2011 Esri UC Special Edition

Compass Points

Esri • Summer 2011

GIS for Map, Chart, and Data Production and Spatial Data Infrastructure

Swiss National Mapping Agency Breaks New Ground in Geodata Products

Traditionally, the key task of national mapping agencies like swisstopo (the Swiss Federal Office of Topography) has been the production of national map series. In recent years, the need for digital topographic base data has continued to increase because it is used to produce printed paper maps, as well as a variety of products, including digital multimedia products, digital elevation models, and 3D city models. For swisstopo, the increasing demand for better, more up-to-date, and more diverse digital data has meant that the generation and rapid updating of such products has taken on a high level of importance.

To create this new type of topographic data products, swisstopo established a production infrastructure called TOPGIS. This system is used to create, manage, and update the new Topographic Landscape Model (TLM) of Switzerland, as well as update a corresponding digital terrain model (DTM).

The TLM serves as the base landscape model for Switzerland's spatial data infrastructure and is a central dataset from which many products can be derived. Every feature of the TLM is stored in a geodatabase with better than one-meter accuracy in all three dimensions. Using this process has a number of advantages for swisstopo: processes are streamlined, the time to market for products is reduced, data is more accurate, and a 3D model is created.

continued on page 10

In This Issue

TOPGIS successfully marries GIS and digital photogrammetry, providing the infrastructure for the production of the TLM and DTM. (Images and maps courtesy of swisstopo, © 2009 swisstopo)

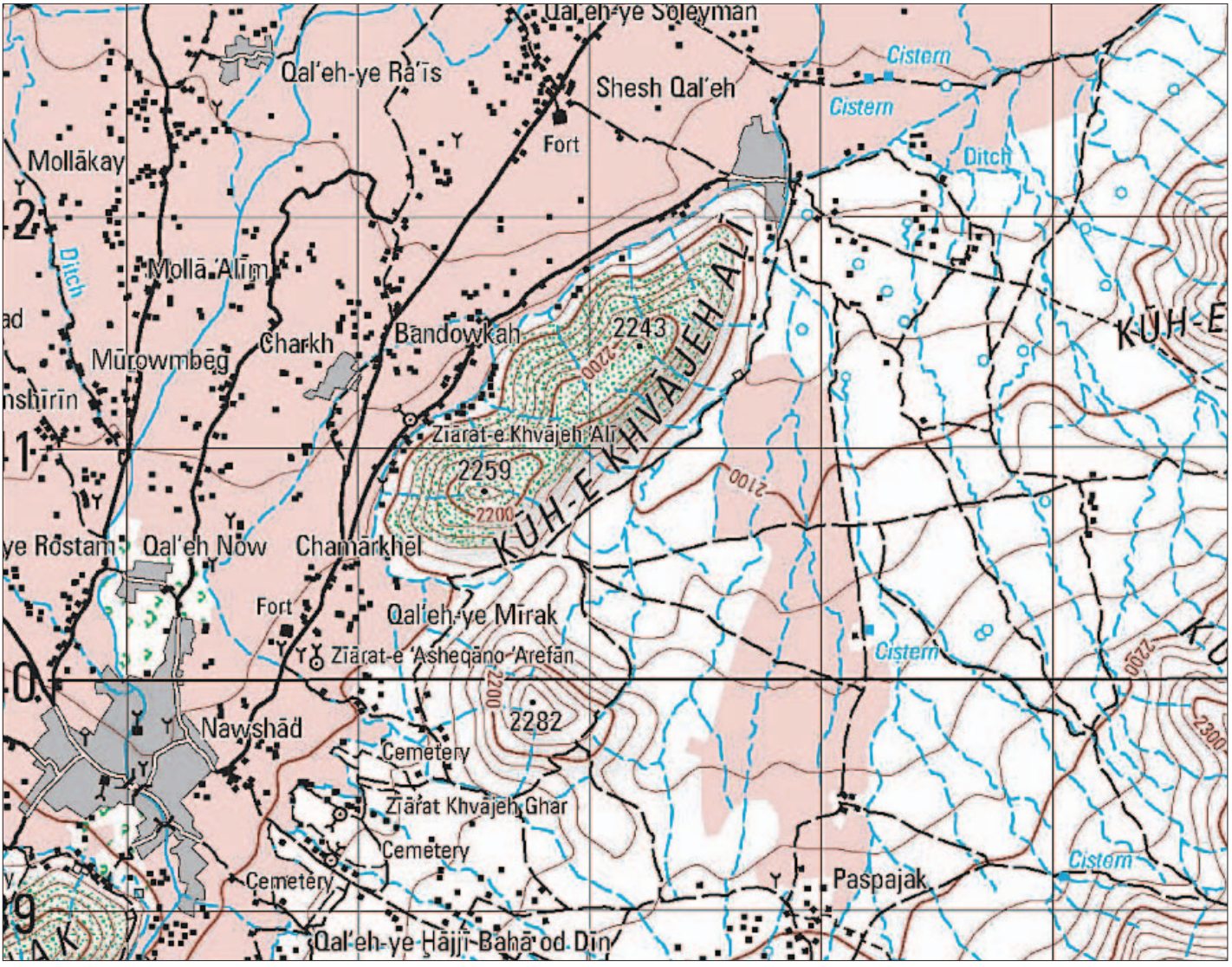
Multinational Mapmaking in the Czech Republic

