

ArcUser

The Magazine for Esri Software Users

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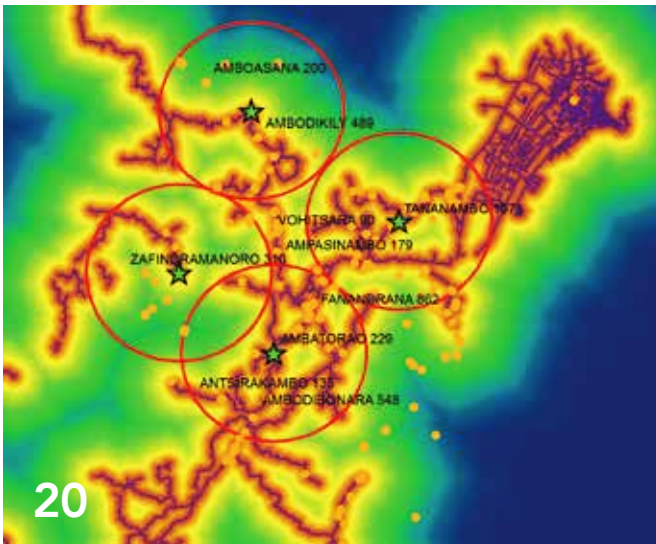
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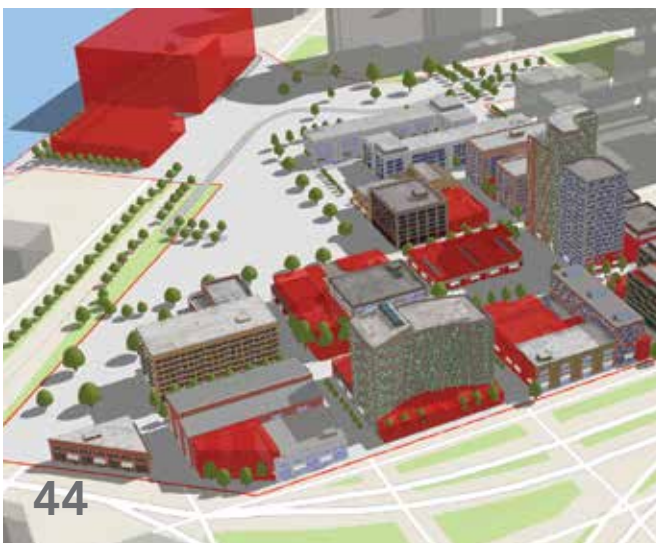
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Supporting and incorporating science

On the Cover

Imagery of Oahu, Hawaii, from the World Imagery basemap, courtesy of DigitalGlobe. As part of its 2016 partnership, Esri and DigitalGlobe will update approximately 90 million square kilometers of imagery in the World Imagery basemap. Read "Esri and The Science of Where" on page 44.

Reimagining an Urban Future

The world recently passed a tipping point. In 2014, the United Nations noted in *World Urbanization Prospects—The 2014 Revision* that 54 percent of the world's population lives in cities. That is a trend that will only intensify as the world's population heads for an estimated 10 billion in 2050, and more than 6 billion of those people will live in urban areas.

While megacities like Tokyo, Delhi, and Mexico City will continue to expand, the most rapid growth is expected to come from relatively small cities of 500,000 or fewer inhabitants—that means not only more people but more cities.

Historically cities have been centers of innovation and wealth that shape civilizations. While concentrating people in cities has beneficial effects, it also creates challenges. These challenges can be as basic as providing water, sanitation, food, and housing. Beyond these essential requirements, preventing environmental degradation, scaling transportation networks, and maintaining the livability of cities are challenges that become more pressing as the extent and density of cities increase.

Information derived from the analysis of data—lots of data—and the tools to integrate, visualize, and communicate the information generated from that data offer the best way to answer these challenges. The science-based technology of GIS provides a geographic framework for making sense of not only the structured data maintained by government organizations but also the massive amounts of data being captured by the burgeoning labyrinth of sensors that make up the Internet of Things.

Articles in the Focus section demonstrate how cities around the world are using GIS to turn data into information that optimizes processes, enhances resilience, and identifies better solutions. The Greek city of Thessalonki implemented a geospatial portal that has improved nearly all municipal decision-making and enhanced its communication with citizens. The City of Long Beach, California, and the State of Arizona have developed similar portals with similar results. In the Netherlands, the municipality of Zwolle brought geospatially enabled sensor data and local developer talent together in the hackathons it sponsored. The result was apps that have improved the quality of life for citizens and Zwolle's decisions.

GIS applies The Science of Where to challenges that cities face now and the even more formidable challenges they will face in the future. GIS adds the smart to smart communities.

Monica Pratt
ArcUser Editor

Editorial

Editor Monica Pratt
Contributors Jim Baumann, Carla Wheeler
Technical Adviser Paul Dodd
Copyediting Linda Thomas

Design

Creative Director James Hitchcock
Designer Doug Huijbregtse
Photographer Eric Laycock
Illustrators Daniel Gill, David Lauruhn
Print Coordinator Lilia Arias

Advisory Board

Corporate Marianna Kantor
Products Damian Spangrud
International Dean Angelides
Marketing Communications Jeff Brazil
Industries Mike Quin

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Editorial Inquiries

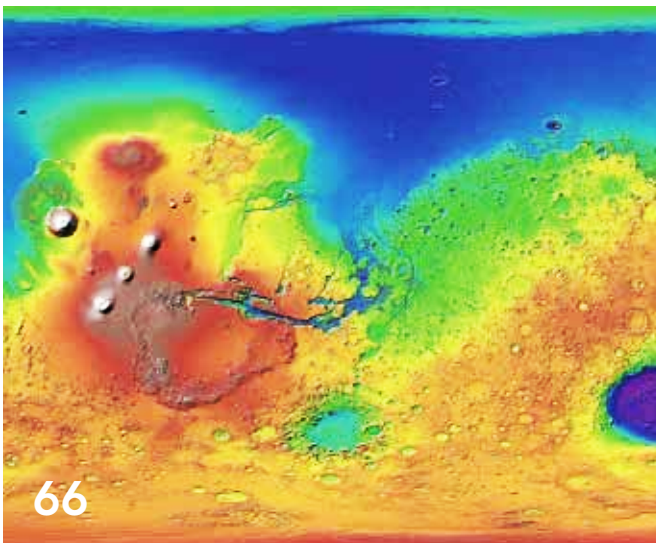
Monica Pratt, *ArcUser* Editor
380 New York Street
Redlands, CA 92373-8100 USA
arcuser_editor@esri.com

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5 Reasons to Use Survey123 for ArcGIS

By Derek Law, Esri Technology Evangelist



← Direct Relief embarked on a mission in April 2015 to treat and document skin conditions among Syrian refugees in Jordan. With Esri's Survey123 for ArcGIS app, Direct Relief rapidly diagnosed, treated, and collected medical records on more than 1,000 refugees in just six days. Read the whole story in the Fall 2015 issue of *ArcNews*.

1 It is easy to set up and use.

Getting started with Survey123 for ArcGIS is a simple 1-2-3 process (hence the name). It can be used by people who don't have GIS expertise.

Survey123 for ArcGIS is a simple and intuitive form-centric field data gathering solution that makes creating, sharing, and analyzing surveys possible in three simple steps: ask questions, get answers, and make better decisions.

Instead of being map-centric, Survey123 works with forms (or surveys), which are frequently used to collect information for many different disciplines. Surveys—from simple to sophisticated—are authored with Survey123 and then shared in ArcGIS. Using the Survey123 mobile app, teams in the field can capture survey results with their smartphones and tablets. Surveys can also be completed and submitted in a web browser.

Data captured is immediately available for analysis in ArcGIS to help you and your organization make better decisions. Survey123 is a versatile data collection solution already popular with users in public health, education, public works, resource management, disaster response, and humanitarian agencies.

Ask Questions (Design & Publish) → Get Answers (Collect Data) → Make Decisions (View & Analyze)



↑ Getting started with Survey123 for ArcGIS is this simple 1-2-3 process.

Step one: Ask questions

You can author and design surveys in one of two ways. For simple surveys, you can use the Survey123 website, which provides a user-friendly, drag-and-drop configuration user experience. For more sophisticated surveys, you can use Survey123 Connect, a desktop app that lets you author surveys using a spreadsheet program such as Microsoft Excel.

With Survey123, you create “smart” forms. These are survey documents have built-in logic that supports default values, skip logic, calculations, branching questions, and multiple languages. Surveys are then published to ArcGIS. You control who can access and work with your surveys. You can limit access to members of your ArcGIS organization or specific groups or share it with the public.

Step two: Get answers

Using the Survey123 mobile app, you can download surveys and start collecting data in the field. The Survey123 mobile app is supported on iOS, Android, Windows, Mac OS X, and Ubuntu. It works on both smartphones and tablets as well as desktops. The mobile app was built using AppStudio for ArcGIS and takes advantage of the location-tracking capabilities found on mobile devices so you will know where the survey was submitted. Field crews can be deployed to gather data in both connected or disconnected environments. Surveys that are completed when crews are working in a disconnected environment can be submitted to ArcGIS when a network connection is reestablished.

Surveys authored in the Survey123 website can also be shared as a URL link, another useful option for collecting survey information. For example, you can email someone the survey URL link that they can click to open the survey in a web browser. Survey123 is a versatile solution that can support many different field data collection workflows.

Step three: Make good decisions

The data in surveys submitted to ArcGIS can be immediately accessed in the Survey123 website. The website includes reporting and



↑ Survey123 adheres to the XLSForm open standard and provides options for customizing the appearance of surveys with HTML tags.

mapping capabilities that can help you detect and identify trends and patterns in your survey data that can help you make better decisions for your organization.

2 Minimal training is needed for field crew users.

Having field crews gather data as correctly and as accurately as possible is one of the common challenges of field data collection. In some cases, the field crews performing the data collection operations may not be subject matter experts or technically savvy. They may be contractors or part-time workers. Field crews that use the Survey123 mobile app require minimal training because the product has been designed with simplicity in mind. In addition, completing forms is something that most people can do with absolutely no training. They simply sign in to the app with their ArcGIS account, select and open the desired survey, and start collecting data. The Survey123 mobile app user experience is form focused and meant for nontechnical end users.

3 It uses formcentric data collection with smart forms.

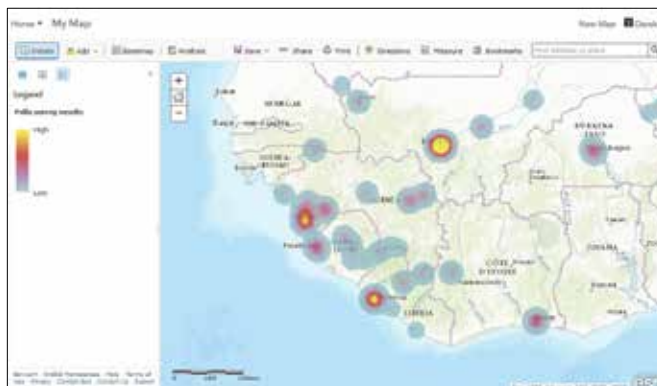
Survey123 for ArcGIS works with smart forms. A form is a document with questions and blank spaces for inserting the required information. A smart form contains logic and validation. For example, as a respondent answers questions in the form, additional questions may appear or some questions be removed in later sections, depending on responses to previous questions. A smart form only asks questions that are applicable to the respondent.

4 Survey123 is integrated with the ArcGIS platform.

Survey123 for ArcGIS is part of the ArcGIS platform. When Survey123 publishes a survey to ArcGIS, behind the scenes, a form item and a hosted feature service are created in ArcGIS Online or Portal for ArcGIS and secured with the same security model your organization uses. Collected survey data is stored as points in the hosted feature service. This hosted feature service works and behaves like any other hosted feature service and can work with the entire ArcGIS platform.

By clicking the Data tab on the Survey123 website and then clicking the Open ArcGIS Map Viewer button on the lower left corner, you can open a new web browser tab displaying your survey data in the

↓ You can leverage the smart mapping and analysis tools available in the ArcGIS Online Map Viewer when visualizing your survey data.





↑ Survey123 website has great out-of-the-box reporting capabilities.

ArcGIS Online Map Viewer. You can leverage smart mapping for cartography, the analysis tools, and all the functionality available in the ArcGIS Online Map Viewer with your survey data points. Because submitted surveys also include the spatial location where they were submitted, you can leverage the power of geography when working with your survey data.

In addition, you can save the displayed survey data as a web map so your survey data can be used in other ArcGIS client apps. The configurable application templates, Web AppBuilder for ArcGIS, Operations Dashboard for ArcGIS, Collector for ArcGIS, and Workforce for ArcGIS, can be potentially used by a larger audience to access your survey data and easily integrated to support other business workflows within the organization.

The Survey123 mobile app is also designed to be tightly integrated with other Esri mobile field apps such as Collector for ArcGIS and Workforce for ArcGIS. Using URL scheme functionality, a well-known protocol that lets apps communicate with each other, both Collector for ArcGIS and Workforce for ArcGIS can launch the Survey123 mobile app, open a survey, and prepopulate answers in

the survey. This makes Survey123 part of a powerful and integrated mobile field solution.

The collected survey data can also be exported from ArcGIS to a comma-separated values (CSV) file, shapefile, or file geodatabase and used for other analysis purposes in ArcMap and ArcGIS Pro. Your collected survey data is immediately available without requiring additional data conversion.

5 It has built-in reporting capabilities.

One of the key features of the Survey123 website is its great out-of-the-box reporting capabilities. Once surveys are submitted to ArcGIS, you can view a summary of your collected survey data on the Overview tab and look at basic stats such as the number of submitted surveys, number of unique survey participants, and first and last submitted surveys. You can also view data graphically to discover when and how frequently surveys were submitted over time and filter the reported stats based on the last 7 days, last 30 days, or a custom time period that you specify. Reporting is dynamically updated with each submitted survey to ArcGIS.

The Survey123 website also includes an Analysis tab that provides more detailed reporting on individual survey questions. For every survey question, summary and statistical information is presented. Reporting results will vary depending on the type of question. For numeric and choice questions, results will be shown as charts and tables. By default, a column chart will summarize the results, but you can switch to a bar or pie chart. You can also view the results on a map. For text questions, each unique text response is counted. For large volume text answers, a word cloud is generated that illustrates the frequency of common text responses. You can control which survey questions to include or exclude in the report, and you can print the report.

Survey123 for ArcGIS Resources

Help documentation	doc.arcgis.com/en/survey123
GeoNet Place	geonet.esri.com/groups/survey123
Video Tutorials	links.esri.com/survey123/videos/overview

Get Support Help Faster on My Esri

Using the Request Case link on the Support page of My Esri will cause your issue to be more quickly routed to a support analyst who can resolve your issue. This process for creating a support ticket replaces emails to support@esri.com.

The Request Case link on My Esri opens a web form after you sign in. On the form, you can describe the issue and identify the software you are using. Support cases can be opened from the

Support page on My Esri where all support resources are available in one place. All case work—creating tickets, tracking cases, and viewing the history of case work—occurs there.

The support@esri.com email address was deprecated on April 3, 2017. All email and chat cases should be made through the Support page on My Esri. This method streamlines the process, letting you track the status of cases and access support resources as soon as possible.

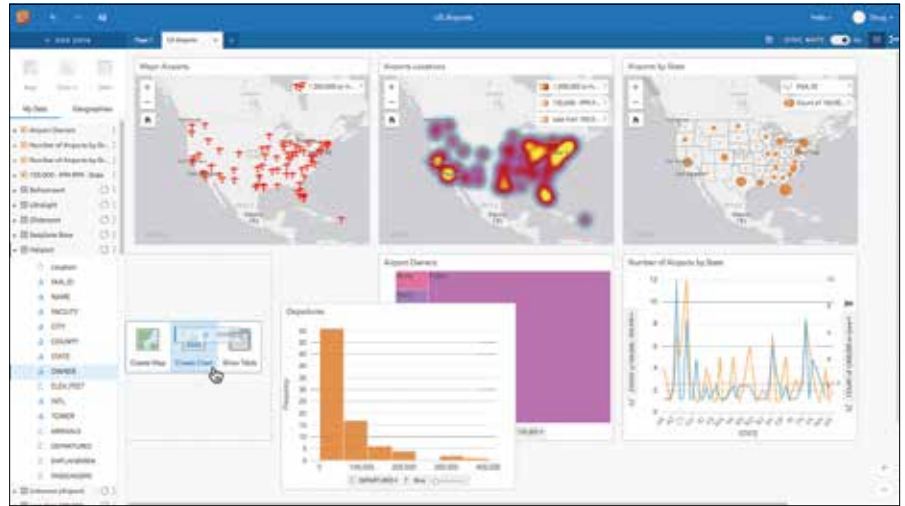
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In response to numerous requests, Insights for ArcGIS is now offered as an Esri Managed Cloud Services (EMCS) so your organization can quickly start benefiting from an enhanced ability to glean actionable information from both spatial and nonspatial data.

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Insights, whether running as a managed service or on an organization's on-premises infrastructure, is a shortcut to thinking spatially. Through dimensional modeling, Insights intelligently determines which visualizations best suit the data. Insights can provide guided workflows that help users answer spatial questions—even ones they wouldn't have thought to ask, jump-starting spatial analysis. GIS analysts can save time using common workflows to find simple answers quickly before heading to ArcGIS Pro to do further analysis.

Getting this kind of digital intelligence



↑ Through dimensional modeling, Insights intelligently determines which visualizations best suit the data.

is easier when back-end operations are less demanding. That is why, once Insights is operational in the cloud, EMCS stays connected to the organization, providing regular updates on usage, operational assistance, and early warnings about storage capacity and outage events.

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↓ Insights for ArcGIS as an Esri Managed Cloud Services (EMCS) lets your organization quickly start gleaning actionable information from both spatial and nonspatial data.



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→ This statue of Alexander the Great astride Bucephalus is located on the waterfront, one of the most popular areas of Thessaloniki.



Open Data

Helping City Improve Operations and Enhance Resilience

By Jim Baumann, Esri Writer

The data sharing policies adopted by the GIS office of a Greek city, initially adopted to improve internal operations, have grown into robust open data practices that support resilience and smart community goals. The city now plans to adopt a Hub pattern to realize the full benefits from its geospatial data.

Thessaloniki, the second-largest city in Greece, began using GIS about 10 years ago for basemapping purposes in its department of building and planning. The department soon realized that GIS could improve its decision-making capabilities and provide better oversight for capital improvement and other construction projects as well as contribute to policy initiatives. The city's use of GIS gradually expanded so that—by 2008—it had centralized all the city's GIS work by establishing a GIS office in the city's department of building and planning.

The city is currently using several Esri products to develop and serve Web GIS applications that include a city guide, georeferenced building codes and regulations, optimized routes for waste collection, electrical distribution modeling, business permit access, and land-use planning.

Thessaloniki implemented a centralized GIS portal to make its data readily accessible. Most datasets are freely available, with access to only some datasets restricted to city employees and business partners. The many datasets the city's GIS office manages for the portal—demographic information, the built environment, transportation, environmental data—allow the city to provide strategic, up-to-date geospatial data to all departments.

The portal is constantly being updated with new data collected

by its departments. The municipal government is also developing partnerships with the city's utility companies. A mutual cooperation agreement with Greek natural gas provider DEPA has already been established. Agreements with other utilities are planned. A partnership with the local public transportation organization will also allow the data it collects to be included in the database.

The role of the city's geospatial data was further enhanced when, in late 2014, Thessaloniki was selected to join the Rockefeller Foundation's newly formed 100 Resilient Cities program. According to the foundation, "City resilience reflects the overall capacity of a city to survive, adapt, and thrive no matter what kinds of chronic stresses or acute shocks they experience."

The program evaluates a city's resilience in four strategic areas: health and well-being; economy and society; infrastructure and environment; and leadership and strategy. That analysis is used to determine where a city needs to strengthen its resilience. The foundation then provides funding so that the city can hire a chief resilience officer, as well as support to build a resilience plan, and other related activities. Because the issues are complex and interrelated, the resolution of these challenges can take several years to complete.

Thessaloniki's resilience challenges stem from its aging infrastructure, growing unemployment, environmental degradation, the influx of refugees, and the need to respond to natural disasters. Thessaloniki created a resilience strategy blueprint to deal with these challenges in an integrated way and mitigate their impact.

"ArcGIS is central to our participation in the 100 Resilient Cities program," said Simos Misirloglou, the city's GIS analyst and manager.

“It allows us to analyze each of the primary issues from a locational point of view and see how those issues might interrelate as we drill down through the data. It provides us with the information and direction we need to advance the project.”

The city also participates in the European Innovation Partnership (EIP) for Smart Cities and Communities. The partnership supports the implementation of information and communication technologies with sustainable energy and transportation initiatives to develop innovative solutions for the environmental, societal, and health challenges facing European cities. The goal is to create scalable and transferable solutions in support of the European Union’s 20/20/20 climate action objectives, which includes the reduction of energy consumption, greenhouse gas emissions, poor air quality, and roadway congestion.

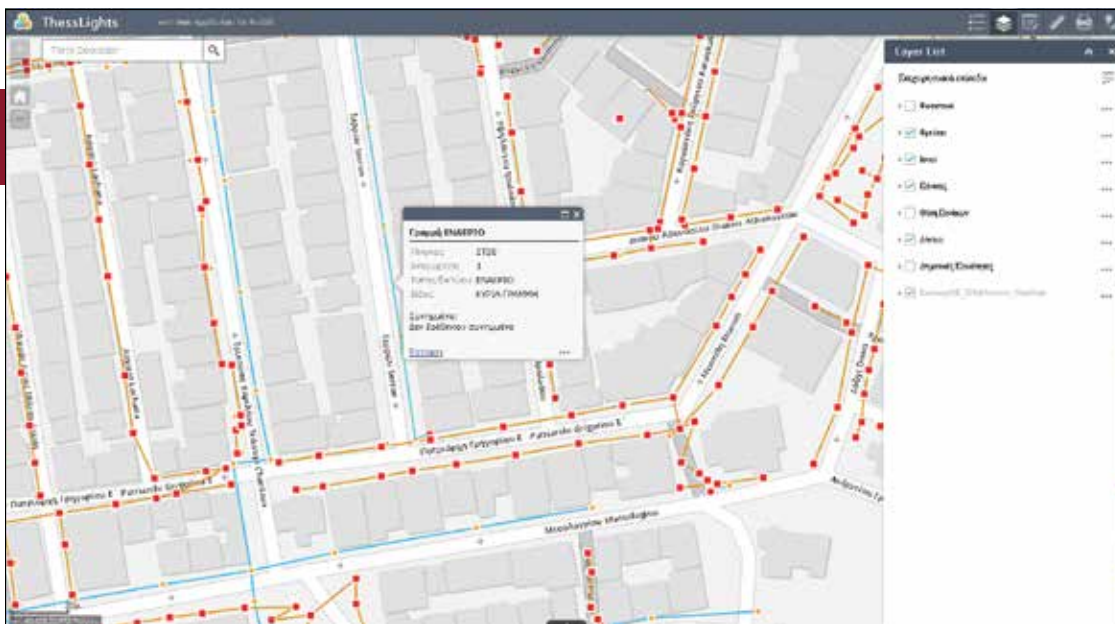
“The goals of both the 100 Resilient Cities and the Smart Cities and Communities initiatives reinforce one another,” said Misirloglou. “Having the opportunity to participate in them helps generate cooperation and an exchange of information, which leads to solutions for the very real challenges faced by cities today.”

for the common good, such as the development of Trans European environmental policies.

“When we first implemented GIS, we had no idea how quickly the technology would develop to facilitate virtually all aspects of the municipal decision-making process, while allowing us to better communicate with our constituents and for them to communicate with us,” concludes Misirloglou.

Thessaloniki’s next step is to incorporate all operational software and data into a Hub pattern. *[A Hub is a public platform for open data that facilitates exploring, visualizing, and downloading data and lets that data be combined in web and mobile apps.]* This pattern will let the city focus on expanding the geospatial-based services it provides its citizens. Making data available online and in real time (or near real time) will boost efficiency and eliminate information bottlenecks. By making data available in intuitive apps, residents can play a greater role in shaping government.

Misirloglou believes Hubs enable cities to reach their full potential by helping residents, businesses, universities, and government



← Underground and aerial electrical networks were recorded and include the attribute data needed by the departments that oversee their operations.

Open data is part of the EIP’s smart communities initiative and fundamental to Thessaloniki’s future Hub implementation. “The municipality of Thessaloniki has embraced open government so that we can maintain transparency to our residents, and part of this effort is open data,” said Misirloglou. The city’s open data program was initiated in 2014 and has published approximately 90 open datasets. These datasets are available in near real time across multiple platforms through the city’s portal. An appropriate legal framework is in place that allows the data to be repurposed.

“As the Thessaloniki GIS continues to expand, it is also important that it remains compliant with the European Union’s INSPIRE Directive,” said Misirloglou. “This is another aspect of engagement with other smart and resilient communities.” The INSPIRE Directive has established standards for an EU spatial data infrastructure that expedites the exchange of geospatial data among member nations

to work more efficiently, interact with each other in new and better ways, and increase the overall quality of life. A fully connected and interactive city uses networks, sensors, data analytics, and emerging technologies to become more efficient, productive, and livable and provide its residents and businesses with essential information that will let them take advantage of “everything the city has to offer.”

“The implementation of a Hub is part of our overall digital strategy that will be achieved through a common, disciplined approach to the technologies, tools, and processes that will enable broad participation and access to a wide range of services and information while improving our operational intelligence. We know that both our citizens and municipality staff are at their best when everyone works together,” said Misirloglou. “Our vision is to use innovation and engagement to enable secure anytime/anywhere access to an open government for our citizens today and in the future.”



↓ The central square of the old center of Zwolle.

Dutch Municipality Uses GIS to Become a Smart City

In 2016, the municipality of Zwolle was voted the “smartest city” in the Netherlands by Slimste Binnenstad, a platform for the Smart Cities initiative in the Netherlands. Zwolle, which competed against cities such as Utrecht and Roosendaal, won in the Vision category by ranking at the top of more than 50 cities based on International Organization for Standardization (ISO)

indicators of city services and quality of life.

The board for the Dutch municipality of Zwolle originally instituted the “Smart Zwolle” project to make the city a more attractive place to live. With a population of 125,000, Zwolle is the capital city of Overijssel.

“Zwolle is always on the lookout for ways to improve the city,” said Marcel Broekhaar,

Zwolle’s geoinformation officer for the last 10 years. “But the same applies to us as to other cities—bigger challenges and less funding. That’s why we have to be smart with the information that is available.” In his daily work, Broekhaar optimizes the use of ArcGIS by the city as well as performing geospatial tasks as part of Zwolle’s Search and Statistics department.

data and expertise," said Broekhaar.

Zwolle used King's Day in 2016 as an opportunity to gather a lot of sensor data generated by holiday crowds. King's Day [*Koningsdag*] is an important national holiday in the Netherlands that celebrates the birth of Willem-Alexander Claus George Ferdinand, the king of the Netherlands.

"When there are a lot of people walking around, you can use sensors to discover the visitor flows, where there is congestion, and where people park their cars or bicycles. This is incredibly useful information," said Broekhaar.

The Smart Traffic Management Urban Traffic Data Hack encouraged the creation of apps and services that used the big data collected by the city on King's Day to enhance the accessibility and hospitality of Zwolle. Students and consultants participated in the 24-hour-long hackathon that was held May 21 to 22, 2016. The event generated many revelations and several apps.

The event was part of the Smart Zwolle initiative in collaboration with Better Utilization Zwolle and Kampen Data Science Amsterdam/Zwolle (DSA). DSA is a non-profit professional organization dedicated to the free, open dissemination of data science to improve government efficiency, health care, and law enforcement and promote innovation in business and science.

To come up with even more ways that the data collected and analyzed could be used to help the city achieve its Smart Zwolle goals, another event was held: the

Zwolle Internet of Things Hackathon, on November 26, 2016. Technicians and entrepreneurs were challenged to develop technically feasible and commercially viable use cases that used Internet of Things (IoT) connectivity via a public LoRaWAN network. [A media access control (MAC) protocol for wide area networks, LoRaWAN was designed to allow low-powered devices to communicate with Internet-connected applications over long-range wireless connections.]

During the event, stakeholders had an opportunity to exchange knowledge. This hackathon produced several apps, including a smart postbox, dementia warning system, and an event app that shows visitors the least congested routes to an event. It gave real-time information on the fastest routes, which were not necessarily the shortest, as well as efficiently guiding visitors to parking.

Broekhaar is very enthusiastic about these efforts with various partners to meet the Smart Zwolle goals to make it a better city. He strongly supports using data to organize and build cities in a smarter way.

"The most important thing is to establish connections. Everyone wants something smart, and everyone is trying to find their own way to achieve it. Work out your common interests and work together," said Broekhaar. "Create a network and participate in it. Take initiative and have courage, as only then can ideas be put into practice."

↓ Marcel Broekhaar, geoinformation officer for Zwolle



This article was contributed by Esri Nederland B.V.

As part of its quest to become a smart community, the city wanted to utilize big data to respond more effectively to important policy issues. ArcGIS offered a way to accomplish this goal. City departments were already using information supplied in maps to accomplish daily tasks. "The ArcGIS platform integrates information with other data. It is the link between all

Long Beach Geospatial and Data Portal Opens City to a Better Future

By Jim Baumann, Esri Writer

In January 2017, the City of Long Beach, California, expanded its geospatial platform with the introduction of DataLB, a public geospatial and open data portal website that helps the public and city staff explore, visualize, download, and use city data. The site implements practices for sharing data with the public, staff, and policy makers that were outlined in the Long Beach Open Data Policy, adopted in 2016.

“Long Beach’s DataLB portal is making the vast amount of city data useful for a wider variety of purposes,” said Mayor Robert Garcia in an official statement. “Not only will people be able to use DataLB and new apps available online to chart information like crime rates, but businesses can see the best areas to establish themselves and grow. This is a great tool for the city and the community.”

DataLB provides public access to city data that was previously only available to internal staff. The open data site lets anyone map and develop reports on topics of their own choosing ranging from the rate of

homelessness in specified areas to business license activity in the city.

More than 100 unique datasets available include local information on community health issues, infrastructure, city spending, business opportunities, planning, parks and recreation, safety, schools, and transportation. All datasets can be viewed or downloaded.

For example, information on the capital improvement projects in fiscal year 2017 funded by Measure A is presented in an Esri Story Maps app. It details how and where the increased revenue will be spent on infrastructure, public safety, parks, community centers, and libraries. The measure, a sales tax increase that was passed by local voters last year, funds a \$150 million capital improvement program.

