Esri News
for Map, Chart & Data Production Summer 2013

New Solutions for Historic Cities

↑ The stages of any workflow are important, but it is the visualization of the small details that can have dramatic impact, such as the placement of palm trees.

Iraq has had a rough ride in recent times, and many of its cities are showing the scars of years of neglect and warfare. A lack of investment in basic infrastructure, combined with a brain drain of professionals, has left many Iraqi cities in a very poor state of repair and with limited plans for the future. But with the fall of the previous regime have come opportunities to revive and repair these aging and often historic cities.

In 2007, the Iraqi Ministry of Municipalities and Public Works (MMPW) awarded a British firm, Garsdale Design Limited (GDL), and its Iraqi Planners Group (IPG) the contract to develop a master plan for the city of Nasiriyah in southern Iraq. The project was to deliver urban planning for the new dwellings, infrastructure, sewerage, water, and electric systems needed over the next 30 years. Nasiriyah is the capital of Dhi Qar province in Iraq. Almost 500,000 people call this city their home, located 225 miles southeast of Baghdad on the Euphrates River and close to the ancient city of Ur.

Garsdale Design is a planning, architecture, and heritage consultancy based in Cumbria in the United Kingdom. It has extensive experience in the Middle East, and many of its projects have entailed urban design and city master planning in the Gulf Arab states.

"Master planning any city is a complex task," says Elliot Hartley, director of Garsdale Design, "but Iraq's cities face huge additional challenges from lack of investment in infrastructure to training of planning departments." Hartley manages and analyzes the spatial data that is required for planning projects like the Nasiriyah City Master Plan.

Magical Modeling

The staff at GDL focused on planning a contemporary community in Nasiriyah with an integrated public transport network that still reflects the culture and history of the almost 150-year-old city. The goal is to help the city grow sustainably over the next 30 years.

Over time, GDL had experience with various time-consuming spatial packages that did not meet its needs. Pursuing a better solution, GDL and IPG concluded that ArcGIS with Esri CityEngine met and exceeded the needs of MMPW. On production of some of the 3D modeling, GDL staff found that they were able to remodel iteratively in response to new data or late requests. This created results that Hartley describes as "almost magical."

"When presented with this reality, we thought, what if the project team could change detailed plans with ease, taking into account new data instantly and avoiding the laborious redrawing of layouts?" says Hartley. "This is the promise of the 'instant city' and what we can achieve with GIS."

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New Solutions for Historic Cities

continued from cover

Creating a Responsive Model

The GDL team quickly realized that CityEngine could be part of the master planning process and not just a visualization tool.

"Unfortunately, we can't just jump into a new workflow in the middle of a project. This could have unacceptable impacts for us and our clients," says Hartley. However, the company quickly learned that using CityEngine on elements of master planning projects helped to visualize where the pieces best fit.

The first task performed with the 3D modeling software was building a new neighborhood with basic block models. Data from previous phases of the project was used to visualize elements of the master plan quickly in realistic 3D visualizations in just a matter of hours.

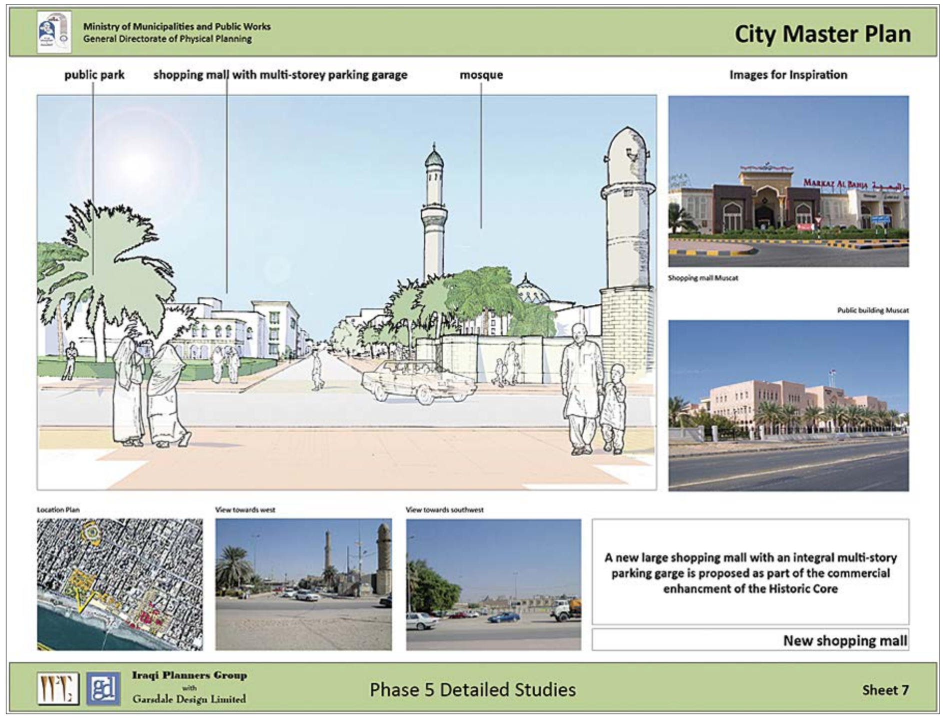
"This would have taken many hours, if not days, to produce in-house using other 3D modeling packages," says Hartley.

Mining Its Stock of 3D Models

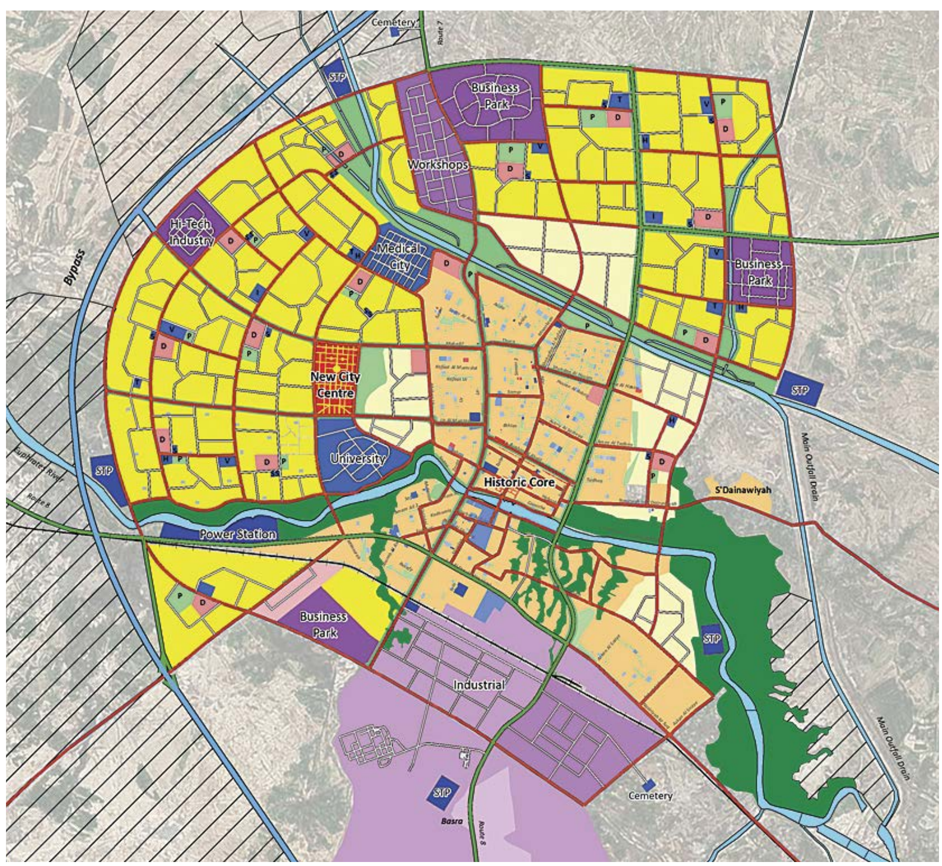
Over the years, GDL has built up a stock of 3D models used for previous jobs that provide inspiration for current work. Using CityEngine, these models were imported and their preexisting 3D assets and rule files put to use, with a few quick adaptations. For example, staff employed a rule file that tests the size of a plot and places an appropriately sized building model accordingly. A specific set of vegetation models that included native trees was also used, with one tweak—existing tree rules were replaced with a new definition. Streets were then modeled with these trees—palm trees—and the trees were randomly inserted on lots to give a more natural look to the model.

Employing Python scripting allowed staff members to go back and forth between the ArcGIS environment for conventional mapping and CityEngine for 3D modeling. For example, a street centerline was created in ArcGIS and then brought into CityEngine, where curbs, central medians, streetlamps, and trees were added in accordance with the rule file. The result was then exported back to ArcGIS for analysis and mapping. This data was then used to create plots and place building types according to the underlying land use in CityEngine, then brought back into ArcGIS for further analysis.

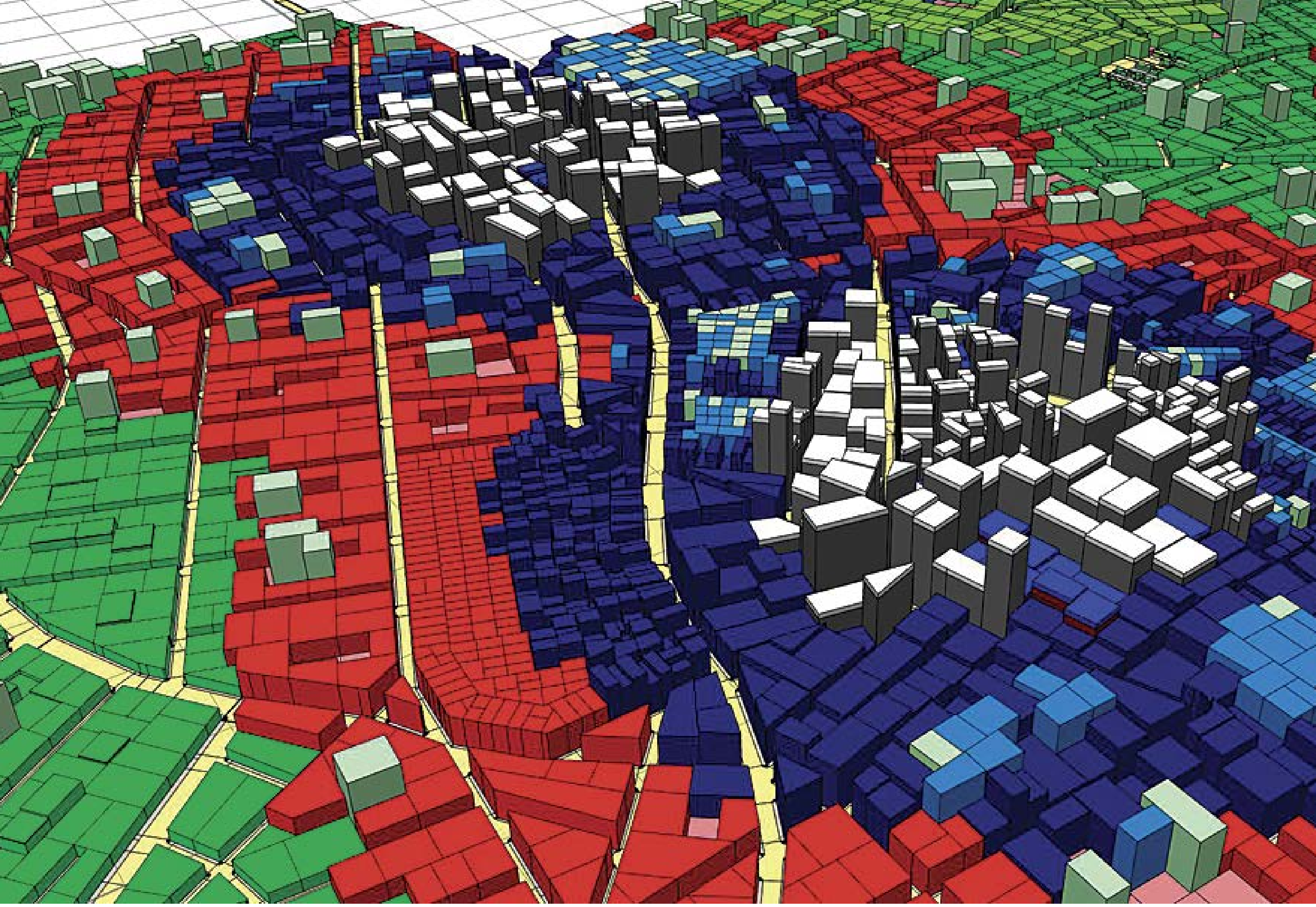
"This goes beyond standard visualization and into actual creation of data based on



↑ This Nasiriyah display sheet for detailed study presents a proposal for a large shopping mall.



↑ This is a typical Nasiriyah City Master Plan sheet.



↑ This is a simple demonstration of a density-based concept.

our specific urban planning standards," says Hartley. "The ability to dynamically add attributes to plots with rules allows for a more responsive model."

When the Future Means Change

Underlying data, such as relief or geology, can also be used. For example, a raster with a red color can be used to restrict development in particular areas, and elevations can be used to restrict building heights or types.

Staff used the modeling rules they need for each individual project, no matter how general or detailed, so different issues can be modeled at either micro or macro scales.

"Sometimes we have started with a relatively simple rule file for land uses," says Hartley, "but have then combined it with a previous dwelling rule file that links to yet another one to locate small elements, such as water tanks and satellite dishes."

Intelligent modeling in this manner is starting to generate questions, such as the following, and quickly provide answers:

- What size of plot is needed within a particular land block?
- Can building height be varied to recognize the underlying geology?
- How can lots smaller than a certain size be shown as playgrounds within a residential area?
- What lane and sidewalk width is required for the different grades of roads?
- How wide should the central median be for higher-order roads?
- Can streetlamps be modeled differently to suit the various grades of road?
- Can buildings be modeled at different heights depending on how close they are to a center or transport node?