A Database-centric Approach to Mapping Distant Territories

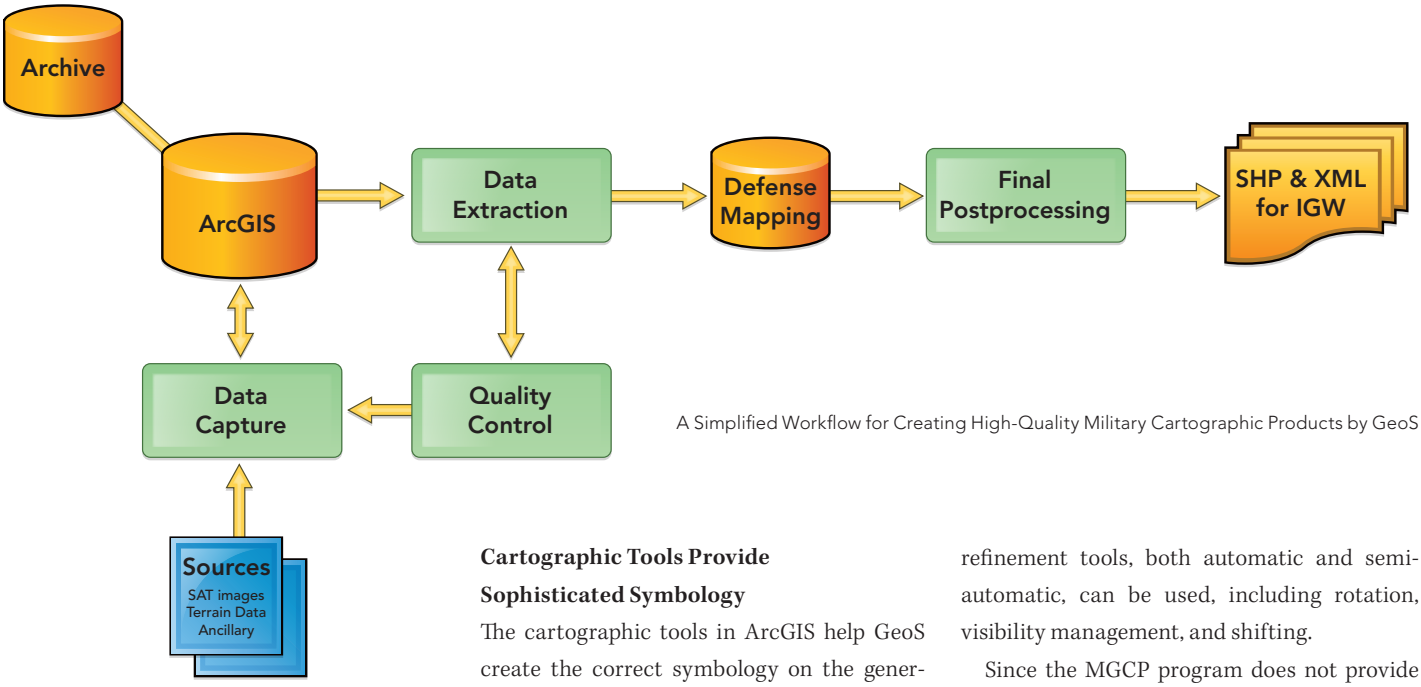
The Geographical Service (GeoS) of the Armed Forces of the Czech Republic has produced high-quality national maps for the country for decades. This experience has led the organization to offer its services to the Multinational Geospatial Co-Production Program (MGCP), an international program that brings together 28 participating countries from all over the world to assist in data production for countries where commercial satellite imagery is usually the only data source.

GeoS has been producing the maps, called MGCP Derived Graphics (MDG), since 2007. These maps resemble Topographic Line Maps at 1:50,000 scale (TLM50) and are used to support international humanitarian and peacekeeping operations in these countries.