The inception of the Long Beach GIS can be traced to a specific tragedy that occurred on December 1, 1980. A large underground pipeline carrying naphtha, a volatile petroleum liquid, ruptured below the Gale Avenue residential area of Long Beach, shooting flames 70 feet into the air and severely damaging

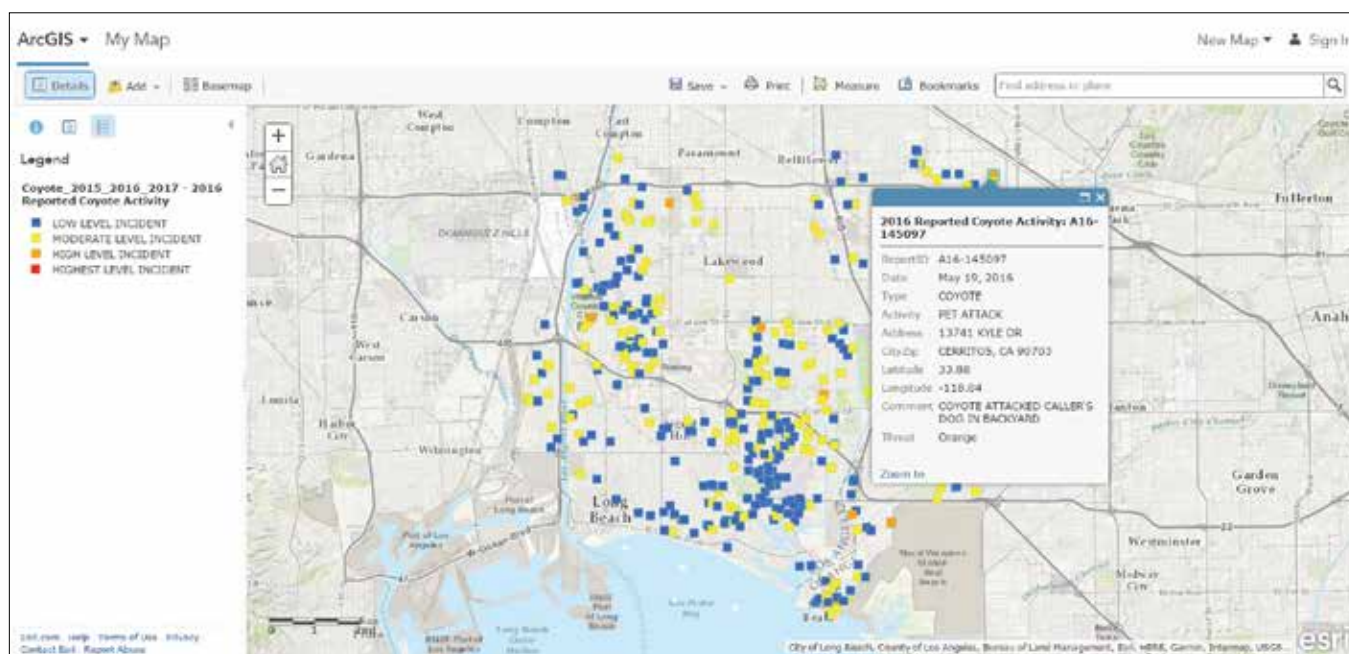
several homes and automobiles. Fortunately, only five people were injured. When firefighters arrived, they noticed a river of fire flowing into a nearby storm drain. They tried to determine the route of the storm drain network to mitigate further destruction, but could not find information on the network.

This event made the city realize the value of a cross-departmental mapping and asset management system. Consequently, the city made its first investment in Esri’s GIS technology shortly thereafter. Since that time, the city has used spatially enabled systems extensively, employing ArcGIS across its asset, permit, and utility operations.

In 2014, the city’s newly formed Technology and Innovation Commission proposed a geospatial data hub to make its data more easily available to the public as well as other government and private organizations.

The result was DataLB, the Long Beach implementation of the Esri Hub concept. It is an integrated platform for enterprise collaboration and community engagement

↓ Once a dataset of interest is identified, it can be immediately mapped, symbolized, and queried in ArcGIS.



that has been customized for the city. The platform organizes and manages services by integrating and analyzing the city's data feeds throughout its operations. DataLB then provides insights that are accessible organization-wide through an internal enterprise GIS.

With support for a variety of interoperable technologies, DataLB datasets can serve as the basis for virtually unlimited maps and applications that make the city operations data driven. This process is facilitated for nondevelopers through ArcGIS configurable apps and web builder apps and for developers with ArcGIS APIs and SDKs that make it easy to find and connect relevant data to ongoing services and community initiatives.

DataLB includes an open data portal for the public that provides easy access to much of the city's geospatial and tabular data, as well as policy-related maps and federated data from other government jurisdictions and private organizations. It also includes links to information about current initiatives, which promotes public discussion in the development of lasting solutions that benefit the entire community.

Mayor Garcia also believes that the portal will help the city more easily meet requests from the media and others for public records as required by the California Public Records Act. The portal will allow researchers to search for the information themselves, rather than the slower process of submitting requests through city hall.

A major goal of the portal was including datasets that were of value and interest to the community. To accomplish this, Bryan Sastokas, Long Beach's chief information officer, led community outreach efforts by hosting forums online and at local universities where residents could discuss what information they would like to have available to them through the portal. Findings indicated that there was great interest in budget, crime, and transportation data as well as information about commerce so that entrepreneurs could do business more easily with the city.

"Providing data online is not a new concept in government," said Sastokas in the city's announcement about the project. "But the City of Long Beach wants to drive beyond presenting data online, and our DataLB hub is an innovative approach that allows the public to operationalize data, making it more useful

to the community and building on the city's commitment to transparency."

In the long term, the city hopes to measure the open data hub's success against broader issues such as economic development and the way the city uses data to improve services.

→ In addition to making city data available for online mapping, download, or development into apps, Long Beach has apps on the site that address economic development such as this property site selector.



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One-Stop Shop for Arizona Open Data

By Jeremiah Lindemann, Esri Solution Engineer

The Arizona State Cartographer's Office recently launched AZGEO—Open Data, an ArcGIS Open Data site that gives government organizations—such as the cities of Phoenix and Tucson and Coconino County—the ability to federate open data to one common site via the individual ArcGIS Open Data sites each organization has set up.

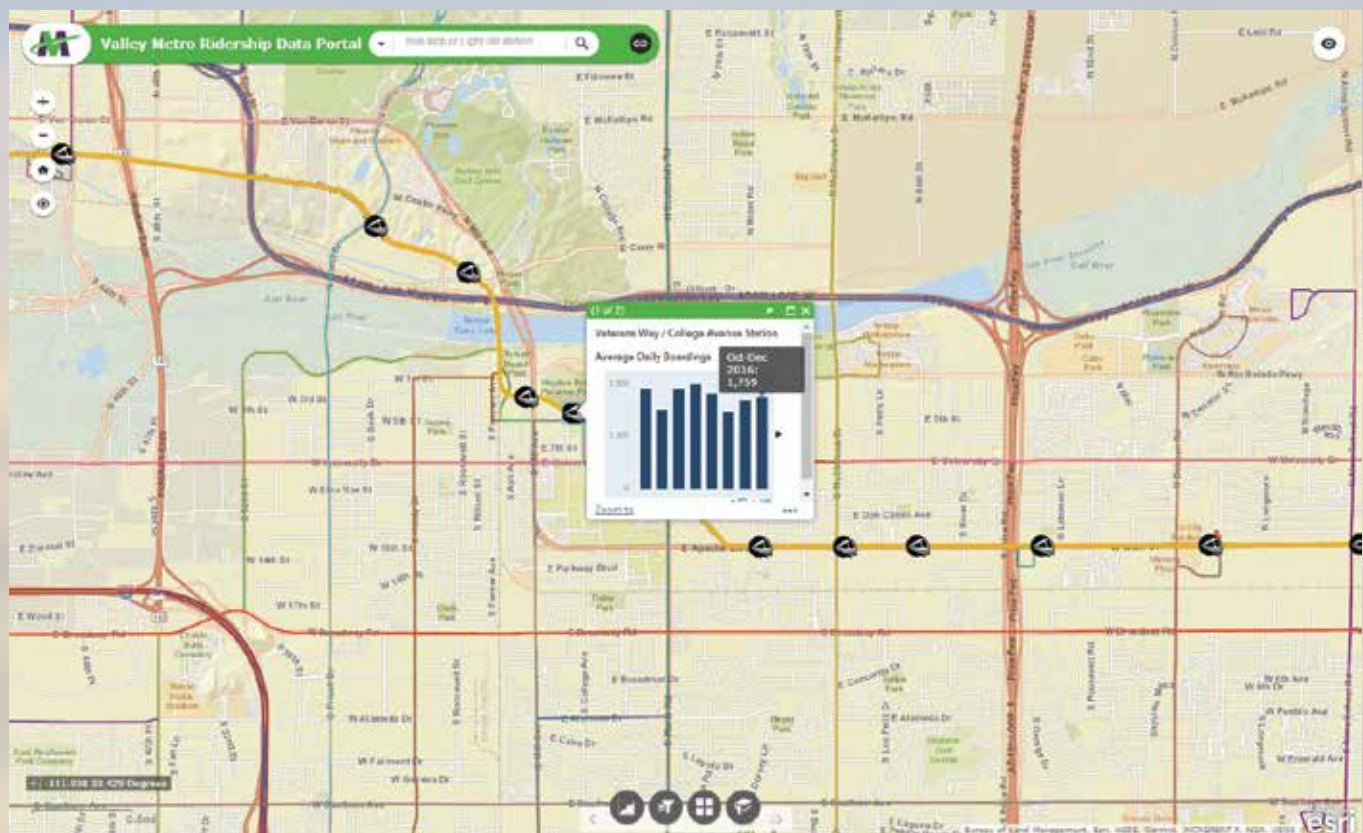
ArcGIS Open Data is an Esri-hosted solution that is available as part of an ArcGIS Online subscription. With ArcGIS Open Data, organizations can set up websites the public can use to search for

and download data quickly and at no cost.

AZGEO—Open Data was created on behalf of the Arizona Geographic Information Council (AGIC) to create a one-stop shop for data from participating municipalities in the State of Arizona and other authoritative sources of geospatial data.

A wide range of data on a variety of topics, including zoning, air quality, employment, and transit, can be accessed at AZGEO—Open Data. The site also features applications that make the data instantly useful. They range from “A Tour Along the Arizona Trail,”

↓ The Valley Metro Ridership Data Portal features apps that provide ridership data, along with information on Valley Metro bus routes, light-rail stations and routes, bus ridership, transit centers, and park and rides.





↑ Valley Metro provides information on ridership numbers via Valley Metro GeoCenter, an ArcGIS Open Data site.

an Esri Story Maps app built by the Arizona Trail Association, to “Rx Drug Drop Off Locations” from the Arizona Department of Health Services, which shows where prescription drugs can be safely disposed of.

The Arizona State Cartographer’s Office hosts and designs AGIC websites and manages the AZGEO data and servers, said Arizona state cartographer Curtis Pulford. The AZGEO—Open Data portal aligns with AGIC’s vision to provide credible, timely, and accurate geographic information that Arizona decision-makers and citizens can use, according to Pulford. It’s a good resource for app developers trying to create solutions that address important issues in the state.

Pulford said that AZGEO—Open Data collects what it deems authoritative data from government organizations. “Right now, we’re only harvesting from discoverable open data sites,” Pulford said. These authoritative data custodians use their ArcGIS Open Data sites to channel information through AZGEO—Open Data in a dynamic way using web services rather than static data.

According to Pulford, creating an open data site using Esri technology was simple. “The ease of setup was rather amazing,” Pulford said. “After we spent a little time studying ArcGIS Open Data and brainstorming on how we could best use it, we had most of our Open Data site operational in one afternoon. The one aspect that most matched our needs and made it work for us as part of our state portal was the ability to filter content for delivery. It was very important that we show only those custodians who we recognize as authoritative and Arizona-centric. That is what we have always

done through AZGEO.”

For example, the public transportation agency Valley Metro provides information on its ridership numbers via its own ArcGIS Open Data site, Valley Metro GeoCenter and now through AZGEO—Open Data. People will find applications like the Valley Metro Ridership Data Portal that features ridership data, along with data on Valley Metro bus routes, light-rail stations and routes, bus ridership, transit centers, and park and rides.

“Valley Metro provides public transit service to 16 different jurisdictions in the Phoenix area. Open Data provides the most efficient means of getting each of these jurisdictions, as well as the public, accurate and authoritative transit-related GIS data,” said Cory Whittaker, GIS administrator for Valley Metro.

The City of Glendale provides information on planning and zoning using its open data portal, Glendale Arizona Open Data, and the AZGEO—Open Data site. The cities of Phoenix and Scottsdale do the same thing. This means entrepreneurs and others interested in pursuing economic development projects have one place to find data from multiple agencies.

Pulford said that over time, improvements will be made to AZGEO—Open Data that will strengthen search and categorization, make more open data available, and provide additional showcase applications. “We have now added, literally, hundreds of new data sources,” he said. “I think the data consumers within our state will be excited to discover these, and I can’t wait to see the new and exciting ways they make use of them.”

The Building Blocks of Open Data Success

What makes one open data site better than another?

This question leads to a lot of other questions such as:

What can you do when setting up your ArcGIS Open Data site to maximize its benefits for your government or organization?

What will help your site promote accountability, build relationships with businesses, drive economic development, and generate revenue?

How will you encourage developers of mainstream apps to incorporate your data?

Just as important, how can you ensure that your organization benefits from sharing data internally to inform decision-making, eliminate duplication of efforts, improve staff productivity, and establish a hub of innovation?

When building your open data site, the following practices will answer these questions and help your site go from good to great.

Make Your Data Explorable

A site that is difficult to navigate or a search tool that doesn't provide easy access to relevant information will discourage the public and the people in your organization from using your site and benefiting from open data. Your site should make it easy to discover and use your data.

Open Data Externally and Internally

Open data encourages collaboration inside and outside the organization. It can benefit your organization by breaking down silos so everyone who needs data to do their jobs can get it without a protracted request process. Emphasizing internal data access and interagency communication will boost your site's success.

Include Mapping and Operational Data

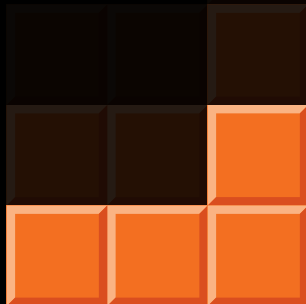
Open data can benefit non-GIS users as well as GIS professionals. ArcGIS Open Data sites support all types of datasets and provide access to geospatial, tabular, and operational data in one place.



↑ Make your data explorable and include operational data, such as this investigation data supplied by the City of Philadelphia on its OpenDataPhilly site, and some tools that let visitors better understand the data.

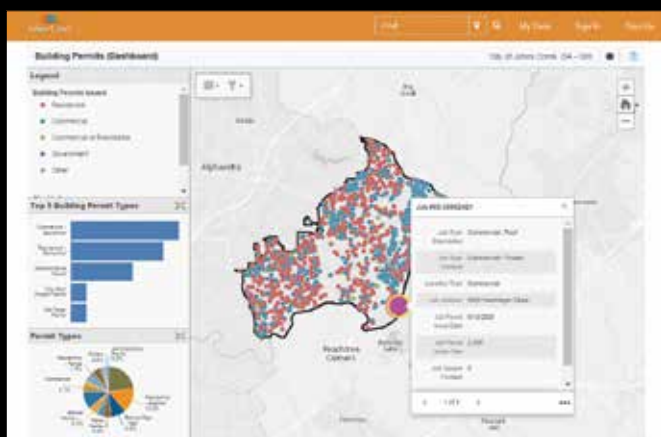
Offer Training and Developer Tools

Great open data sites understand that visitors may not always know what the data can do. By providing video tutorials and how-to documentation, more people can use your data. Providing resources for developers can also encourage them to leverage your data and create new solutions and apps that will benefit your community.



Launch Apps That Can Be Used Immediately

Prebuilt apps can help visitors realize the benefits of the data you've made available. Providing a few examples of how you used the data can help them think of ways they can use your data.



↑ On its open data site, the City of Johns Creek, Georgia, provides apps such as this one that provides immediate answers to common questions about city data.

Provide Context through Story Maps

A great open data site should not only provide data, but it should give context to the problems that governments and organizations are trying to solve. Creating apps and story map apps that give the background of an issue helps visitors understand the power of the data you're providing.



↑ The Ordnance Survey Ireland (OSi) uses Esri Story Maps apps to provide context for the data it provides on its open data site.

Leverage Your Community

Take advantage of every opportunity to find new and innovative ways for the data to be used by involving the entire community. Engage with startups, entrepreneurs, nongovernmental organizations, and developers to increase the support for an initiative, improve efficiency and productivity, cut cost by reducing duplication of work, and drive economic growth and entrepreneurship.

Open data is a foundation for building smart communities. It can be a tool for making more data-driven decisions. The greater collaboration, improved productivity and efficiency, and increased communication that open data makes possible have a tangible return on investment. With open data, technology, government, and citizens can come together.

The hub concept is expanding beyond city and county to the state level and beyond. It will help solve larger problems and support initiatives. Learn more about how you can create an open data strategy by visiting go.esri.com/opendata.

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Predictive Analysis Brings Food Aid Closer in Madagascar

By Jim Baumann, Esri Writer

A food security project in Madagascar used predictive analysis tools for optimizing the siting of food distribution locations to minimize the distances women and children had to travel to receive aid.

In its 2015 Global Hunger Index, the International Food Policy Research Institute assigned Madagascar and six other developing countries, alarming, the worst classification that year. With 80 percent of Madagascar's rural population deemed poor or extremely poor by the World Bank, this is not surprising. Though the country's economy is agriculturally based, production levels are low due to a lack of agricultural inputs

such as fertilizers. This is one of the reasons the country is a net importer of rice, which is a dietary staple and also its primary crop.

The United States Agency for International Development (USAID) Office of Food for Peace announced in 2014 a new food security project for Madagascar. The project is called Fararano, which means harvest season in Malagasy, the local language. Fararano follows the nutritional guidelines developed by 1,000 Days, an international nonprofit coalition of nearly 100 government and private agencies. This organization is dedicated to providing wholesome food for new and expectant mothers and their young children

during the first 1,000 days of life. Nutrition during the first 1,000 days of an infant's life is critical for mental and physical development. In Madagascar, a significant number of infants and young children are stunted owing to insufficient nutrition.

Catholic Relief Services (CRS) Madagascar worked with local partners to develop the distribution network necessary to deliver food commodities to women and children. The Fararano project was established in three rural regions in Madagascar where lack of food security is a particular problem. The program directly benefits approximately 364,000 people in the lean

↓ At the warehouse, USAID corn/soy supplement bags are stacked prior to being trucked to distribution centers.



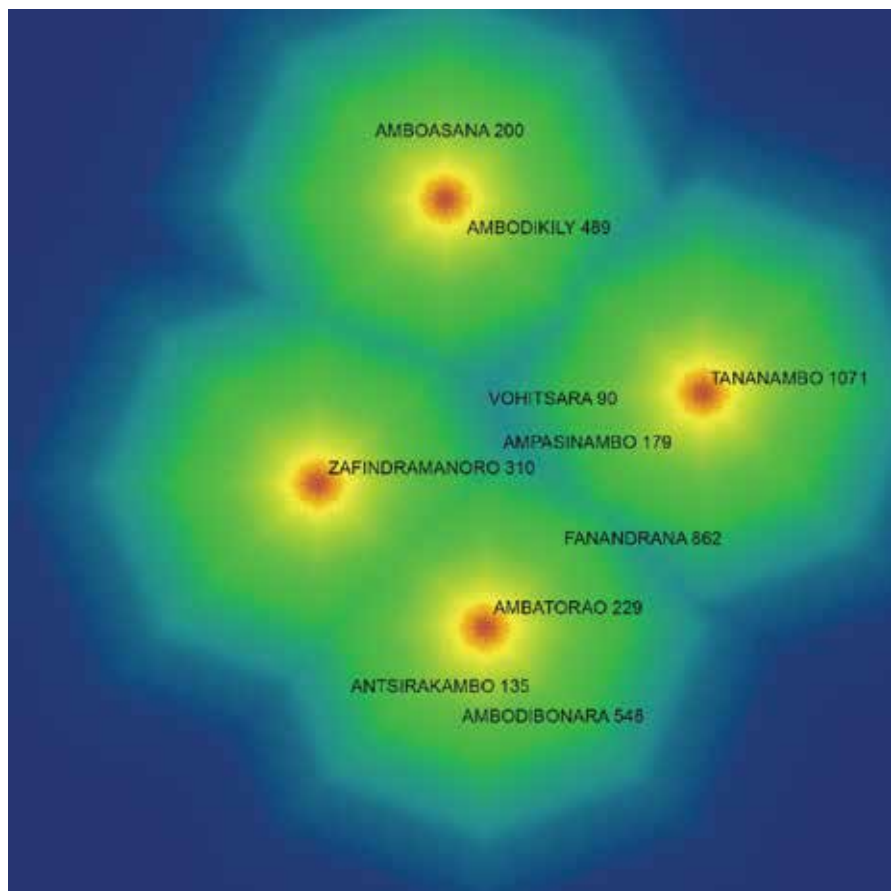
season (women, children in their first 1,000 days, and their households) by providing food supplementation on a monthly basis. People in these areas often live many kilometers from paved roads. To obtain nutrition supplements, program recipients must walk to distribution sites that are only open for a few hours each month when the CRS teams make scheduled deliveries.

Since program participants are pregnant women or women carrying small children, it was important to optimize site locations to minimize travel distances. To accomplish this, CRS teams collected the GPS coordinates for the location of each participant's home. The site selection process considered the distance that participants would have to walk to their food distribution location and the presence of a road that could accommodate the six-ton trucks used to provision the distribution site. Sites also needed a source of potable water, adequate storage for food, shelter, toilets, and security for participants. In general, participants who live in the same group of villages (known as a fokontany) are encouraged to collect food allotments from the same distribution center on the same day each month.

CRS Madagascar worked with implementing partners in the regions that participate in the Fararano project. These are mainly local charity organizations that assist by warehousing foodstuffs and providing vehicles and drivers for food deliveries. In addition, CRS coordinated with each fokontany's care group and village development committee to recommend distribution center locations for women living in rural regions who participate in the program.

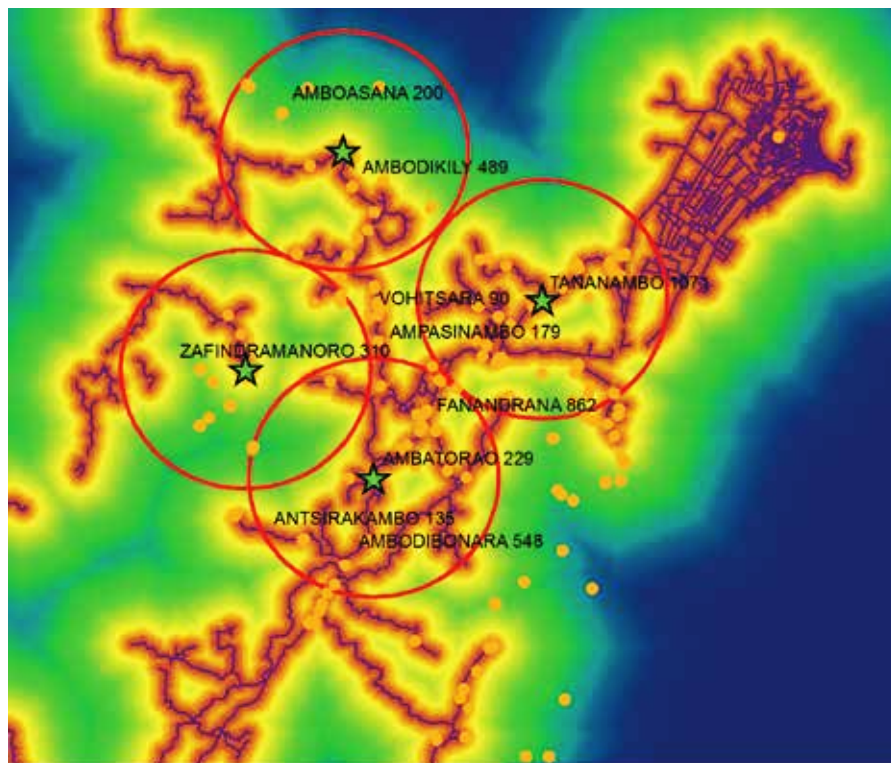
Shortly after the program began, only about 75 percent of those eligible to participate were collecting their food allotment on their distribution days. Follow-up interviews revealed that participants had to cross rivers four to six times when traveling to distribution center locations. In this wet climate, flooding could prevent women from crossing rivers and reaching distribution sites on the appointed days. Washed-out roads or bridges sometimes made it impossible for trucks to make deliveries on time.

The distance to distribution sites also



↑ Output from the selections of each site produced by the Distance From tool.

↓ Output from the Distance From ROADS tool, which is included in the analysis because the CRS model suggests women can travel somewhat faster on a road than overland on tracks and trails.





↑ An Esri partner project lead interviewed women about their walk to the distribution site.

lowered participation rates. If food was not collected, the CRS program incurred additional costs associated with returning the food to storage. These disruptions in the supply chain made planning difficult.

“We recognized this was a geography problem and decided to apply geospatial analysis to help optimize the site selection for new food distribution locations to make the project more successful,” said Daniel Andriantsimba, Regional Solutions architect and GIS specialist for CRS. This process included identifying better routes for delivery trucks traveling to the distribution sites and increasing the efficiency of all logistical operations. Instead of determining distribution sites based solely on the average walking times of beneficiaries, new locations were based on an optimal walking distance that was no more than 5 kilometers (3 miles) for most participants.

“In addition, we wanted to develop a versatile predictive model that could be adapted to our other local projects such as water, sanitation, and hygiene programs.

We also wanted to use it for the management and monitoring of various activities and facilities such as home visits and sanitation infrastructure, value chains and market access programs, food for work projects, and disaster preparedness,” said Andriantsimba.

CRS worked with Esri Professional Services to develop the algorithm and methodology for its predictive analysis model used to improve the food distribution locations for the Fararano project. Initially, beneficiaries’ homes were located on a topographical map and a circle with a 5-kilometer radius was drawn that encompassed the greatest number of participants. Participants who lived outside the 5-kilometer boundary were counted.

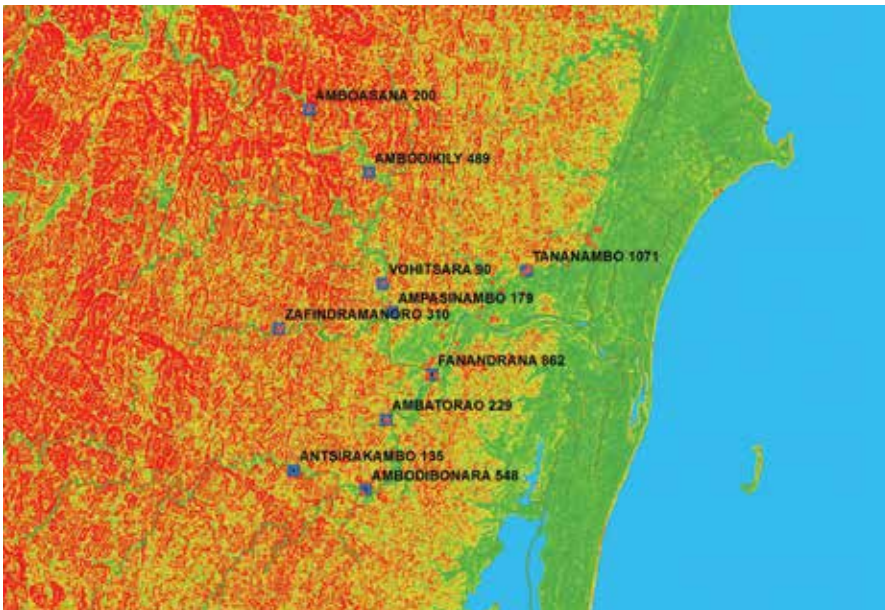
The ArcGIS Predictive Analysis Add-In was used to refine the predicted walking times for each distribution site. This add-in provides a set of tools for building models for predicting the location of moving or stationary targets or events.

A 30-meter digital elevation model (DEM) of Madagascar was processed to generate

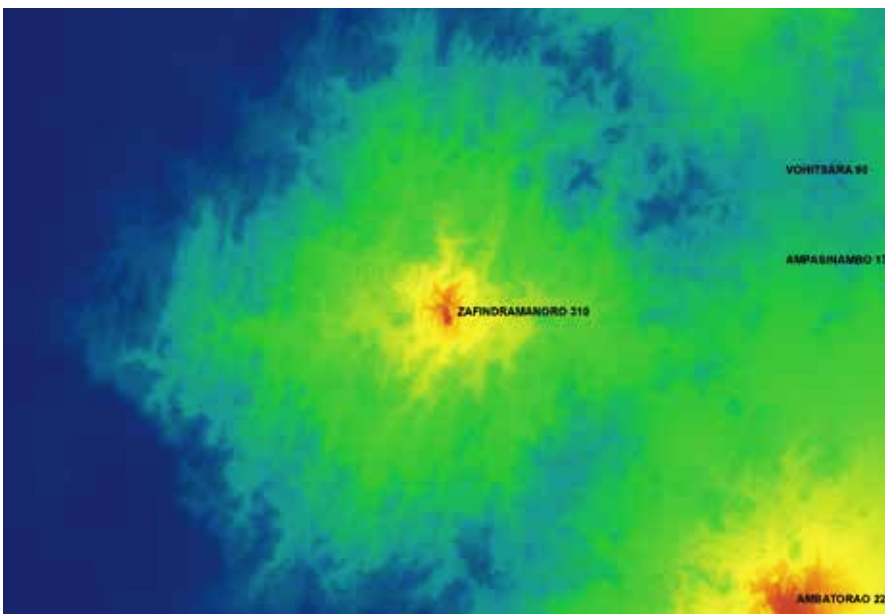
a slope layer. This layer showed how flat or steep the terrain was between each village and distribution site. The Distance From tool in the Predictive Analysis Add-In used the DEM to produce a raster that codes the distance to the nearest potential distribution sites.

Next, the Speed Model Builder, a tool in the ArcGIS Predictive Analysis Add-In, used the slope layer and the raster produced by the Distance From tool to develop a SpeedModel raster that took into consideration multiple environmental variables such as the slope of the terrain, existing roads, and the locations where rivers can be crossed.

Naismith’s Rule was applied at this point. Originally devised in 1892 by Scottish mountaineer William W. Naismith, it is a rule of thumb for calculating the time required to walk a distance that modifies time estimates based on the steepness of the terrain. This rule was adjusted to take into account the fact that Madagascar women, who were often carrying children, were unlikely to use routes that included steep terrain or



↑ This raster is the output from the SpeedModel, which accounts for multiple environmental variables and uses Naismith’s Rule for estimating the speed people travel over different slopes.



↑ Incorporating results from the SpeedModel raster and Distance From tool, the Time From tool is run for each distribution site creating a unique distance-from and time-from for each planned site as shown.

required them to ford streams.

The SpeedModel raster was used as input for the Time From tool to create a time-of-travel layer. Using these terrain-derived layers, the Route Finder tool was used to evaluate the distance and travel time for program beneficiaries for various scenarios. This let CRS evaluate different potential distribution site locations by using the most likely paths beneficiaries would take to avoid steep terrain and hazards.

By running the model many times on potential distribution sites, CRS predicted travel times for all participants in each region. With this information, CRS could add new food distribution sites and replace some existing ones to minimize walking time for most participants. As a result, many women spent less time traveling to distribution sites. Even those who lived outside the 5-kilometer boundary had total travel times of less than four hours.

CRS adapted this approach for its Food for Work (FFW) program. Using the same organizational structure and predictive analysis model used to plan and implement the Fararano project for the FFW program saved time and improved the performance of workers involved in the project. The cost calculation algorithm CRS developed that was based on geographic awareness was used to evaluate the program and improve outcomes.