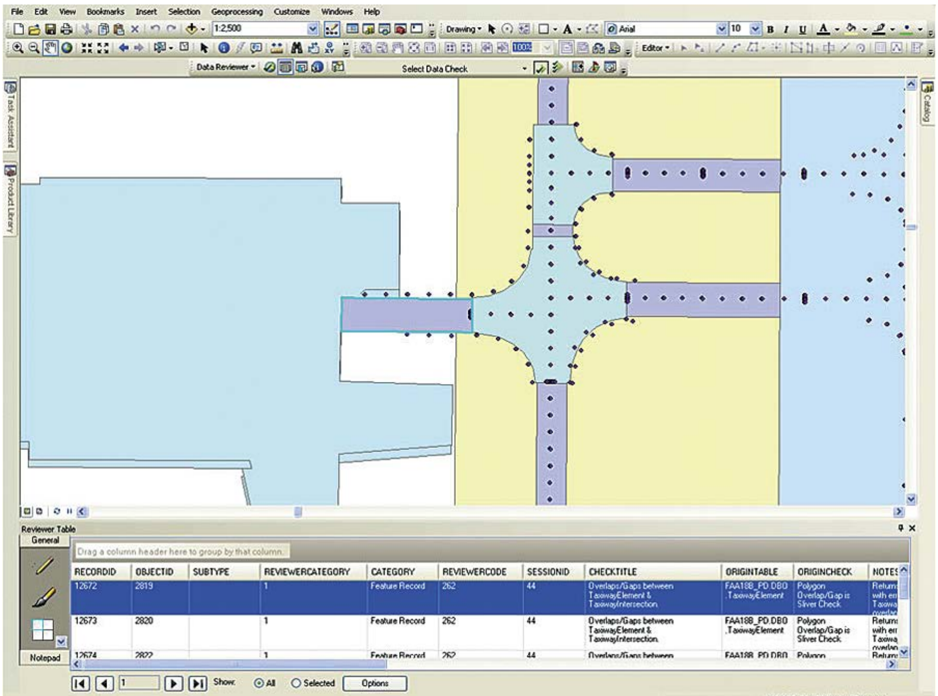
"In the future, we are going to be able to create a city plan that changes very quickly as new data arrives from the client," says Hartley. "This is a game changer for firms like ours, as last-minute client requests at a late stage are inevitable."

A Living Model

When Garsdale Design staff started working with CityEngine, the primary appeal was the software's ability to work with GIS data and export it into a variety of 3D modeling and rendering packages to provide the materials required by the client. "But once we started to explore the potential of the software, we saw that it could be more useful as an urban planning tool," says Hartley. "In fact, it has also shown us an exciting new direction for planning cities in the future. We can start to use these sophisticated 3D visualizations in a variety of media, including printed reports, websites, video, and full, interactive walk-throughs. Our clients want to see how their cities would look when their plans are implemented."

For more information on how GIS can help manage and manipulate 3D data and more, visit esri.com/maps

ArcGIS for Aviation Improves Aeronautical Data Management and Chart Production



↑ Automated data validation tools come with more than 450 preconfigured checks developed from the Federal Aviation Administration (FAA)-18B specification.

ArcGIS for Aviation is a new solution to support users in the aeronautical information management, air navigation service provider, and airport markets. This solution enables users to create, manage, review, and share aviation data. ArcGIS for Aviation includes ArcGIS for Aviation: Charting and ArcGIS for Aviation: Airports. Together, these products provide a comprehensive geospatial platform for aeronautical chart production and airport operations data management:

ArcGIS for Aviation: Charting (previously Esri Aeronautical Solution) improves, standardizes, and increases data and workflow management by allowing standards-based aeronautical data to be captured, maintained, and managed in a centralized database. With it, users can produce standardized and customized electronic and paper aeronautical charts.

ArcGIS for Aviation: Charting provides the ability to do the following:

- Significantly reduce chart production times via automated batch cartographic processing
- Share data within the aeronautical community using the Aeronautical Information Exchange Model (AIXM) standard
- Enhance data quality through direct loading of digital changes and automating change verification

ArcGIS for Aviation: Airports assists airports and their consultants in complying with data management and quality standards, such as the Federal Aviation Administration's (FAA) Airport Surveying—GIS program. It provides tools, templates, and analysis functionality that introduce efficiencies and new capabilities into the planning, maintenance, and day-to-day operations of airports.

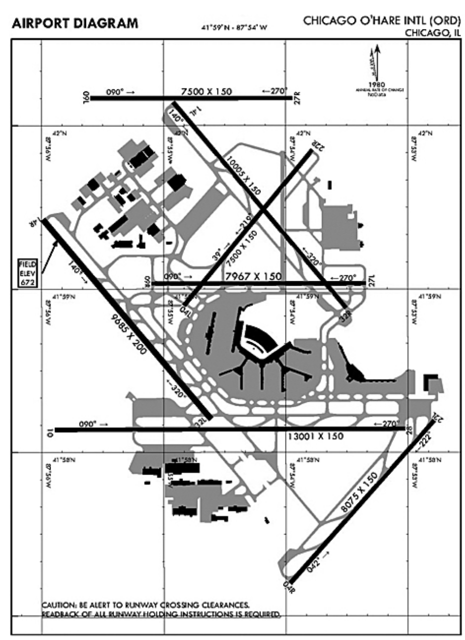
ArcGIS for Aviation: Airports allows organizations to do the following:

- Efficiently collect and manage airport data using a fully implemented airport data model based on the Advisory Circular 150/5300-18 standard
- Improve airport data quality and compliance via automated validation against a preconfigured rule base of more than 450 data checks
- Automatically generate 3D Obstacle Identification Surfaces for planning and analysis against obstacle datasets

"GIS is used across all sectors of aviation, but each sector has unique requirements," says Bruce Frank, Esri's ArcGIS for Aviation program manager. "ArcGIS for Aviation provides our aeronautical information management and airport customers with an optimized solution for their unique business needs."

ArcGIS for Aviation is part of the ArcGIS platform to solve problems and gain efficiencies for civil, military, and commercial aeronautical agencies, airports, consultants, and related businesses. It enables organizations to manage aviation data, products, services, workflows, and quality. The platform provides significant efficiencies for creating and maintaining aviation data according to industry standards to support chart production, airspace analysis, airport operations, and regulatory compliance.

For more information on the ArcGIS for Aviation platform, contact aero@esri.com or visit esri.com/arcgisforaviation.



↑ Create aeronautical charts using AIXM datasets (sample chart—not for navigation).

Telling Thematic Stories in ArcGIS Online

By Kenneth Field (Research Cartographer), Damien Demaj (ArcGIS Online Cartography), and Linda Beale (Geoprocessing)

↑ Figure 1. Proportional Symbols: Olympic Medal Count

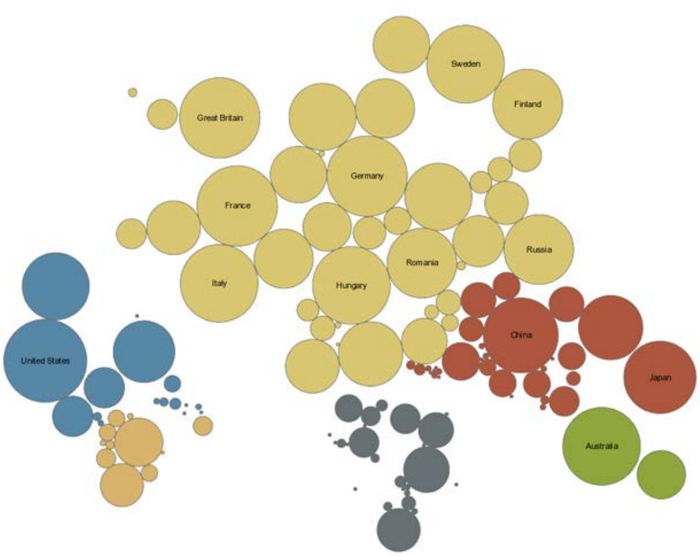
> Each map made use of the Light Gray Canvas basemap to provide a neutral background for the thematic content...

At the 2012 Esri Education GIS Conference and the 2012 Esri International User Conference, we demonstrated how you can build informative thematic maps using the ArcGIS System. The purpose of the sessions was to take relatively simple datasets and create a range of alternative thematic map types that told a story in different ways. This demonstrated the techniques for creating the maps using ArcGIS for Desktop as our authoring environment and ArcGIS Online as our publishing mechanism. As the XXX Olympiad was taking place in London, UK we illustrated how alternative maps can be made to tell different stories of the relative success of nations over the period since the first Olympic games in 1896.

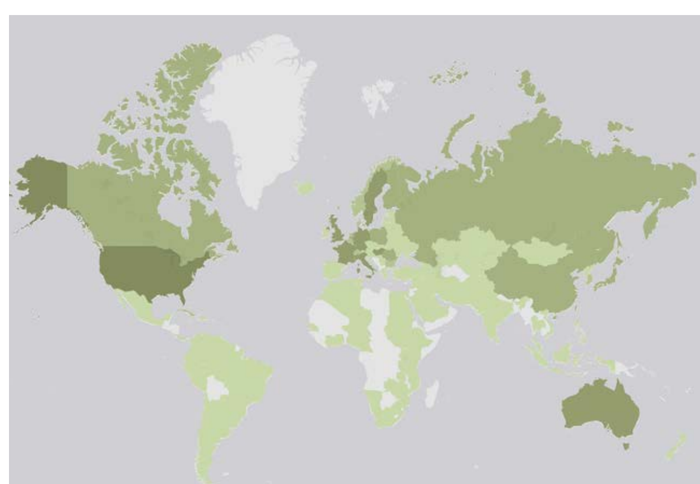
This blog entry explores how the message of the map communicates a very different story depending on how it is designed. The gallery of web maps referred to in this blog entry is available here. Future blog entries will focus on some of the details of how the maps were constructed. Each map made use of the Light Gray Canvas basemap to provide a neutral background for the thematic content, and popups were designed to reveal further information and encourage exploration of the map.

Figure 1 is a proportional symbol map of the total medal count since 1896. The size of the symbols are scaled to the total number of medals awarded and they are symbolised to reflect the map theme using an Olympic medal graphic. At small scales, the symbols overlap, which we countered by placing a small white border around each symbol.

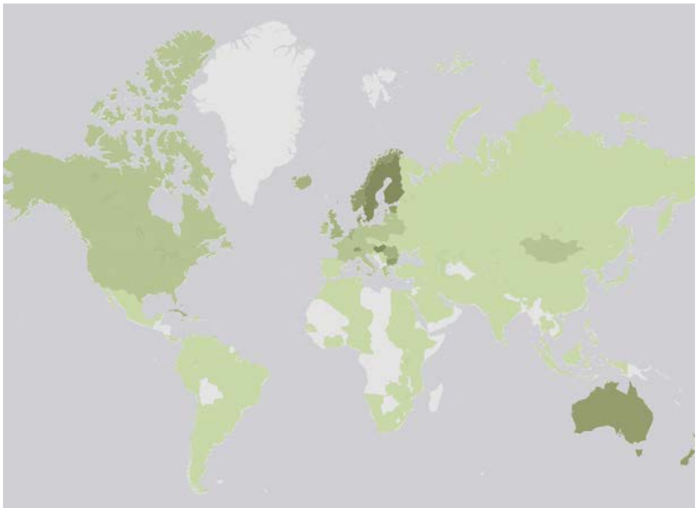
The multiscale characteristic of web maps means that as you zoom in, the symbols maintain their relative size and begin to separate to reveal each distinct symbol. This map reveals the dominant nations as measured by the most medals. The US total of 2,302 medals is the largest symbol and suggests an overall dominance. Popups reveal the breakdown of medal success by gold, silver, and bronze. At smaller



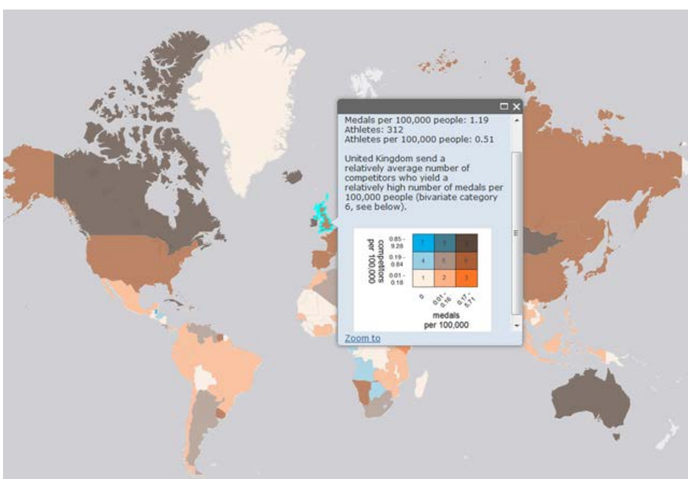
↑ Figure 2. Dorling Cartogram: Olympic Medal Count



↑ Figure 3. Choropleth Map: Olympic Medal Count as Totals



↑ Figure 4. Choropleth Map: Olympic Medal Count Normalised by Population



↑ Figure 5. Bivariate Choropleth Map: Olympic Medal Count by Population and Number of Competitors

scales, however, the symbols are often hard to disentangle, so an alternative approach is to construct a Dorling cartogram (figure 2).

This sort of map redistributes the proportional symbols to give each its own unique position in space. Now, all symbols are visible at all scales. We added labels to the map so that they appear at different zoom scales and the popups are retained to give the medal breakdown. Using scale to determine label visibility helps promote those countries with the highest medal totals at the smallest scales with detail being revealed as you zoom in. This map still shows the US as having a dominant total but the message is altered to one that suggests a European regional dominance.

We also mapped the same data as a choropleth map, firstly, using raw totals (figure 3) and then by normalising in relation to the country's population (figure 4).

The map of total medal counts shows how a choropleth can be extremely misleading when no account of the different size of areas or population is considered. In fact, one of the take-aways from our presentation was to avoid mapping totals at all costs as it presents a false picture. When the medal totals are normalised (and we map using a similar quantile classification scheme for visual comparison), we see that the story changes dramatically. Now, the US's medal haul is nowhere near as impressive compared to, say, Sweden, Hungary, or Australia, who have far lower populations which means their relative success could be considered to be more impressive.

And what if we build in the number of competitors that each nation sends to the Olympics because that too ought to show some relationship with medal success? We created a bivariate choropleth to explore the story of the relationship between medal count normalised by population against medal count normalised by the number of competitors (figure 5).

↑ Figure 6. Area Cartogram: Olympic Medal Count

↑ Figure 7. Olympic Reference Map

Because this sort of map is sometimes difficult to interpret, as it combines two choropleths into one, we used the popup to explain the interpretation for each country as well as provide a legend for interpretation. Countries like Sweden, Australia, and Canada send a relatively high number of athletes per 100,000 people, but this investment is matched by a relatively high medal haul. Turkmenistan and Botswana also send a relatively high proportion of athletes but have a far poorer relative medal haul, indicating a lower measure of relative success. At the other end of the spectrum, Kenya sends relatively few athletes compared to their high medal haul, so their relative success is greater. The USA sends an average number of athletes compared to their total population in relation to other nations, but they achieve a high relative medal haul.

Since a choropleth map always requires you to normalise by some meaningful denominator, an alternative approach is to create an area cartogram. An area cartogram uses the values themselves to modify the shape and size of the area in which they are mapped. Thus, the shape of the country is warped to accommodate the inherent differences between areas. This creates a sometimes strange yet powerfully visual way to display area-based thematic data.

