to-date, including the map design, and make it ready to use, and it would just show up on the Quiet

↓ The Janes dashboard includes details reported by news outlets, and information about possible evacuation points. and was combined with the Quiet Professionals dashboard.



↑ The Quiet Professionals dashboard made a variety of data accessible and enhanced rescue efforts. The City of Kabul is shown.

Professionals dashboard," Conklin explained.

As the amount of data collected by Janes increased, this workflow became inefficient. Janes designed a dashboard that could be effectively embedded within the OSINT Tracker dashboard that Quiet Professionals created.

"It was completely ready to use, and they didn't have to do anything," Conklin said. "It's another tab in their dashboard, but we control it."

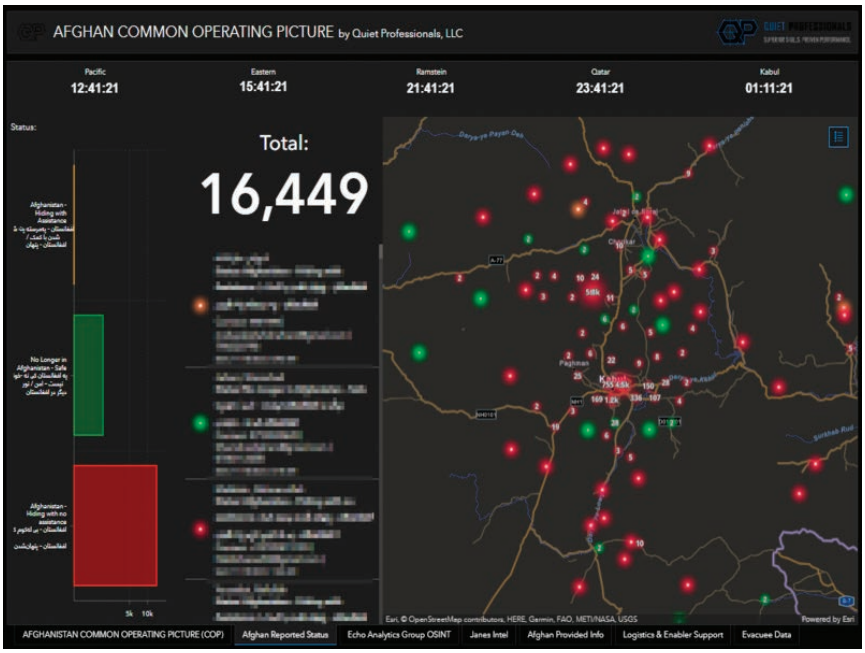
This allowed Janes to contribute to the kind of shared perspective the company was not set up to provide.

"You couldn't do this from the Janes website," Conklin said. "It's built for Janes customers, and there's no common operational picture. But now I can push our data into this common picture because we have it as a feature service in ArcGIS. It validated what I already knew, which is that it's really easy to use ArcGIS Online to merge two companies' data."

GIS Offers Protection and Discretion

The most immediate purpose of the OSINT Tracker dashboard was to depict the ongoing crisis. For those hoping to leave Afghanistan, GIS offers further utility as a data storage system.

"If people go through the wrong checkpoint, they could lose their passport or other documents," Kryszewski said. "We give them the opportunity to upload photos of the documents, so if they do lose



↑ Quiet Professionals built an evacuation tracker dashboard to manage data about the people in Afghanistan who needed help, what kind of help they needed, and where they were located.

them, they're sitting here in a safe, secure environment. They can reach out, and after vetting, we can provide the documents for them."

Even the confiscation of a cell phone need not be catastrophic. "We didn't want people to have anything on their phone that could compromise them," Keddington said. "And because Survey123 is a web link, as soon as they hit submit there's no trace back to what they submitted."

Keddington noted that it's the invisibility of the GIS aspect that makes the system work so well. "Web-based GIS allows you to offer the technology to the many people in the world who don't know what it is and didn't know they needed it," he said. "All they have to do is fill out a little form, probably without even realizing that we're able to manage their problem across multiple organizations and around the world."

Creating a Common Language

Two months after launching the OSINT Tracker dashboard, it was tracking 13,000 people across Afghanistan. Quiet Professionals and Janes have vowed to stay the course.

The scale of the effort recalls the team of teams management philosophy advanced by Gen. Stanley McChrystal, who was the commander of the Joint Special Operations Command in the mid-2000s. By employing a shared cartographic framework, Quiet Professionals and Janes—in a very real sense—put everyone on the same map.

For the purposes of the Afghanistan rescue tool, the term everyone means the people the tool is designed to help. Every interaction with the survey form adds a data point to the map and increases the overall knowledge the map can impart.

"We can put everyone on the same level, from government entities to NGOs to private individuals," Keddington said. "It's using geography as the common language."

About the Author

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

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