“Due to the implementation of predictive analysis to select optimal food distribution sites, some of the most problematic locations achieved a 20 percent increase in consistent attendance, from 75 percent to 95 percent and a significant decrease in average walk times,” said Mike Ruth, Esri project manager. “This means that pregnant mothers and children are significantly more likely to have consistent access to nutrition that they need to overcome malnutrition. And the families do not have to spend so many valuable hours of their day walking to and from the distribution sites.”



Web App Sheds Light on Solar Energy Potential

By Shafi Bashar Khan

The Northern Virginia Solar Map was successfully completed and unveiled in August 2016. GIS technology and Esri's ArcGIS software proved indispensable in the development of the web app, which lets property owners evaluate the benefits and impacts of placing photovoltaic (PV) panels on their roofs.

"With existing GIS technology, can the solar energy potential of northern Virginia building roofs be determined and provided to the public as an online service?" Robert Lazaro, director of Regional Energy and Sustainability Policy at Northern Virginia Regional Commission (NVRC) had asked. At the time, it was not clear if such a project could be undertaken. NVRC began thinking about creating an online solar map that would provide information on the potential of this alternative energy source.

NVRC is a regional council of 14-member local governments in the Northern Virginia suburbs of Washington, DC. It is composed

of Alexandria, Arlington, Fairfax, Loudoun, Prince William, Falls Church, Herndon, Leesburg, Manassas, Purcellville, Dumfries, and Vienna local government jurisdictions.

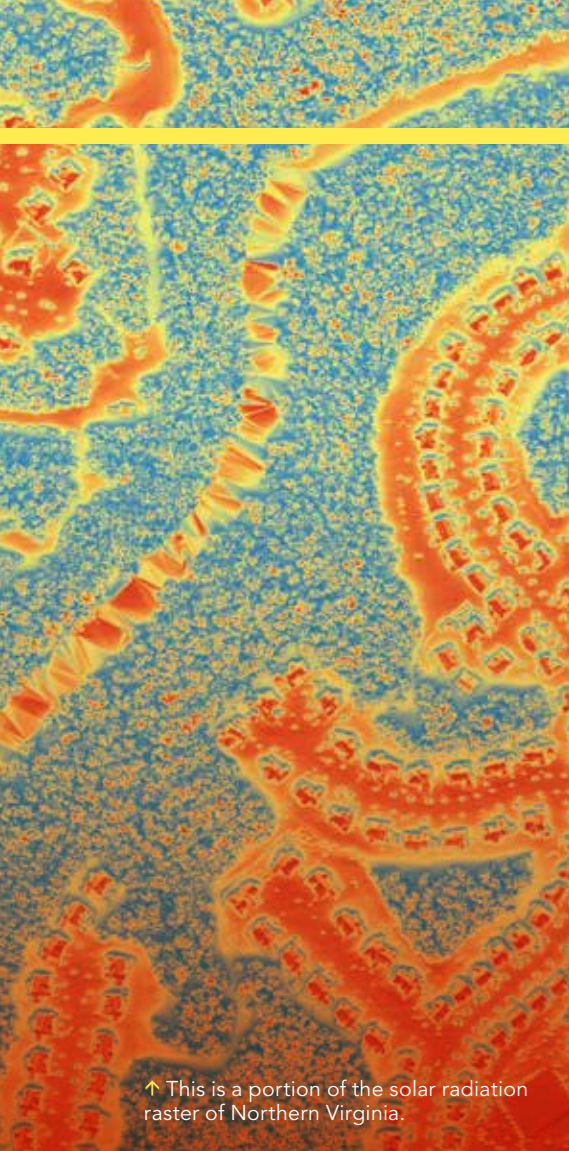
Scoping the Project

To determine how it would go about creating a solar map web app, NVRC studied the processes recommended by the National Renewable Energy Laboratory (NREL) for calculating solar energy potential. NVRC also consulted publications on this subject and contacted energy experts and people who had experience with solar mapping—even local solar panel installers.

Brandon Flessner, a GIS analyst with the Ohio-Kentucky-Indiana Council of Government (OKI), readily shared his experience in developing the web map OKI Solar Ready II, using a grant from the US Department of Energy. NVRC decided to adopt Flessner's method in the development of its own solar map, which would be the first of its kind in the Commonwealth of Virginia.

Elevation data was required to produce the solar radiation, slope, and aspect rasters needed to calculate solar energy potential. Areas occupied by buildings would be extracted from these rasters by using building polygon data in a clipping operation.

The slope raster was used to eliminate roofs with a slope of more than 50 degrees from the solar raster, as these roofs would be unsuitable for solar panels. The aspect raster was also used to filter out north-, northeast-, and northwest-facing roofs from the solar raster, as those roofs would be



↑ This is a portion of the solar radiation raster of Northern Virginia.

unsuitable for solar panels. The last step was to determine the size of the portion of each roof that was suitable for solar panels and aggregate the energy potential for each roof.

Obtaining Data and Choosing Software

Once the kind of information product that would be supplied by the web app was determined and the methodology for providing it was identified, the next challenge was deciding where to obtain the data and what software would be required.

Jurisdiction boundary and building polygon data would be needed. Fortunately, NVRC maintained geographic data in digital format for all local jurisdictions. However, because not all the data was current, some data had to be recollected. Lidar point cloud data records the elevation of surfaces very accurately, so lidar was chosen as the source for elevation data. However,

the jurisdictions lacked lidar data.

The US Geological Survey (USGS) had lidar data as part of its multistate data collection effort. Initially NVRC had lidar data only for Loudoun County and a small part of Fairfax County. However, the project could start with the available data while it waited for the rest of the data.

USGS lidar data was either downloaded from the USGS Earth Explorer site or collected on disk from the USGS headquarters in Reston, Virginia. NVRC had license agreements for four seats of ArcGIS for Desktop and several licenses for the ArcGIS Spatial Analyst and 3D Analyst extensions as well as an ArcGIS Online for organizations subscription. ArcGIS Online could be used to create and publish the web application online, but the application—analyzing data for an area of 1,338 square miles that included 534,000 building polygons and 47 GB image data—would occupy a lot of space on ArcGIS Online. NVRC did not have sufficient ArcGIS Online credits to keep the application running all year.

The alternative was to use ArcGIS for Server software to host the site on NVRC's own server. The Washington Metropolitan Consortium of Governments (WMCOG) agreed to provide a grant to NVRC to acquire ArcGIS for Server, overcoming a significant hurdle.

Lidar data was furnished in raw LAS file

format that was in two coordinate systems: State Plane and Universal Transverse Mercator (UTM). NVRC decided all data would be processed in UTM, so lidar data in State Plane had to be converted to UTM. All Northern Virginia local government boundary and building data, also in State Plane, was also converted into UTM coordinates.

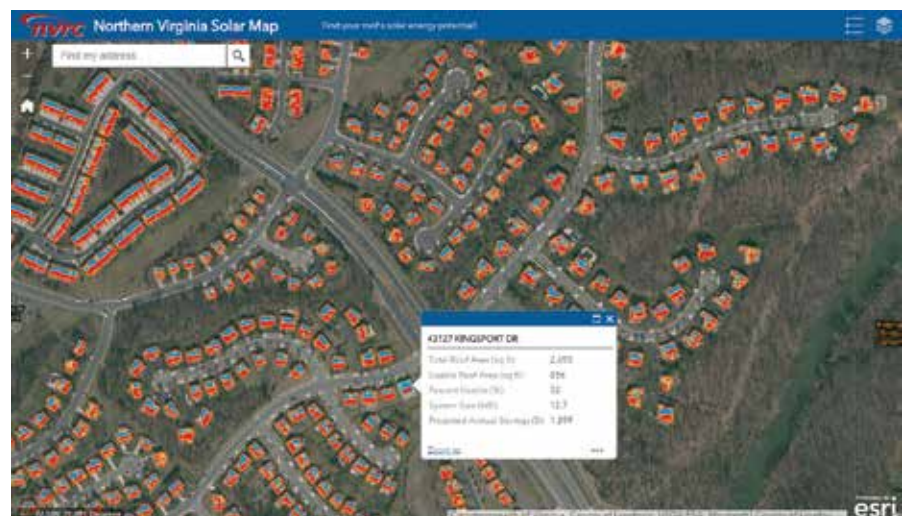
Generating Solar Radiation Rasters

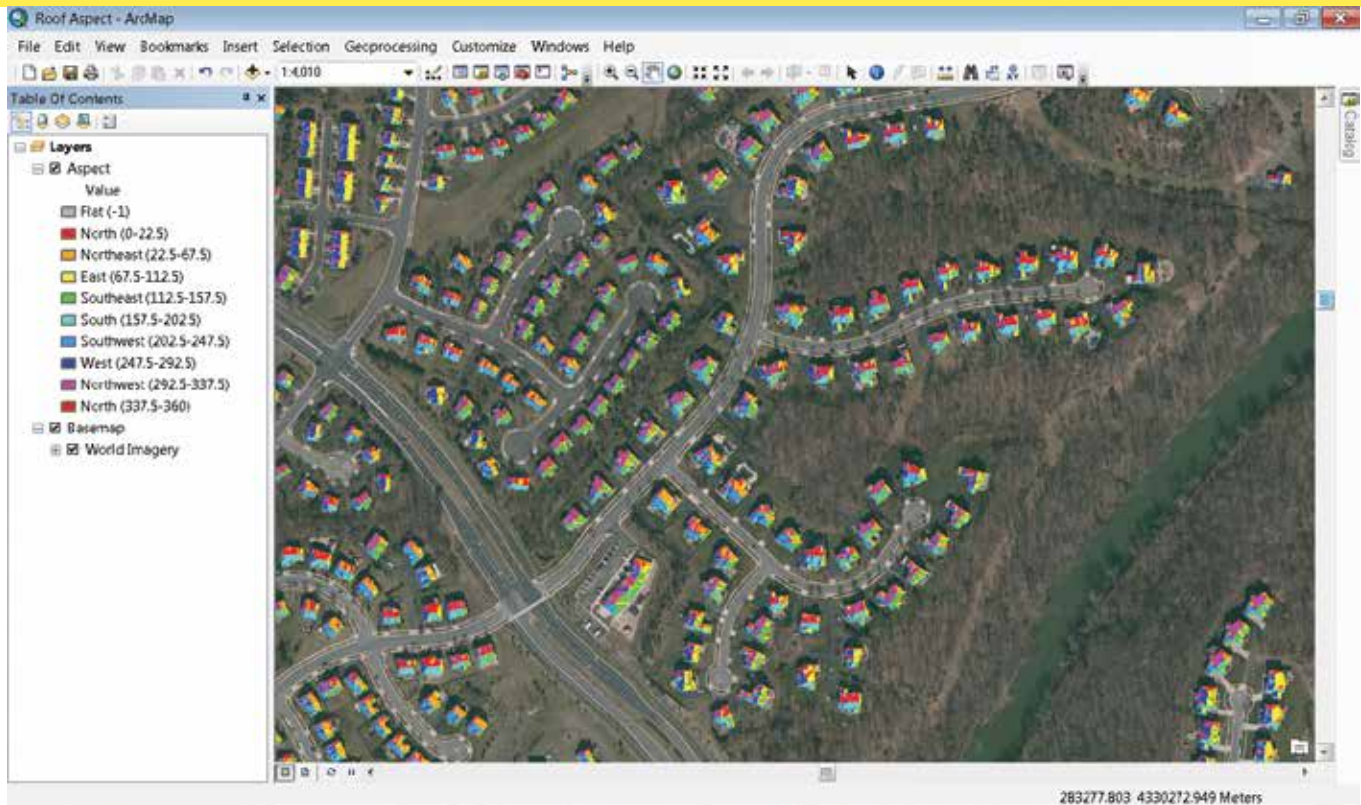
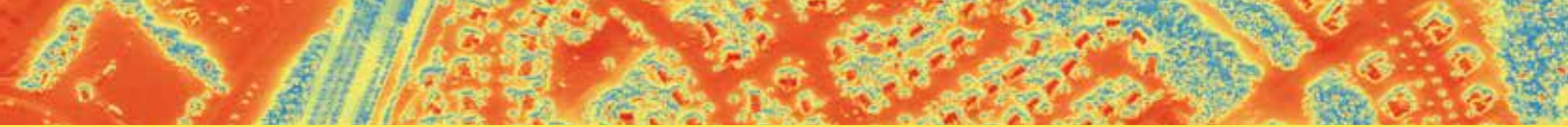
Generating solar rasters was a multistep process. First, a 1-meter resolution digital surface model (DSM) was created from first-return lidar points for each jurisdiction. Using this DSM as input for the Area Solar Radiation tool available with the ArcGIS Spatial Analyst extension, a solar radiation raster for each jurisdiction was created. These rasters essentially identify areas that get a lot of sun and areas that do not.

The Area Solar Radiation tool employs an elaborate algorithm that calculates potential solar energy on a given surface by taking into consideration daily and annual variations of sun exposure and obstructions that would affect the amount of sunlight a surface receives.

The DSM for each jurisdiction was divided into approximately 30 tiles. It took between 18 and 20 hours (on average) to complete the calculation of solar insolation for an individual tile using a computer with

↓ Property owners can use the Northern Virginia Solar Map web application to find the total roof size, suitable roof size, percentage of suitable roof, system size (in kilowatts) for their roof, and the projected annual savings from installing solar panels.





16 GB of RAM and a 2.93 GHz processor. The ModelBuilder application in ArcMap was used to loop through each tile and apply the Area Solar Radiation tool. Once all tiles were processed, they were reassembled into jurisdiction-wide solar radiation rasters.

Processing this data for 14 jurisdictions that ranged in size from small to large was the most expensive and time-consuming part. It would have taken approximately a

year. Access to a facility with substantial computing power was needed to shorten this time. Fortunately, professor Matt Rice of the department of geography and geoinformation systems at George Mason University in Fairfax, Virginia, volunteered the use of a university computer laboratory during the 2015 Christmas break. The facility was otherwise idle, and this allowed NVRC to process the data quickly. The solar raster was

generated in a matter of days. The collaboration with George Mason University helped NVRC achieve a critical project milestone.

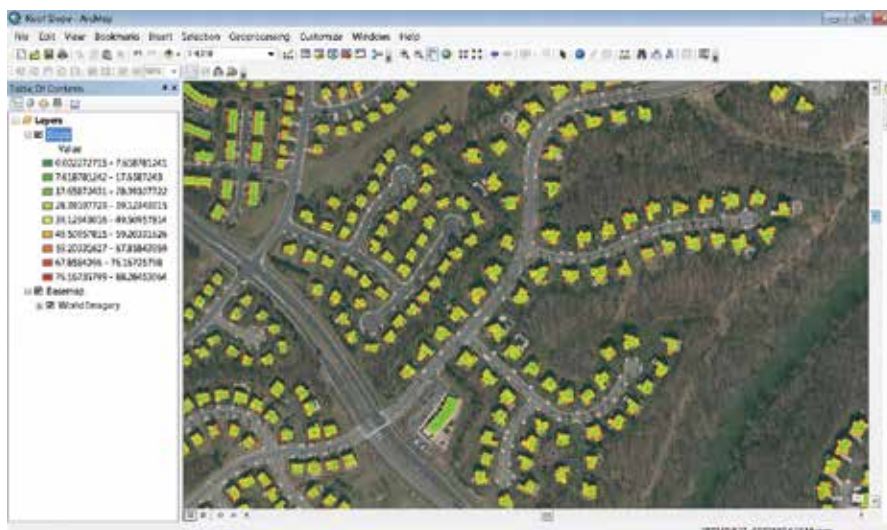
Jurisdiction-wide slope rasters (slope in degree) and aspect rasters (surface orientation) were next generated for all jurisdictions. Once solar radiation, slope, aspect rasters, boundary layers, and building polygons were processed, solar energy potential could be estimated.

Estimating Solar Energy Potential

To estimate solar potential for each roof, the solar, slope, and aspect rasters were clipped using building polygons to obtain only the building footprint portions of each raster. Slope and aspect rasters were reclassified by entering 1 (suitable) or 0 (unsuitable) values for each cell. Eventually these reclassified rasters were multiplied by the solar

↑ The aspect raster after it was clipped by building polygons. The north-, northeast-, and northwest-facing roof planes are unsuitable for solar panels.

← The slope raster after it was clipped by building polygons. Slopes are steeper along edges of the roof. A slope of more than 50 degrees is considered unsuitable for solar panel installation.



raster in the Raster Calculator in ArcMap. This process eliminated all unsuitable roofs or roof planes, leaving only suitable roofs.

The Zonal Statistics as Table tool, also available with the ArcGIS Spatial Analyst extension, was used on suitable roof rasters. The energy potential for each roof was aggregated, but further refinement was needed because not all available energy could be harnessed. Suitable roof size was calculated from total roof size. The system size in kilowatts (kW) was determined based on suitable roof size and the average solar panel size in the area. In the final step, projected annual cost savings were calculated based on average energy costs per watt (which are 11 cents per watt in Northern Virginia) and suitable roof size. The building table was populated with this information. This process was repeated for each jurisdiction separately.

All 14 jurisdiction-wide solar rasters were reassembled into one area-wide (Northern Virginia) solar raster as a mosaic dataset, which was converted to a TIFF format file. All jurisdiction-wide building polygons, populated with solar energy attributes, were merged into a building layer for northern Virginia.

Creating the Web App

The app required an area boundary layer, a building polygons layer, and a solar raster. Two map services were created: one for the solar raster and the other for the building polygons.

The Northern Virginia Solar Map (novasolarmap.com) was created using ArcGIS Online. The Esri-provided Imagery with Labels basemap provided a geographic context for the app. The boundary layer for northern Virginia was added from the file, then the solar raster (as an image map service) and the building polygons (as a map service) created were added to the web map.

With the Northern Virginia Solar Map, property owners in northern Virginia can type in a valid address or pan and zoom in the app to locate their house and click on the building footprint, which displays a pop-up table showing the solar energy potential of their roof.

The project took about 18 months to

complete. The Northern Virginia Solar Map will continue providing solar energy information on the buildings in northern Virginia for the foreseeable future, until updated lidar data is available or a new method for calculating solar energy potential is developed.

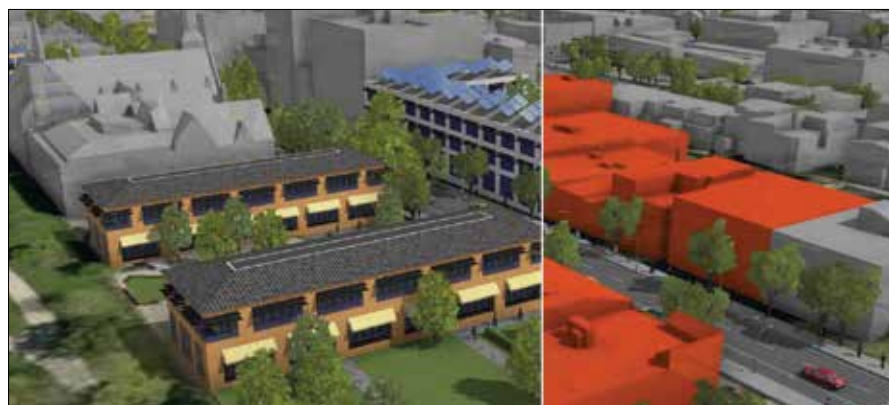
Commenting on the project, NVRC acting chairman Laurie DiRocco, who is also the mayor of the town of Vienna, said, "I am proud of NVRC's efforts to help residents and businesses reduce their energy use and to promote solar in the region. This map is an effective tool in helping take the

mystery out of going solar on your residence or commercial building."

For more information, contact Shafi Bashar Khan at shafi.email@gmail.com.

About the Author

Shafi Bashar Khan has bachelor's and master's degrees in geography from the University of Dhaka, Bangladesh. He works as an independent GIS consultant and was the project manager for the Northern Virginia Solar Map project. His current interests include database management, web app development, and solar mapping.



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Data Collection Goes from Months to Minutes for Australian Utility

One of Australia's largest water providers used the advanced location-based analytics in ArcGIS to conduct a meter audit far more efficiently and quickly than previous methods it used.

Power and Water Corporation is responsible for electricity transmission and distribution and provides water and sewer services across Australia's Northern Territory, an area of more than 1.3 million square kilometers (or 521,000 square miles). With the company's bottom line affected by a network of aging water meters, the utility embarked on a water meter replacement program. The company used an advanced location-based analytics solution and improved the efficiency of processes, particularly in the capture and communication of information.

Each day Power and Water Corporation's aging network of meters remained

untouched, revenue leaked from the company. Some meters had completely failed and recorded none of the water used. Other meters inaccurately measured usage. In one case, an older meter had been recording usage of \$10 per day. When it was replaced, the new meter recorded usage of \$85 per day. The company needed to check and—when necessary—replace meters for all its commercial clients.

The previous data collection workflow was inefficient and time-consuming. Contractors visited each meter, assessed its condition, replaced the meter if required, and manually entered all the data they collected on printed spreadsheets. These documents were carried back to a central office, where the data was typed into a central database so it could be used by the project manager to coordinate the rollout and identify any data gaps.

This workflow caused data to be handled

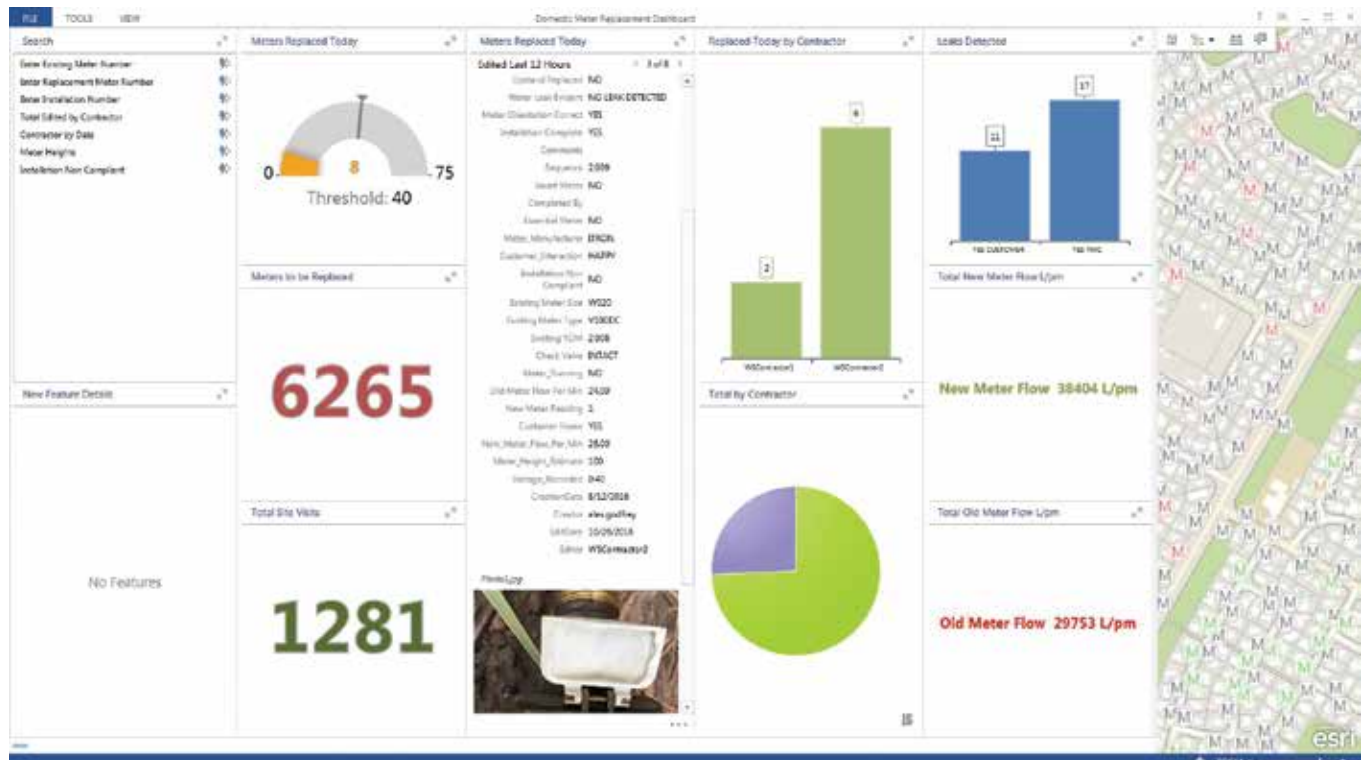
multiple times, required return visits that delayed data collection and entry, and sometimes resulted in lost and mismatching data to assets. This significantly delayed meter replacement and increased costs.

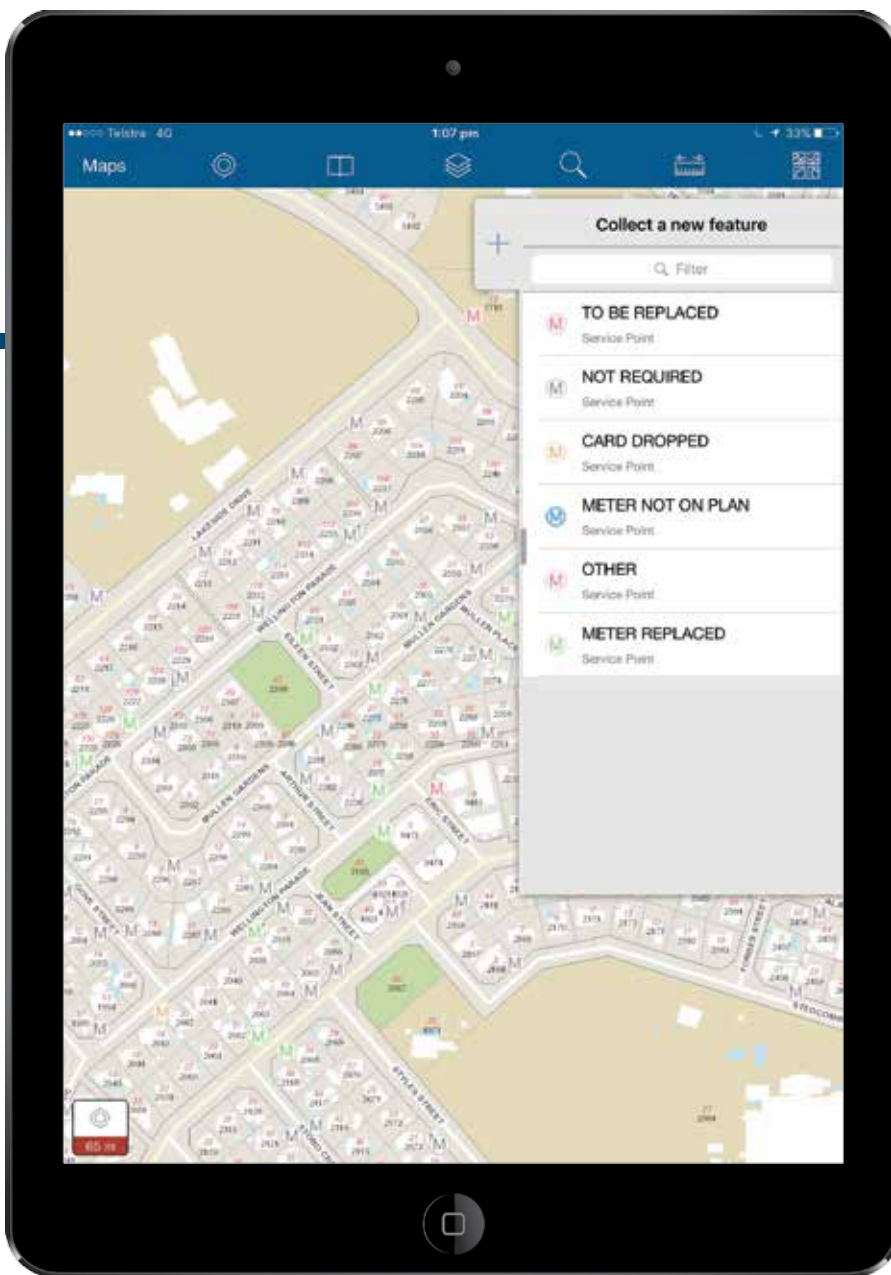
Power and Water Corporation needed to reinvent its data collection processes and wanted to try a GIS technology solution so it could build a business case for a full-scale location-based analytics implementation.

The company chose a commercial off-the-shelf (COTS) solution that leverages Esri's ArcGIS platform. This solution sped up every stage of the project. It provided fast routing to each meter and enabled work in the field to be reviewed remotely as soon as it was completed.

The solution was deployed on Apple iPads so staff and contractors could efficiently collect and update information in the field. Before the solution was taken into the field,

Managers could view the project's progress on the Operations Dashboard for ArcGIS app and quickly address issues, rather than waiting weeks or months for paper documents to be manually entered into the system.





← As part of the agency's Water Meter Replacement Program, iPads equipped with Collector for ArcGIS let staff and contractors efficiently collect and update information in the field and upload it to an operations center in near real time.

The system's user-friendly interface allowed the project manager and staff to make confident and timely decisions about the roll-out, instantly visualize data gaps, and rapidly access and analyze information pertaining to physical infrastructure and environmental assets by simply clicking on a map.

With the success of the trial project, the technology will be expanded and used in a new—and much larger—project. Based on the results and the return on investment generated, the executive management team has approved the expansion of location-based analytics to the existing Retail Management System. It is also being considered for use in the strategic analysis of expansion and asset management plans in the future.

To download a full case study on Power and Water Corporation's industry-leading solution, visit esriaustralia.com.au/powerandwater.

the system was populated with records for the meters so that a meter's location and other details could be verified on-site and corrected immediately if needed.

Once an inspection was completed, the data was uploaded to the operations center so teams in the office could work with it immediately. The project manager, who monitored the project's ongoing status via a map-based dashboard, could identify any issues and act on them immediately. In addition, data on meters can now be instantly accessed, enabling many issues to be resolved from the office rather than sending a contractor to the site.

This solution improved data reliability and accuracy, furnished data in near real time, and reduced the duplication of efforts.

This enabled the project to be completed much more quickly than expected.

In some cases, it had taken three months to log data, but now the same process was reduced to minutes. While it was initially projected that 20 to 30 meters would be replaced each day, in practice the number of meters replaced daily averaged between 40 and 50.

"This has sped the entire project up by 60 to 70 percent, which pleases management and our customers," said Power and Water GIS officer Alex Godfrey.

The solution took just two weeks to deploy.

The project also improved Power and Water's data integrity. As a single-point-of-truth, the solution provided a streamlined data collection process that removed the risk of misallocated, lost, or duplicated data.

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What Makes Some GIS Teams STAND OUT?

By Gary Maguire, Department of the Premier and Cabinet, South Australia

Have you ever wondered why some GIS teams succeed more often and stand out from the rest?

We all know a GIS team that stands out. You want your team to excel. We all know a peer who is leading the rest of the pack. You want to emulate that leader.

That's why you attend that leader's conference presentation or meet with them to find out why they are successful. You note that they have the same technology, the same software, the same size operating budget (or maybe even a smaller one), and their team structure is similar to yours.

But their teams stand out.

Over the years at meetings, workshops, and one-on-ones, I have noticed that managers and executives rarely talk about their greatest asset: their people. They talk freely about technology, software, data, innovation, and management practices. Managers and executives who do talk about their people—and recognize that they wouldn't be where they are without them—understand that technology is the tool, data creates the evidence, but people are the most valuable commodity in their business.

I don't have all the answers to making your team stand out, but I would like to share with you some of my experiences, observations, and the lessons I have learned as a manager of GIS teams and the president of a not-for-profit organization.