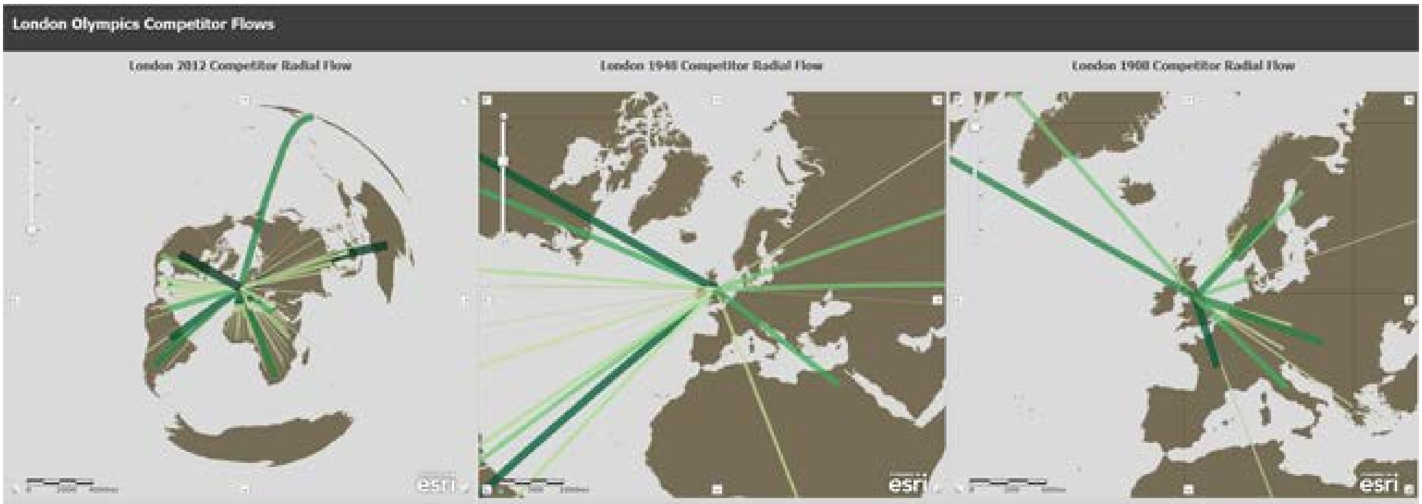
We created an area cartogram using the Gastner-Newman method which preserves the general appearance and adjacency of countries while modifying the shape so that the area is proportional to the variable being mapped (figure 6). The resultant map illustrates the variable without the baggage of having to normalise the data. It's certainly an eye-catching alternative to our normal view of the world map and shows the bloated shapes of countries with large medal hauls compared to their slimmed-down counterparts.

Turning away from the medal count data, we created one further area-based map that we used to present reference information about each individual country (figure 7).

For this qualitative map, each country should be given equal visual treatment, so we used a four-colour basemap of countries. This is a good way of using a minimum number of colours to create a visually uniform backdrop. Since we wanted to design a popup with reference detail, we created symbols using the flags of nations that aid us in identifying the location of each country based on a familiar visual cue. The flags invite users to interact, and the popup reveals detail including a link to an audio file of each country's national anthem. This illustrates how you can embed multimedia inside a popup in an engaging way.

Having considered point and area maps, we then turned our attention to linear thematic maps and, using data for the number of athletes by nation who competed in the London Olympics in 1908, 1948, and 2012, we created a side-by-side web map app of competitor flow (figure 8).

This map illustrated the construction of quantitative geodesic flow lines between two points—the nation of origin and the destination, London, where width is proportional to the number of athletes and colour is used to accentuate the appearance of countries with a larger



↑ Figure 8. Flow Map: Competitors for the London Olympics of 1908, 1948, and 2012

Altering the projection and centering the map on the destination point helps to make the lines become more discernible.

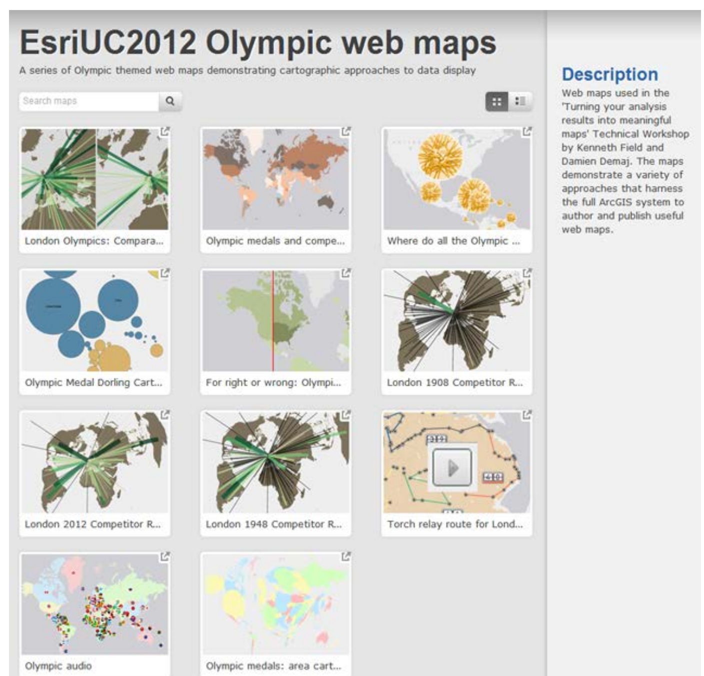
↑ Figure 9. Time-Aware Map: Route of the Torch Relay prior to the XXX Olympiad

number of athletes. Presented on Web Mercator, the lines would be highly curved and distorted, but we used an azimuthal equidistant basemap centred on London as our basemap in ArcGIS Online. This creates a radial flow map with origins flowing to a central point. Altering the projection and centering the map on the destination point helps to make the lines become more discernible. Using the side-by-side template gives us a great way of viewing three periods of data to show how the number of athletes and competing nations have altered across the three Olympics hosted by London.

Our final map made use of the time-aware functionality in ArcGIS for Desktop to create an interactive web map of the Olympic torch route during the days leading up to the opening ceremony (figure 9). The route of the torch was built as a time-enabled layer, and we added points for each of the main destinations with popups that revealed detail for that location as well as a picture, again demonstrating the important role that multimedia plays in creating an engaging popup that provides a window to additional information. Published using a time-aware web map app template, the map user can animate through the time-aware data, pausing and moving to key places as they wish. The authoring and publishing of this map were described in the previous blog entry, Creating a time-aware web map for the torch relay event.

The maps we've outlined here form a small collection and the new ArcGIS Online Public Gallery template provides a great way to show them as a unified collection (figure 10).

In this blog entry, we've shown how you can design a thematic map in a range of styles and how that choice alone might have a profound impact on the way the map is interpreted. It 0simply isn't possible to present all of these different views on the same map effectively, but using different maps that focus on a common theme can illuminate different aspects and can be used collectively to build a more rounded story. The new Public Gallery templates also help organise related maps to group them by theme. Future blog posts will look at some of the detail of the methods used to construct the maps that can be implemented using your own data to create informative thematic maps published on ArcGIS Online.



↑ Figure 10. ArcGIS Online Public Gallery Template for the Collection of Olympic Thematic Maps

Ships Use ArcGIS to Successfully Navigate in Polar Regions

↑ The National Ice Center is located in the NOAA satellite operations facility in Suitland, Maryland.

To navigate safely in polar regions, ship commanders operating near, through, and beneath sea ice rely on data supplied by the National Ice Center (NIC), an organization that uses Esri ArcGIS software to produce sea ice and iceberg maps. Ice analysts process satellite imagery in GIS to study the condition of the ice and map it.

They use the Satellite Image Processing and Analysis System (SIPAS), an extension to ArcGIS.

"A great majority of NIC ice information products are created using the SIPAS editor," explained Mark Denil, a GIS analyst for NIC. "This editing environment handles most of the data shuffling, processing, and housekeeping operations for ice analysts, allowing editors to concentrate on interpreting ice conditions. The majority of ice data products are generated out of the enterprise geodatabase."

On Thin Ice

The Arctic polar ice cap is thinning and shrinking. This results in longer navigation seasons, which keeps routes open for commerce; makes natural resources more accessible for drilling; and provides opportunities for shorter, more efficient voyage routing. But with increased ship traffic in icy waters, conditions can be dangerous. Ice and iceberg maps become essential navigation tools.

So ships' crews rely on NIC, a cooperative partnership that includes the US Navy, the US Coast Guard, and the National Oceanic and Atmospheric Administration (NOAA). Residing in the NOAA Satellite Operations Facility in Suitland, Maryland, NIC is tucked in a corner of a striking, postmodern structure bedecked with satellite dishes. In an operations room, a staff of 15 to 18 ice analysts (most of whom have a background in meteorology) study and interpret ice images. They are supported by small teams of cryogenics scientists and GIS/IT technicians.

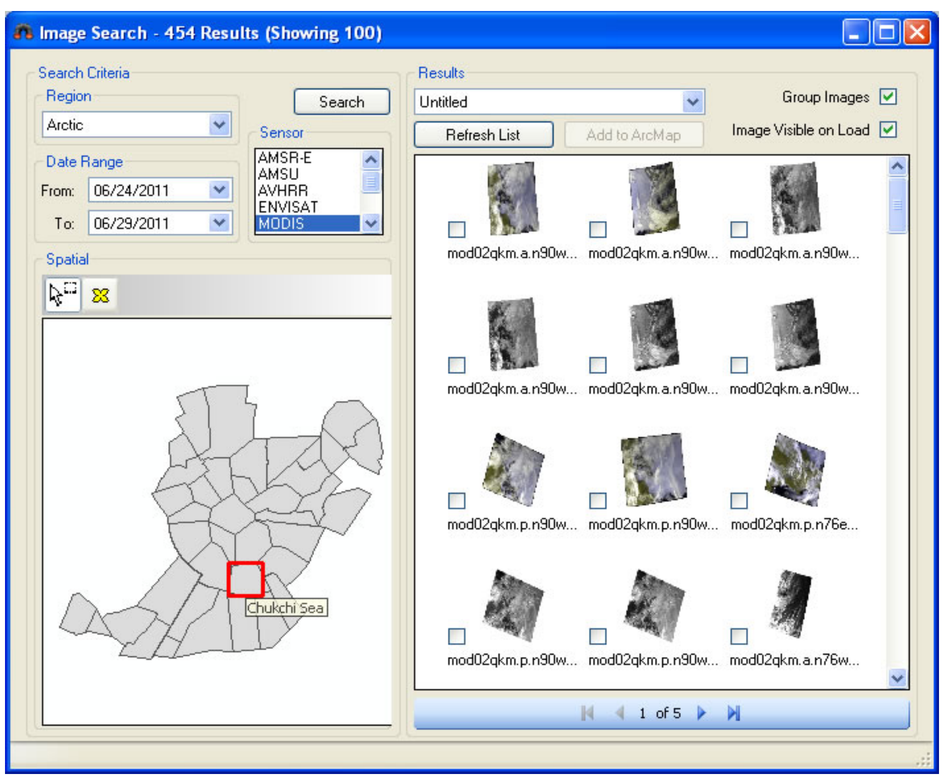
On a daily, weekly, and biweekly basis, NIC experts analyze data from satellite imagery and other sources to assess sea ice conditions in the Arctic, the Antarctic, the Great Lakes, and Chesapeake Bay. They decipher the various types of ice at the poles based primarily on images from a diverse number of satellites, such as Canadian Space Agency's (CSA) RADARSAT-1 and 2, the European Space Agency's Envisat, and NASA's Terra and Aqua.

Making sense of ice data is very different from deciphering land-use data because images of sea ice do not have the same types of recognizable features, so interpretation requires different skills. Rather than exploring vegetation, rivers, and human development, the ice analyst looks for visual clues indicating characteristics such as ice concentration, stage of development (age), and ice form (is it the size of a floe, a sheet of floating ice?).

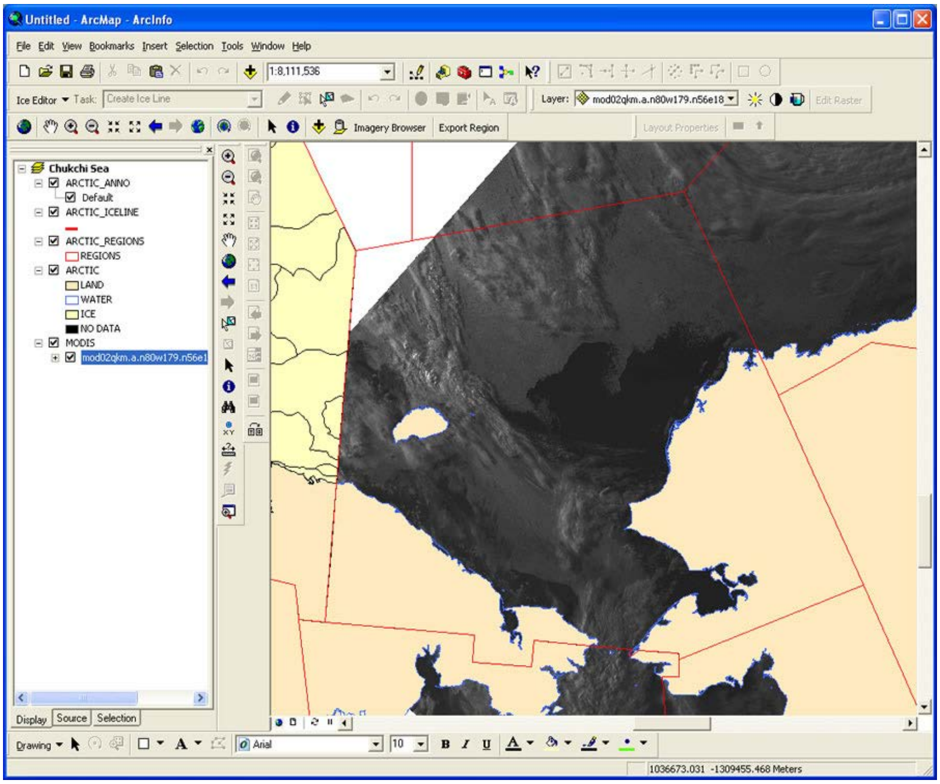
The Role of GIS

More than 95 percent of the data used in sea ice analyses is derived from polar orbiting satellites. Every day, the center receives approximately 6,000 images, or roughly 160 gigabytes of data, which automated routines turn into GIS-ready files. These images are cataloged and made available to individual analysts through a custom imagery browser application. They load their imagery selections into SIPAS. The majority of the analysts' work takes place in this environment.

This extension makes the workflow



↑ Using the Image Search utility, the analyst searches by area, date, and sensor to see the available images.



↑ A SIPAS interface makes it possible for the user to load a moderate-resolution imaging spectroradiometer (MODIS) image into GIS and edit this region for the Chukchi Sea.