A longtime user of Esri technology, the Military Geographic and Hydrometeorological Office (MGHO) that serves as the executive body of GeoS chose ArcGIS, including Esri Defense Mapping, to produce the MDG maps. GeoS was looking for a system that would provide a broad range of tools for various military geographic applications. Esri Defense Mapping is used by 25 of the 28 participating nations to help promote standardization of features and maps within the MGCP working group. This, coupled with the capabilities for building and maintaining digital databases and producing high-quality cartography, led the organization to choose Esri Defense Mapping for its military mapping. As a result, MGHO has built its own digital production system based on the ArcGIS platform for the MDG production workflow.



GeoS produces maps for the Multinational Geospatial Co-Production Program, like this one for the country of Afghanistan.



A Simplified Workflow for Creating High-Quality Military Cartographic Products by GeoS

A Workflow for Producing Maps Quickly

One of the typical operational requirements coming from military and civilian data users is to quickly prepare the TLM50-like map for a distant territory. As most cartographers know, this task is quite complex. The source geospatial data must be obtained in the correct format and a map created according to the specifications, including properly applied symbology. Cartographic noise, such as overlapping text on the map, must be deleted, and surrounding elements need to be refined. Finally, the map needs to be published as either a printed or digital copy. All this must be finished and delivered in a specified time frame, which is usually short.

Using ArcGIS, GeoS has a workflow that resolves several key issues when publishing these maps in such a short time frame. Staff are able to do several important tasks with ease, including creating appropriate symbology sets and harmonizing them, providing administrative boundaries, and determining appropriate map composition and finishing.

Cartographic Tools Provide Sophisticated Symbology

The cartographic tools in ArcGIS help GeoS create the correct symbology on the generated map. Technically, two new attributes must be added inside each feature class with a cartographic representation definition: the rule and the override. In general, a rule is represented by a symbol and its behavior, while an override serves as a place to store exceptions to the rule. Appropriate symbology rules have been defined for each feature class inside the MGCP database, and each feature is represented by one rule.

Rule matching for each feature is based on properly defined attribute combinations. This database-driven approach to symbolization provides many advantages: Both the digital landscape model and the digital cartographic model can coexist in one dataset. Geometry edits of cartographic representations do not change the original feature geometry. Quick symbology matching based on attribute combinations is achieved through a user-defined Python script that has been compiled for converting the landscape model into the cartographic model. The out-of-the-box MGCP symbology supplied with Esri Defense Mapping enables quick and efficient cartographic production. Improved cartographic refinement tools, both automatic and semi-automatic, can be used, including rotation, visibility management, and shifting.

Since the MGCP program does not provide elevation data and delta features, other data sources must be exploited to fill gaps in the map content. User-defined tools for processing these sources have been established, such as an ArcGIS geoprocessing model for assembling and successfully applying spot height generation. Digital Terrain Elevation Data level 2 was implemented to create contour lines, as well as shaded relief. This helps improve terrain portrayal and map readability.

Esri software has been used successfully in two editions of MDG and will continue to be the technology of choice. Using the software to create MDG data and maps helps GeoS customers receive rapid map output of the highest quality.

For more information, contact Radek Wildmann at radek.wildmann@vghur.army.cz; Vladimir Kotlar at vladimir.kotlar@vghur.army.cz; Lubos Belka at lubos.belka@vghur.army.cz; or Jan Soucek at JSoucek@arcdata.cz, ARCDATA Praha, s.r.o., Esri's distributor in the Czech Republic.

Naval Oceanographic Office Launches Enterprise Geospatial Data Services

Delivering Oceanographic Information to War Fighters and Civilians

The Naval Oceanographic Office (NAVOCEANO), based at the John C. Stennis Space Center in Mississippi, continually collects oceanographic data around the globe. NAVOCEANO uses that data to produce a wide variety of oceanographic products and services for the United States Department of Defense (DoD), along with other US government and international customers including civilian organizations. NAVOCEANO's top priority, however, is to provide the best available oceanographic, coastal, and shoreline information to US war fighters.

Oceanographers, cartographers, and geographic information system (GIS) professionals collect and analyze data from commercial and US government remote-sensing satellites and NAVOCEANO's fleet of ships, seaborne buoys, gliders, and lidar-equipped aircraft. They then turn the data into tailored oceanographic, hydrographic, bathymetric, geophysical, and acoustic products and services. These include bathymetric data for navigation; ocean measurements; and forecast properties such as tides, salinity, temperatures, wave height, swell periods, current direction and speed, optical visibility, mine detection, and acoustics. War fighters, researchers, homeland security organizations such as the US Coast Guard, and many others, greatly depend on these products and data to safely navigate vessels through ports and the open ocean and effectively plan their strategic, operational, tactical, and humanitarian missions.