I have found that the essence of a successful team is getting the right balance of people to work toward a common goal. A good starting point is understanding the leadership qualities and the skills you can offer your team.

I remember when my director believed I was ready to lead a team of GIS professionals to work on some exciting and innovative projects. The very first piece of advice he gave me was, "We are only as good as the

people in our team." He then told me who would be in my team. Before I could respond, he said, "You will have to make them work together."

I had such a diverse group of people on the team. I had traditional cartographers who didn't think that computers could replicate hand-prepared maps. I also had graduates who had only used mobile technology to collect data and GIS software to make maps. I had worked with some of these people for several years, and there were some people I didn't know. I had people who were older than me that I thought should be the team manager instead of me.

When I first became a manager, I attended some management courses and spoke with other managers about how they managed teams. I thought I would just "copy and paste" this new knowledge directly into my management practices. However, this didn't necessarily work all the time.

I was quickly learning that managing a diverse team wasn't easy. I was failing in some parts of my role, while succeeding in other spaces. I knew I had to find a way to unite the team and deliver on my performance indicators. My problem wasn't management; it was leadership.

This is where my journey took the path less traveled by many GIS professionals. This was the moment in which I went from a technologist to a leader of people and a manager of business.

It is important to understand that management and leadership philosophies are worlds apart, but they intersect daily. As a manager, it is your job to process day-to-day tasks, keep business on track, and direct people to work.

Traditional management works on the

principles of punishment and reward for effective performance management, but evidence suggests that this works for a while until staff lose interest in the vision, the manager, or their team members.

In contrast, leadership builds purpose. It develops a collective vision, enables trust, values each team member, and promotes continuous learning. The new millennium workplace demands more leadership, collaboration, engagement, and respect for the skills and knowledge of an individual no matter their age, job classification, or experience.

Some teams excel because they are led by exceptional people who have a passion for their professional discipline along with carefully crafted management and leadership skills.

There is another level of leadership that creates teams really stand out. These teams are led by transformational leaders. These leaders see themselves as moral exemplars. They have a greater understanding of the value of the people around them who are working toward creating significant change in each other, the team, and the organization.

Leadership expert and presidential biographer James MacGregor Burns defined transformational leadership as a process in which "leaders and followers help each other to advance to a higher level of morale and motivation." This process is more than managing people differently. It is a philosophy in implementing culture change.

At this point I'm not saying that you need to change the whole organization's cultural environment. But as a leader you can influence the culture in your team or even outward into your division. This is the starting point of creating a high-performing

team—one that stands out.

You are now at the crossroads. You have a choice to follow others or to create a new path. The first step in becoming a transformational leader is the hardest step because of the many unknowns ahead of you. There is no one book that will give you a road map and directions to success or describe what success should look like for you.

I can say with experience that blazing a new path is not easy some days. It can be lonely. It can also feel like everybody wants a minute—or an hour—of your time but that there are not enough hours in the day. In the end, you will always find the energy within yourself because you understand that the rewards are greater than the effort you put in.

If you are ready to take the first step in becoming a better leader and building a team that stands out, it is a good time to evaluate your current leadership skills and knowledge while comparing them to some characteristics of a transformational leader.

There is no magic list to become a transformational leader, but you can adopt some of their common traits. Transformational leaders have an inspirational vision, motivate individuals, calculate risks, make tough decisions, have an organizational consciousness, cultivate openness, make sure their actions demonstrate integrity, know their personal values, and capture the hearts *and* minds of their teams.

Inspirational Vision

Set a realistic and achievable vision. Create a vision that can motivate and be owned by each team member. Communicate the vision effectively with passion and humility within the team and to supporters. The vision will inspire belief, commitment, and purpose.

Motivate Individuals

Take the time to understand what makes individuals come to work every day. What are their strengths? Where do they feel strong at work? What tasks motivate them to excel?

It's more than a formal acknowledgment of a job well done; treat each team member as a valued individual.

Calculated Risks

Bravery is trusting yourself. Be brave and take calculated risks. You must trust your instinct to make informed decisions quickly. When time is on your side, lean on your most valued resource, the team. Empower them to assist with research, gathering the intelligence, evaluating the situation, and making recommendations. This will facilitate growth, respect, trust, and confidence within the team and with you.

Make Tough Decisions

Do not shy away from difficult decisions. They never go away. Make your decisions with a clear focus on the values, vision, objectives, and goals of the team and the organization.

Organizational Consciousness

As a leader, you need to understand the collective consciousness of the entire organization. You need to be aware of what is happening outside your team. Where are the pressure points in the organization? What divisions are doing well, and why? Engage other individuals to tap into the organizational consciousness.

Openness

Be open to new ideas and suggestions. Understand that success is dependent on the effort of the entire team. Growth only happens in teams that have a culture of openness to new ideas from all levels. You need to make a deliberate effort to seek new ideas, challenge your intellect, and be prepared to be questioned by team members.

Demonstrated Actions

Be proactive in your approach. Through actions, you will demonstrate that you are a person of integrity. You turn words into actions and are willing to take risks to benefit the team while taking an active role in growing the organization.

Personal Values

Understand your core values. Your values, beliefs, and behaviors influence everyone around you, especially your team. It is important to seek others' insights to make the best decision for the team and the organization without compromising your own values.

Hearts Plus Minds

You need to connect the heart and mind of each individual to the vision. Engage your team through passion, strength, and belief. If you can connect with them at an individual level, emotionally and rationally, they will respond with passion and feel a profound connection to the vision to drive innovation and growth.

Stand-out teams excel because their leader understands the wisdom of Nelson Mandela, longtime champion of the anti-apartheid movement and former president of South Africa, who said, "It is better to lead from behind and to put others in front, especially when you celebrate victory when nice things occur. You take the front line when there is danger. Then people will appreciate your leadership."

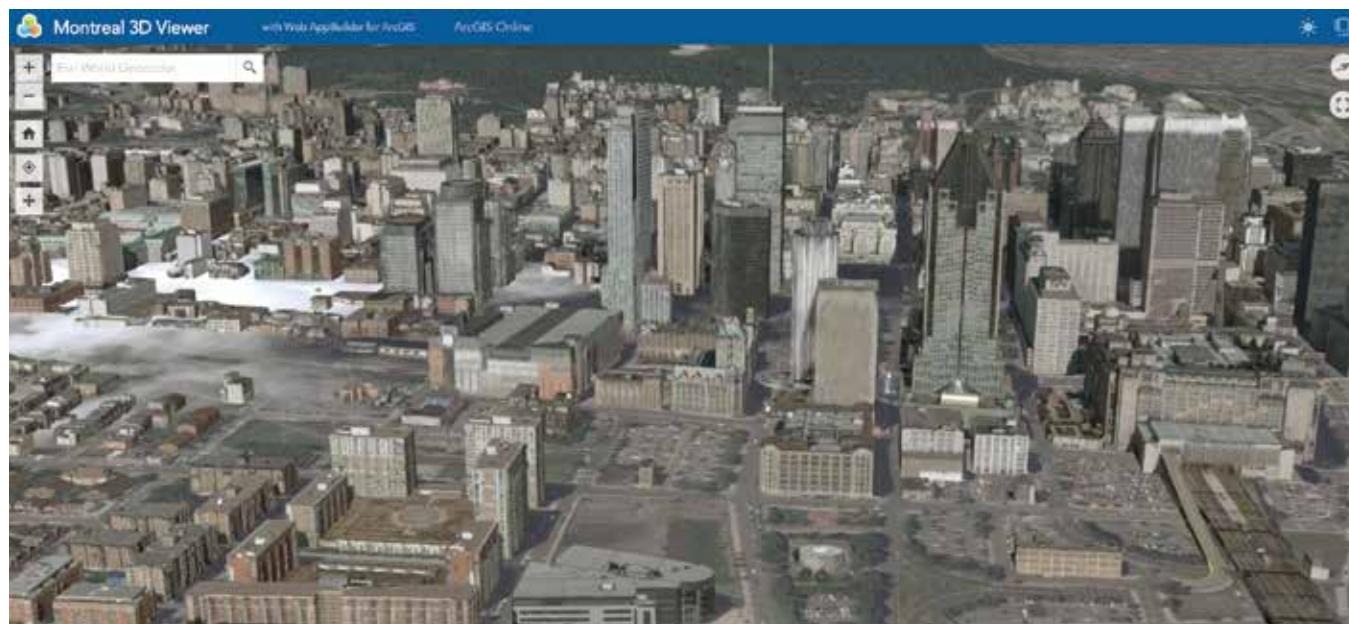
About the Author

Gary Maguire is the senior geospatial intelligence officer for the Department of the Premier and Cabinet, South Australia. He has been involved in the spatial industry for 32 years, and during this time, he has led several major state government geospatial initiatives and held executive positions including the president of the Surveying and Spatial Sciences Institute and a board member of the Centre for Spatial Law and Policy. In 2014, his team was recognized by Esri with a Special Achievement in GIS Award. He is a fellow of the Leadership Institute of South Australia.



Use Web AppBuilder to Meet Your Organization's Needs Quickly and Easily

By Derek Law, Esri Technology Evangelist



↑ Web AppBuilder for ArcGIS supports both 2D and 3D data content and provides the same dynamic and interactive WYSIWYG user experience that requires no additional learning curve.

In many organizations, web apps—especially those with online mapping—are a key component in supporting business workflows.

Web AppBuilder for ArcGIS is a fully integrated client application of the ArcGIS platform. It lets GIS managers, GIS analysts, and non-developers easily create and deploy new web apps with online mapping but it doesn't require programming. The apps can run on any device. Because Web AppBuilder for ArcGIS has an extensibility framework, the Developer Edition of Web AppBuilder for ArcGIS can be used by developers who save time because they don't have to start from scratch when building web apps with custom functionality.

Web AppBuilder for ArcGIS is embedded in both ArcGIS Online and Portal for ArcGIS. It provides a simple and intuitive workflow for creating new web apps by specifying the app's look and feel, data content, and functionality. With many configuration options, it allows you to decide how simple or advanced you want your web apps to be. It supports many different application use cases. After signing in to ArcGIS Online and/or Portal for ArcGIS, you can begin creating new web apps by accessing Web AppBuilder for ArcGIS from the map viewer via the Share button or the My Content page

by choosing Create > App from the drop-down menu.

Although Web AppBuilder for ArcGIS Developer Edition is a separate stand-alone application that is installed on a local machine, its user experience is very similar to Web AppBuilder for ArcGIS in ArcGIS Online and Portal for ArcGIS. To use it, you sign in to either ArcGIS Online or Portal for ArcGIS to access web maps and other GIS resources such as basemaps and locator services. Here are just five of the many reasons you should use Web AppBuilder for ArcGIS.

↓ You get eight different themes—styled user interface layouts for your web app. You can easily switch between themes and customize color and tool button locations.



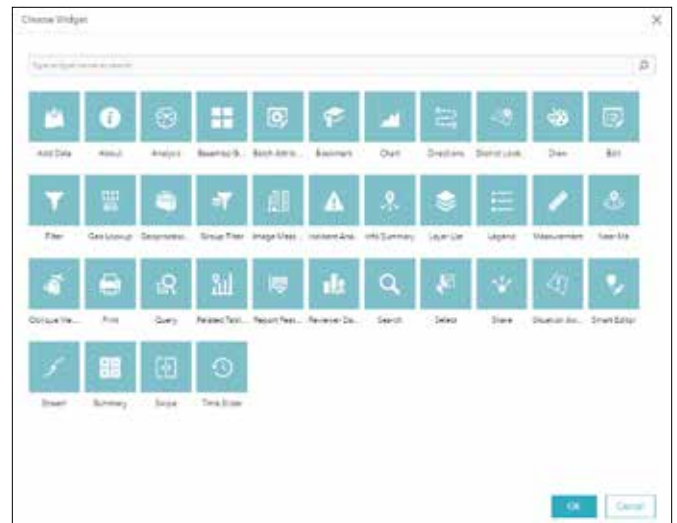
Dynamic and Interactive Builder User Experience

The interactive application building experience in Web AppBuilder for ArcGIS is a what you see is what you get (WYSIWYG) user experience. The interface is divided into two parts. The left side contains the configuration panels. The right side displays a live preview of how the web app will appear and behave. As you make configuration changes to the web app's properties, the preview immediately updates so you can see how your changes will appear in the app. This is very beneficial because you can experience what the end user will see as you configure and edit the app.

The web app's look and feel are determined by the Theme and Attribute tabs. The data content is specified on the Map tab. The app's functionality is defined on the Widget tab. Because the workflow for configuring a new web app is nonlinear, you can set and modify the web app properties in any order you wish. Eight different themes—styled user interface layouts for your web app—are included. You can easily switch between them and customize their color and tool button locations.

The Previews button displays how the web app will appear and behave on a smartphone or tablet. Even after an app has been deployed, you can open the app in the builder experience and make changes to it such as adding or removing a tool. This makes the process of creating and updating web apps very easy.

Web app configurations can also be exported from Web



↑ Web AppBuilder for ArcGIS comes with many widgets that let you add functionality to your app instantly. New widgets are constantly being developed and shared through the Web AppBuilder for ArcGIS community.

AppBuilder for ArcGIS as a template. For example, you apply your organization's corporate colors, logo, and branding to create a new web app and export it as a template. Enable it as a selectable template option in ArcGIS Online and Portal for ArcGIS so other users can select your web app configuration when they create a new web app. This promotes web apps for your organization that have the same branding and a consistent look and feel.

↓ Applying themes and adding widgets customizes your app and lets you build an app that suits your needs.





↑ Themes change the placement of tools, use of color, and include features such as an overview map.

Many Widgets = Lots of Functionality

Web AppBuilder for ArcGIS has a core framework but was designed to be modular. Most of its capabilities are enabled based on widgets. A widget is a self-contained code component that enables some functionality when added to a Web AppBuilder for ArcGIS app. Widgets that appear on the Widget configuration panel form part of the app's user interface. Other widgets are typically tool buttons in the app. In the builder experience, you enable new tools and capabilities in web apps by selecting widgets and adding them to the app.

Web AppBuilder for ArcGIS includes more than 45 widgets that enable many of the core capabilities you need to create and build a GIS web app, such as Add Data, Draw, Edit, Filter, Geoprocessing, Legend, Overview Map, Print, Query, Search, and Select. Since the builder user experience is dynamic and interactive, you can add a new widget, configure it, then observe how it behaves in the web app. Widgets can be added or removed at any time, so you can adjust your web app as needed. New widgets are continually being developed by both Esri and the Web AppBuilder for ArcGIS user community.

Supports Creating 2D and 3D Web Apps

Web AppBuilder for ArcGIS supports both 2D and 3D data content. It enables you to create new custom web apps for both easily. Web maps are the foundation for 2D enabled web apps. Web scenes are

the starting point for 3D web apps. Web AppBuilder for ArcGIS provides the same dynamic and interactive WYSIWYG user experience for both types of data. Creating web apps that help you visualize and display your 3D content requires no additional learning curve. With each release of Web AppBuilder for ArcGIS, the library of widgets specifically designed to support 3D content grows.

↓ The Previews button lets you see how your app will look in the viewport of various devices.



Active and Large User Community

Users of Esri technology meet on GeoNet to discuss ideas and problems and collaborate on solutions. Three discussion forums on GeoNet are dedicated to Web AppBuilder for ArcGIS: Web AppBuilder for ArcGIS (the general forum), Web AppBuilder Custom Widgets, and Web AppBuilder Custom Themes. All three are very active. Many members contribute content and help on a regular basis. In the Content section of the Web AppBuilder Custom Widgets forum, more than 30 custom widgets have been posted and shared by the user community. These widgets provide additional capabilities that may not be available in the core widgets and can be leveraged using Web AppBuilder for ArcGIS Developer Edition.

In addition, some Esri Solutions teams and Esri partners have developed custom widgets to enable new functionality in the Developer Edition. Based on interest and usage, some of these custom widgets have been integrated into the core Web AppBuilder for ArcGIS product.

An Extensible Framework for Customization

Web AppBuilder for ArcGIS is built on the ArcGIS API for JavaScript and HTML5 technology. Developers familiar with JavaScript can extend Web AppBuilder for ArcGIS by developing custom widgets that supply additional functionality and tools and custom themes that provide more styled user interface layouts. The ArcGIS for Developers site contains additional information in an online guide, API reference, and many code samples that will help get you started.

Web AppBuilder for ArcGIS was designed to be modular, so custom widgets and themes can be easily added or removed in the Developer Edition and previewed through the builder experience. This means that using the Developer Edition, GIS managers, GIS analysts, and nondevelopers can work with the custom functionality in the familiar builder experience, and developers can test and prototype custom widgets and themes.

Conclusion

Web AppBuilder for ArcGIS is a great solution for organizations that need to quickly create and deploy new custom web apps with minimal effort. It is a Swiss Army knife solution that you can use to create custom web apps for a variety of uses, but it does not require in-house developer resources. You can view live production sites of some of the

many customers who have already deployed custom web apps using Web AppBuilder for ArcGIS at the Web AppBuilder for ArcGIS Live Sites Showcase.

Resources

These free resources will help you learn more about Web AppBuilder for ArcGIS.

- The live training seminar “Get Started with Web AppBuilder for ArcGIS,” available from the Esri Training site
- Web AppBuilder for ArcGIS help documentation
- Web AppBuilder for ArcGIS Developer Edition resource site
- The *ArcWatch* article, “Configure Web AppBuilder for ArcGIS Developer Edition to Work with Your ArcGIS Online Organization”

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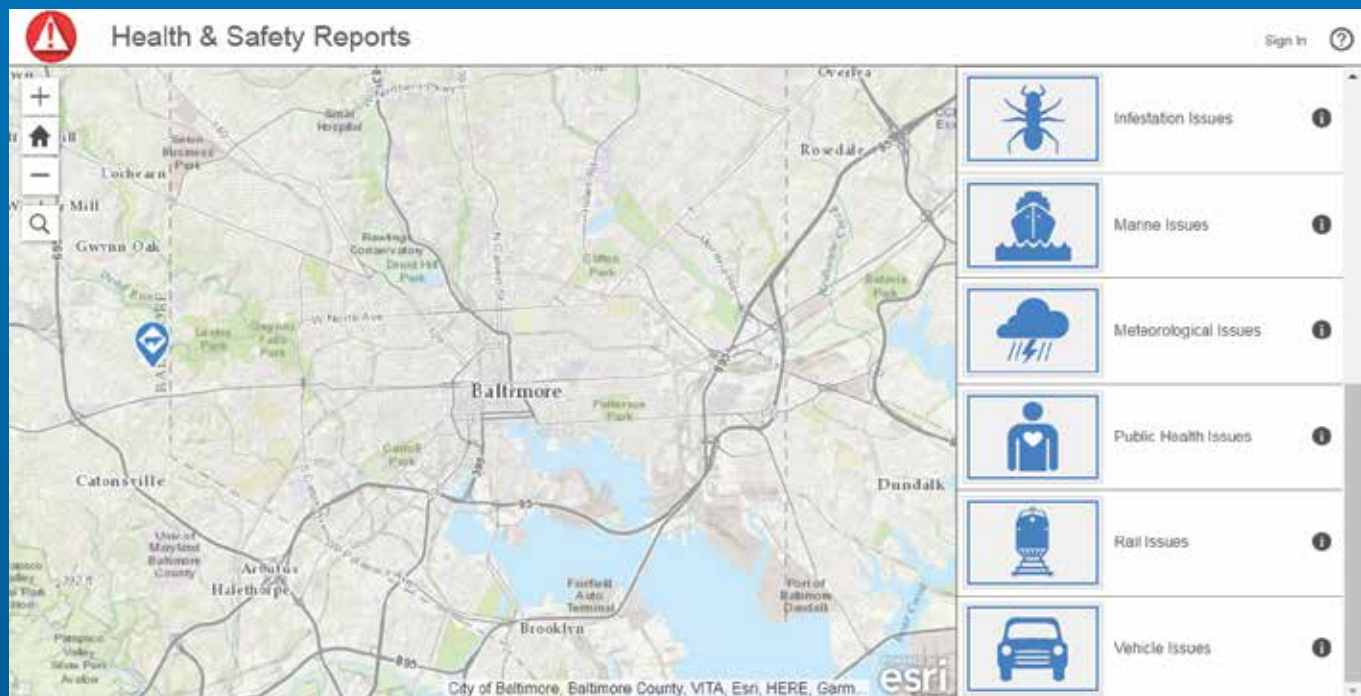
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Find and Deploy ArcGIS Solutions Right Now



↑ Some ArcGIS Solutions, like this Health and Safety Reports app, are designed to solicit information from the public so you won't need to load data before sharing them.

ArcGIS Solutions Deployment Tool, an ArcGIS Pro add-in, will make it easier for you to find and deploy ArcGIS Solutions. If you are not already using them, ArcGIS Solutions are free and supported configurations provided by Esri for defense, utilities, state government, local government, and other industries that enable typical workflows in specific industries, deliver innovation, and incorporate best practices that improve your organization's workflows.

Released in January 2017, the ArcGIS Solutions Deployment Tool lets you browse the catalog of hundreds of ArcGIS Solution apps or search by industry or keyword in the same way you would locate an office productivity add-in, but the deployment tool does much more. The tool lets you deploy the selected solution to ArcGIS Online or Portal for ArcGIS simply and with little effort on your part. The tool only needs to be installed once, because the list of ArcGIS Solutions apps is dynamically managed by Esri.

This add-in includes a series of tasks that have been optimized to deploy ArcGIS Solutions for your organization. Each solution generally includes one or more feature layers, maps, and applications. The deployment tool creates the items, groups, feature layers, maps, and applications associated with the solution you have chosen.

After a solution is deployed, you can make any additional configuration changes that might be needed to meet the specific requirements of your organization. In some cases, you may need to modify the feature layers used by the solution to support specific business needs in your organization by adding or altering fields, domains, and other parts of a layer. Maps provided with solutions may need to be harmonized with specific cartographic design requirements to support the maps or applications in your organization.

In some cases, you may need to load existing data into the ArcGIS Solutions app before sharing the maps or applications. Reviewing the maps and applications provided with the solution will let you identify if there is source data you need to load. Some ArcGIS Solutions apps are designed to capture new data for your organization or solicit information from the public. For these solutions, you won't need to load data before sharing the ArcGIS Solutions app.

The ArcGIS Solutions Deployment Tool requires ArcGIS Pro (Standard or Advanced) version 1.3 or 1.4 and ArcGIS Online, ArcGIS Enterprise 10.5 (Standard or Advanced), or ArcGIS for Server (Standard or Advanced) 10.4 and Portal for ArcGIS for map service hosting. Application hosting requires ArcGIS Enterprise 10.5, Portal for ArcGIS 10.4, or ArcGIS Online.

To deploy ArcGIS Solutions in your organization, install the ArcGIS Solutions Deployment Tool on each ArcGIS Pro machine that will be used to deploy solutions in your organization. Installation of the tool adds the ArcGIS Solutions Deploy button to the Share tab of the ribbon interface. To deploy a solution, users must have privileges to create new content in their ArcGIS Online organizational subscription or Portal for ArcGIS.

Andrew Peters, GIS manager for the City of Falls Church, Virginia, has found the tool a time-saver. "The Deployment Tool automatically performs those tedious processes in just a few clicks. The tool exponentially reduces time because I'm not fiddling around making decisions about which icons, fields, and schemas to use. I can easily configure the app to true it up with the data I already have."

Learn more about the ArcGIS Solutions Deployment Tool and download it from solutions.arcgis.com/shared/help/deployment-tool/.

New ArcGIS Developer Program Reflects the Way You Work

The new ArcGIS Developer Program gives you access to the software and resources you need to be successful with the ArcGIS platform. This simple and flexible program helps you build, manage, and deploy apps quickly. It combines the best aspects of the Esri Developer Network (EDN) and the original ArcGIS Developer Program.

Program Benefits

Program membership has no cost and provides you with

- Credits for developing and testing your apps
- Web and native client APIs and SDKs
- Conceptual API reference documentation and a vast library of developer samples
- Basic online app builders
- Membership in the large GIS developer community so you can collaborate via blogs and forums and on GitHub
- The new ArcGIS Developer Program Essentials plan subscription

New Developer Subscription Plans

Developers who enroll in the ArcGIS Developer Program automatically receive the Essentials subscription plan. This plan lets you build, test, and deploy your applications with 50 monthly service credits and access to community support.

Four additional paid subscriptions—Enterprise, Premium, Professional, and Builder—are tailored to what developers do with the ArcGIS platform. The Enterprise plan comes with a major perk: registration for one of the annual Esri Developer Summit events in either Palm Springs; Washington, DC; or Europe. Table 1 relates subscription plans to types of development.

Whether you're building apps for the first time or are an experienced developer who wants to extend the ArcGIS platform, you can choose the subscription plan that best aligns with your current development skills and business objectives. These plans provide cost-effective access to the suite of ArcGIS developer products so you can enhance, supplement, and complement ArcGIS platform capabilities or build complete industry-focused solutions. Learn more about it and sign up today at developers.arcgis.com/pricing.

Plan	For developers who
Enterprise Plan	Build solutions that perform advanced analysis and provide high-end cartography
Premium Plan	Extend the ArcGIS platform with a complete set of GIS editing capabilities
Professional Plan	Automate tasks and create new functionality in ArcGIS Enterprise and ArcGIS Desktop
Builder Plan	Kick-start app development using configurable apps and builders such as Web AppBuilder for ArcGIS and AppStudio for ArcGIS

↑ Table 1: A guide to picking an ArcGIS Developer Program paid subscription plan

Jump-Start Your ArcGIS for Developers Subscription

Are you a GIS professional new to app development or a developer new to GIS tools? Esri DevLabs (developers.arcgis.com/labs/) was designed just for you. You can learn how to build an app in 15 minutes by working these brief, free, highly focused tutorials or labs.

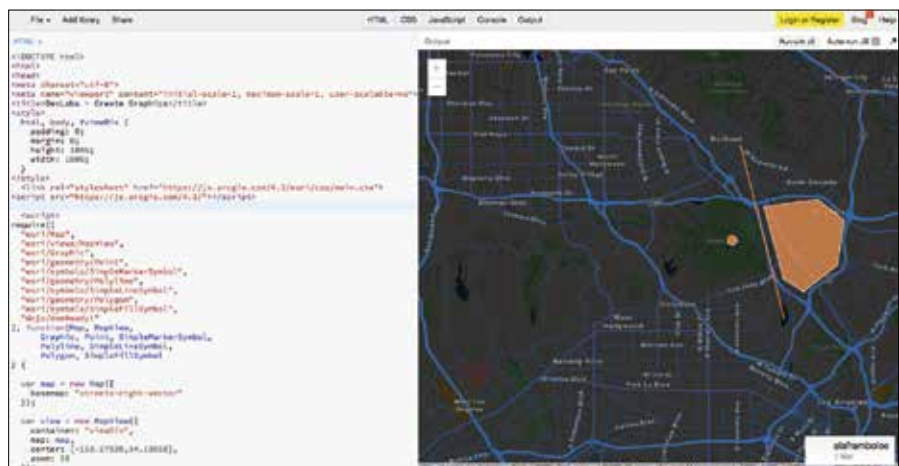
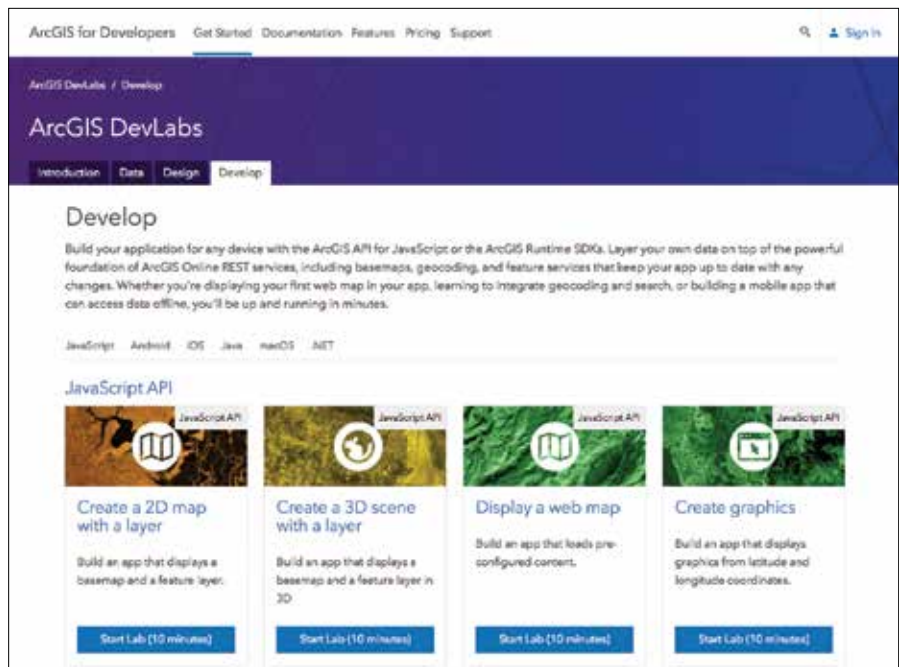
These short labs guide you through the data, design, and development aspects of app development with ArcGIS tools. They work with the Essentials, Builder, Professional, Premium, and Enterprise ArcGIS Developer subscription plans. You can use the data that comes with each lab or use your own data.

The Data section labs show how to import, create, and manage data; enrich datasets; and perform spatial analyses to create new data. The Design section labs show how to create effective mapping apps that make use of great cartography, smart mapping, and efficient workflows.

In the Develop section labs, you will learn how to build apps for any device that layers your data on top of a foundation of ArcGIS Online REST services that include base-maps, geocoding, and feature services that automatically keep your app up to date.

Labs cover importing data from an open data hub into the ArcGIS Online cloud, creating datasets for apps, discovering contributed data for the Living Atlas of the World and other sources, and creating mobile map packages in ArcGIS for offline use with mobile SDKs. You will learn how to create 2D web maps and 3D web scenes, style web maps, and configure pop-ups.

The Develop labs focus on how to use ArcGIS API for JavaScript or ArcGIS Runtime SDKs to create 2D and 3D scenes



↑↑ Esri DevLabs lets you learn how to build apps through short, focused tutorials.

↑ A solution for one of the Esri DevLabs on using the ArcGIS API for JavaScript.

with layers, build apps that can search for locations and find addresses, and create apps to reach private layers that require login credentials. Individual labs are available for the JavaScript API, Android SDK,

iOS SDK, Java SDK, macOS SDK, and .NET SDK.

Visit [38 au Spring 2017 \[esri.com\]\(http://esri.com\)](http://Esri DevLabs (developers.arcgis.com/labs) today to start learning.</p></div><div data-bbox=)

Keeping Up and Getting Better

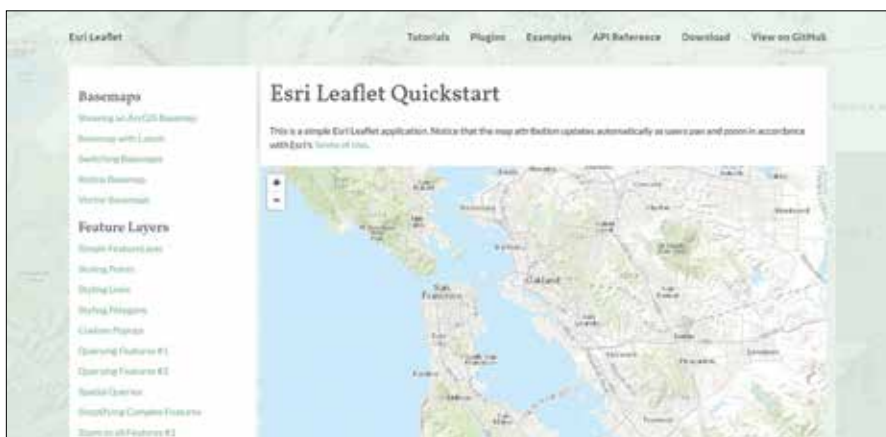


↑ Follow Esri GeoDev on Facebook and other social media to find out about local events near you.