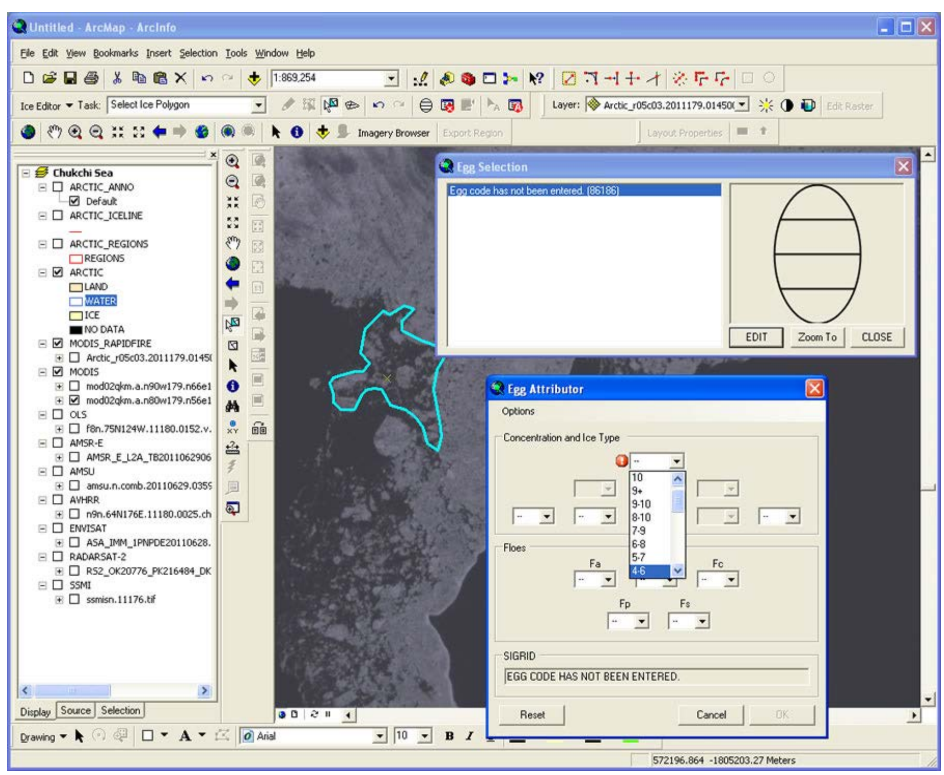
more efficient. The analyst opens SIPAS, zooms to a polar sector, selects imagery from Image Search, and gets to work. The analyst examines and compares images and then selects the most appropriate source for determining the significant characteristics of the ice for that particular location. Next, the analyst carefully digitizes the edges of each of the various ice types (defined by thickness; floe size; and age—first year, second year, or older) to delineate them from the different types of ice nearby and from the open sea.

Features such as fractures, leads, and polynyas (FLAP) are also captured. A fracture is a break or rupture in close-packed ice, a lead is a fracture or passageway through sea ice that is navigable by surface vessels, and a polynya is a nonlinear area of open water enclosed by ice. All these descriptors characterize the ice and surrounding waters. With this information, the ship's master knows about conditions and risks that lie ahead and can make informed decisions about how, or if, to proceed.

By freeing them from other concerns, SIPAS lets analysts focus on the critical and difficult task of understanding the ice conditions they see. For example, preconfigured constraints built into the attribute coding tools help ensure quality of the data. Map topology rules are in place so that splinters or overlapping polygons aren't created. Additional quality checks verify that an area's delineated regional boundary edges and attributes match polygons already created in neighboring regions. Digitized polygons are directly input to NIC's enterprise geodatabase.

In addition to mapping sea ice, NIC names, tracks, and reports weekly on large icebergs in the Southern Hemisphere. An iceberg must be at least 10 nautical miles across to receive this attention, so these are really more ice islands than bergs. Still, NIC tracked 41 of these through 2011 and has tracked 223 since 1973. Today, analysts use ArcGIS for Desktop for this task.

NIC usually generates between 70 and 80 standard GIS maps each week, which are used by the US Navy, shipping enterprises,



↑ An ice analyst draws a polygon on the MODIS ice image and uses a SIPAS attributing tool to create an egg diagram that describes ice concentration and type.

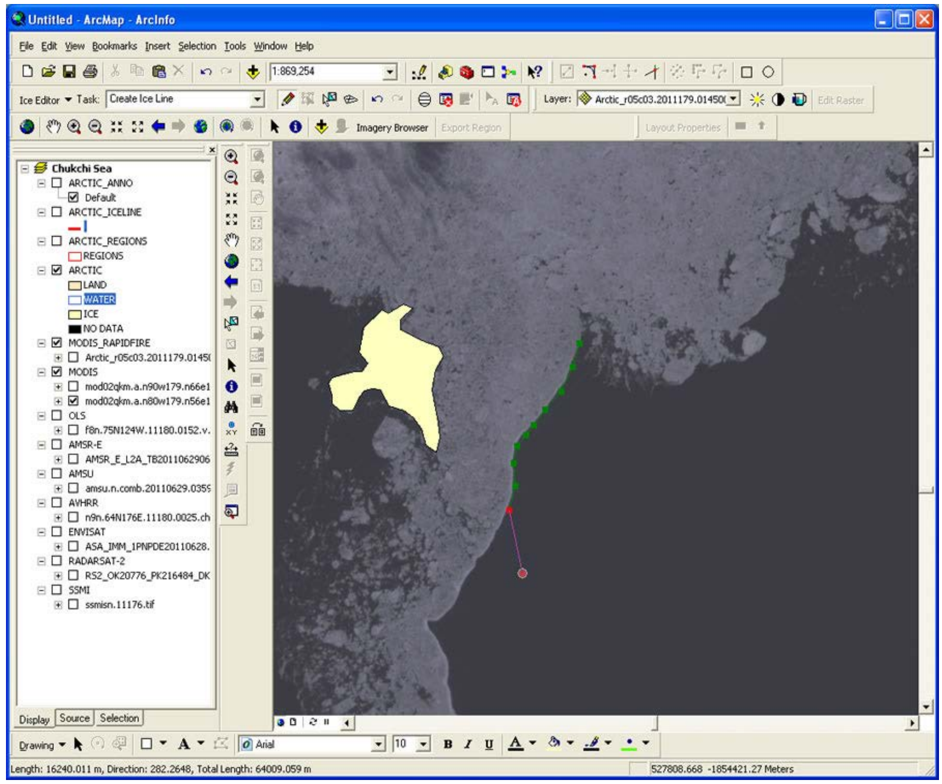
petroleum companies, fisheries, and ocean scientists. Almost all these products are made available to the public via the NIC website. NIC also creates ice analysis maps and reports upon request in support of an array of special operations, and these products are made available directly to the requesting customer in various formats.

Technology has enabled NIC to generate high-quality products on demand and get them out quickly. A consumer visiting the NIC website can, with a few clicks, access maps and data through interactive map interfaces and/or download data in formats such as shapefile, geodatabase feature class, raster layer, PDF, KML, and movie loop. Since many NIC data consumers operate in remote regions with very low bandwidth capabilities, the website provides options for selecting high- or low-bandwidth interfaces. With either option, the user can search and query the data by date and area of interest. A calendar tool facilitates access to historical data, so users can see how the ice has changed during the last 40 years. The site also has interactive user help and allows the user to provide feedback.

Because NIC has been keeping track of polar ice since 1972, it has built a baseline for evaluating change. In the early days, NIC produced all its global ice condition charts using hard-copy cartography techniques for dissemination by fax. Starting in 1996, however, NIC began making its historical data more useful for environmental research and studying ice-related climatology by digitizing the archive of older, paper-based charts, reconfiguring its data so it could be used for digital analysis.

ArcGIS Speeds the Workflow

In 1999, Semeon Sertsu, the center's director of information technology, committed NIC to using GIS because it had the greatest capacity to meet the center's needs. "It was worth the effort, because today, ArcGIS is providing us with wonderful data management, image analysis, output, and dissemination capabilities," Sertsu said. "It is delivering more than I had originally imagined. For instance, we have a GIS tool that can perform a routine in about



↑ An analyst traces the ice edge in SIPAS.

30 seconds that once took us a week to do."

The analyst team includes US Navy civilian employees and enlisted men and women. Most come to NIC with no previous GIS experience, but they find they can easily step up to the workflow requirements because imagery handling and data generation are integrated in a unified and accessible ArcGIS software environment. This means users no longer need to learn to use and integrate multiple types of imagery viewing and data generation software and tools.

Professionals such as ice analyst Brian Jackson are assigned to analyze a specific area. Using the graphic, menu-driven Image Search, Jackson selects the best satellite imagery and brings it into the SIPAS work environment. He then manually analyzes the images using heads-up digitizing to draw boundaries of specific ice types. "It easily manages the data," said Jackson. "I don't have to transfer data between systems. I can draw a line in ArcGIS and share it in the exact same file so there is no loss of clarity. One aspect of the software that I particularly find amazing is that I can be working on an Arctic polar section, click an icon, and within 20 seconds access Antarctic real-time satellite data within the same desktop environment."

A Call for Sharing Polar Data

Although Jackson sees polar regions changing, he will not venture an opinion as to whether this is caused by climate change, nor will anyone else at NIC. The analysts leave this issue to the scientific community. However, they said that there are notable changes in the northern sea route (along the Asian coast north of Siberia), which in 2011 was open for four weeks—the longest period in NIC's 40 years of analysis. This creates opportunity for surrounding nations to develop shipping, fishing, and natural resource enterprises.

Sertsu has been working with a committee to get nations located around the poles to share their polar data for collaboration. "Nobody knows their own backyard better," he said. "If nations agree to this idea, they will have a comprehensive polar map. Working together on such a map may well lead them to work together as a global community to address polar ice cap concerns."

A World of Imagery

ArcGIS Updated With More Than 10 Million Square Kilometers of DigitalGlobe Aerial Views

Esri and DigitalGlobe updated the ArcGIS World Imagery basemap service with more than 10 million square kilometers of high-resolution aerial views. The World Imagery Map is a free map service for ArcGIS users that contains quality contributions from Esri partners and the global GIS community. The World Imagery Map is one of several useful basemap services freely accessible through ArcGIS Online.

The new update includes 30-centimeter imagery for the continental United States down to 1:1,000 scale and 60-centimeter imagery for large parts of western Europe down to 1:2,000 scale. Throughout 2013, Esri and DigitalGlobe will grow the map with more than 100 million square kilometers of updated high-quality imagery, making it one of the most detailed free basemap services available.

"We are excited to offer our users over 100 million square kilometers of new imagery at resolutions of 30 centimeters for the United States and 60 centimeters for Europe," says Christophe Charpentier, Esri's group product manager for ArcGIS content. "This is a breakthrough improvement thanks to our partnership with DigitalGlobe that allows our customers access to up-to-date and powerful global imagery."

To access the World Imagery Map, go to the basemap gallery in your ArcGIS application and click Imagery or Imagery with Labels.

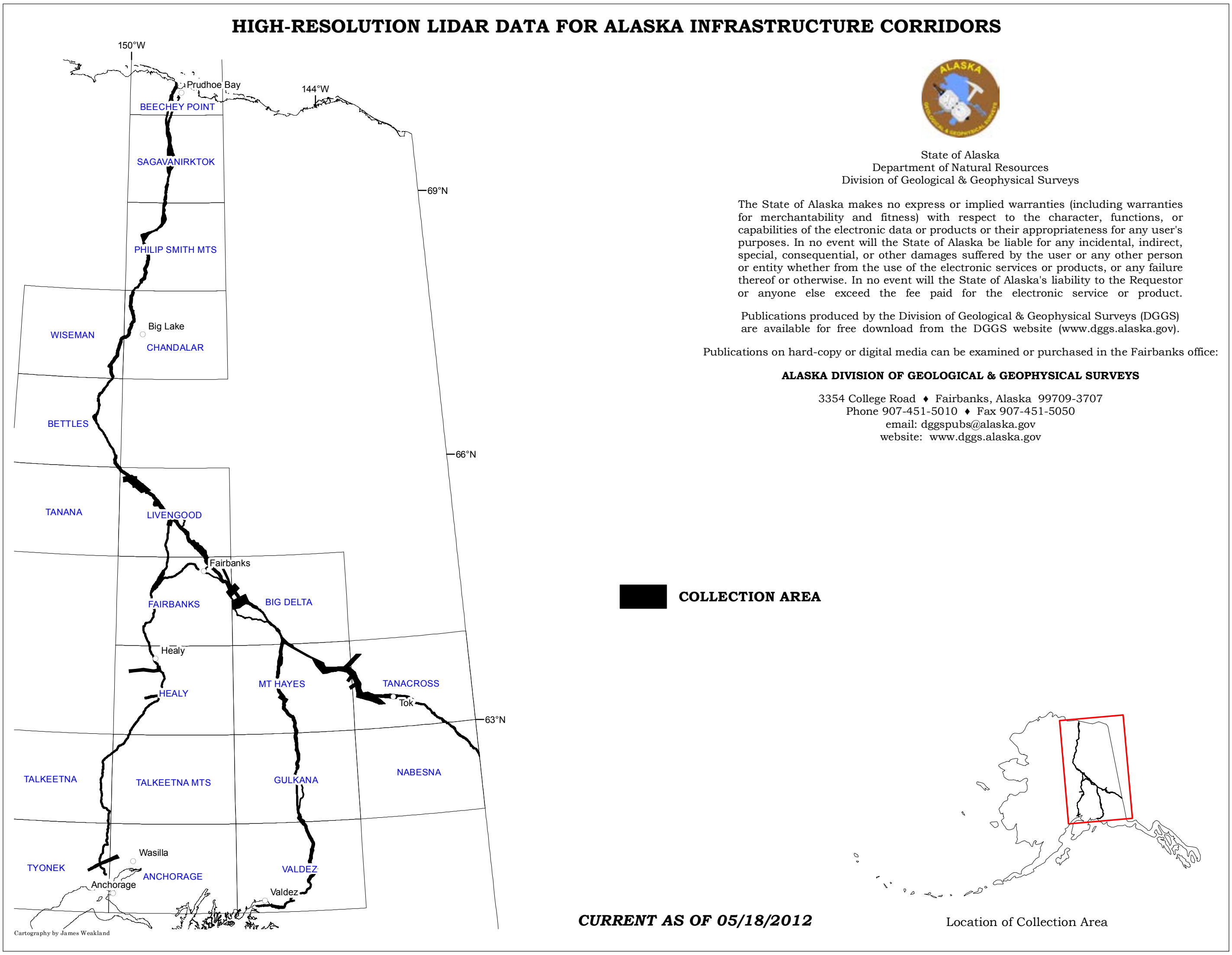
"This is a breakthrough improvement thanks to our partnership with DigitalGlobe that allows our customers access to up-to-date and powerful global imagery."

↑ Olympic Stadium and Botanical Garden in Montreal, Canada

Ensuring Data Quality for Alaska's North Slope

Alaska Division of Geological & Geophysical Surveys Uses ArcGIS to Evaluate 3,000 Square Miles of Lidar Data for Proposed Natural Gas Pipeline Routes

By James Weakland, GISP, Alaska Division of Geological & Geophysical Surveys



↑ Alaska DGGS collected lidar topographic data covering approximately 3,000 square miles of proposed natural gas pipeline corridor.

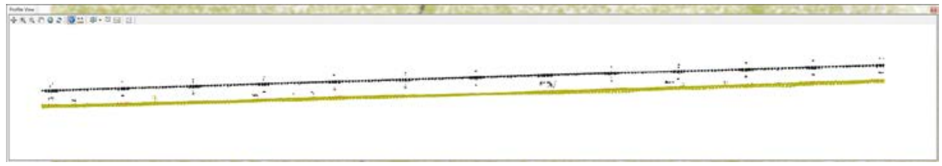
The Alaska Department of Natural Resources, Division of Geological & Geophysical Surveys (DGGS), collected high-resolution lidar topographic data for swaths of land that would likely be used if new natural gas pipelines were constructed in Alaska. The pipelines would be designed to deliver Alaska North Slope natural gas to out-of-state and Alaska customers. Collection of lidar data was supported by the State of Alaska Gas Pipeline Project Office, the Office of the Federal Coordinator, and the Alaska Gasoline Development Corporation.

The data—covering approximately 3,000 square miles along the proposed pipeline routes—was acquired to facilitate analysis during the design, permitting, and construction of the pipelines, including evaluation of active faulting, slope instability, thaw settlement, erosion, and other engineering constraints along the proposed pipeline routes. The data will also provide an Esri ArcGIS base layer for the state-federal GIS database and will be used to evaluate permit applications and construction plans.

Lidar was chosen as the preferred data format because it has proved to be one of the most useful forms of remotely sensed data for identification and characterization of potentially active faults and many other surficial-geologic landforms and hazards, especially in areas of heavy vegetation where access may be difficult and other forms of remotely sensed data are ineffective.

Tapping into Data

Lidar data was acquired and processed by Watershed Sciences, Inc. (WSI), based in Corvallis, Oregon. The data consists of continuous 1-mile-wide minimum coverage of existing infrastructure along the entire length of the proposed natural gas pipeline corridors from Prudhoe Bay, Alaska, to the Canada border along the Trans-Alaska Pipeline System (TAPS) and Alaska Highway; Delta Junction to Valdez, Alaska, along the TAPS corridor; and Livengood to Point McKenzie, Alaska, along the George Parks Highway. Lidar data was collected between September 21 and October 1, 2010, for an area that included portions of the Alaska Highway east of Johnson River to Robertson River and 117,357 acres within the requested area. This area was expanded to include a 100-meter buffer to make sure coverage was complete and there were adequate point densities around survey boundaries, resulting in 121,746 acres of delivered data.



↑ Oblique View of the Trans-Alaska Pipeline System

The lidar survey data was collected with Leica ALS60 sensors in a Cessna Caravan 208B and Partenavia P-68 aircraft. The Leica systems were set to acquire 200,000 laser pulses per second and flown at 900 or 1,300 meters above ground level, depending on cloud ceiling and terrain, capturing a scan angle of plus or minus 14 degrees from nadir. The system achieved a minimum survey density of 8 pulses per square meter and up to four returns per pulse. The data included minimum 1-mile-wide corridors covering gas pipeline routes being considered by applicants and half-mile-wide coverage of existing primary pipeline support roads outside the main corridor. Other expanded coverage included areas where data is needed for evaluation of active faults, slope instability, and other geologic hazards.

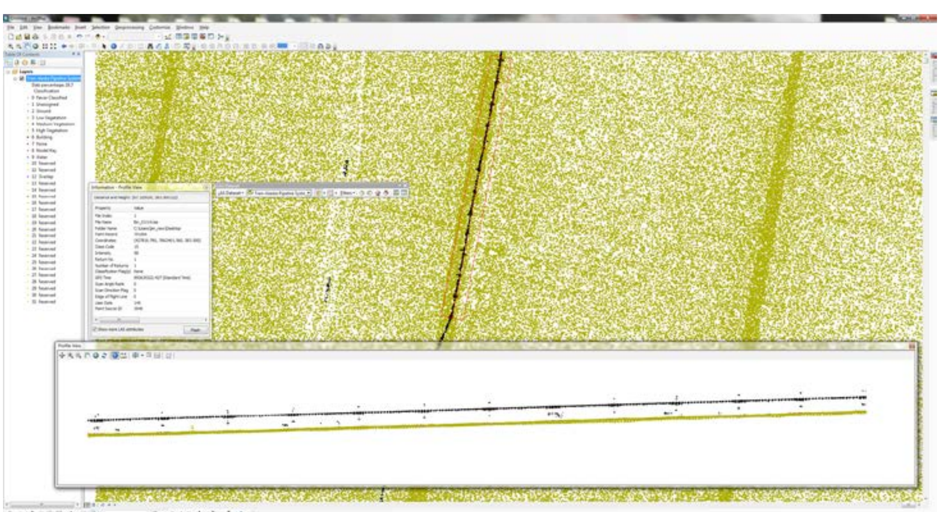
To facilitate processing and product delivery, WSI grouped the data into delivery areas (subsets of the entire data collection region) in the order in which it was collected and processed. Files for each delivery area were organized by 1:63,360-scale quadrangle. Next, WSI sent the data for each delivery area to the State of Oregon Department of Geology and Mineral Industries (DOGAMI) for independent quality control analysis under separate contract with DGGS. DOGAMI is a proven leader in the collection and use of lidar data, with vast experience in these types of analyses.

After correcting any errors identified by DOGAMI, WSI sent the revised dataset to DGGS along with a delivery report describing details about lidar acquisition, accuracy, and quality for the delivery area. DOGAMI also provided a separate report for each delivery area, summarizing the methodologies and the results of quality control checks.

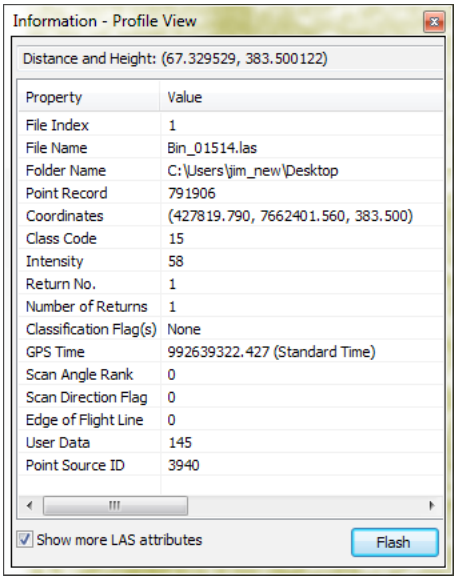
Lidar points were classified as ground, low and medium vegetation, buildings or man-made structures, noise/error points, water, snow, and pipeline. Contour lines were derived at 1-meter intervals from ground-classified lidar point data using TerraSolid processing software and MicroStation. For the derived digital elevation models (DEM), lakes and other closed water bodies with surface areas of greater than 150 square meters were flattened to a consistent water level using a hydroflattening procedure to ensure stream channels break at culvert locations and the sinks and pits in the data are removed.

Ensuring Quality Using ArcGIS

Bare-earth and highest-hit grids were delivered in ArcGIS grid format with 1-meter



↑ Viewing the LAS Dataset along the Trans-Alaska Pipeline System (TAPS) in ArcGIS



↑ ArcGIS Pop-up Window Identifying a LAS Point in the Profile View

cell size. Lidar point data was delivered in LAS binary format for ground-classified returns as well as the entire lidar point cloud. Georeferenced intensity images of 1-meter cell size were supplied in GeoTIFF format. Supplementary data includes 1-meter-cell-size vegetation rasters displaying canopy and other vegetation metrics. Real-time kinematic ground survey data used for absolute vertical adjustment was supplied in shapefile format.

All data associated with the delivery was loaded and viewed to ensure completeness. Raster imagery, such as elevation grids and intensity GeoTIFFs, were viewed in ArcGIS and cross-referenced with the delivery area. These grids were loaded into ArcGIS software for visual analysis. Data was examined through slope and hillshade models of bare-earth returns. Hillshades of the highest-hit models were used to identify areas of missing ground. Both bare-earth and highest-hit models were examined for calibration offsets, tiling artifacts, seamline offsets, pits, and birds (both real and anomalous).

Errors noted during visual analysis were digitized for spatial reference and stored in Esri shapefile format. Each feature was assigned an ID value and commented to describe the nature of the observed error. The shapefile was delivered to WSI for locating and fixing apparent errors. Upon receiving the observed error locations, the vendor performed an analysis to conclude whether the error was valid, and reprocessed if necessary.

Delivering the Goods

DGGS has made this lidar data available free to the public at its website (www.dggs.alaska.gov/pubs/id/22722). The data is arranged by US Geological Survey (USGS) quadrangle in the order that delivery areas were received from WSI. A single data delivery from WSI typically covered portions of several 1:250,000-scale quadrangles. Individual delivery reports from WSI were combined into a comprehensive report organized by delivery area. Section 1 of this delivery report contains information about the first delivery received by DGGS, section 2 contains information about the second delivery received, and so on. A similarly organized quality control report contains information provided by DOGAMI. Both reports are available via the DGGS website.

DGGS delivered lidar data for 11 areas and is making this data available to the public through its website.

The DGGS data release includes bare-earth DEMs, lidar intensity images, bare-earth DEM hillshade images, water-body polygons, canopy cover digital surface models (DSMs), normalized DSMs, vegetation DSMs, mean vegetation elevations, highest-hit DSMs, coefficient of variation DSMs, and point-cloud data.

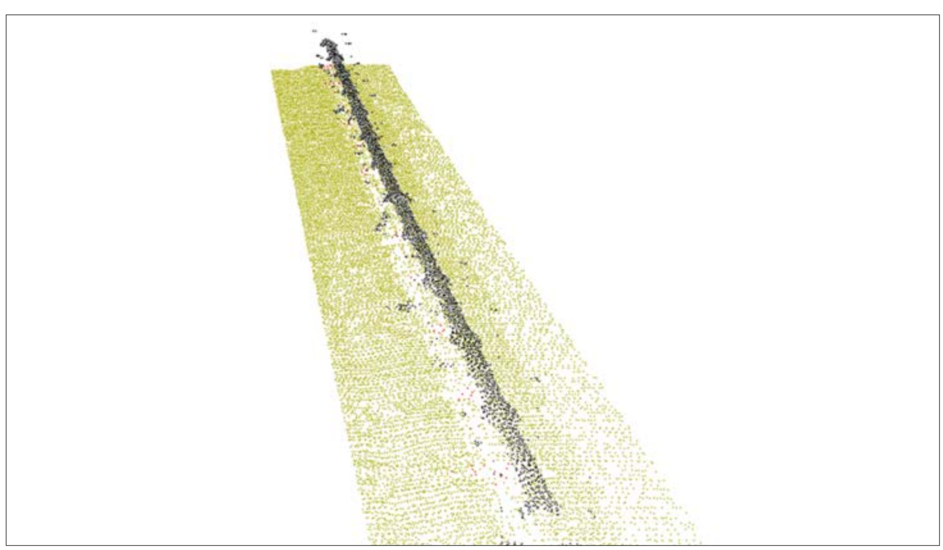
Processing three-dimensional data, such as lidar, requires software that can accurately manage, represent, and analyze its feature information. Alaska DGGS found that ArcGIS provided the platform needed to ensure the data is ready for analyzing proposed pipeline routes by providing a base layer of data for the GIS database that will be used by both the state and federal governments for evaluating permit applications and construction plans.

The coverage area for lidar data will be available for analysis of permit applications and construction plans for proposed natural gas pipelines in Alaska.

About the Author

James Weakland, GISP, has been with DGGS since 2011 and serves as a GIS analyst in the Geologic Communications Section, updating legacy geologic mapping techniques including instituting division standards for GIS data and creating web mapping applications for customers without access to GIS software. Weakland holds a degree in geography from Excelsior College and is currently studying at the Pennsylvania State University for his postbaccalaureate certification in GIS. He can be reached at james.weakland@alaska.gov or 907-451-5029.

For more information on lidar and 3D mapping with ArcGIS, visit esri.com/lidar.



↑ 3D View of TAPS

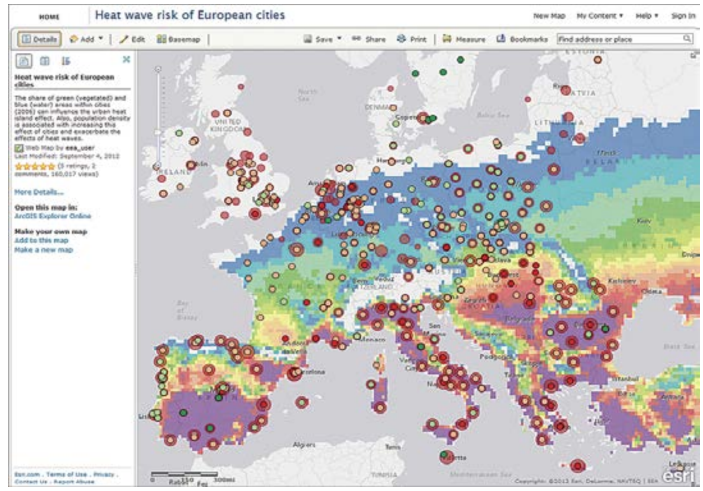
European Cities Are Getting Warmer

EEA's Heat Wave Risk Map Powered by ArcGIS Online

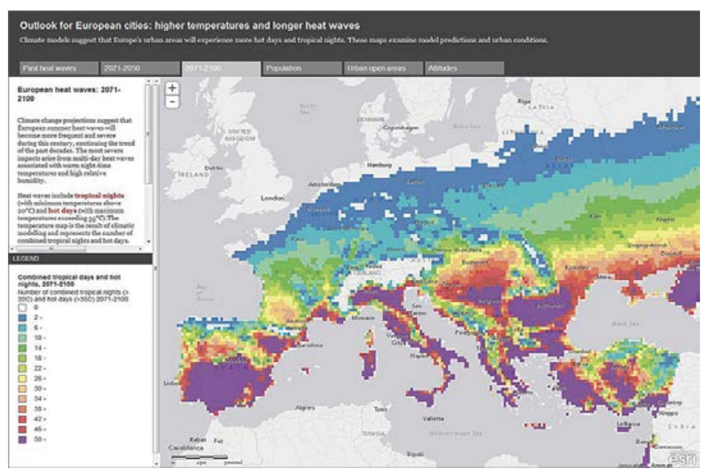
Less than 24 hours after the European Environment Agency (EEA) posted an interactive web map on its Eye on Earth website, the map received more than 100,000 views. Clearly, the impact of global climate change on weather patterns is of interest to many people, regardless of their location. The heat wave risk map was created by EEA and shared through the Eye on Earth site using ArcGIS Online.

The map was originally created by EEA for its *Urban adaptation to climate change in Europe* report (EEA Report No. 2/2012) and shows the heat wave risk for 500 European cities. The map combines the simulated number of both tropical nights and hot days, with population density and share of green and blue urban areas. Vegetation and water areas, along with population density, can influence the urban heat island effect. For example, high population densities are associated with a lack of green space, high building mass, and high production of anthropogenic heat per area. Italy; some parts of southern France; southern Spain; and areas around the cities of Belgrade, Serbia, and Bucharest, Romania, are clearly vulnerable.