The pace of change in technology—especially geospatial technology—is brisk and accelerating all the time. The Esri Developer Summit (DevSummit) will return to Palm Springs, California, March 6 through 9, 2018, but here are some things you can do right now that will make you a more productive, informed, and connected developer.

Two articles in this issue tell you about free Esri resources you can take advantage of today. “New ArcGIS Developer Program Reflects the Way You Work” describes the new streamlined and customizable ArcGIS Developer Program that incorporates the best of the Esri Developer Network and the original ArcGIS Developer Program.

↓ Esri GitHub projects, like this Esri Leaflet Quickstart, are a great way to learn more about tools and interact with other developers.



“Jump-Start Your ArcGIS for Developers Subscription” tells you how Esri DevLabs can help you instantly take advantage of your ArcGIS Developer Program subscription through short, focused tutorials that cover working with data, designing apps, and using the ArcGIS API for JavaScript, ArcGIS Runtime SDK for Android, ArcGIS Runtime SDK for iOS, ArcGIS Runtime SDK for Java, ArcGIS Runtime SDK for macOS, and ArcGIS Runtime SDK for .NET.

Attending local Esri developer events, coding socially, and following Esri developer accounts on social media are three ways you can get more done as a developer, connect with other developers, and become more successful.

Esri hosts GeoDev Meetups held in dozens of cities in the United States. These tech socials bring geospatial app developers together to demonstrate apps, share ideas (often through Lightning Talks), and connect with other developers over appetizers and beverages. Developers in each state can join regional GeoDev Meetup groups.

GeoDev HackerLabs, four-hour tutorial sessions led by Esri developers, will teach you how to build geospatial apps with ArcGIS Online, open-source data, ArcGIS API for JavaScript, and AppStudio for ArcGIS. You just need a computer, a text editor, and either an ArcGIS for Developers or ArcGIS Online organizational account. The 2017 GeoDev Meetups schedule includes GeoDev

HackerLabs and GeoDev Meetups (esri.com/events/geodev-meetups).

Join others in the ArcGIS developer community on GitHub. The Esri site (github.com/esri) on GitHub has hundreds of open-source projects. You can participate in or explore these projects or simply download and use them. These repositories contain apps, libraries, templates, datasets, and tutorials. Coding socially can be enjoyable and enlightening, but even if you don't contribute code, examining source, logging and tracking issues, and discussing enhancements can be valuable.

Follow Esri GeoDev feeds on Instagram, Facebook, and Twitter. This is a great way to meet others, share knowledge, and stay current throughout the year. All Esri DevSummit events have feeds on Instagram, Facebook, and Twitter, so watch for the #devsummit hashtag to get conference news and announcements. Don't forget to visit the Esri YouTube channel to view the plenary and technical session videos from the 2017 DevSummit.

Four Friends Head for Careers as GIS Developers

↓ (From left to right) Marzena Koziak, Alicja Kujda, Anna Kuryłowicz, and Karolina Mamczarz. Photo courtesy of Katie Decker, Esri.

Four young developers who attended the Esri Developer Summit (DevSummit) held in Berlin, Germany, in December 2016, shared their experiences and feelings about their work in GIS and geospatial development.


The four—Karolina Mamczarz, Anna Kuryłowicz, Marzena Koziak, and Alicja Kujda—recently obtained engineering degrees from AGH University of Science and Technology in Kraków, Poland, and are active members of the Dahlta Scientific Association of Surveyors.

Apart from their academic work with GIS, they find that GIS helps them in daily life. They use an app to plan trips on public transit. With another app, they check air quality in Kraków. The app shows data from monitoring stations deployed throughout the city in graphs, maps, and descriptions and helps them decide if staying outside for a long time will be a good idea.

The women explained their backgrounds, what drew them to GIS, why they attended the DevSummit, their areas of interest, and their plans and dreams.

Karolina Mamczarz is from Rzeszów, the capital of Subcarpathian Voivodeship in southeast Poland. She graduated with an engineering degree from AGH University of Science and Technology in Kraków, Poland, and is currently a graduate student in the Mining Surveying and Environmental Engineering department specializing in geometrics. Her “adventures” in programming started when she began preparing her engineering thesis,





which will focus on cartographic generalization. She most often uses Python in her work and is interested in the automation of data acquisition and processing and the creation of GIS web apps.

Mamczarz was excited when she learned the Esri DevSummit would be held in Berlin, not far from where she lived. She wanted to attend not only to learn how GIS is evolving but also to present her latest project on geoprocessing solutions. She wanted the opportunity to become part of the GIS community and connect with other people who shared her development interests.

Mamczarz has a passion for cartography that began when she was a child. "One of my favorite activities was to lead my finger on the maps that I had at home," she said. In school, she participated in several orienteering competitions. Those events, combined with geography classes, made her realize how important spatial information is in daily life.

When she got to the university, she learned to use ArcGIS to map environmental phenomena. "It gave me so much joy to create my own maps and later some custom geoprocessing tools," said Mamczarz.

In her free time between lectures, she works at a local company in Kraków. Her work relates to geoinformatics. She uses her skills in lidar data classification and GIS

development, performing spatial analysis and automating data processing.

Her work with GIS spans nearly four years. Faculty at her university encourage students to carry out research projects using GIS tools. She became proficient with ArcGIS through web courses and seminars offered by Esri. Mamczarz found online learning resources informative and feels they "introduced me properly to start thinking like a geospatial analyst."

As a person who constantly wants to learn something new, she has been reading to improve her Python skills and has been taking advantage of online tutorials and web courses to learn JavaScript, HTML, and CSS so that she can learn how to create her own applications. She also takes Esri massive open online courses (MOOCs).

She sees a future that will be shaped not only by opportunity but also by self-improvement. In that future, she might be a geospatial data analyst for an international company or government organization or a front-end/back end geoapps developer

delivering new GIS tools to the community. "If it is my destiny, I may even start my own business with friends," said Mamczarz. No matter what she does, she plans on using programming and project management skills that she will continue to develop.

Anna Kuryłowicz, originally from central Poland, now studies and lives in Kraków. Her field of study is land surveying, and she is in a graduate program pursuing a specialization in geoinformation that focuses on photogrammetry and environmental remote sensing. Her passions are photography and old maps.

Kuryłowicz believes GIS is a tremendous tool for disseminating information, and she loves interesting solutions that use

GIS. That is why she decided to attend the Esri DevSummit in Berlin. She came to the summit to learn new things about GIS, and she was not disappointed. Kuryłowicz also presented her work at the summit, and the feedback she received has helped her extend her project.

The first time Kuryłowicz saw a web map, she was enthralled. She traversed the world virtually for hours. She couldn't imagine then that she would be using web maps every day. Kuryłowicz marvels that "GIS is our everyday life," and thanks to her field of study, she can create new GIS applications that improve lives.

She has been working with GIS for nearly three years. Her university studies have provided a lot of GIS training as well as many opportunities to develop related interests through participation in online courses and scientific associations. She has

taken advantage of these resources since her second year in the program and participated in interesting scientific projects as well as completing additional courses.

She keeps up-to-date with GIS news through reading GIS blogs and is interested in Esri conferences that let her learn about new developments in the software. She hopes to work with her friend, Marzena Koziak, on a project. With that in mind, she is learning Python and taking Esri online training seminars.

"In the future, I would like to have a job, which will be my hobby," said Kuryłowicz. She wants to work in GIS and make use of her experience in photogrammetry and remote sensing and looks forward to continually developing her skills.

Marzena Koziak, also from Poland, currently lives in Kraków where she is studying geomatics at AGH University of Science and Technology. Before attending the university, she competed in volleyball. Her adventures in GIS started on GIS Day three years ago at an event organized by one of the universities in Kraków. Her areas of special interest are GIS analysis and connecting GIS with various other fields such as history.

She wanted to discover new solutions and learn about new GIS software at the Esri DevSummit in Berlin. In addition, Koziak wanted to present her project to others in the field and gather feedback from them that would help her develop the project.

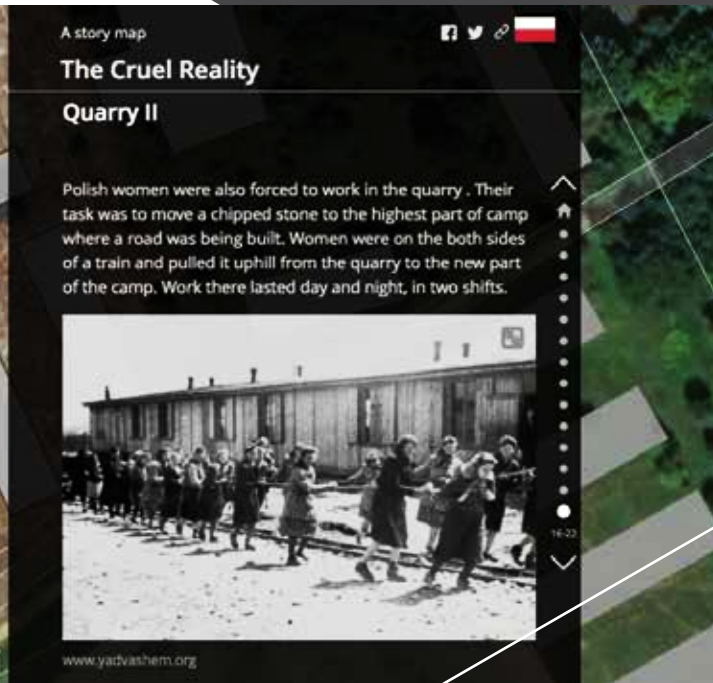
Like Kuryłowicz, her fascination with GIS began with web maps, and their subsequent development as tools for navigating, investigating, and virtually sightseeing far exceeded her initial expectations. She observed that by creating new GIS applications, "we can make everyone's life easier."

Her university curriculum has given her many opportunities to develop interests through online courses and scientific associations. She has participated in some interesting scientific projects and completed many additional courses.

To expand her skills, Koziak is focusing this year on improving her knowledge of and proficiency with Python. She is also doing more work on a project about the history of a former German Nazi Concentration Camp called Płaszów. She created an Esri Story Maps app describing her work on this project called *The Cruel Reality*, which is hosted on ArcGIS Online.

Looking to the future, Koziak wants to work for a company that develops innovative GIS applications in a cooperative team setting where she can focus all her attention on her work.

Alicja Kujda, who lives in Kraków, is interested in GIS analysis and programming languages such as Python. She hopes to create



GIS tutorials for everyone and tools for performing cartographic generalization. In her spare time, she loves cooking and swimming.

For Kujda, the question was not why attend the Esri DevSummit but why not. Esri is her favorite company, and the summit was close to her home and about things that interest her. Also, she could meet people from the GIS community from all over the world and find out how GIS solutions are changing industries in other countries.

The combination of maps, analysis, and informatics technology encompassed by GIS led her to study it. Kujda cares about the things GIS does: It makes life easier, creates web maps, and serves community needs.

When she was a child, she devised solutions for improving everyday processes that were often based on math. She knew she wanted to work with huge amounts of data, analyze that data, and make beautiful presentations. Her study of GIS for the past four years has been a way to learn how to do the things she has wanted to do since she was a child.

Her university studies have given her many opportunities to learn about the rapidly changing developments in GIS technology and work on team projects. Kujda has also taken the online training and web seminars offered by Esri. She believes that,

↑ Marzena Koziak's Esri Story Maps app, *The Cruel Reality*, is about her project on the history of a former German Nazi Concentration Camp called Płaszów.

to be successful in GIS or any field, "you have to work at home, use various solutions, and be hardworking. It is worth it, for sure."

She is currently a graduate student specializing in geomatics at AGH University of Science and Technology and will receive her master's degree this year. Her thesis is focused on using Python with GIS. To prepare for this work, she is reading books from the university library and ones she finds on the Packt Publishing website. She is constantly taking new Esri online courses.

Kujda hopes to work for an international company in a position that will let her use her GIS and developer skills, especially her programming skills. She wants a job as a geospatial analyst or geoapps developer working on a team in which all members are valued and contribute. She believes this kind of job will require continuous self-improvement and soft skills. In addition to working in GIS, she wants to have a GIS blog and "help others understand the importance of GIS in our lives."

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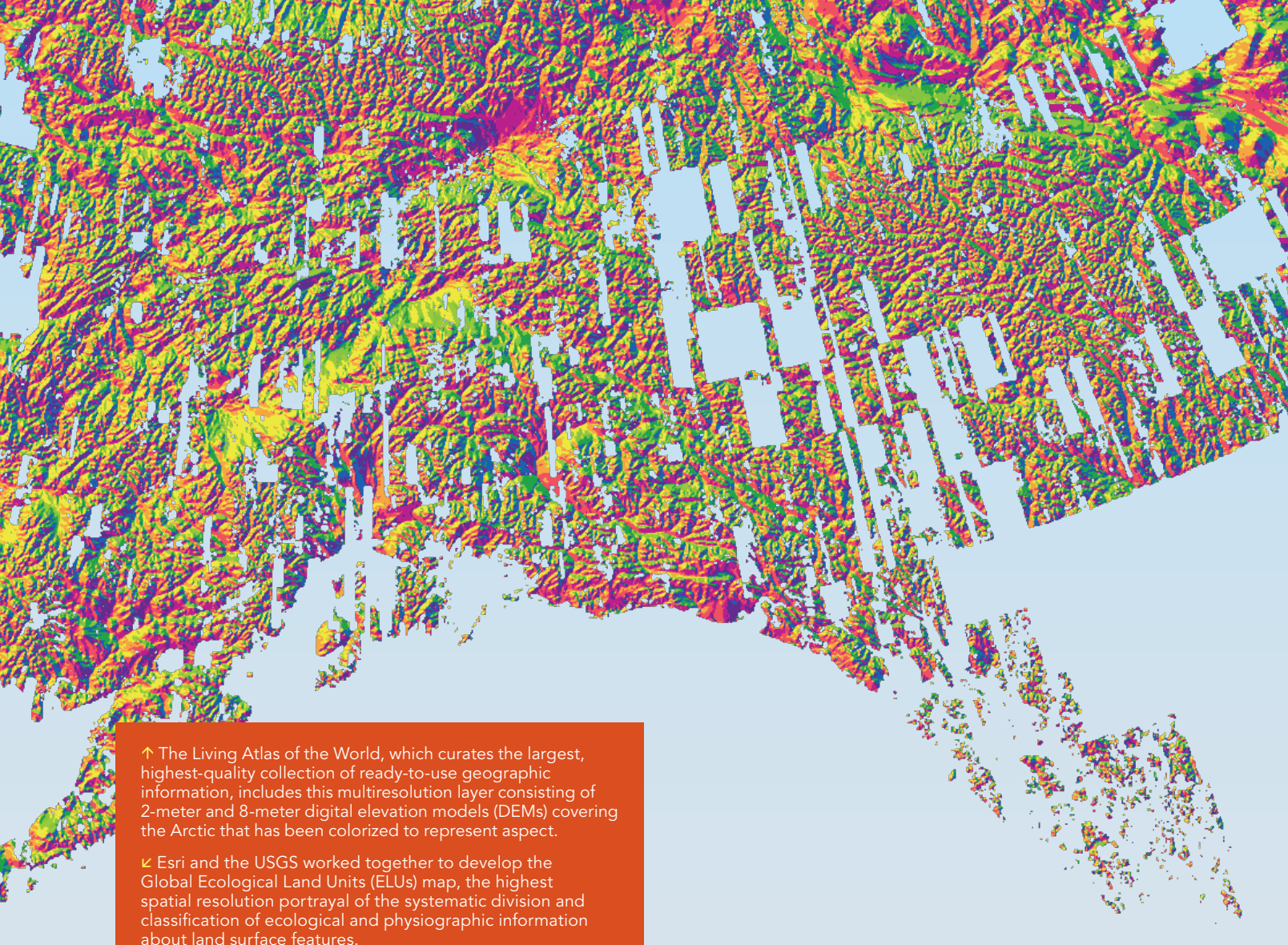


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↑ The Living Atlas of the World, which curates the largest, highest-quality collection of ready-to-use geographic information, includes this multiresolution layer consisting of 2-meter and 8-meter digital elevation models (DEMs) covering the Arctic that has been colorized to represent aspect.

↙ Esri and the USGS worked together to develop the Global Ecological Land Units (ELUs) map, the highest spatial resolution portrayal of the systematic division and classification of ecological and physiographic information about land surface features.

Esri's technology has always been grounded in science.

Dawn Wright, Esri chief scientist, summarized the company's many-faceted relationship with science. "Science at Esri continues to evolve on many exciting fronts as we focus on supporting both basic and applied science while also recognizing that there are many major themes of compelling interest to society that will drive scientific research for the next several decades." She noted that Esri views science not only as a way to understand how the Earth works but also to understand how the Earth *should* look through the application of geodesign principles and to understand how we *should look at* the Earth through the lens of datasets that are developed, documented, analyzed, and modeled.

Esri has a long history of creating geospatial tools that are particularly helpful to scientists who are expanding fundamental understanding in many fields of scientific study. Ocean science, conservation biology, ecology, sustainability, climate science, forestry, agriculture science, geology and geophysics, hydrology, and geographic information science are areas of scientific inquiry that Esri has extensively supported through the development of specific tools.

Beyond enhancing basic scientific research, Esri's GIS tools promote fact-based decision-making and enable effective stewardship of natural resources, protection of life and property, and promotion of economic vitality.

An ever-expanding arsenal of spatial analysis tools available in ArcGIS Pro and ArcMap assist scientific inquiry such as space-time pattern analysis and mining using the Space-Time Cube tool, raster segmentation and processing, additional 3D functionality and visualization of lidar datasets, and pairwise feature processing. ArcGIS is a comprehensive platform for using imagery. Robust management and processing tools improve the accessibility and usability of data sources.

Access to high-quality, accurate, and current data is essential to scientific work. In addition to supplying a comprehensive platform for creating, managing, integrating, modeling, and sharing users' data, Esri has been continually expanding the data it furnishes to users from the Digital Chart of the World (DCW), created in 1992, to today's Living Atlas of the World.



Esri has always sought to provide access to authoritative maps and datasets on a global scale. The basemaps it provides through ArcGIS Online eliminate the nontrivial task of generating foundational datasets for mapping operational layers of interest to scientists. The Living Atlas of the World, available through ArcGIS Online, provides easy access to the largest, highest-quality collection of ready-to-use geographic information that has ever been assembled. This collection is available from any device, anywhere, at any time and is constantly growing and changing as maps, apps, services, and layers are added or updated by Esri and the ArcGIS user community.

The *World Imagery* map, which receives several billion map requests each month, is the most popular basemap provided by Esri on the Living Atlas. Available online as a tile service hosted by Esri and on-premises through the Data Appliance for ArcGIS, it provides a natural-color, multiscale image map of the world built from the best available sources. The *World Imagery* map can be used for many applications including visualization, data collection, and offline mapping.

As part of Esri's constant efforts to improve the scope, currency, and usefulness of the data in the Living Atlas of the World, a new multiyear partnership with DigitalGlobe was announced at the 2016 Esri User Conference. DigitalGlobe provides high-resolution imagery to update large parts of the *World Imagery* basemap. Through this partnership, Esri has access to DigitalGlobe's flagship basemap products to provide submeter resolution imagery for the United States, western Europe, Australia, and several hundred large metropolitan areas and 1-meter imagery for other parts of the world and will update this imagery periodically to improve the image quality and currency. During the first year of this partnership, Esri and DigitalGlobe will

update approximately 90 million square kilometers of imagery in the *World Imagery* map.

Standards and Open Source

ArcGIS tools support standard scientific processes and integrate well with other platforms and programs thanks to Esri's longstanding support of standards and interoperability. ISO TC 211, Open Geospatial Consortium (OGC), and more than 100 other geospatial standards are supported by the ArcGIS platform, resulting in direct read, import, and export capabilities for more than 300 data and service formats. The ArcGIS Runtime SDKs and APIs that let developers build and deploy native applications to popular platforms and devices are all open.

ArcGIS integrates with two of the most popular scientific software packages: R and Python. The R–ArcGIS Bridge lets developers create custom tools and toolboxes that integrate ArcGIS and R and let ArcGIS users incorporate R into their workflows without having to learn the R programming language. As a member of the R Consortium, Esri will continue to work with the R community to increase analysis capabilities across multiple disciplines.

Python, the scripting language for ArcGIS, has been part of the ArcGIS platform ecosystem since ArcGIS 9.0. The strong and diverse Python community includes many scientists who may not consider themselves programmers but who use Python—like GIS—to get their work done.

In 2014, ArcGIS was integrated with the SciPy stack, a collection of modules that perform functions useful to the scientific and engineering communities and are also the basis for other packages focused

on applications such as deep learning and Bayesian statistics. The use of Python with ArcGIS has expanded with the integration of the Python Spatial Analysis Library (PySAL) and the introduction of the ArcGIS API for Python.

A powerful, modern, and easy-to-use Python library for performing GIS visualization, analysis, and spatial data management, the ArcGIS API for Python provides access to big data tools programmatically and popular and powerful Python packages for data analysis. The Python netCDF4 library has been added so netCDF, the most popular scientific community format for multidimensional data, can be directly used. It also can automate GIS system data management and administration tasks interactively or through scripts.

Esri participates in open-source development though incorporating and contributing to more than 200 open-source projects and hosting more than 350 Esri open-source projects on GitHub. Through GitHub, a social network for programming, Esri promotes development and collaboration in the creation of open source software. The Esri repository contains hundreds of projects as well as resources for troubleshooting and concept samples.

Communicating Science

For the most part, policy makers and the public are not trained in science but can greatly impact the funding of science and the application of scientific findings to policy decisions. GIS is not only a valuable tool in conducting scientific studies but can also be invaluable in communicating science.

↪ NOAA uses Esri Story Maps apps to communicate its scientific research.

↓ ArcGIS provides 3D tools for visualizing proposed developments that are an important aspect of geodesign.

Esri Story Maps apps were developed as information products for making complex concepts and data comprehensible. Scientific organizations are finding story maps to be exceptionally effective tools for communicating the value of their research activities.

The National Oceanic and Atmospheric Administration (NOAA) website hosts a gallery of story maps that explain topics from the scope of its current hydrographic surveys to the impact of the ocean and Great Lakes economies.

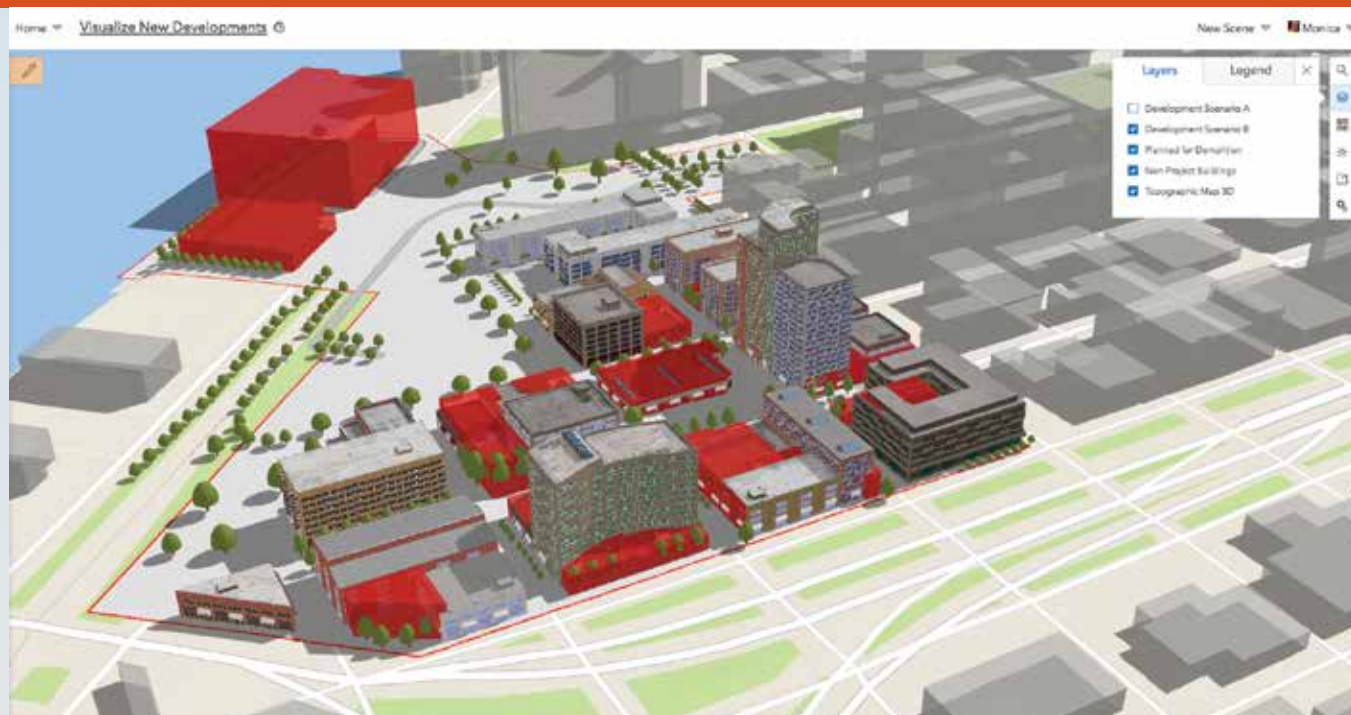
The United States Geological Survey (USGS) uses story maps to transform its reports into interactive information products that bring the science—and the stories behind the science—alive through maps, photos, videos, graphs, and charts. These story maps communicate benefits of the varied and vital work done by USGS.

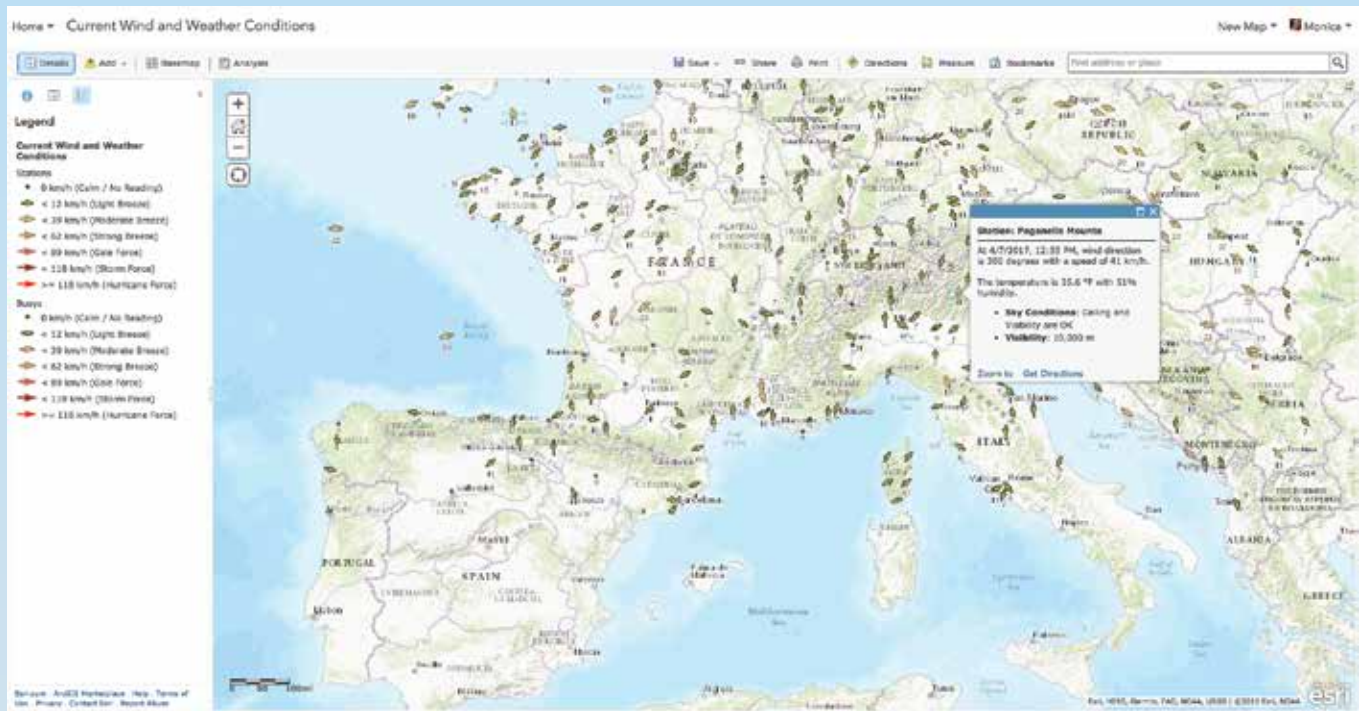
Story maps are also being widely used by educators to teach lessons that promote science, technology, engineering, and math (STEM) education. The University Corporation for Atmospheric Research (UCAR) Center for Science Education uses Esri Story Maps apps as part of its science education curriculum for K–12 students, education technology, undergraduate education efforts, and school and public programs.

Doing Science with Esri

Beyond its work in developing the platform, tools, and data to support scientific work, Esri itself has sought to do good science because science underpins the company's work. To this end, Esri works with scientists from many academic, government, and nongovernmental organizations. Recently it has closely collaborated on two global projects that provided a research framework for land and ocean.

Esri and USGS worked together to develop the Global Ecological Land Units (ELUs) map, the highest spatial resolution portrayal of





the systematic division and classification of ecological and physiographic information about land surface features. Released in 2014, layers from this map are freely available from ArcGIS Online.

The global map of Ecological Marine Units (EMUs), released in September 2016, was commissioned by the Group on Earth Observations (GEO) and created through an innovative public-private partnership. That partnership was led by Esri and the USGS in collaboration with NatureServe, the Marine Conservation Institute, the University of Auckland [New Zealand], GRID-Arendal [Norway], Duke University, the Woods Hole Oceanographic Institution, the National Institute of Water and Atmospheric Research (NIWA) [New Zealand], NOAA, and the United States National Aeronautics and Space Administration (NASA). (See “The First Global, Data-Driven, and Truly 3D Ocean Map” in the winter 2017 issue of *ArcUser*.)

Esri is currently involved in many other projects; here are just a few of them.

Esri’s statistical design teams will be consulting with Distinguished Professor Noel Cressie and his research group at the Centre for Environmental Informatics, University of Wollongong, Australia, on a range of development projects in areas including geostatistics, space-time pattern mining, R statistical software integration, and statistical clustering algorithms to optimize Esri ecophysiological, ecological marine, and world population layers.

In its collaboration with 52 North, Esri has worked on projects to facilitate the interoperable processing of sensor data and improving spatial data infrastructures. (Read about this work in “Sharing Geoprocessing Tools Via the Web” in the Fall 2016 issue of *ArcUser*.)