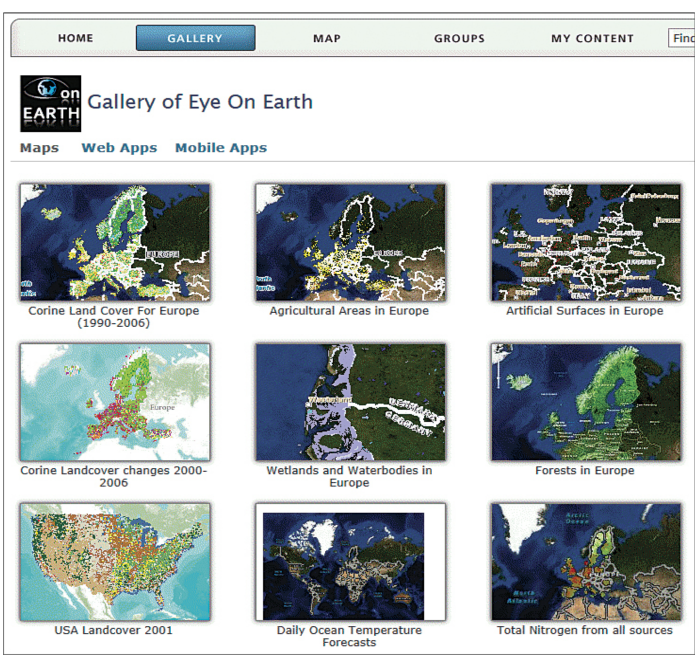
The backdrop for the data is the Light Gray Canvas Map, one of the ArcGIS Online basemaps that's well suited to overlaying datasets. The map author added layers of green (vegetation) and blue (water) urban areas extracted from the Urban Atlas product; population density; and combined tropical nights (minimum temperature exceeds 20°C) and hot days (maximum temperature exceeds 35°C) for the periods 1971–2000, 2021–2050, and 2071–2100, an output based on multiple regional climate models from European FP6 project ENSEMBLES (see below the list of datasets and methodology used). The map also includes pop-up



↑ The EEA's heat wave risk map, powered by ArcGIS Online, shows that the southern region of Europe is most likely to see an increase in daytime and nighttime temperatures due to global climate change. (Source: EEA.)



↑ The EEA's map of heat wave risk of European cities inspired the above ArcGIS Online story map "Outlook for European cities: higher temperatures and longer heat waves." Tell your own stories using Esri's storytelling templates and from within the ArcGIS Online map viewer and publish your web maps into them. (Source: EEA.)



↑ Eye on Earth, EEA's custom website powered by ArcGIS Online, features many environmental maps and invites users to share their observations and data.

windows for the 500 cities that show the city name, city code, and percentage of green vegetation and blue urban area for each location.

This type of map can easily and quickly be made in ArcGIS Online by anyone. Start with one of the ArcGIS Online basemaps best suited to your needs. In addition to the Light Gray Canvas Map, you can choose from street, topographic, and imagery maps. Then simply add the layers—either a layer that has been shared on the web, for example, through ArcGIS for Server or Open Geospatial Consortium, Inc., Web Map Service services; KML or CSV layers; or your own data stored in a delimited text file, GPS Exchange Format, or shapefile. A detailed description and tags provide context and help others find your map.

EEA Wins Prestigious Honor at Rio+20

Eye on Earth, an ArcGIS Online App, was Chosen as a Solution for Sustainia100

Esri joined the European Environment Agency (EEA) at the Rio+20 Conference, held June 20–22, 2012. Rio+20 was organized by the United Nations Conference on Sustainable Development (UNCSD) and marks the 20th anniversary of the 1992 United Nations Conference on Environment and Development (UNCED) and the 10th anniversary of the 2002 World Summit on Sustainable Development. Rio+20 brought together heads of state and government and other representatives, members of the private sector, nongovernmental organizations, and others, to discuss how best to reduce poverty, advance social equality, and ensure environmental protection.

EEA is responsible for ensuring the quality of environmental information for 38 European Union (EU) states. EEA helps EU and its member countries make informed decisions about improving the environment, integrating environmental considerations into economic policies, and moving toward sustainability. It also coordinates the European Environment Information and Observation Network. Esri's ArcGIS plays a prominent role in helping EEA achieve its goal of delivering geographic visualization and analysis capabilities to environmental data consumers.

Another role of EEA is to connect the in situ monitoring data with space station observations and past reporting and help citizens understand the implications of this data. Thanks to EEA's efforts, many European countries are becoming interested in geospatial science and are consequently reaching out for the spatial tools provided by Esri and others in an effort to better communicate environmental issues to their citizens. This has led to an environmental legislation transformation within those countries.

Top Honors at Rio+20

EEA was given a top honor at Rio+20 when its Eye on Earth environmental application, based on ArcGIS Online and developed with the assistance of Microsoft, was chosen as a solution for the prestigious Sustainia100. Sustainia100 is a complete guide to innovative and scalable solutions, gathered from 56 countries spread over six continents, that are instrumental in creating sustainable societies. Building on ready and available solutions only, Sustainia100 is a tangible tool for sustainability professionals—from politicians to CEOs—dedicated to creating desirable and sustainable societies.

Individually, the solutions represent sustainable innovation in areas such as city planning, energy, fashion, water and waste management, technology, and transportation. Collectively, they provide a guide of the building blocks available for transforming our societies.

Sustainia100 is a cornerstone in Sustainia—a construction site for the desirable society we could live in if we implemented ready and available solutions. Developed by world-leading companies, organizations, and experts—in close collaboration with UN Global Compact and former California governor Arnold Schwarzenegger, the honorary chair of Sustainia's initiative Regions20—Sustainia is the first holistic introduction to the attractive, sustainable future. Sustainia100 solutions are nominees for the Sustainia Award, which honors outstanding performance within sustainability initiatives.

"Eye on Earth's place in Sustainia100 shows real recognition for information sharing," says Jacqueline McGlade, executive director of EEA. "Knowledge can change our relationship with the environment, helping us become more sustainable and resilient to the challenges ahead. We hope the award will encourage even more citizens and organizations to get involved in Eye on Earth."

Watchkeepers of the Earth

Eye on Earth provides tools for creating maps, accessing thousands of readily available maps and datasets, and managing geospatial content. People can use the network to share content with the public and among groups or for private use. Governments, research organizations, nongovernmental organizations, and the public can use the network to work together to understand problems, develop policy, design plans, and take action. The cloud-configured network also provides the foundation for other regions to create similar environmental platforms.

McGlade underscores: "Our community has a great appetite for all kinds of applications, and we can move these in and out of the cloud as needed. Every time we add a new service that has a transaction element, we see the access numbers go up and up. We have to accommodate the fact that the more information we put out there, the more people want to look at it. We anticipate that people want to do their own start-ups and their own applications out of the reference data that we are creating."

Eye on Earth provides access to essential geographic environmental data supplied by approximately 450 organizations in the agency's 32 member countries and 6 cooperating countries. Esri's ArcGIS Online technology, coupled with Microsoft Windows Azure and Microsoft SQL Azure, allows EEA to host and maintain the platform, create database and business process management systems, and integrate security constraints. GIS web applications help user groups create and share map-based services, perform analysis, and publish geospatial products.

↑ The Asa Branca favela community hopes to increase citizen participation through mapping to develop solutions that lead to new, more public infrastructure that benefit the people who live there.

Creating the Sustainable Future That We Want

EEA was a participant in and showcased the Eye on Earth application at the Eye on Earth Summit organized by the United Nations Environment Programme (UNEP) and the Abu Dhabi Environmental Agency (AGEDI) and held in Abu Dhabi this past December. EEA and Esri participate in several of the eight special initiatives launched at the Eye on Earth Summit.

The primary goal of the Community Sustainability and Resilience (CSR) Special Initiative is establishing an international community of practice linking urban practitioners and activities in the areas of sustainability and resilience. CSR Special Initiative stakeholders participated in side events at the US pavilion and within the main venue at Rio+20.

This network, connecting people with both people and information, is designed to facilitate the exchange/sharing of ideas, geospatial data, and geotechnology that can be applied to addressing these closely linked topics. Particular focus is on accomplishing the following specific objectives:

- Building and providing access to a common knowledge platform for sharing the outputs of ongoing urban sustainability and resilience programs and projects
- Connecting urban practitioners and researchers on the north–south and south–south axes to facilitate discussion of urban problems and solutions and data/information sharing
- Building the capacity of urban professionals and civil society to use available urban geospatial data, geotechnology, and management tools by providing training workshops, materials, and enhanced public outreach

CSR seeks to create a forum for exchange between projects and capability building efforts focused on urban sustainability and resilience (including climate resilience) initiatives, including the My Community, Our Earth program; the GeoInformation for Sustainable Urban Management and Resilience initiative; and the World Bank Urbanization Knowledge Platform.

According to UN-HABITAT, "A sustainable city is one where achievements in social, economic, and physical development are made to last and where social, economic, and environmental factors are in balance." And Dr. Marsha Goldberg, Association of American Geographers (AAG), adds, "Urban sustainability increasingly requires resilience against both man-made and natural disasters, as well as the associated effects of climate change."

EEA organized two key events at Rio+20 exploring how sharing information and knowledge helps everyone in designing and creating a future that is sustainable and resilient for nature and human beings. The premiere of Planet RE:think, produced by EEA and its many partners, including UNEP, highlighted the need for us to consider more environmental methods for waste management that promote healthy livelihoods for the poor who are involved in the process of recycling in many parts of the world. Additionally, EEA hosted a side event on sharing environment information in action. EEA, UNEP, the United Nations Economic Commission for Europe, and Esri were among panelists discussing the needs for making environmental information more actionable.

↑ A Community Waste Oil Program Where the Waste Oil Is Collected, Processed/Cleaned, and Then Returned to the Community as a Fuel It Can Use Again for Cooking

Ultimately, the following statement, paragraph 274 in The Future We Want, the outcome document adopted at Rio+20, highlighted the need for quality geospatial information and accessible systems, such as the Eye on Earth network:

> "We recognize the importance of space-technology-based data, in situ monitoring and reliable geospatial information for sustainable development policymaking, programming and project operations. In this context, we note the relevance of global mapping and recognize the efforts in developing global environmental observing systems, including by the Eye on Earth Network and through the Global Earth Observation System of Systems. We recognize the need to support developing countries in their efforts to collect environmental data."

For more information, contact Carmelle J. Terborgh, Esri (cterborgh@esri.com).

Amazonian States Map Threatened Borderlands

By David S. Salisbury, A. Willian Flores de Melo, Jorge Vela Alvarado, and Bertha Balbín Ordaya

↑ A River in the Transboundary Region

The 800 kilometers of boundary separating the Peruvian region of Ucayali from the Brazilian state of Acre crosses some of the wildest landscapes left on earth. The lush rain forests of this borderland region still resound with the low grunt of jaguar, while their canopy sways with acrobatic troops of woolly monkeys. Underneath the canopy roam hundred-strong herds of white-lipped peccary and the elusive and elegant ocelot.

This biodiversity inspired parks such as the Sierra del Divisor, Alto Purús, and Chandless reserves, but these forests also hold humans. The "uncontacted" Mashco Piro, Murunahua, and Isconahua indigenous people still move stealthily through the trees, seeking no contact from outsiders or their goods other than the occasional machete. As these people migrate through their reserves and neighboring parks, other traditional peoples, such as the Ashéninka, Yaminahua, and descendants of rubber tappers, live along neighboring rivers and adjacent lands. More recent arrivals include loggers, miners, and drug traffickers seeking to exploit these remote areas for high-value timber, minerals, and trafficking routes.

Improving Transboundary Planning

Recently, the Regional Initiative to Integrate South America has begun promoting a transboundary road that would bisect the forested borderlands and connect the two largest cities in the region, while the state governments seek to promote a direct ecological railroad alternative. Both transportation initiatives promise to alter forests and rivers and transform economies and cultures, but these projects also lack the base geographic information necessary to understand their potential transboundary impacts and benefits. To improve transboundary planning, a grant from the Pan-American Institute of Geography and History was obtained to lead the Workshop to Integrate Data and Improve Technical Capacity to Mitigate Environmental Challenges in the Brazilian and Peruvian Amazon in June 2012.

The workshop used GIS as a common language and shared framework to bring together 16 GIS professionals from 13 institutions and two different countries to the National University of Ucayali (UNU) in Pucallpa, Peru. Each of the participants relied on ArcGIS in its home institution and brought work laptops to allow maximum flexibility for organic group work within UNU's Amazon Borderlands Research Center.

Bringing Diverse Areas Together

In the last decade, the Brazilian and Peruvian states have increasingly targeted the borderlands for conservation and development projects but with almost no knowledge of what lies on the other side of their respective boundaries. At the same time, the impacts of illegal logging and drug trafficking have spilled across borders, causing damage to the environment, local livelihoods, and diplomatic relations.

During this weeklong workshop, participants used ArcGIS to create a database and representative map integrating spatial data from both countries. However, before beginning the technical workshop, participants and invited speakers held a conference to educate the public and local policy makers on the importance of geographic information for conservation and sustainable development. Indigenous leaders, university professors, GIS technicians, nongovernmental organization directors, and government officials shared their insights:

- How ecological and cultural diversity permeate international boundaries
- How the environmental challenges on both sides of the boundary are similar
- How local and indigenous populations have been historically marginalized in the borderlands despite their local knowledge and leadership potential to reach transboundary sustainability goals

The conference ended with all participants empowered by the importance of the workshop in providing the information necessary to make informed decisions about natural resources management, development, and conservation along and across political boundaries.

A Common Platform to Standardize Management

Despite their enthusiasm, participants quickly faced numerous challenges, such as different spatial representations of their international boundaries; outdated national datasets; low-quality and missing geographic information; and data with variable scales, datums, and projections. Undaunted, the assembled GIS technicians utilized ArcGIS to standardize the best available data. The participants decided their efforts would focus on creating a capacity-building process and products for improved transboundary management rather than one flawless map. To this end, they divided into three mapmaking groups: threats, protected areas, and ethnogeography.

Each group contained representatives from both Brazil and Peru and used ArcGIS as a common language and arena to make the important decisions necessary for transboundary mapmaking. At the conclusion of the five-day workshop, the interdisciplinary team of participants named itself the Acre-Ucayali Transboundary Geography Working Group and held up three unique transboundary maps as examples of its craft and camaraderie. However, the greatest result of the workshop was the formation of a transboundary network of professionals taking the first step toward an integration based on geographic understanding rather than speculation and uncertainty.

To continue building on the workshop, the participants signed a document declaring their intention to meet annually to continue to build a transboundary network of geographic information interchange and improve the technical capacity to solve transboundary socioenvironmental challenges. A week following the declaration, the governor of Ucayali underscored the utility of the workshop by using the workshop maps in a presentation to Brazilian, Bolivian, and Peruvian delegates at a Pan-Amazonian seminar focused on tourism and commerce. A month later, the governor and his Brazilian counterpart in Acre signed the agreement of cooperation formalizing the interchange of geographic data across their shared border.