Working with the NCAR’s GIS Program, Esri is helping develop web services to add climate data in netCDF format to the Living Atlas of the World to support the NCAR Community Earth System Model (CESM). NCAR is also working with Esri on LearnGIS (learn.arcgis.com) modules.

Organizational Representation

As members of numerous scientific boards and councils, Esri staff members are working on committees to accomplish short- and long-term strategies for the research, education, and application of science related to government, academic research, data stewardship, and technology standards.

This is just a sampling of the organizations that have Esri representatives: NOAA Science Advisory Board, the Department of Commerce Data Advisory Council (CDAC), US Census Bureau Census Scientific Advisory Committee (CSAC), the National Geospatial Advisory Committee (NGAC), the Vespucci Initiative for the Advancement of Geographic Information in Science, the Federation of Earth Science Information Partners (ESIP), committees and the board of directors of OGC, the Scientific and Technical Advisory Board of 52 North, Liaison Team service plus advisory roles on three funded projects of the National Science Foundation (NSF) including the EarthCube Initiative, the International Cartographic Association, the Consortium for Ocean Leadership, the Science Advisory Council of the Conservation International, and the National Science Teachers Association.

Esri staff members publish their scientific research in scholarly journals. The Esri_Pubs group on zotero.org is a repository of peer-reviewed publications and related materials by Esri staff members. Some Esri staff also hold editorial positions. Kenneth Field is the editor in chief of *The Cartographic Journal*, and Dawn Wright is an associate editor for *Marine Geodesy*.

Supporting STEM Education

The ConnectED initiative, launched in 2013 by then-US president Barack Obama to make American schools more technologically savvy, has been supported by Esri from the beginning. Esri founder and president Jack Dangermond offered ArcGIS Online to every public, private, and home school in the United States for free. Since

← Live feeds, such as this wind and weather condition data, are available in the Living Atlas of the World.

then, approximately 4,000 schools have activated ArcGIS Online accounts and downloaded hundreds of thousands of the GeoInquiries lessons produced by Esri.

In 2016—after investing more than \$40 million—Dangermond pledged continued participation in ConnectED through 2019, offered ArcGIS Online for free to 300 primary and secondary schools and vocational institutions in 10 European Union member states, and launched ConnectED programs for schools in Australia and New Zealand. Esri supports the American Association of Geographers' efforts to recruit GeoMentors and pair them with schools and teachers around the country. Along with corporate support for STEM education, Esri products, such as Collector for ArcGIS and Survey123 for ArcGIS, enable citizen science projects.

Connected with the Scientific Community

The Esri User Conference (Esri UC) has always been a venue for scientists to share the work they do with GIS. For the second year, the Esri UC will host the Science Symposium, a gathering designed to improve ties between Esri and the scientific community. Esri also hosts other events of special interest to scientists: Geodesign

Summits in Redlands, California, and Europe; the Health and Human Services GIS Conference; the Ocean GIS Forum; and the Esri Developer Summit.

In addition to annual events, scientists can connect online to get the most current information about the GIS science community and GIS technologies of special interest. The Science Group on GeoNet (geonet.esri.com/groups/sciences) hosts discussions related to scientific work, provides direct interaction with Esri staff, and answers to how-to questions.

Science topics are often the subject of posts to the *ArcGIS Blog* and *Esri Insider* blog (blogs.esri.com/esri/), and new developments in the use of GIS for scientific research are Tweeted out from these Esri Twitter accounts: @deepseadawn (Esri chief scientist Dawn Wright), @esriscience, @GISandScience, and @ArcUser.

Working with the Scientific Community

Esri is committed to continually advancing the underlying science of GIS, improving how it is applied through Esri GIS technology, and supporting scientists who use this technology to understand and solve the world's most important problems.

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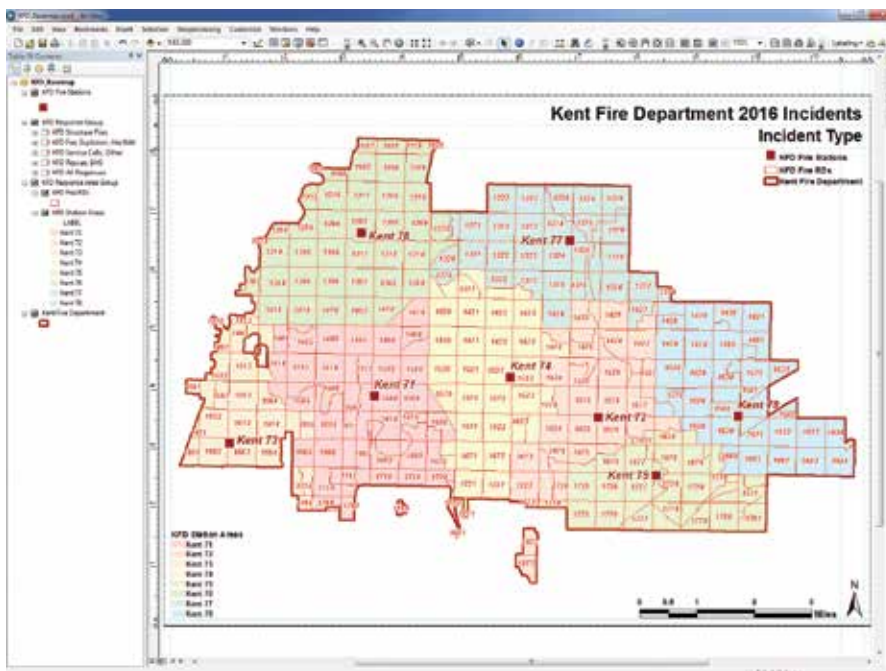
www.salisbury.edu/msgism

Managing Multiple Layouts in ArcGIS Pro

By Mike Price, Entrada/San Juan, Inc.

What you will need

- ArcGIS Desktop with ArcMap 10.4 or higher and ArcGIS Pro 1.4 licenses
- ArcGIS Online for organizations account
- Sample dataset downloaded from ArcUser website
- Basic ArcMap and ArcGIS Pro skills



← This tutorial starts with a map created in ArcMap that shows boundary and response information for the Kent Fire Department.

made and prepared as individual layouts for publication to response groups.

Getting Started with an ArcMap Document

To begin, go to the *ArcUser* website (esri.com/esri-news/arcuser), download the KFD_Pro_1 training dataset, and unzip it locally.

Start ArcMap and open KFD_Basemap.mxd. This map was created in ArcGIS 10.4 for Desktop and includes boundary and response information for the Kent Fire Department (KFD), located in southern King County, Washington.

This map includes one layout created in a custom 12-inch by 9-inch frame, an aspect ratio that exports as a 4-inch by 3-inch landscape graphic suitable for reports and Microsoft PowerPoint slides. It has been updated with 2016 titles and legends and includes several spatial bookmarks. In the table of contents, notice the broken data links to all response data. After you review this MXD document, close ArcMap.

Importing the Map into ArcGIS Pro

Verify that an ArcGIS Pro license is available to you through your ArcGIS Online for organizations account. Open ArcGIS Pro. If you are not already signed in to ArcGIS Online or Portal for ArcGIS, you will be prompted to sign in.

In the ArcGIS Pro startup screen, choose

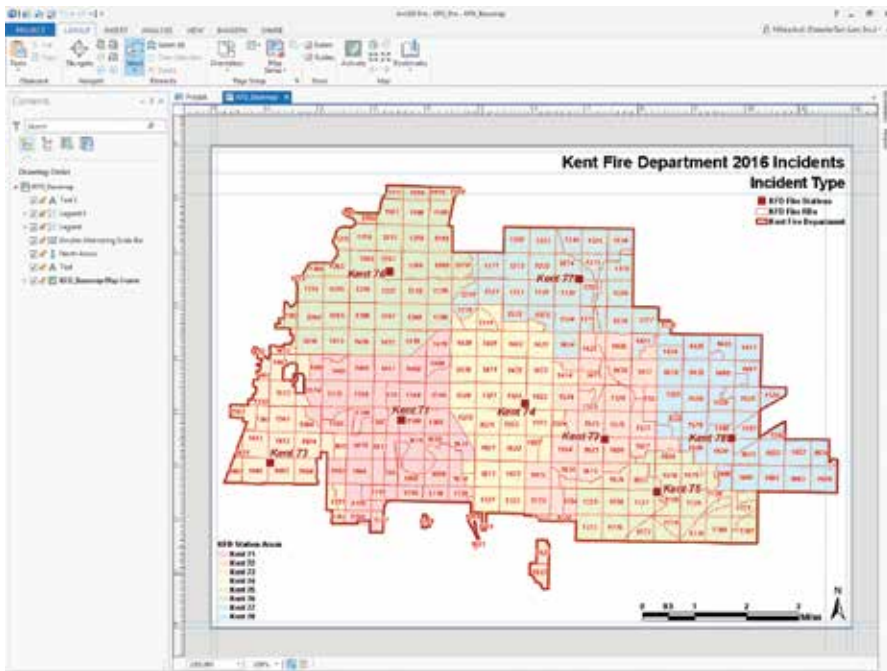
This tutorial will show how to create multiple layouts in ArcGIS Pro by importing an existing ArcMap document. Individual layouts will be exported as a series of PDF maps designed for printing, posting in reports, and viewing with presentation software.

ArcGIS Pro is a 64-bit, multithreaded application that runs on Windows and allows users to share maps with others using ArcGIS Online or Portal for ArcGIS. It readily imports existing ArcMap map documents (.mxd files), including symbology, project parameters, and layouts.

Exercise Overview

The first step will be to import a legacy fire

department incident response planning map that was previously created, updated, and managed in ArcMap into ArcGIS Pro. It was designed to report specific types of emergency responses. Data links will be updated to display current information using standard data grouping and symbology. Next, 2016 emergency response points will be added to the map from a Microsoft Excel worksheet. Multiple copies of this single layout will be



Project Pane to open the Project Pane on the right side of the workspace.

In the Project pane (not the Contents pane), expand Maps, right-click KFD_Basemap, and choose Open. The interface changes to the Map tab and the Contents pane shows how the layers are symbolized. All data sources to the layers in the KFD Response Group are broken, but don't worry about them. They will be fixed.

Before saving the project, add a basemap from the Living Atlas gallery. Click the Basemap drop-down. From the available basemaps, select OpenStreetMap.

← The original MXD file looks just the same after it is imported into ArcGIS Pro.

↓ Open the new project based on the imported ArcMap document using the Project pane.

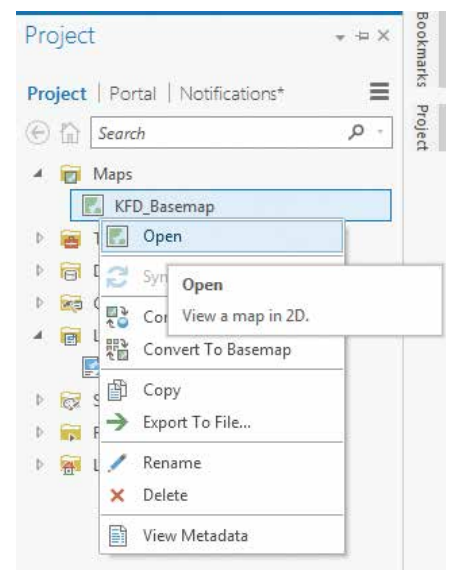
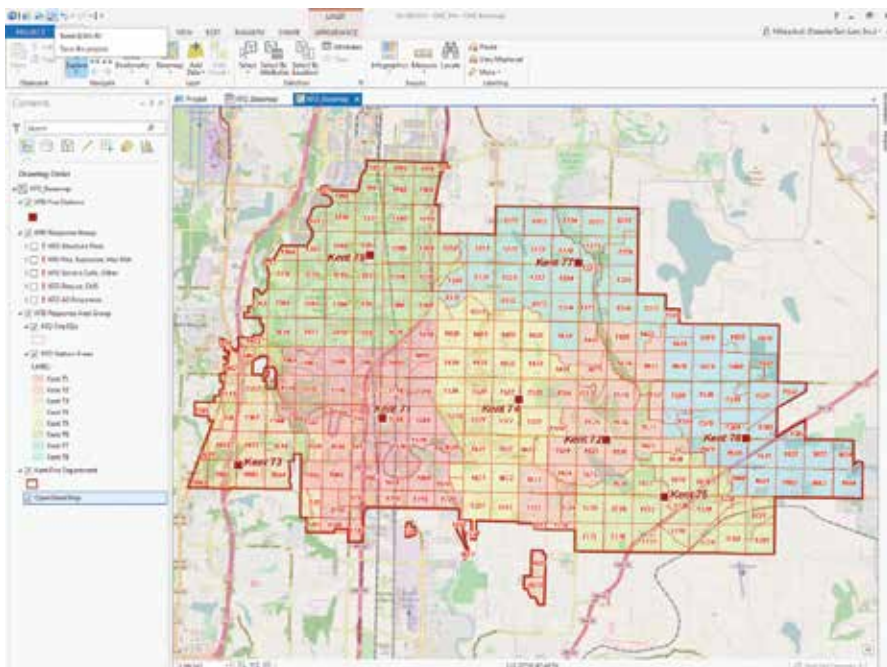
Create a new project and use the Blank template. Store the new project in \KFD and name it KFD_Pro. The new KFD_Pro folder is located at the same level as the GDBFiles (containing the data files) and XLSFiles (containing the incident data) folders.

Import KFD_Basemap.mxd into the project by clicking the Insert tab on the ribbon, selecting Import Map from the Map tab and

navigating to \KFD, and choosing KFD_Basemap.mxd. The imported map will look just like it did in ArcMap.

Look at the top of the Map pane to see the active KFD_Basemap Layout tab, which is highlighted in blue. On the left, the docked Contents pane shows the drawing order of items contained in the KFD_Basemap Layout. Click View tab and choose Project >

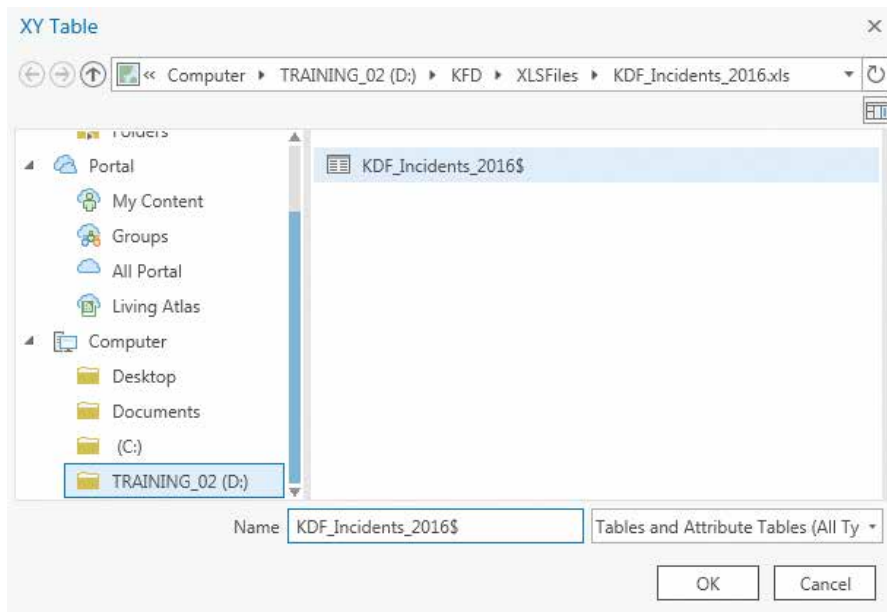
↓ After opening the map in the Project pane, the interface changes to the Map tab and the symbolized map layers are displayed in the Contents pane.



Click the Save button (third folder icon in the upper left corner of the interface), or press Ctrl+S to save the updated project.

Adding, Posting, and Exploring 2016 Incidents

An Excel worksheet, KFD_Incidents_2016, stored in KFD\XLSFiles, contains a training subset of the 2016 incidents for the Kent Fire Department. On the Map tab, click the Add Data drop-down (in the Layer group) and select Add XY Event Data. In the Make XY Event Layer pane on the right, click the



↑ Import the 2016 incidents from the Excel spreadsheet as an XY Event layer.

folder icon and navigate to KFD\XLSFiles. Open KFD_Incidents_2016 and select KFD_Incidents_2016\$.

X Field and Y Field should be automatically populated. If not, choose LonDec83 from the drop-down for the X Field and choose LatDec83 from the drop-down for the Y Field. The spatial reference will remain GCS_WGS_1984. Accept the default Layer Name. Click Run. More than 6,000 incidents will be added to the map.

Several bookmarks were created in the original ArcMap document and have been exported to the ArcGIS Pro project. Click the Bookmarks drop-down to view them. The KFD Basemap 1:65000 bookmark is set at the project's full extent. Other bookmarks show each station's primary response area at a larger scale. Test each bookmark before returning to the 1:65000 bookmark.

Return to the Contents pane, right-click the KFD_Incidents_2016\$ _Layer, and open its attribute table. Explore the contents. There should be 6,347 records, and the IncTypeNo field should contain three-digit integers that range from 100 to 999. This field will be used to filter and symbolize all members of the KFD Response Group. Close the attribute table.

Exporting and Updating Incidents

The incident data from the Microsoft Excel spreadsheet that was added to the project as an XY Event Layer will be used as the source for the Response Group layers.

Return to the Contents pane, right-click KFD_Incidents_2016\$ _Layer, and choose Data > Export Features. The Copy Features pane appears on the right side. Set the Output Feature Class to \KFD\GDBFiles\WASP83NF Risk.gdb and name the layer KFD_Incidents_2016_X.

In the Copy Features pane, click Environments. Click the drop-down for Output Coordinate System and choose

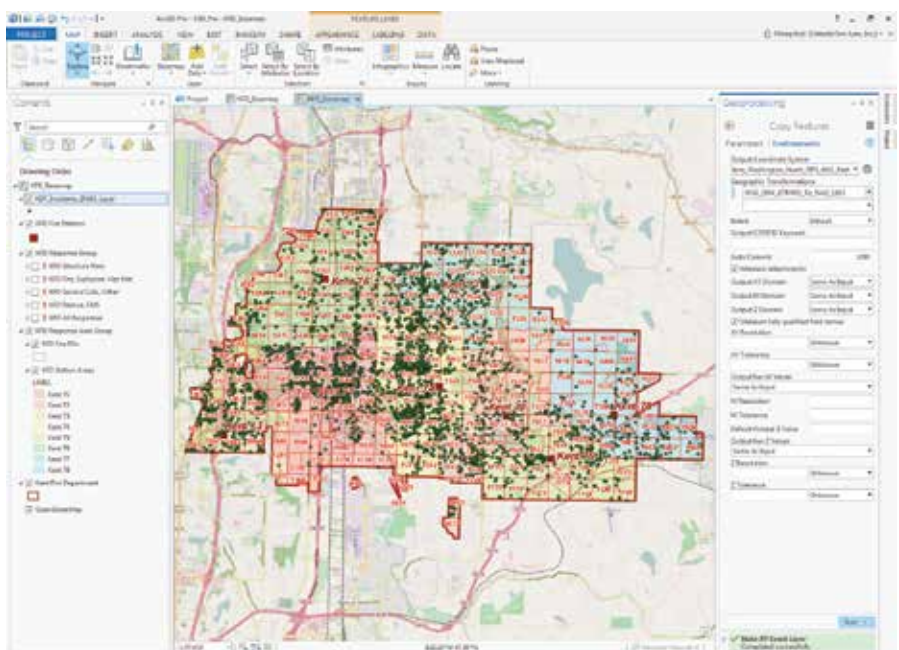
Kent Fire Department. Set the Geographic Transformation to WGS_1984_(ITRF00)_To_NAD_1983 (located near the bottom of the transformation list). **This is an important step!** Make sure the correct transformation is selected, accept the rest of the default settings, and click Run. After the resultant point layer is added to the map, turn off the layer and turn off KFD_Incidents_2016\$ _Layer.

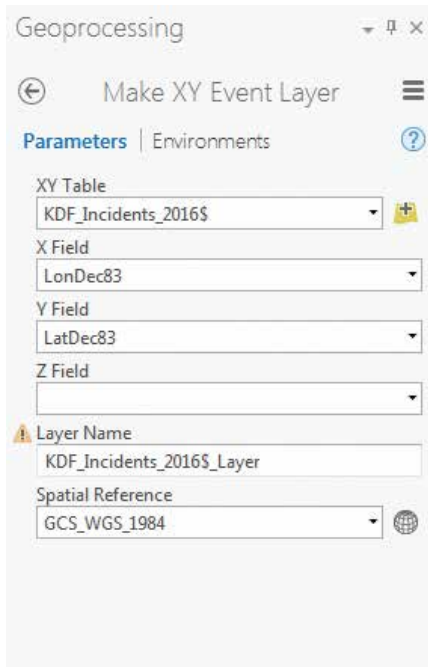
In the Contents pane, locate KFD All Responses layer in the KFD Response Group. Click the right-pointing arrow to expand its legend. Right-click this layer and open Properties. In Layer Properties, choose Source item and click the folder icon to set the source layer to KFD_Incidents_2016_X in the \KFD\GDBFiles\WASP83NF\. Click OK to update the source. Check the box to display the layer and note symbolized points.

Update the data sources for the remaining four layers in the Response Group using KFD_Incidents_2016_X as the source.

Save the map and use Bookmarks to explore individual Station Areas. Use the Bookmarks to explore the distribution of response types by station. Add more Bookmarks if you like. Explore different response types for several stations. Return to KFD 1:65000 when finished.

↓ In the Copy Features pane, make sure you set the Geographic Transformation to WGS_1984_(ITRF00)_To_NAD_1983 (located near the bottom of the transformation list).





↑ The XY Event layer retains the GCS_WGS_1984 spatial reference.

Creating, Updating, and Managing Multiple Layouts

In ArcGIS Pro, several layouts can be added to a project and used to map, characterize, and export specific data. Creating a template for the incident layout and then copying and pasting the template is the most efficient way to prepare a layout for each Response Group.

Click View tab and choose Project > Project Pane to open the Project Pane. In the Project Pane, expand Layouts (*not* Maps), right-click KFD_Basemap1 and select Copy. Right-click Layouts and choose Paste to add a copy with the default name of the KFD_Basemap. It will become the Incidents template. Right-click KFD_Basemap1 and choose Open.

KFD_Basemap1 becomes the current object displayed in the map canvas. The Contents pane switches to Drawing Order. In the KFD Response Group, make KFD All

Responses the only visible layer.

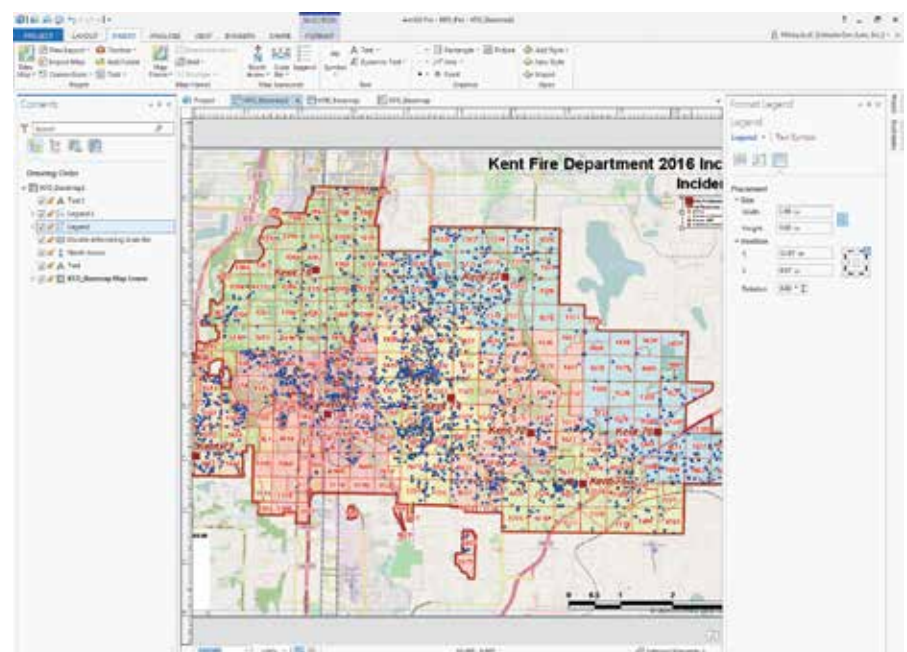
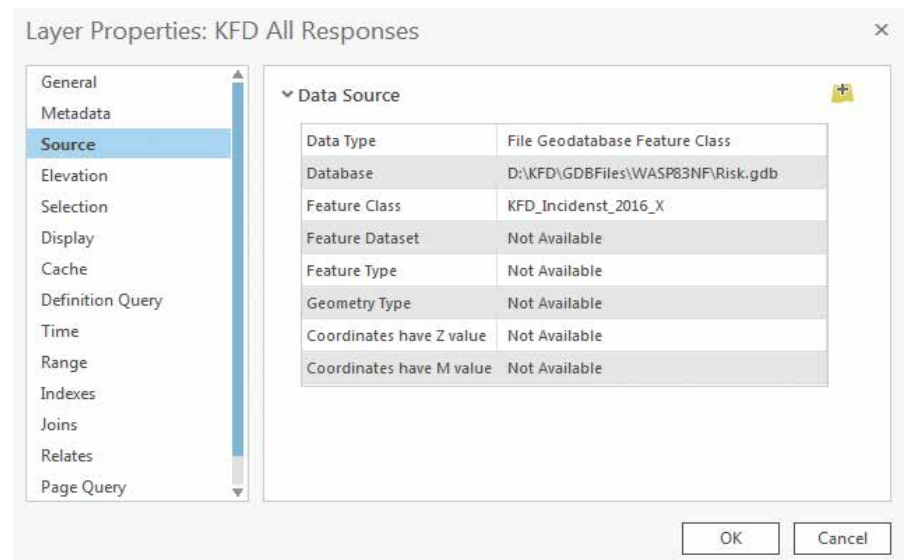
To change the way ArcGIS Pro resizes the default legend so it can properly display all Incident legends, locate and click the small default legend to select it. The default legend is located under the Incident Type title in the upper right-hand side.

Right-click Legend in the Contents pane (*not* the small legend you just clicked) and choose Properties, and the Format Legend pane appears. Hover over the three icons to locate the Legend Arrangement Options icon and click it.

Under Arrangement, click the Fitting Strategy drop-down. Change the strategy from the default, which is Adjust columns and font size, to Adjust frame.

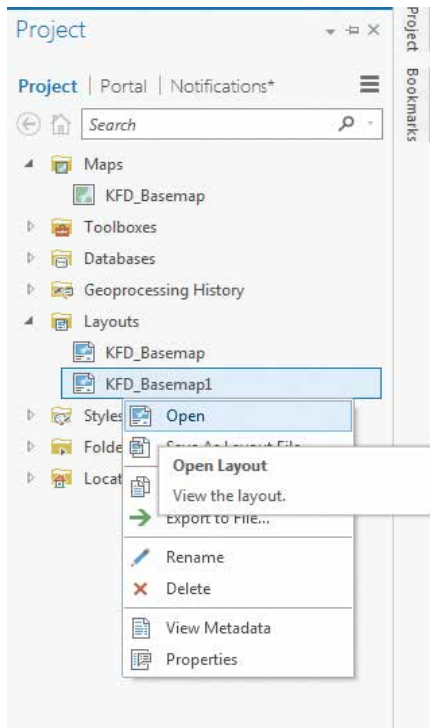
Hover over the icons in the Format Legend pane to locate Placement and click it. Open the rightmost Placement tool and verify that legend will be placed in the upper right corner.

Go back to the Contents pane and select Text 1, and the Format Text pane appears on the right side. In the Format Text pane, click the Options icon and change the contents of



↗ Repair the broken data sources for the KFD All Responses layer and other layers in the KFD Response Group by opening Properties for each layer and setting the data source to KFD_Incidents_2016_X.

↘ Change the way ArcGIS Pro resizes the default legend so that it can properly display all Incident legends in the Format Legends pane.



← After copying and pasting the KFD_Basemap layout, open it, change its title, and change the visible layers to reflect the title.

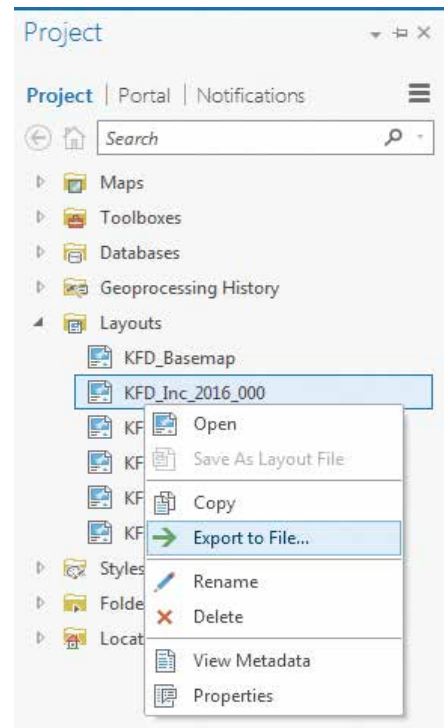
→ Export the finalized layouts as PDF files with embedded fonts.

Reopen the Project pane. Locate and right-click the KFD_Inc_2016_000 layout and select Copy. Right-click Layouts and select Paste. Right-click Layouts and paste the layout on your clipboard three more times. ArcGIS Pro will sequentially number the copies. When finished, save the project again.

Return to the Project pane and right-click KFD_Inc_2016_0001 (the first incident layout copied) and choose Open. Open the rest of the copied layouts. When all layouts are open, arrange them from left to right beginning with KFD_Inc_2016_000.

In the Project pane, under Layouts, right-click the KFD_Basemap layout and choose Delete. **Do not remove KFD_Basemap under Map.** Save the project again.

In the Contents pane, select KFD_Inc_2016_0001. Right-click its name, open Properties, and rename it KFD_Inc_2016_100. In the Contents pane, select Text 1, and the Format Text pane opens. Use Options on this page to change the title to Fire, Explosion, Haz Mat. Change the titles of the remaining three layouts using information in Table 1. Save the project.



the text box under TEXT from Incidents to All Responses and click Apply.

Return to the Contents pane, right-click the KFD_Basemap1 (at the top of the Contents pane) and choose Properties. The Format Map Frame pane appears on the right side. Click the Options icon. In the text box under General, change the layout name to KFD_Inc_2016_000. In this naming convention, 000 represents the National Fire Incident Reporting System (NFIRS) numeric range for all incident types.

In the Contents pane, change the display to Element type by clicking the second icon and turn off all layers in the KFD Response Group. Save the project.

Exporting or Printing Multiple Layouts

To export or print the layouts, individually activate each layout, update the visible KFR Response Group item, and export or print the layout. Begin by selecting layout KFD_Inc_2016_000 layout, click the Layout tab, and click Activate Map Frame for this layout.

Verify that this layout title is All Responses and in the KFD Response Group, and make KFD All Responses the only visible layer.

Open the Project pane, right-click layout KFD_Inc_2016_000, and choose Export to File. Navigate to \KFD and create a new folder called Graphics where the PDF files will be saved. Retain KFD_Inc_2016_000 as the name of the PDF, choose 200 dpi PDF file, and be sure that Embed Fonts is checked. Click Export to finish.