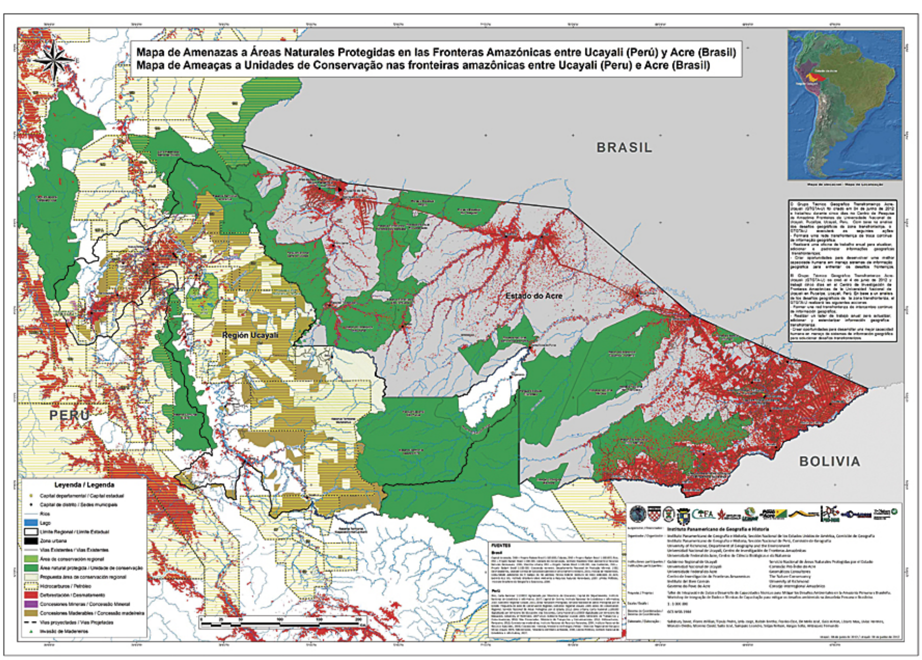
Sharing Data across Boundaries

The ability to comprehensively share transboundary data across Amazonian boundaries at the state and local scales is unprecedented and marks a major advance not only for the governments, institutions, and universities involved but also—hopefully—for the indigenous peoples, landscapes, and species in the bioculturally diverse borderlands of Amazonia. Only with improved geographic data and transboundary GIS analysis can policy makers make the best decisions possible to mitigate transboundary threats to the Amazonian rain forest.

About the Authors

David Salisbury is an assistant professor of geography at the University of Richmond, Virginia; honorary professor at the National University of Ucayali in Peru; and member of the United States National Section of the Pan-American Institute of Geography and History. A. Willian Flores de Melo is an assistant professor in the Center for Natural and Biological Sciences at the Federal University of Acre in Brazil. Jorge Vela Alvarado is professor of agronomy and director of the Amazon Borderlands Research Center at the National University of Ucayali. Bertha Balbín Ordaya is professor emeritus of geography at the National University of San Marcos in Peru and a member of the Peruvian National Section of the Pan-American Institute of Geography and History.

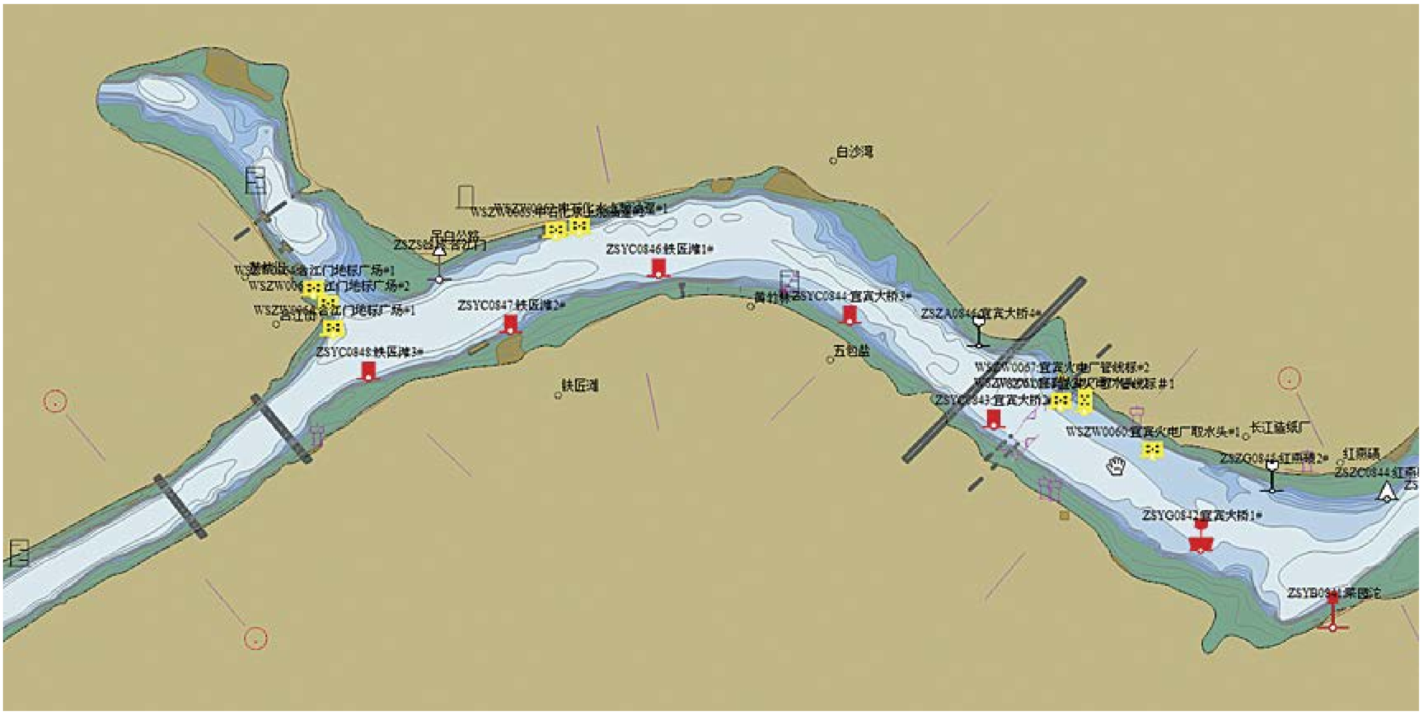
For more information, contact David Salisbury at dsalisbu@richmond.edu or 804-289-8661.



↑ ArcGIS is used to create a thematic map showing threats to protected areas.

Intelligent Charting for Asia's Longest River

The Changjiang Waterway Bureau Adopts GIS to Improve Navigational Charts



↑ Using ArcGIS, the Changjiang Waterway Bureau charts approximately 5,300 navigating markers, including beacons and buoys, along 3,915 miles of river.

The Changjiang (or Yangtze) River meanders 3,915 miles through China, from the glaciers in Tibet to the East China Sea. Since opening the river to foreign trade 30 years ago, China's shipping industry on the Changjiang River has grown by leaps and bounds. In 2011, freight volume exceeded 1.6 billion tons, making it one of the largest and busiest transport rivers in the world. Increasingly, electronic navigation devices are being used instead of paper charts to keep up with the rise in vessels on the waterway.

The Changjiang River is managed by the Changjiang Waterway Bureau, part of China's Ministry of Transport. The bureau is responsible for waterway planning, construction, management, conservation, and waterway administration on the river. The bureau's cartographers and chart makers use ArcGIS to create standardized Electronic Navigation Charts (ENCs). These charts are a vector database of the marine environment, comprising the shape of the coast; the river bottom, including depths; and the location of navigational aids along the river. More than 10,000 people work in the bureau, many charting and mapping hundreds of miles of the river and approximately 5,300 navigating markers, such as beacons and buoys, that allow ships to safely sail. Staff members are spread throughout 77 waterway management departments, ensuring that the data is collected as close to the source as possible, increasing its accuracy.

Multiple Data In—Local Authoritative Data Out

Historically, the bureau had been providing navigational reference services in the form of hard-copy charts. However, ships sailing the Changjiang River are increasingly using modern digital information technology, including electronic navigation devices instead of paper charts, and need more current ENC data. Bureau staff chose ArcGIS because it was the only solution available that could handle the large volumes of disparate geographic data used throughout the organization and distribute information quickly as ENCs.

Each local bureau creates and maintains its own data in its own projection using different software. This data, including both topographic and bathymetric data, is shared centrally with the main Changjiang Waterway Bureau in both text and Microsoft Excel data formats. The data is imported into ArcGIS using a customized toolbar that was created for users to transform local coordinates to the standard cartographic and navigational coordinate system. Once in a standard coordinate system, the data is then input into one of two centralized GIS geodatabases for either survey and mapping (terrain data) or ENC (bathymetric data).

The Changjiang Waterway Bureau has developed its own local river ENC chart standard—CJ-57—based on the maritime industry's international S-57 standard. These standards are developed to ensure digital data can be transferred from one system to another without jeopardizing the integrity of the data. Since the GIS data model is based on the industry standard, bureau staff can maintain the local data standard when it is stored in the geodatabase.

Le Xu, the ENC production technical leader, explains that the GIS and its extensible data model, objects, and attributes make meeting Changjiang standard characteristics easy, paving the way for the bureau's ENC production.

No Man Needs to Be an Island

Traditionally, multiple workstations in stand-alone mode were used by bureau cartographers to edit data and export maps and charts individually. This operational workflow has quite a few shortcomings. Many workstations must be used to store data, and the cartographers cannot interact. From a technical perspective, it is difficult to make each individual map sheet and ENC cell match exactly once they are created.

All the source data editing and modification is now centralized in the bureau's geodatabase and shared over the internal network. The end result is the ability to export seamless maps from a single database. Having a centralized geodatabase has also improved the quality of the data and cartography by reducing the inconsistencies that occurred when the maps and cells were edited individually in silos.

When a cell or sheet is checked out, the editor will get a local copy of the geodatabase, and no other editor can edit or delete this cell. This ensures there are no conflicts in editing. When the cell is checked back in, other editors can check it out for a second edit, allowing consecutive editing of the data. Inconsistencies that occurred when the maps and cells were edited individually have been reduced significantly.

Intelligent, Complex Editing

For complex editing, the bureau uses a more sophisticated workflow. Cartography in general is changing rapidly to accommodate the expectations of users. No longer is a single map produced on a paper sheet—today, maps combine foreground information for analysis, as well as a background map to give spatial context. The bureau does this by combining multiple scales for its maps. Sometimes one export file will include two scales.

GIS makes managing and editing these different scales manageable using scale band technology. The ENC in Nanjing, for example, has both 1:1,000 and 1:2,000 scales in one file. To modify the scale band, the cartographers use ArcGIS, which prompts them to edit areas of interest at the appropriate scale band.

When multiple datasets must be edited at the same time, the map tile or chart cell is first divided into continuous stream segments, or river reaches, in the main geodatabase. Then, each version is divided into different versions: contours and soundings, riverbanks, and other objects. The advantage to this workflow is the ability to modify the data without affecting another editor's edit.

Golden Opportunities on the Golden Waterway

As traffic increases, so does the risk of water accidents and loss of economic opportunities. Ensuring water traffic safety on the Changjiang River is essential to the health of the river and the national economy. Creating one unified nautical information system is helping China increase trade along its "golden waterway."

"By implementing GIS," says Shuo Xu, the ENC production team leader, "the waterway authority has improved the extensibility of the system; achieved the functionality required by the ENCs to achieve multiscale, distributed ENC production; and improved the efficiency and quality of the system."

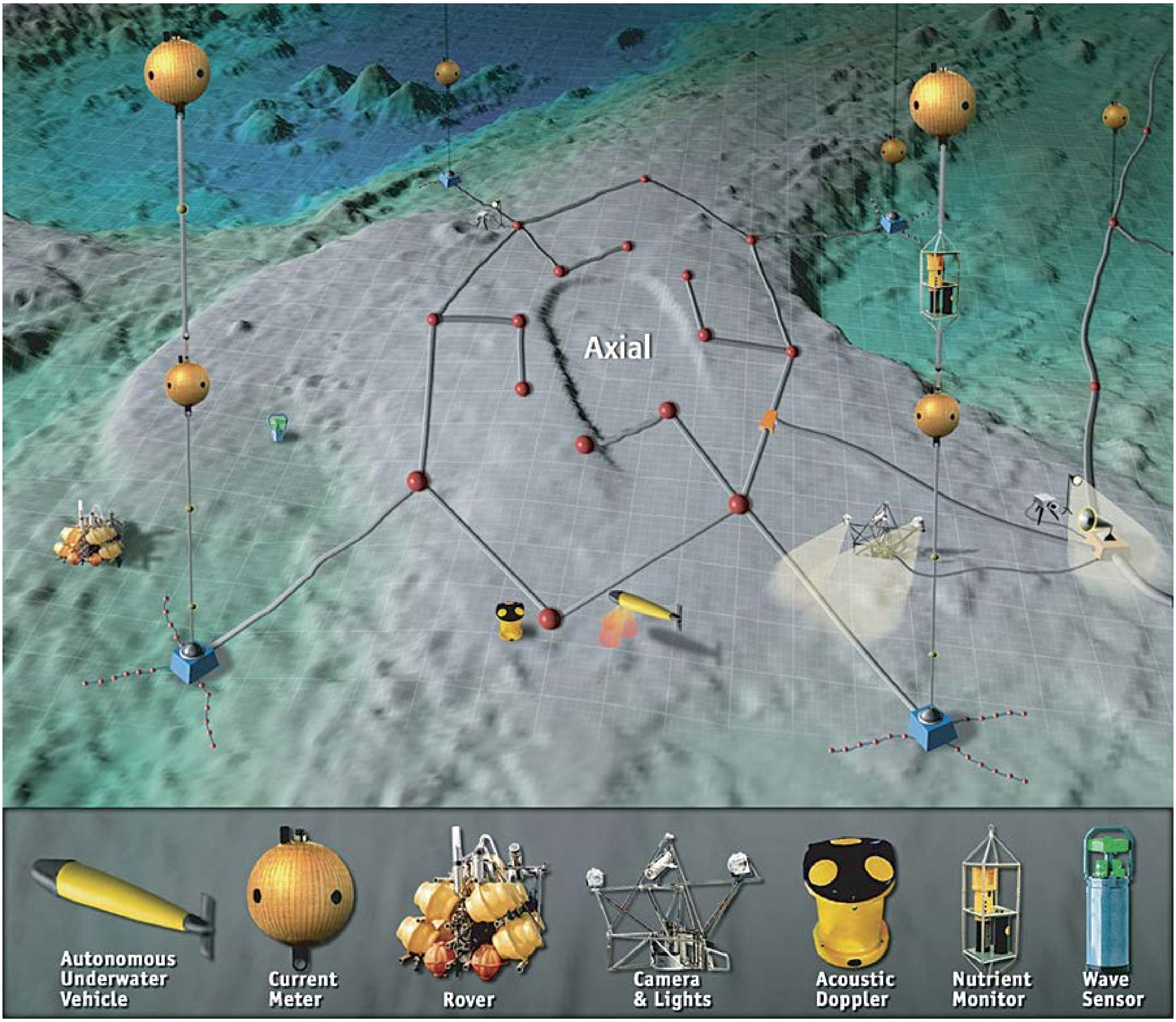
For more information on how ArcGIS is used at nautical organizations around the world, visit esri.com/nautical.