Use the same process to export PDFs for each of the remaining four layouts. Make the layer visible that matches the name of the layouts and accept the name of each layout for the PDF file name. Refer to Table 1 to

Copied Layout	New Title for Layout	Visible Layers for Layout	Filtered NFIRS Codes
KFD_Inc_2016_000	KFD_Inc_2016_000	All Responses	100 to 999
KFD_Inc_2016_0001	KFD_Inc_2016_100	Fire, Explosion, Haz Mat	100 to 299, 400 to 499
KFD_Inc_2016_0002	KFD_Inc_2016_110	Structure Fires	Selected 100 series codes
KFD_Inc_2016_0003	KFD_Inc_2016_300	Rescue, EMS	300 to 399
KFD_Inc_2016_0004	KFD_Inc_2016_500	Service Calls, Other	500 to 999

↑ Table 1: New titles and visible layers for layouts

select the visible layer for each layout. When all layouts are exported, save the project once more.

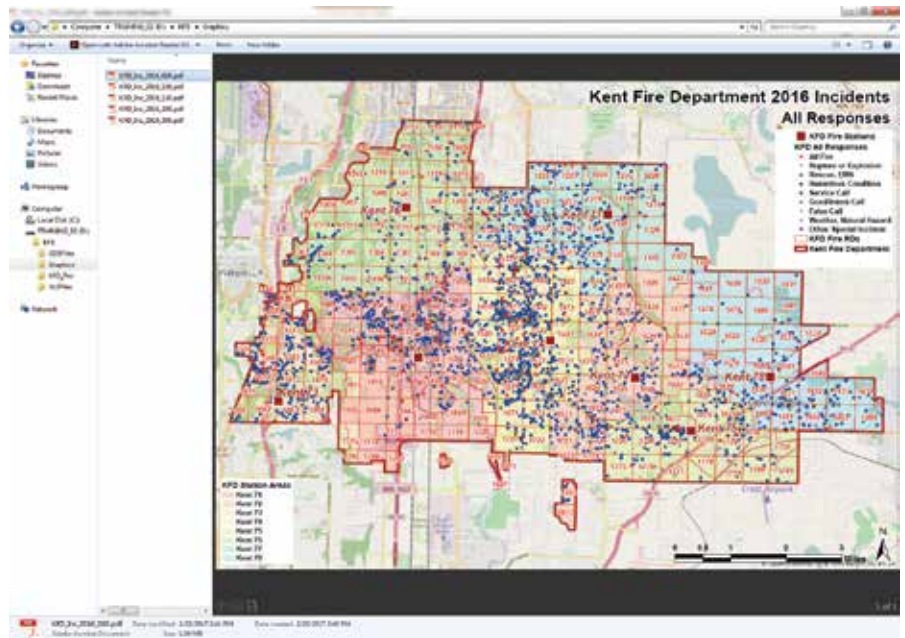
Inspect the exported files to ensure they have the correct titles and symbolization. Leave ArcGIS Pro and open Windows Explorer. Navigate to KFD\Graphics and view each exported map in preview mode, Acrobat Reader, or another program that displays PDF files.

Summary

In this ArcGIS Pro exercise, you learned how to import an existing ArcMap map into ArcGIS Pro, display and save point data with *x,y* coordinates, create multiple map layouts, and export maps as PDF files. You can use this project to experiment with other export and printing options. You can capture screenshots of the layouts and use them in a Microsoft PowerPoint presentation.

Acknowledgments

Again, special thanks to the Kent Fire



↑ Open the exported PDF files in Acrobat Reader or another viewer to check them.

Department for allowing me to use its great data and include a subset of very recent incident data. Thanks also to Esri technical

staff for their advice and support as I move into the world of ArcGIS Pro. Stay tuned for more articles.

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How to Make Smart Color Choices in Your Maps

By Lisa Berry, Esri Cartographic Product Engineer

When creating a narrative around your data, you are the most valuable tool you have. Being conscious of which colors you use in your map is an important way to get the reaction you intend out of your audience. Color is a powerful instrument when mapping your data because it can help create clarity about your map's underlying message. Your color choices can make the difference between confusing—or convincing—your audience.

This quick guide introduces easy ways to tell captivating stories with your maps by using the color options in smart mapping. As you create your map in ArcGIS Online or Portal for ArcGIS, you have the opportunity to go beyond the smart mapping defaults to create a story centered around your knowledge of the subject and the data.

But how do you know which options to use? It's as easy as 1-2-3!

- 1 Plan it.
- 2 Basemap it.
- 3 Color it.

1 Plan It

This step is a mental exercise. It only takes a moment but can help you later when you are making color choices. Think of your map as the interface to your data. You have been tasked to create this interface, so it is important to be as clear as possible for your audience.

You want to relay an important message. Rather than just dump data onto the map, take advantage of color to tell your narrative. Really consider why you are making your map. Are you answering a question? Are you trying to convince someone to take action? Are you telling a story? Are you trying to learn something new?

No matter your purpose, make sure to take a step back as you make your color choices, and ask, what is this map telling me? When looking through the options, consider that certain colors like red might unintentionally trigger negative or strong emotions. Color can make people feel differently about your topic, so consider what you want your audience to feel when they look at the map.



↑ Only counties with above-average unemployment rates get a deep red color, which provides an easy distinction for the map reader.

2 Basemap It

Smart mapping will offer color ramps suitable for each basemap, so it is a good practice to choose your basemap first. It helps create context for your map, and it takes only seconds. You can choose from the Basemap Selector or the Living Atlas or use your own custom basemap. You can also apply transparency to your basemap and its reference labels to draw more attention to your data.

3 Color It

Smart mapping will automatically provide you with a map that uses a High to Low theme. This is a great way to emphasize the highest and lowest values in your data using a gradient of colors or two distinct colors (one for the highest and one for the lowest).

For example, if you were mapping annual average daily traffic on roads in the city of Des Moines, Iowa, the default High to Low theme would show roads with the most traffic using the darkest color in the ramp. Remember the first tip? Let's put it into action and plan the map. We can select one of the many color ramp options to change the roads from the default blue to a brown.

Another way to change the story being told by the data is to change the theme option to Above and Below. This focuses map symbology around a central value using color to show which features have values above or below the specified value. By default, smart mapping uses the statistical average of your data, but you can also adjust the center value to one you know is more meaningful for the map's subject.

Using the city of Des Moines example, to show which roads have above-average daily traffic, you could use the Above and Below theme to easily highlight this information. When using this technique, smart mapping provides color ramps that diverge into two different colors. The value you choose as the center value for your map will be the point at which the colors split, so you can easily see that the brown streets have daily traffic levels that are above average, while blue streets are below average.

Small adjustments can make a world of difference in your maps.

↓ If you were mapping the annual average daily traffic, the default High to Low theme highlights would show roads with the most traffic by using the darkest color in the ramp.



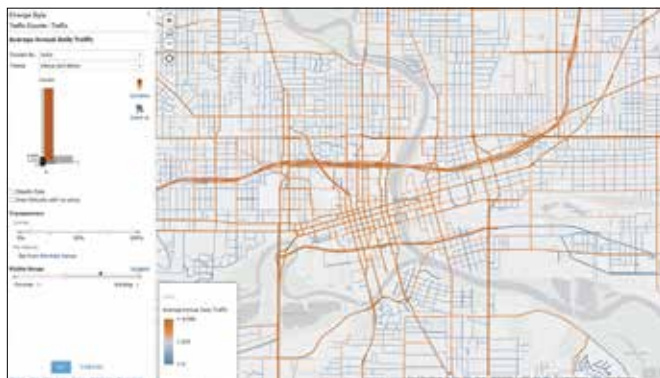
↑ Since smart mapping will choose a color ramp that will harmonize with the basemap, choose the basemap first.



While smart mapping can create a valuable default map for you, these basic tips can help you create more informative narratives using your knowledge of the data.

↑ Change the roads color from the default blue to brown.

↓ Use the Above and Below theme to show which roads have above-average daily traffic.



(and Want)

Why You Need Arcade

If you aren't yet familiar with Esri's new scripting language ArcGIS Arcade, you may be thinking, why do I need another scripting language?

The short answer is that you may not need Arcade, but once you find out all the nifty things you can do with this simple expression language, you are going to want to use (and reuse) it.

Arcade is not a full programming or scripting language for creating stand-alone apps. It is not a replacement for automation.

It is a focused, intuitive, and JavaScript-like language for creating expressions that customize visualization and labeling. Think of it more like a spreadsheet formula.

Because the ArcGIS platform is all about sharing—it runs on everything from desktops to mobile devices—coming up with an expression language that could run across the platform was challenging. To run on mobile devices, the language had to be lightweight. It also had to be secure. Some fully functional scripting languages introduce security issues.

To meet these requirements, Esri developed Arcade. Named for the covered passageway, not the video game haven, Arcade follows in the Esri tradition of naming scripting languages after streets and roads (like Avenue) and including an Arc in the name.

The result is a focused, secure, and portable language. An Arcade expression cannot be injected with executable code outside of its intended context. With Arcade, you can create expressions you can use without modification across the ArcGIS platform in ArcGIS Pro, ArcGIS Online, and applications developed with the ArcGIS Runtime SDKs and the ArcGIS API for JavaScript. For example, you could base visualizations off values returned from custom calculations in ArcGIS Pro, save them as web map items, and share those custom visualizations so that they can be consumed by other web, desktop, and mobile applications.

With Arcade, you can easily perform calculations with layer fields and use the result for label expressions or data-driven

visualizations. This means that when you are making a map and the layer you are using doesn't contain the exact attribute field you need, you can generate that data on the fly without editing source data, adding a field, or permanently calculating values.

With this capability, you can turn counts into percentages, derive new values from provided data, and otherwise turn the raw data behind your map features into information for your map reader. Arcade expressions can also set rendering properties such as transparency and rotation. This is especially useful for ArcGIS Online maps. Simply choose Change Style > New Expression, and construct your expression in the scripting window.

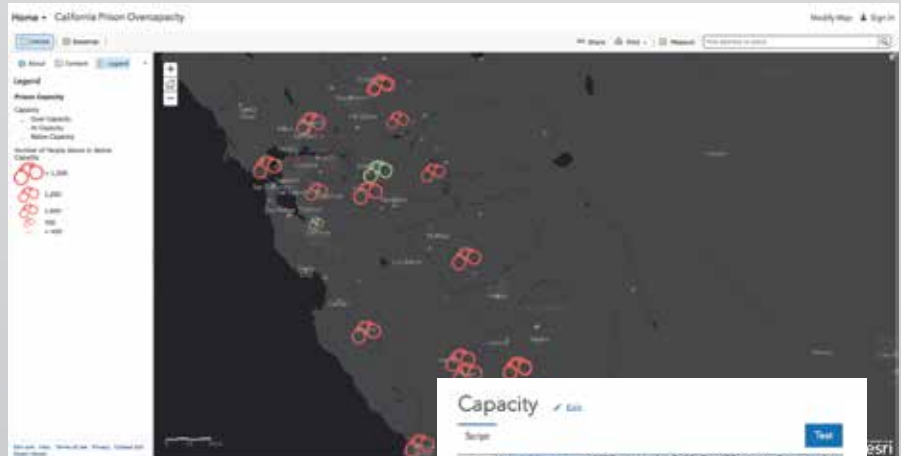
Arcade is purposefully simple. Instead of the many programming constructs found in other languages, it has a rich library of data, logical, mathematical, geometry, date, and text functions that make it easy to do complex calculations. The Arcade team at Esri will continue to extend the language with requested functions that meet use case needs.

Because it is case insensitive, it does not matter if you mix the case of variable and function names. Arcade's type system implicitly casts between types where appropriate using a predefined set of rules.

Use Arcade for single-line or multiline expressions. Either way, it will return the last statement even if the keyword *return* is not used (except in the case of custom functions). With Arcade, geospatial is a first-class citizen. Geometries can be created and referenced. Arcade has profiles for visualization, labeling, and alias. A profile is the context in which an Arcade expression is evaluated. Each profile expects different inputs and produces different outputs.

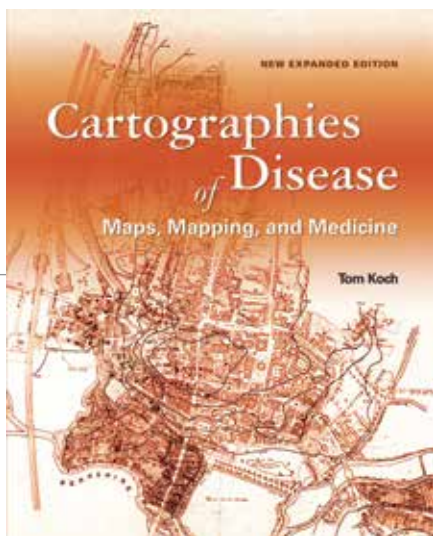
There are lots of resources for learning Arcade at developers.arcgis.com/arcade/. In addition to the guide and function reference, the site has a playground section for testing and fooling around with Arcade expressions. Visit the site today and start learning Arcade, a simple-to-write and quick-running language that will help you easily create more powerful information products.

↓ This map highlights prison overcrowding in California using color (red, yellow, and green) and symbol size to indicate the degree to which each prison is over, at, or under capacity.



→ This multi-line Arcade expression classifies prisons as below, at, or above capacity based on each prison's average daily population divided by the prison's capacity.

Putting Disease on the Map



The new edition of *Cartographies of Disease: Maps, Mapping, and Medicine* from Esri traces the long history of how maps have been used to help unlock the mysteries behind the cause and spread of diseases such as cholera, yellow fever, and Ebola.

When first published in 2005, *Cartographies of Disease* showed how maps could be an important tool for studying both chronic conditions and disease epidemics. It became a must read for policy makers and others working in public health and medicine. In this expanded edition, author Dr. Tom Koch adds new material to deepen readers' understanding of medical mapping from the seventeenth into the twenty-first centuries. The book covers the mapping of diseases and medical conditions.

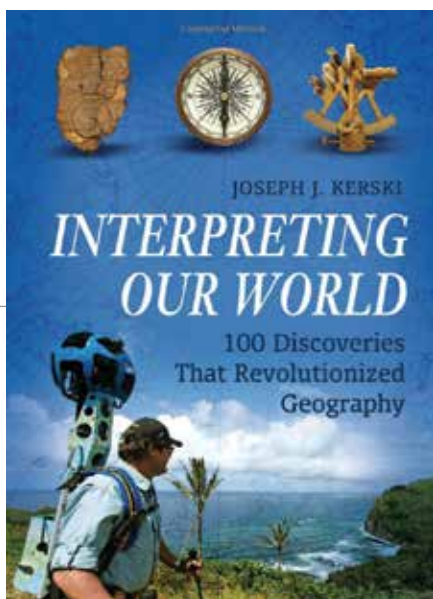
"*Cartographies of Disease* is a book about our confrontations with bacterial and viral agents across history," Koch wrote in the book's introduction. "It is also about how maps help us profile those conditions in our attempts to restrict them. Ebola in 2014 reminded us that it's urgent to understand

the conditions that promote disease and the ways we confront them on the ground."

The book provides a nontechnical narrative and a visual history of mapping's role in studying diseases: their causes, where and how they spread, and how they can be combated. In this new edition, Ebola is the focus of the two new chapters. Perceptions of the disease and reactions to it are mapped using contemporary technologies such as GIS. It includes more than 100 maps and charts, from a pair of 1694 maps of plague locations and containment zones in Bari, Italy, to digital maps of the 2014 Ebola outbreak, created using GIS.

Koch is a medical ethicist, gerontologist, and prolific author who is based in Canada. As an adjunct professor at the University of British Columbia, Vancouver, he developed a series of teaching labs for medical geography. He authored "Visualizing Disease: Understanding epidemics through maps," which ran in the spring 2011 issue of *ArcUser*. Esri Press, 2017, 412 pp., ISBN: 9781589484672.

GIS Bookshelf



Interpreting Our World: 100 Discoveries That Revolutionized Geography

By Joseph J. Kerski

Geography has suffered from a Rodney Dangerfield image in recent decades. It is the unsung science that has played a tremendous role in shaping the world we live in. The author, Joseph Kerski, uses stories of the pivotal discoveries, seminal figures, and concepts of geography from ancient to modern times to reveal the critical role geography has played in the development of civilization. *Interpreting Our World: 100 Discoveries That Revolutionized Geography* presents an unranked and nonchronological list that invites exploration. Though presented as a tool for educators, the format and the further reading list at the end of each chapter encourage any reader not only to appreciate the tremendous contributions of geography as a discipline but to pursue more

information about these fascinating topics.

Kerski is a geographer who teaches an array of courses at the primary, secondary, and university level in the classroom and via massive open online courses (MOOCs). Prior to becoming an education manager for Esri, he served for 22 years as a geographer and cartographer at the National Oceanic and Atmospheric Administration (NOAA), the US Census Bureau, and the US Geological Survey. He received a doctorate in geography from the University of Colorado, Boulder, and has authored, coauthored, and contributed to many books including *Spatial Mathematics: Theory and Practice through Mapping* and *The GIS Guide to Public Domain Data*. ABC-CLIO, 2016, 386 pps., ISBN-13: 978-1610699198

Hooked on Mapping

By Carla Wheeler, ArcWatch Editor



↑ Brenda L. Carter, GIS manager for the Planning and Development Services Department (PDS) for Richland County, South Carolina

In 1986, while Steve Jobs was creating a new workstation computer at NeXT and Dr. Leonard Baily was pioneering infant heart transplants at Loma Linda University Medical Center, Brenda L. Carter was 21 and on the cusp of a new adventure: computer mapping.

She and her friend had intended to go to medical school together after attending South Carolina State University. However, the tragic death of her friend altered Carter's plans to become a doctor.

Instead of going to medical school, she took a job in the Lexington County Planning Department in South Carolina as an addressing specialist for the new E-911 system. "They needed an addressing person to assign addresses and help with road naming," she said.

Carter's interest in medicine was soon supplanted by a passion for computers, mapping, and planning. "I could read the maps very

well, and I picked up everything they would teach me," she said. "And that was simply because I was so interested in the *[planning]* field. I was like a sponge." When Lexington County launched its first GIS in December 1988, Carter was selected for training on ARC/INFO 4.0, the new GIS software from Esri.

"The minute that I started with that software, I was hooked," said Carter, now 52 and the GIS manager for the Planning and Development Services Department (PDS) for Richland County, South Carolina. "It piqued my curiosity. The software helps you to provide important information in the decision-making process."

In the early 1990s, GIS helped her decide where a fire station should be built that would serve a community that included a new housing development. "GIS helped resolve the issue successfully using location allocation," Carter recalled. From that point, Carter had a new duty—finding the best locations for new fire stations in Lexington County.

Carter still answers important questions using Esri software. In 2016, she used ArcGIS for Desktop and the ArcGIS Spatial Analyst extension to create a green infrastructure plan for Richland County. "Richland County is growing. It's hustling and bustling," said Carter. "[*But*] we do want smart development." The Richland County GIS Initiative aims to protect environmentally sensitive areas of the county by acquiring land from property owners using conservation easements.

Carter made an Esri Story Map Journal app, "Green Infrastructure: The Richland County GIS Initiative," that summarizes the project. (Read more about this plan in "Green Infrastructure Plan Fuels Smarter Growth in Richland County," an article in the winter 2017 issue of *ArcNews*.)

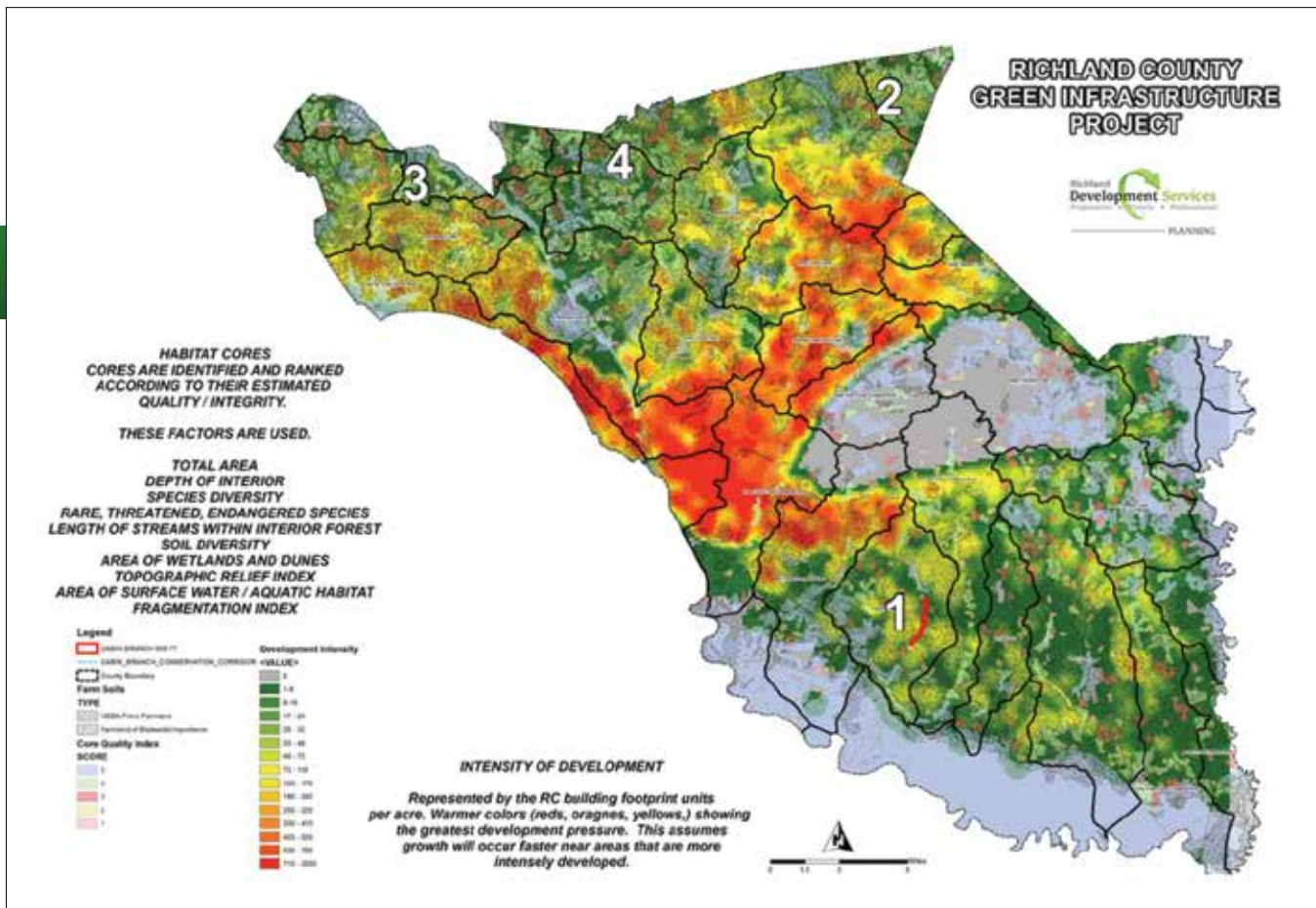
The AML Queen

Carter got her start in GIS in the early years of the computer mapping revolution. Esri released its first version of ARC/INFO in 1982. Lexington County adopted the software in 1989, just three years after Carter began doing addressing work.

The county only had one problem. "When we started, we had no geographic data. None. No layers," she said. "We literally had to create the first basemaps."

To do that, Carter had to learn how to code. Carter learned ARC Macro Language (AML), the scripting language that Esri created in 1986, to automate tasks and create custom applications in ARC/INFO. "This is old-school stuff," she said.

How did Lexington County get its data for the basemaps? "We



↑ The green infrastructure initiative currently serves as the only planning guideline for future development within Richland County.

digitized our road centerline sheets over our [orthoimagery],” she said. “I wrote an AML for everything we needed to do.” They digitized more than 10,000 parcels before the county assessor’s office contracted the project out.

Her colleagues were supportive, Carter said. “I worked with some great people,” she said. “My director at the time, Charlie Compton, allowed me all the time in the world to learn the software and read the manuals so I knew what to do. Cheryl Matheny was there to bounce ideas off of, and my dear friend John Kludo taught me the finer things of AML coding.”

After the data edits were completed in ARC/INFO, the basemaps took shape. Once the 567 individual maps were digitized, Carter wrote an AML script that brought each individual file, point, line and polygon together. “Boom, we had a countywide road centerline layer, we had a countywide easement layer, and so on,” said Carter.

Map production took off. “We printed out everything from subdivision maps and zoning maps to road centerline maps to easement maps to tax maps and special project maps,” she said. “You name it, we printed it.” Carter and her coworkers completed several projects.

By 1996, Carter was known as “the AML Queen of Lexington County.” She even won that year’s AML Short Cut Award in a contest that Esri sponsored. Her winning Freeze and Thaw scripts saved and restored map production settings in ARC/INFO. Her short scripts prevented settings from being lost and printing disrupted

when staff shut down their computers at night. “If you typed freeze, it would remember all your settings. When you came in the next morning and turned on your computer and typed thaw, it would bring all your settings back up and start you back right where you were,” Carter explained.

She Has Rural Roots

Today Carter is a certified GIS professional (GISP). She manages a small GIS and addressing team at Planning and Development Service in Columbia, South Carolina, the county seat for Richland County. However, her office is only about 34 miles from where she was raised in Batesburg-Leesville, a close-knit community with a population of about 5,400 people.

She grew up with four brothers and one sister. Carter was always interested in science and the outdoors. “My father liked fishing, and I loved to go, too,” she said. As a child, Carter loved nothing better than going down to a local lake or stream with a fishing rod in hand. She would bait her hook, cast out her line, and wait. “I loved to go fishing,” she said. “The worms didn’t bother me. My sister—that’s another story,” she said, laughing. There was something relaxing about being on the water and waiting for the big one,” Carter said.

Her father also taught her spatial awareness. He worked for a long time as a truck driver and always impressed upon his daughter that she should be aware of her surroundings. “When I was younger, I



↑ During the 2017 Geodesign Summit, Carter showed the audience her “Green Infrastructure: The Richland County GIS Initiative” story map, which outlines the plan’s goals and displays interactive maps that show the results of her habitat analyses.

didn’t read a map in the car. But when we would travel, my Dad would always say, ‘Read the signs so when you go somewhere, you will know how to get back out.’ So I was always about location, location, location,” she said. “To this day, if I go somewhere once, I can go back again.”

Carter said she later received formal training in map reading in a Reserve Officers’ Training Corps (ROTC) class at South Carolina State University. This training served her well when she applied to be an addressing specialist for Lexington County.

“One of the things you had to do during the interview was to find some locations on a tax map, so you had to be able to read a map,” she said. “I completed that part so fast, it was like a no-brainer for me, but I was told so many others couldn’t do it.”

Keeping It Rich Land

Carter was hired as the GIS manager at Richland County PDS in 2000. In the last 16 years, GIS technology has changed dramatically. ARC/INFO is long gone. So is AML.

While others might resist change, Carter is all for it. She said she always advocates for the use of the best, updated technology that will help the planning department do its job more efficiently. Recently she has been showing the department staff the advantages of Web GIS, including creating configurable apps using ArcGIS Online. She’s also planning to make more Esri Story Maps apps, which are good tools for sharing information with government officials and the public.

“Story maps are easy to use because they help ordinary people visualize important data in an intuitive format,” said Carter. “Story maps provide a nongeographic dimension to the data. If I show you a map, you may soon forget what that was all about, but if I tell you a story,

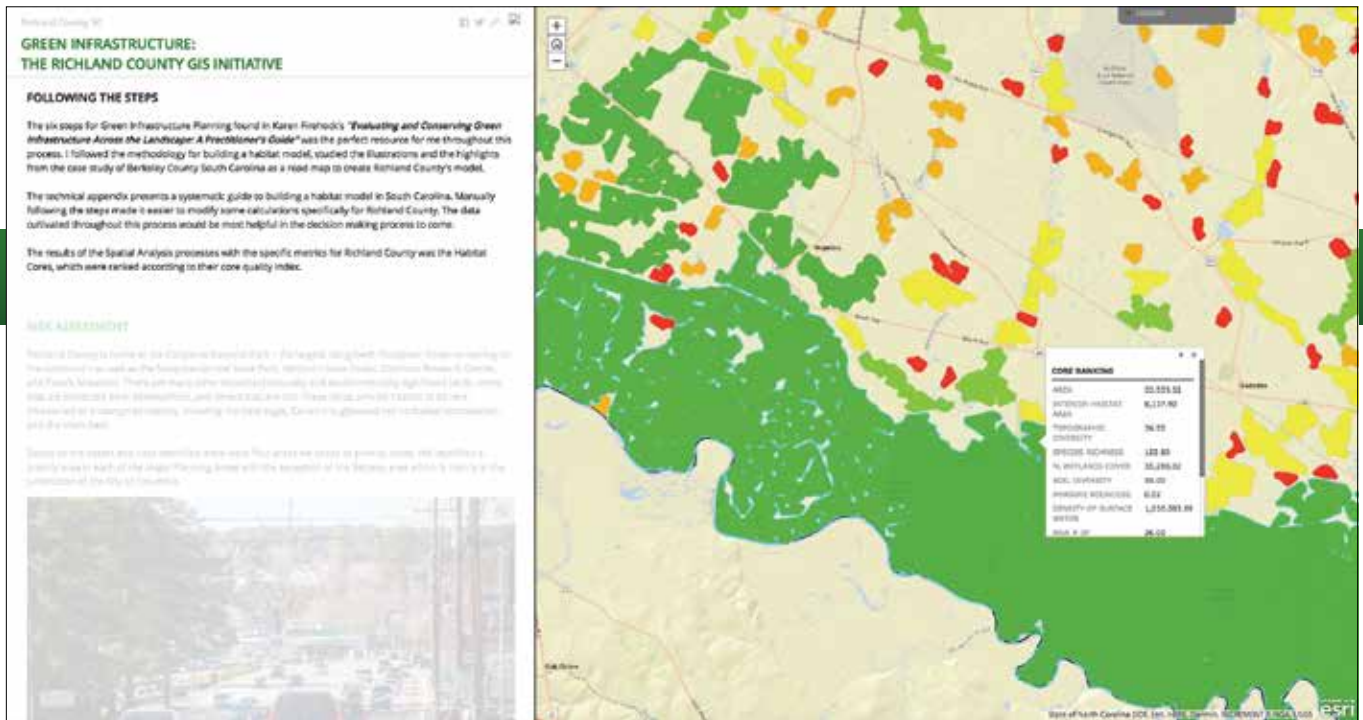
you are more likely to remember what the story was about. Telling stories about data is the way to grab and keep people’s attention.”

Carter gave a presentation on the green infrastructure project during the 2017 Geodesign Summit at Esri headquarters in Redlands, California, in January. She showed the audience her *Green Infrastructure: The Richland County GIS Initiative* story map, which outlines the plan’s goals and displays interactive maps that show the results of her habitat analyses. The story map lists four priority areas for future conservation, including Cabin Branch Creek south of Columbia, where Richland County has already bought land for preservation and plans to acquire easements from several property owners. The green infrastructure initiative currently serves as the only planning guideline for future development within the county.