↑ Staff Member for the Changjiang Waterway Bureau Reviewing Nautical Charts

Esri's Ocean GIS Initiative

A Commitment to Understanding Our Oceans

By Dr. Dawn Wright, Esri Chief Scientist



↑ Our ability to measure change in the oceans is increasing because of improved measuring devices and scientific techniques, as well as new GIS technology.

On a planet where 71 percent of the surface is covered by water, the oceans are critical for life itself. They feed us, regulate our weather patterns, provide over half the oxygen that we breathe, and provide for our energy and economy. Yet only 5 to 10 percent of the ocean floor and the waters beneath the surface have been explored and mapped at a level of detail similar to what already exists for the dark side of the moon, for Mars, and for Venus.

GIS technology, which has long provided effective solutions to the integration, visualization, and analysis of information about land, is now being similarly applied to oceans. Our ability to measure change in the oceans (including open ocean, nearshore, and coast) is increasing not only because of improved measuring devices and scientific techniques but also because new GIS technology is aiding us in better understanding this dynamic environment. This domain has progressed from applications that merely collect and display data to complex simulation, modeling, and the development of new research methods and concepts.

The Ocean GIS Initiative

As an organization with the mission to inspire and enable people to positively impact their future through a deeper, geographic understanding of the changing world around them, Esri recognizes that this understanding must involve a strong commitment to the oceans. And that's why Esri recently launched a major Ocean GIS initiative across the entire company. The team supporting this initiative is composed of professional services staff, GIS software engineers, project managers, instructors, partners, and many others.

The Ocean GIS initiative has been motivated in great part by the need to provide effective mapping tools and techniques to respond to recent disasters such as the Deepwater Horizon oil spill in the Gulf of Mexico and the Tohoku-Oki earthquake and tsunami in Japan. It is also motivated by a sincere desire to assist in the implementation of the United States National Ocean Policy, particularly in the area of coastal and marine spatial planning, for which GIS provides a crucial decision support engine.

As part of this initiative, Esri is expanding from an initial emphasis on nautical chart production and applications for commercial shipping, maritime defense/intelligence, and offshore energy (e.g., oil and gas, wind energy) to ocean science and resource management. Esri is pursuing a greater engagement with the ocean science community, as complex ocean science questions and data are increasingly used to inform the responsible use and governance of the oceans, as well as effective management and conservation.

To support a better understanding of our oceans, Esri is focused on improving and expanding its products, tools, services, partnerships, and connections with the broader ocean community. Some of the initiatives being pursued toward this goal are outlined below.

Grow the Ocean Basemap

Esri will continue to build the bathymetry data asset in the Ocean Basemap via crowdsourcing, with a continued strong emphasis on authoritative contributions from international hydrographic offices and scientific institutions. It will also explore and implement the provision of additional public domain content layers, such as existing nautical chart services with International Hydrographic Organization S-57 symbology, and global maritime boundaries, offshore energy infrastructure, sea surface temperature, salinity, sediment classifications, acoustic backscatter, and more. Esri will also continue to make progress on a version of the basemap without labels.

More Integrated Elevation Services

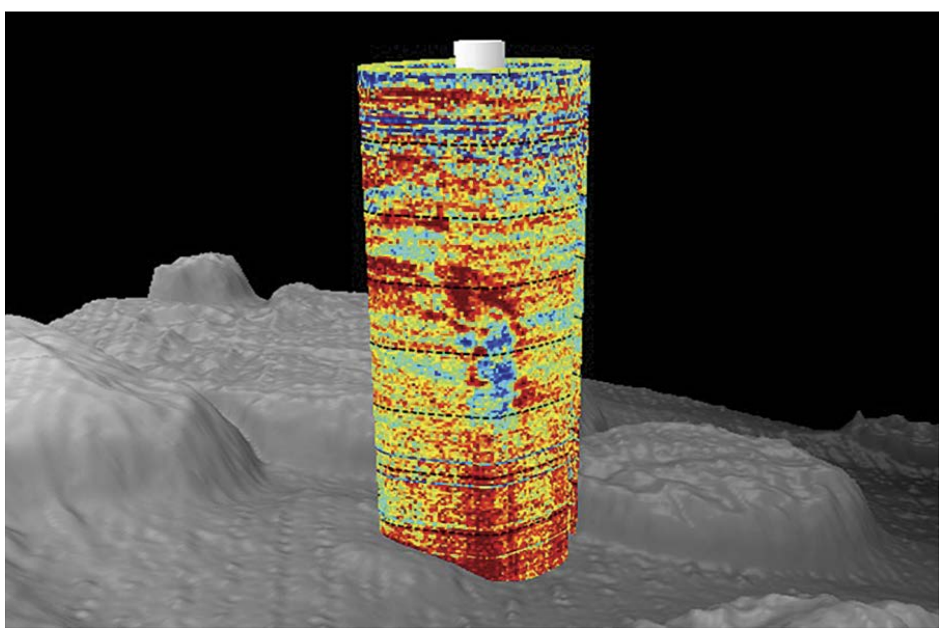
Esri will expose the Ocean Basemap as part of the World Elevation Service, making it a truly integrated "land and ocean" elevation service. This includes building in the potential for raster analytics performed against the bathymetry and other valuable ways to expose the data.

Provide Intelligent Bathymetry in the Cloud

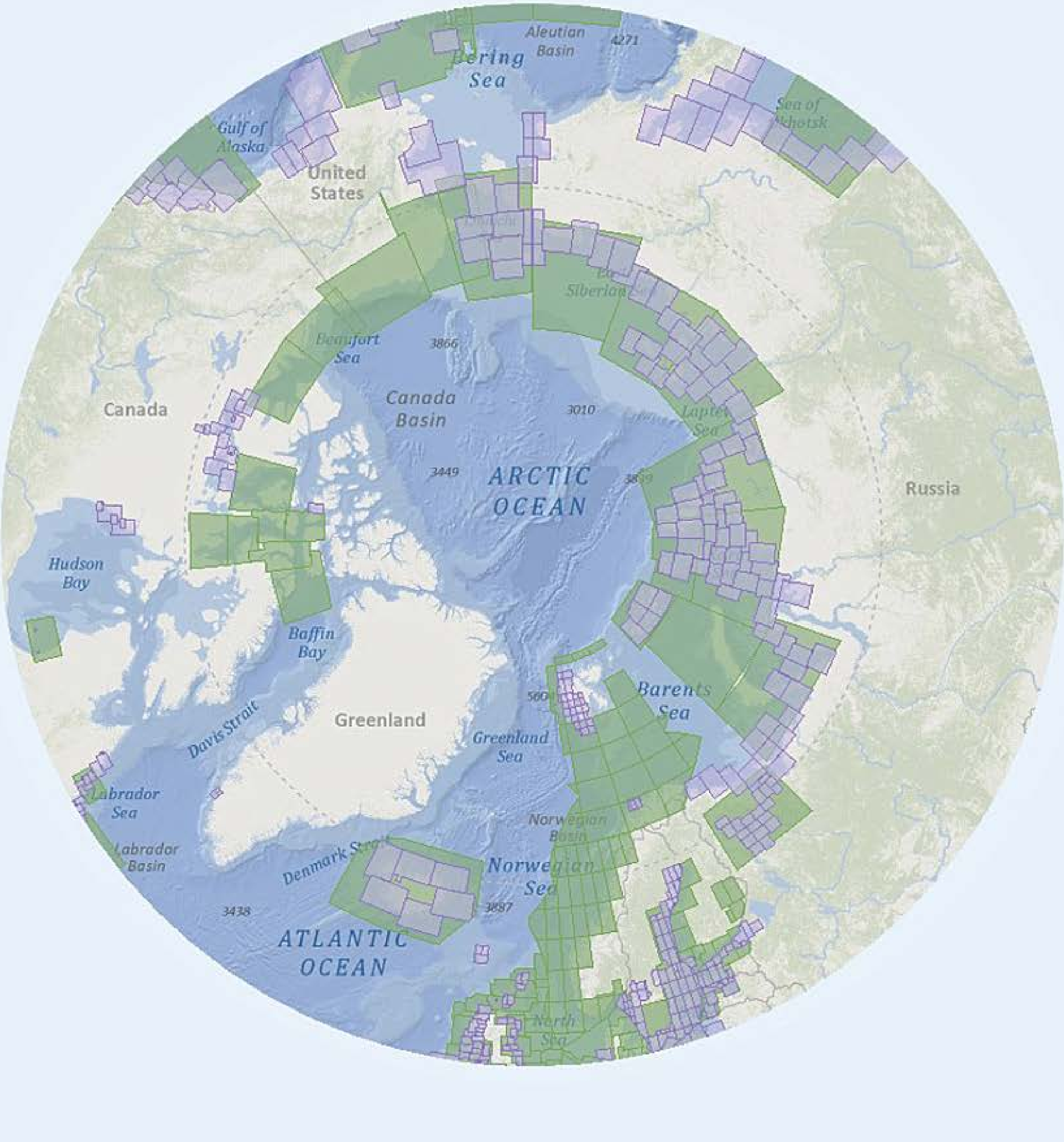
Esri's goal is to provide intelligent bathymetric services in the cloud by underpinning the Ocean Basemap with the power of ArcGIS for Maritime: Bathymetry and the bathymetric information system (BIS) therein. A BIS server would push out additional management functions for bathymetry, such as database rules to sequence and display data by highest resolution, acquisition date, and so forth, as well as have the benefit of faster performance. This capability would allow the Ocean Basemap to deploy, in the cloud, a truly worldwide model of bathymetry.

Establish ArcGIS Resource Centers for Oceans and Maritime

The ArcGIS Resources site has been reorganized and updated in conjunction with the



↑ The water column over the Deepwater Horizon oil spill in the Gulf of Mexico showing acoustic backscatter data over the wellhead. The visualization was produced by the University of New Hampshire Center for Coastal and Ocean Mapping (UNH-CCOM) using the Fledermaus midwater mapping tool. (Courtesy of ccom.unh.edu/project/deepwater-horizon.)



↑ The Ocean Basemap displayed in polar projection as part of an Esri story map. This shows the extent of the Arctic yet to be covered by nautical charts. The footprint of existing nautical charts is in green and purple.

release of ArcGIS 10.1, and final versions of an ArcGIS for Oceans and an ArcGIS for Maritime resource center are now completed. Work continues on populating these resource centers with additional content under the themes of Research and Exploration, Ocean Observation, Marine Ecosystems, Aquaculture and Fisheries, and Recreation and Adventure.

Esri is also developing an advisory group of key customers to assist with guiding the growth and further development of the ArcGIS for Ocean Use Planning section within the Oceans and Maritime resource centers. Current development projects in this arena include the following:

- The addition of economic data and demographic data services, giving all ocean use planning applications the ability to tie impacts to economy or onshore populations
- Development of fisheries management content and resources
- Development of conservation and protection resources

Convene an Oceans Summit

The Esri Oceans Summit, held November 7–8, 2012, is a primary means of advancing Esri's Ocean GIS initiative. This high-level strategy meeting was attended by a select group of intermediate to advanced ocean GIS analysts and developers. The successful event led to an annual Esri Oceans Summit, open to all users, which will serve further to establish an Esri oceans user community with a shared vision of advancing the implementation of GIS in ocean science and resource management.

Update and Support the Arc Marine Data Model

The Arc Marine data model, first published in a research monograph in 2007, has been widely adopted by agencies and organizations responsible for our oceans. It is still recognized as a valuable model, and its adoption appears to be ongoing, with a number of organizations seeking to standardize on Arc Marine. A new plan is being developed to implement the data model in the latest version of the Esri geodatabase (including the ability to use a file rather than just a personal geodatabase), as well as best practices to define a web service platform. It will be newly validated against use cases and cartographic and user requirements. A new tutorial will be prepared to incorporate a broader range of ocean datasets and possible workflows with the model.

Develop Vertical, Time-Dependent Data Transformations

In collaboration with the National Oceanic and Atmospheric Administration, Scripps Institution of Oceanography, and the US Geological Survey, Esri is developing a series of vertical, time-dependent datum transformations to help researchers transform data between ellipsoidal, orthometric, and tidally referenced elevation data at the shoreline. This is absolutely critical for coastal surveying, coastal geomorphology, and coastal terrain models that connect nearshore bathymetry for terrestrial digital elevation models that are used for storm surge, hurricane, and tsunami inundation modeling.

Improve Support for Multidimensional Data and Analyses

Satellites can clearly map the ocean surface, and acoustic sensors can map the ocean floor, but ocean scientists currently have a limited view of the water column between the ocean surface and the ocean floor. There is a critical need to study the internal structure of features in the water column, such as plumes (hydrothermal vent plumes and oil well plumes as in the Gulf of Mexico spill) or schools of fish to obtain fish stock dynamics, spawning grounds, seasonal habitats, and the impact of climate change on these. To exploit water column data, an efficient means of reading, processing, and analyzing the data is required.

Esri is continually improving support for scientific spatial and temporal data formats, such as the climate forecast convention of the Network Common Data Form 4 (netCDF-4) data model and the closely related Hierarchical Data Format. In addition, Esri seeks to better articulate to users the rich palette of 3D representation that ArcGIS already contains, such as features, TINs, vectors, multipatches, and arrays.

Esri will be adding more 3D analytics in the next generation of ArcGIS, enhancing all 3D representations to deal with the visualization and interpretation of scientific data, imagery features, point clouds, and arrays. This is particularly important in Esri's quest to improve software functionality for ocean and atmospheric GIS.

Support Ocean Numerical Models

Building a GIS platform that various kinds of numerical modelers could use to associate their efforts would provide a kind of geospatial fabric to interrelate the models. One of the most widely used models in the oceans space is the Regional Ocean Modeling System (ROMS), yet models such as ROMS pose great challenges for GIS, as they are often not uniformly spaced and may be composed of either unstructured triangles or structured curvilinear grids. There is a great need for tools to handle these grids in a more standardized way, allowing the possibility of standard access to data on the model's native grid. To address this important issue, Esri is investigating the use of netCDF Markup Language, an XML representation of netCDF metadata, which contains attributes that work effectively with the third dimension.

The Esri Oceans Summit, held November 7–8, 2012, was a primary means of advancing Esri's Ocean GIS initiative.

For more information about Esri's Ocean GIS initiative, visit esri.com/oceans.

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