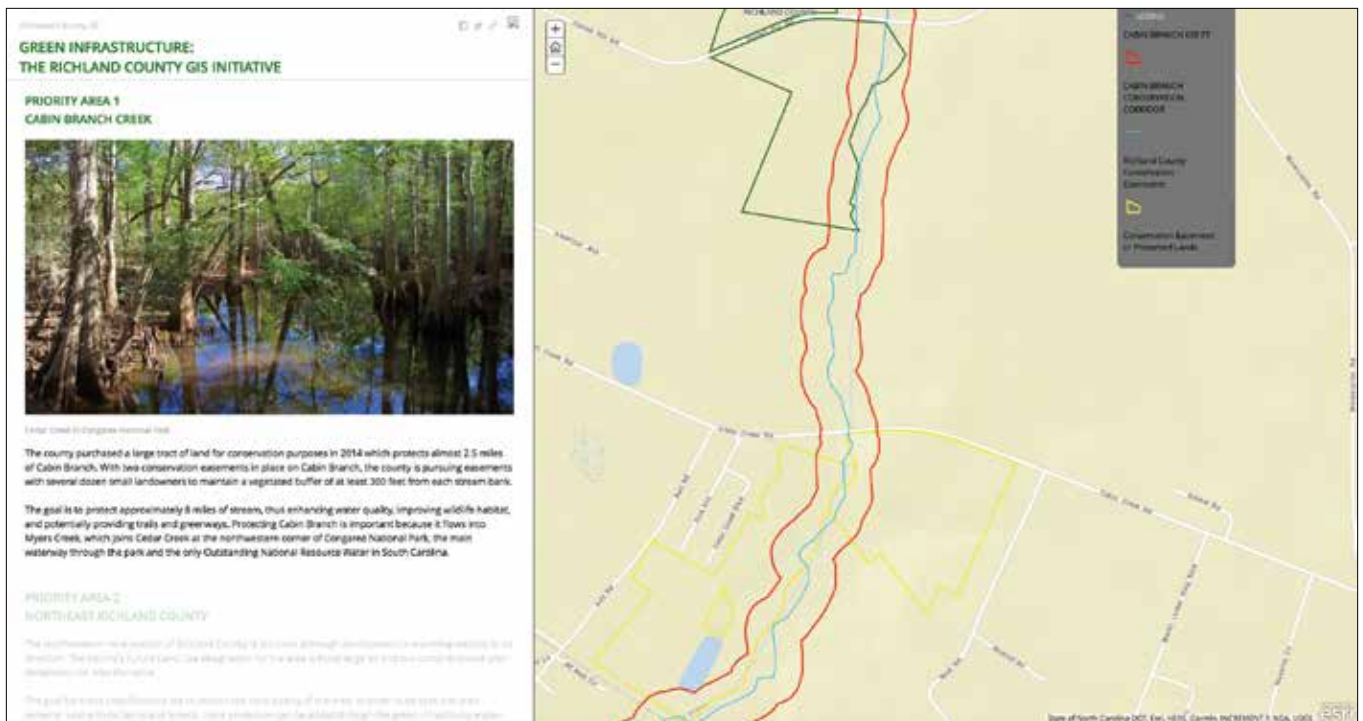
Carter was assigned to the GIS portion of the project in the wake of major flooding that wracked South Carolina in October 2015. Hurricane Joaquin brought torrential rains to the state. Columbia alone was doused with more than 12 inches of rain, while other parts of the state received more than 20 inches. About 160,000 homes sustained damage.

Earthen dams that people had built along streams to create ponds broke loose after days of rain, sending water downstream to low-lying areas. “You had little creeks that became big rivers that washed out roads and railroad trestles,” Carter said. “Bridges were completely washed out, and we had road closures.”

The damage sustained by homes built in the floodplains was the impetus for the green infrastructure project. Its goal—where possible—is to leave more areas along streams and in floodplains undeveloped to reduce the chances of flood damage to houses and infrastructure in the future.



↑ The green infrastructure project's goal is to reduce the chances of flood damage to houses and infrastructure in the future by leaving more areas along streams and in floodplains undeveloped.



↑ Priority Area 1 in North Central Richland County has wildlife corridors, wetlands, and endangered and threatened species.

In Richland County, named for its fertile soil that yielded crops such as indigo and cotton, agriculture has given way to development in recent years. Carter hopes the green infrastructure project will help South Carolina maintain some of the rural character that

marked her childhood—a childhood in which she fished, rode horses, and played in the woods.

“We want to grow,” she said, “but we don’t want to destroy our natural resources while we are growing.”



What Geographers Do

By Amanda Inniss Beck

Geography is an expansive discipline that covers the study of the physical environment and the world's cultures, economies, and societies. It helps us understand and appreciate our changing world. However, the field is often misunderstood and its impact underestimated. This article, which originally appeared in the Texas State University publication *Hillviews*, highlights the work of graduates from the largest geography department in the nation.

Most people know little about geography beyond what they learned in high school.

Dr. David Butler, who is a Texas State University System Regents' Professor, admits it can be frustrating when fellow field researchers ask if he studies capitals.

"Geography as a discipline is not a memorization of facts," he said. "It's about understanding the distribution of things on the landscape."

In 1996, Texas State University established its first doctoral program: geography.

Today, more than 100 geography students have received their doctorates. Since 2014, students select one of three areas of focus: geographic education, geographic information science, or geography. These areas replaced environmental geography and offer a greater breadth of study. Geographic studies span multiple disciplines but are usually organized into two categories: physical geography and human geography. The former focuses on landscapes, mapping, and the environment, while the latter includes urban and historical studies and public policy.

Throughout its 20-year history, the program has become well-known for its experts

← Texas State University graduate Jon Kedrowski owns a business that develops products and training for mountain enthusiasts. He is also a speaker, author, and geography professor. Kedrowski is shown on Everest in 2012. Photo courtesy of Sandra Leduc—Photosubmissions,CC BY-SA 3.0

→ Dr. Alberto Giordano is the chair of the Texas State University geography department.



in environmental geography, attracting faculty from renowned research institutions such as the University of California, Berkeley. As the university moves toward national research university status, programs such as its PhD program in geography will attract new faculty and additional students.

Dr. Alberto Giordano is the chair of the Texas State University geography department. Housed in the College of Liberal Arts, the department is home to 760 students, 52 of whom are enrolled at the doctoral level. The department's 36 full-time faculty members represent a wide range of disciplines within the field.

Giordano was just seven years old when he decided to become a geographer. After finishing a primary school project on the rivers of Russia, he fell in love with maps. He would spend hours looking at the shapes and names of places around the world—he wanted to explore. Giordano's three favorite interests as a child in Italy were soccer, reading, and looking at maps. He determined the last would be his career.

"What all geographers have in common," Giordano said, "is that they study place." But not just what a place looks like. Geographers ask questions. Why are things there? How did they get there, and why?

If you stop to think about it, there are myriad topics in the news that relate to geography. Environmental geographers might study how landforms affect weather and natural disasters such as hurricanes and wildfires. City zoning, gentrification, and migrant travel are issues that would interest human geographers. During election years, politicians use geographic data to communicate with voters. Experts in geographic information science work with software engineers to improve the GPS in smartphones.

"Geography runs in the background," said Dawna Cerney, an associate professor and chair at Youngstown (Ohio) State University who received her doctorate in environmental geography from Texas State University, San Marcos, in 2006. "We work in so many different fields with different monikers: analysts, planners, division leaders. You don't know who geographers are until you ask about their jobs."

About three-quarters of graduates from the doctoral program become college professors or join college faculties. Cerney notes that some of her students' families have a hard time understanding exactly what kind of career can result from a degree in geography.

For Todd Votteler, the doctorate he received in 2000 set him on a career path that led him to research and gave him an opportunity to effect local change. As executive manager of science, intergovernmental relations, and policy at the Guadalupe-Blanco River Authority, he handles scientific research projects and works with local governments to establish public policy. The geography of Central Texas makes water a major issue for environmentalists, politicians, and business owners. Because the authority's reach spans 10 counties, from



San Marcos down to the Rio Grande Valley, Votteler does quite a bit of traveling.

Jon Kedrowski takes traveling for work to the extreme. He is an accomplished mountaineer who has scaled (and camped out on) mountains around the world, from Colorado to Nepal. In 2011, he camped out on every 14,000-foot-high peak in Colorado and wrote *Sleeping on the Summits* (Westcliffe, 2012) about his experience. Kedrowski's adventures don't come without danger. The year he climbed Mount Everest in 2012 was one of the deadliest, and he witnessed firsthand the devastation of the earthquake in 2014.

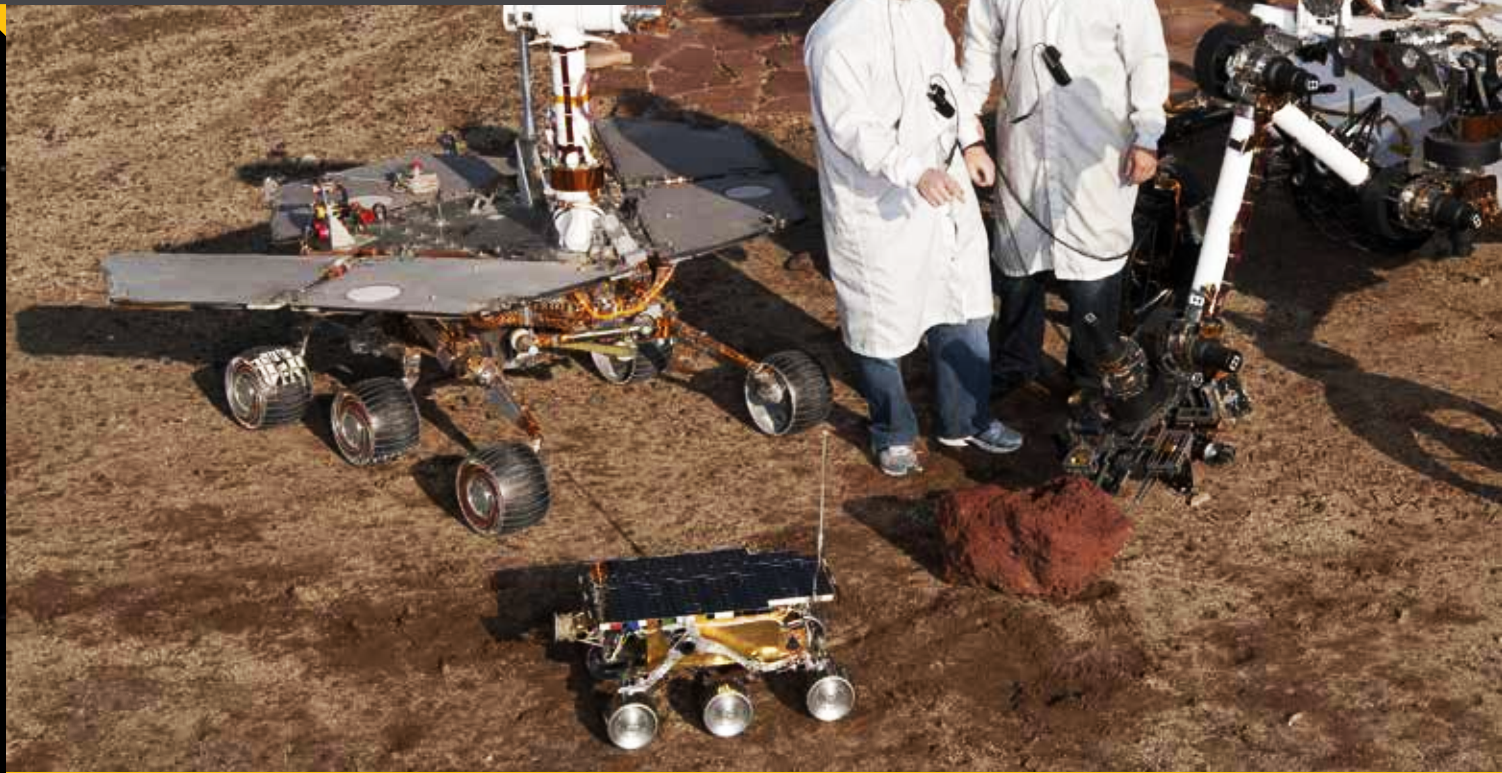
Kedrowski, who received a doctorate in 2010, based his business on his experience in geography. He applies his knowledge of mountain environments to developing new products, training other mountain enthusiasts, delivering inspiring speeches, writing books, and teaching the next generation of geographers.

If the study of place is the common thread that runs through all geographic research, passion is what drives all geographers. From Giordano's childhood research project to Kedrowski's desire to explore the world, geographers study the discipline because they love it.

About the Author

Amanda Inniss Beck is the principal and owner of Amanda Beck Creative, an integrated marketing communications company based in Austin, Texas. Her company works with nonprofit organizations, higher-education institutions, and companies that want to do cause marketing or corporate philanthropy. Beck has a bachelor's degree in English writing and rhetoric from St. Edward's University.

↓ A variety of Mars rover designs have been used to accommodate different terrains and ensure successful mobility. On the lower left, Sojourner was active during 1997. On the upper left, the Opportunity rover, which has remained active since 2004, shares the same design as the Spirit rover. The Curiosity rover, active since 2012, is shown in the upper right.



Finding the Best Paths for Rovers and Humans on Mars

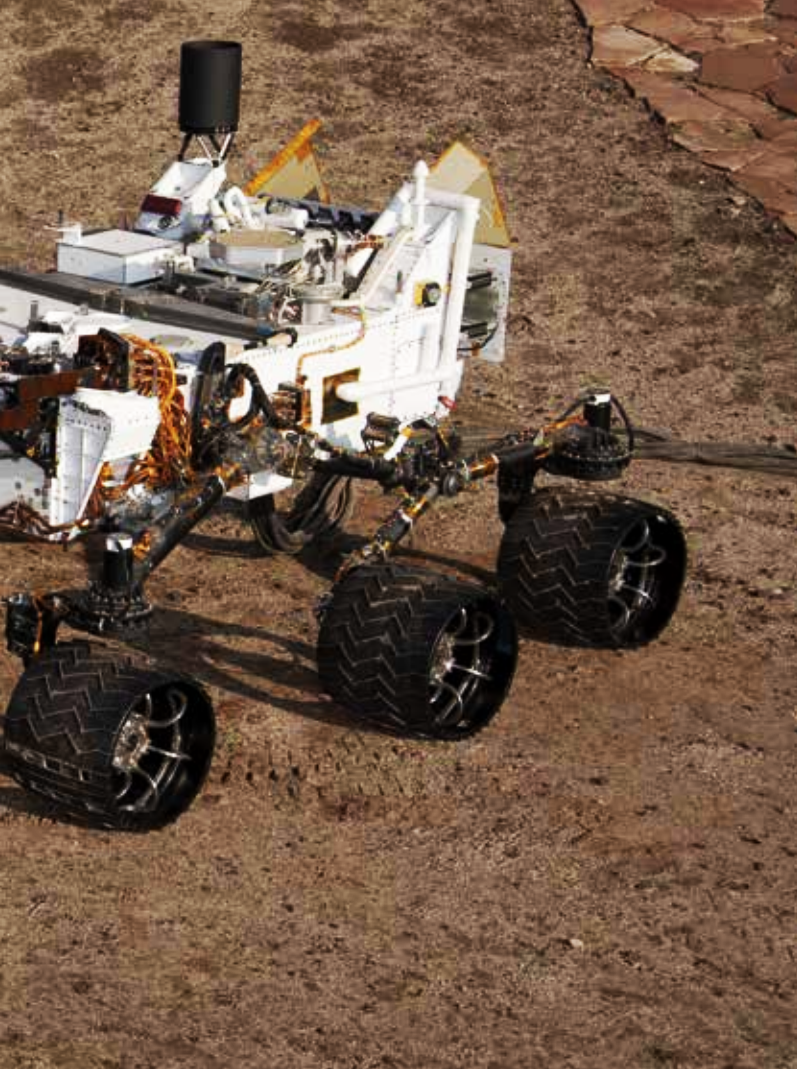
By Jim Baumann, Esri Writer

In anticipation of future missions to Mars, GIS techniques are now being applied to previously collected elevation data from Mars to model the terrain to aid rovers and—eventually—humans.

The possibility of humans exploring Mars in the relatively near future has increased significantly as evidence from several missions has accumulated showing that water was—and perhaps still is—flowing on the planet.

Missions to study Mars have stimulated the public's collective imagination about interplanetary travel while providing a wealth of information about one of Earth's nearest neighbors. Detailed information about the surface of the planet has been regularly

collected for the past 20 years. The National Aeronautics and Space Administration (NASA) created digital elevation models (DEMs) from data provided by the Mars Orbiter Laser Altimeter (MOLA), an instrument on its Mars Global Surveyor spacecraft (1997 to 2001). Digital terrain models (DTMs) have been produced from the High Resolution Imaging Science Experiment (HiRISE) camera on board the Mars Reconnaissance Orbiter that has been collecting data since 2006.



However, sending manned missions presents many challenges that must be overcome and critical technologies that must be developed. While the MOLA and HiRISE data are valuable in themselves, they also provide the opportunity to extract significantly more information from them.

Developing High-Resolution Terrain Models

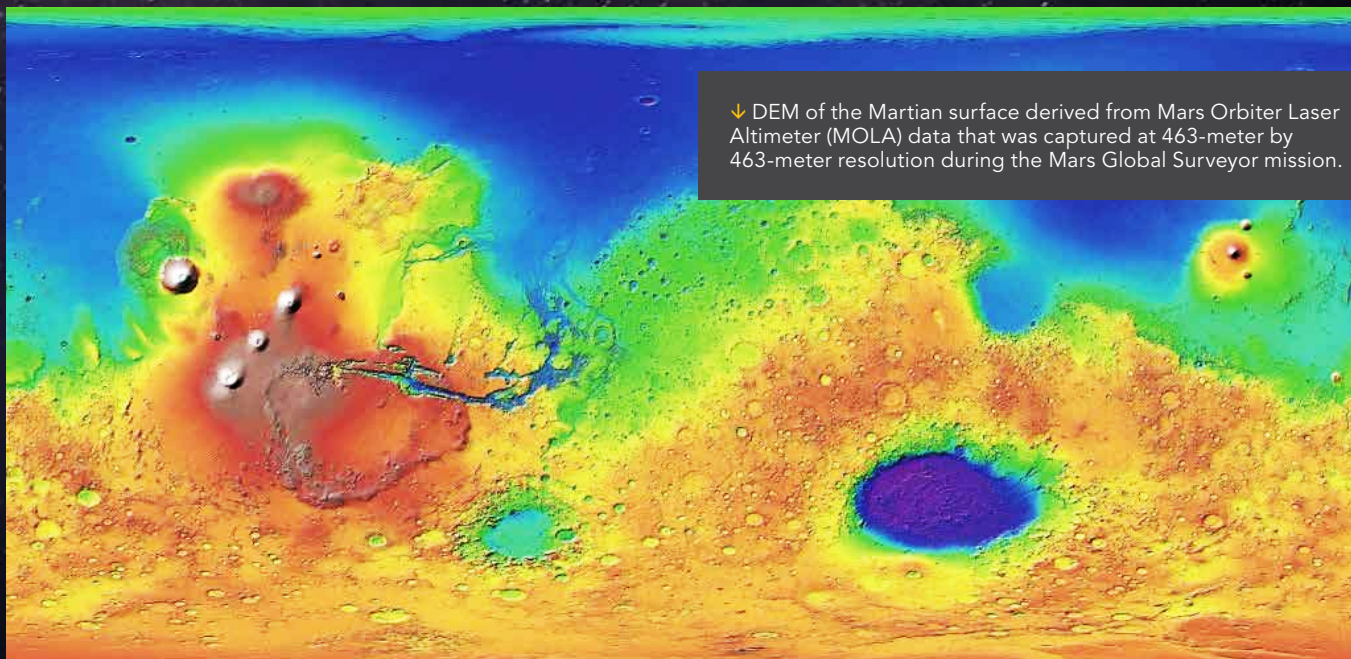
A few years ago, François Smith, geospatial data scientist at MDA Information Systems LLC in Gaithersburg, Maryland, began exploring the application of Earth-based terrain analysis methods to the existing DEMs and DTMs of the Martian surface. He was particularly interested in developing high-resolution geomorphological data layers for use in a vehicle mobility model that would determine the safest routes for rovers—and eventually, humans—to travel across the Martian landscape.

“We are using ModelBuilder and other tools to apply MDA’s Terrain Network Tools [TNT] to the surface data NASA has collected for Mars,” said Smith. “The results feed our Vehicle Mobility model. Determining the best path for the Mars rovers to collect data as they move around the planet is one use of high-resolution terrain data. However, there are many other uses for this technology as we prepare for a comprehensive exploration of the planet. For example, where are the safest places to land? Where are the most interesting scientific locations? Where can liquid water most likely be found? More significantly, all of this information can be used to help determine where human settlement should occur.”

MDA Information Systems has developed the tools to create complex terrain maps of the entire planet at 1-meter resolution. This technology has been tested in different areas and environments on Mars that range from an ancient ocean to mountainous regions and craters. These tools are being used on data from areas where the rovers are currently collecting data.

Deriving Many Products from DEMs

“While we develop our own custom algorithms, we use operators found in the Esri environment,” said Smith. “We use ArcGIS Pro and the Image Analysis Window in ArcMap quite a lot. We also use ArcPy, which is a set of geospatial libraries that we include in our workflows. We systematically use advanced image classification tools that Esri has recently released such as the Segment Mean Shift, which is a segmentation algorithm



↓ DEM of the Martian surface derived from Mars Orbiter Laser Altimeter (MOLA) data that was captured at 463-meter by 463-meter resolution during the Mars Global Surveyor mission.

that we use almost exclusively. We also often use Esri's advanced classifiers such as SVM [*Support Vector Machine*] and Random Forests. Random Forests uses decision tree classifiers on subsamples of large datasets. It employs averaging techniques to improve predictive analysis."

Esri's advanced classification tools are founded on Object-Based Image Analysis (OBIA) concepts. The image is segmented into objects from groups of pixels derived from color, shape, and size characteristics. These objects more accurately delineate and represent the contiguous real-world features in high-resolution imagery than a pixel-based classification does, resulting in better feature recognition and extraction.

Jeff Liedtke, a product engineer with Esri's raster team, worked with Smith to validate the accuracy of the segmentation and classification tools. "Feature classification accuracy is greatly increased when spatial characteristics such as object shape and size are considered along with the multispectral information and analyzed together using advanced non-parametric classifiers such as Random Forest and SVM," said Liedtke. Because he has unique feature classification experience and domain knowledge in operational remote-sensing environments, Liedtke said that working with MDA to validate the accuracy and utility of these tools and workflows was valuable for users engaged in practical feature classification.

MDA developed TNT to produce DEM derivatives that include relative elevation, terrain complexity, terrain characterization, slope diversity, aspect diversity, and elevation range products. These layers are used in different combinations to model specific applications.

"TNT is a set of tools used in the ModelBuilder environment that enables us to utilize the DEM of any region to develop a

variety of products that provide detailed information about the topography of that region," said Smith. "TNT allows the user to create an array of datasets including terrain complexity, relative elevation, and terrain characterization, which are used to model specific geomorphological characteristics of the landscape, which can in turn be used to classify suitable environments for various activities. This is particularly valuable for future missions to Mars."

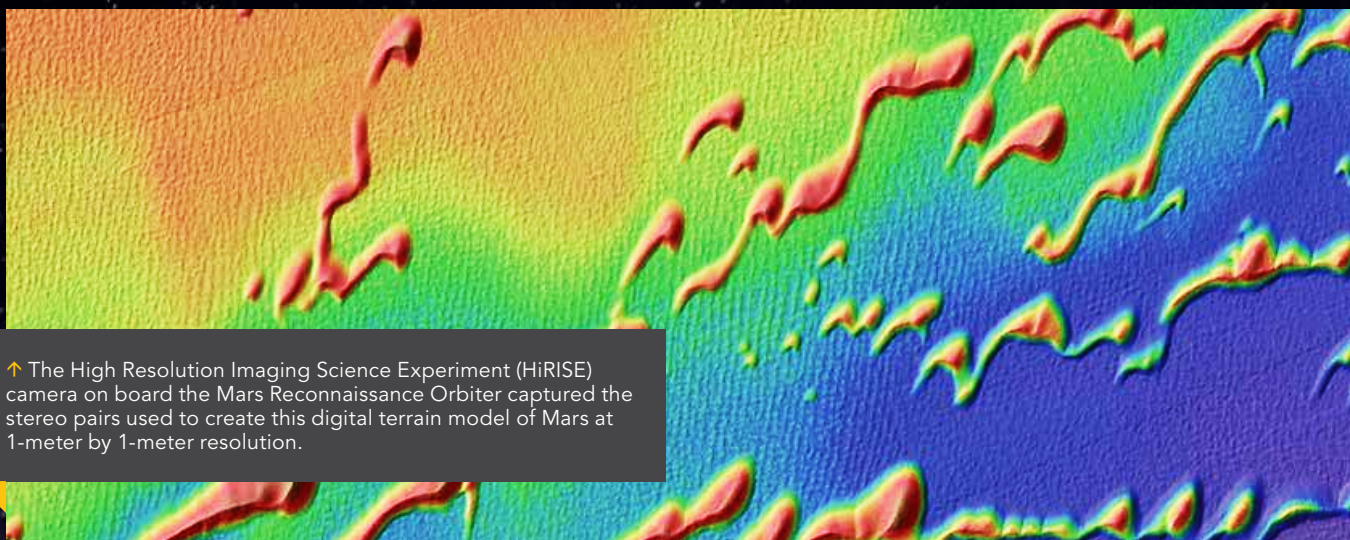
MDA used ModelBuilder in a hierarchical model structure with its TNT toolset to develop a vehicle mobility model in separate modules. A series of models were created to make a modular workflow. The outputs of each of those models was integrated into subsequent models.

Dynamic Use of Big Data

Smith observed that big data lets MDA make products more accurate and efficient and generate solutions for more applications and include temporal components into analyses to show how the data changes over time. "This dynamic aspect of the data provides a key signature for deeper analysis, and with access to more data, [*that*] allows us to make greater use of its temporal aspect. Not only do we use the data for time series analysis and time signatures, but we also use it to corroborate the other datasets. Having multiple sources of data is very beneficial in terms of making our process multidimensional, more efficient, and more accurate," said Smith.

"In addition, by connecting to data from different sources and integrating the resulting data into our geodatabases, big data provides us with more geospatial information in real time to increase our responsiveness," said Smith. "For some of the projects, the datasets are so large and processes so

↑ A subset of MOLA DEM data shown in three-dimensional perspective.



↑ The High Resolution Imaging Science Experiment (HiRISE) camera on board the Mars Reconnaissance Orbiter captured the stereo pairs used to create this digital terrain model of Mars at 1-meter by 1-meter resolution.

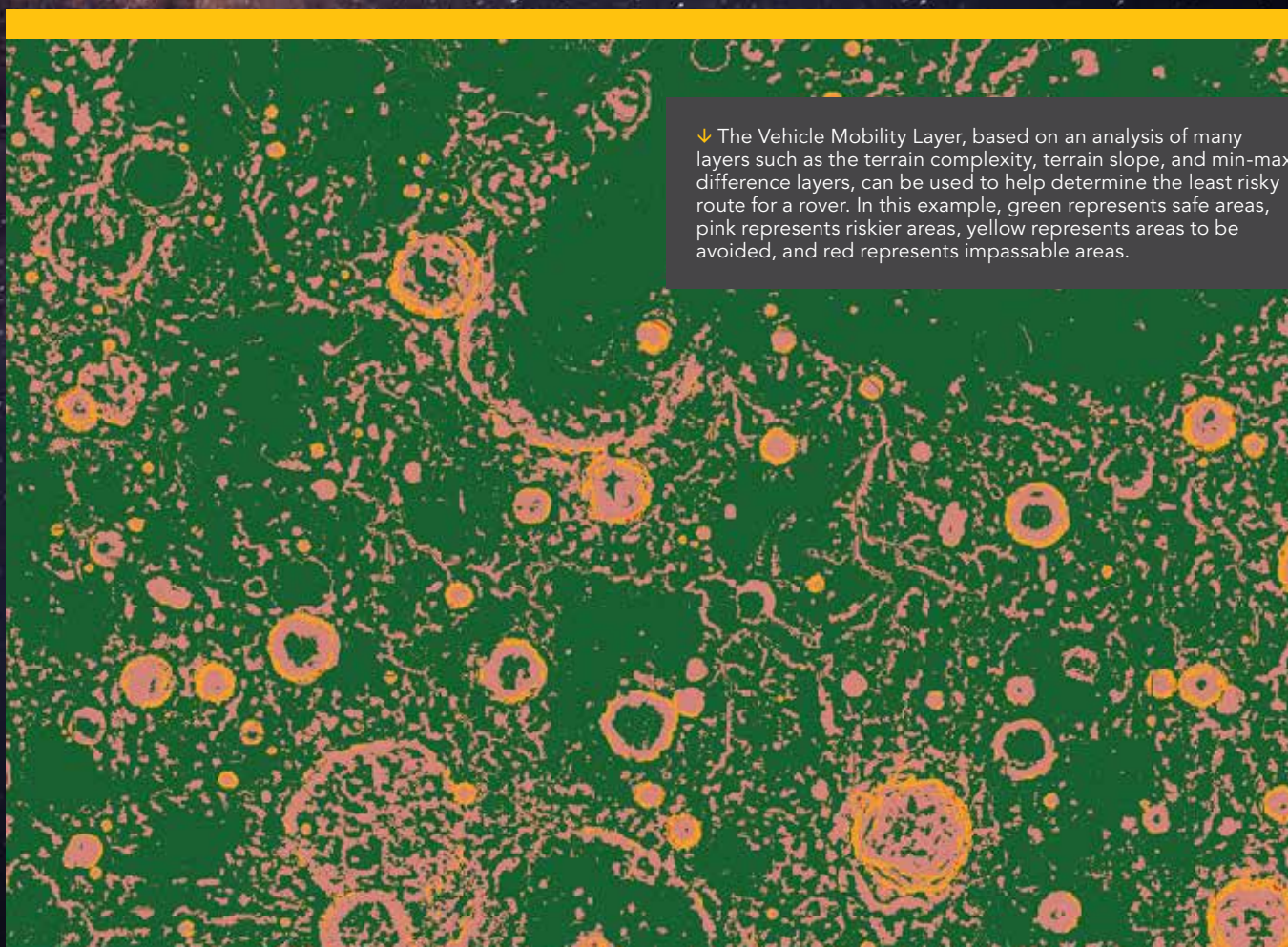
complex that we require cloud-based computing strategies to implement our solutions.”

The Future of Interplanetary GIS

As more geospatial datasets are collected on Mars and other planets, MDA will be able to develop more accurate, sophisticated products and services. Learning more about the planets will let MDA tailor the design of its sensors and processes to more specifically address planetary applications.

“Our understanding of the planets in our solar system, as

well as exoplanets, will begin to increase exponentially. At the same time, we will continue to apply the remote-sensing/GIS processes that we develop for Earth to planetary environments where applicable,” said Smith. “Especially for a planet like Mars, where it is likely humans will be taking field measurements within the next 15–20 years, a unique opportunity for planetary image data verification will develop. It will allow us to better interpret the imagery we collect and improve the geospatial models we create for interplanetary study, and I think that’s very exciting.”



↓ The Vehicle Mobility Layer, based on an analysis of many layers such as the terrain complexity, terrain slope, and min-max difference layers, can be used to help determine the least risky route for a rover. In this example, green represents safe areas, pink represents riskier areas, yellow represents areas to be avoided, and red represents impassable areas.

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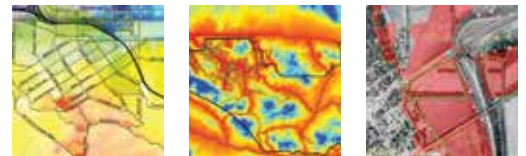
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