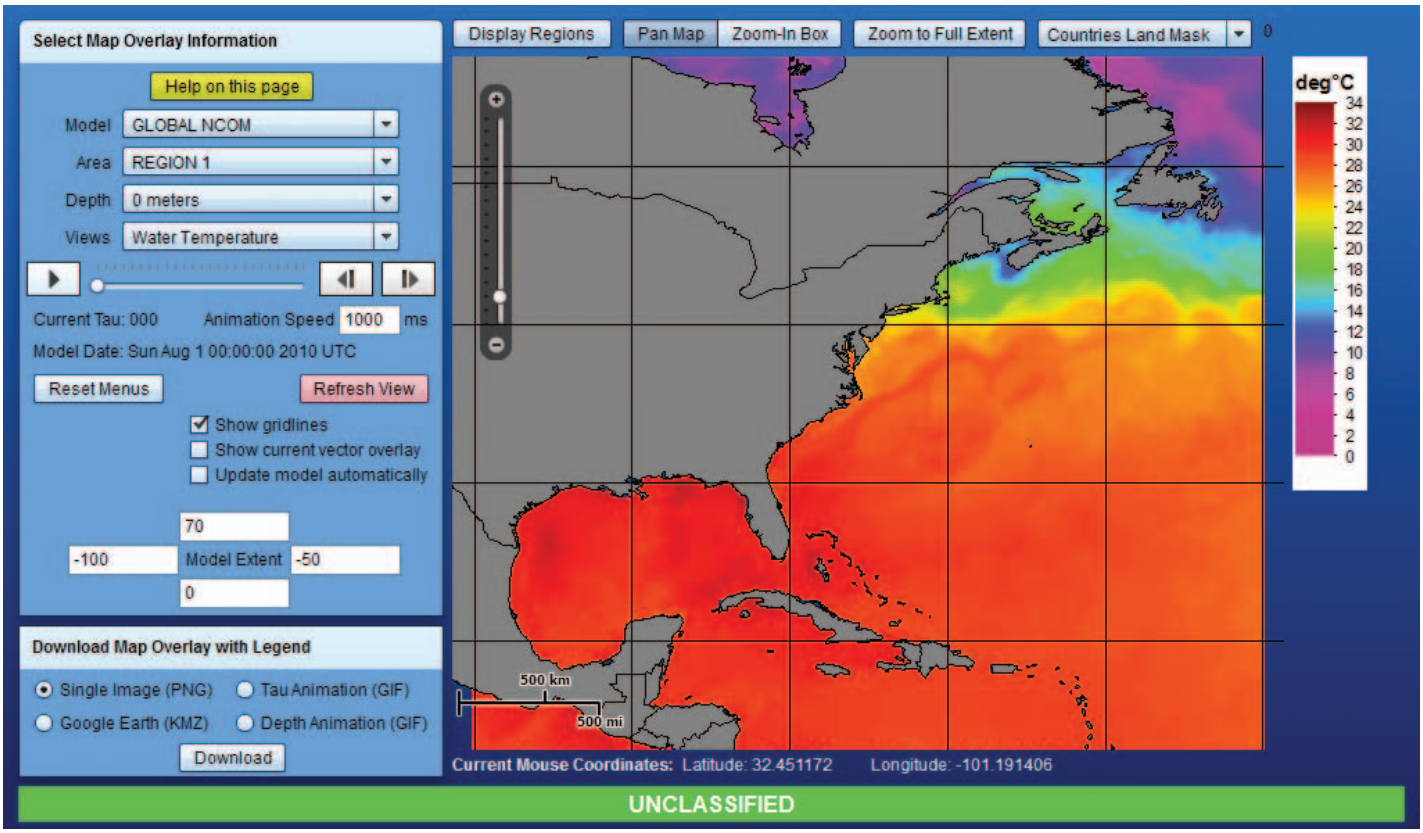
The Challenge

Facing a rising tide of data and a growing demand for dynamic, time-sensitive information about specific areas of the world, NAVOCEANO decided it needed a modern service-oriented architecture (SOA)-based system to speed delivery of data and products to mariners and give them the best tools to build custom products themselves.

Examples of NAVOCEANO's various products and services include nautical charts, ocean temperature forecasts, ocean drift and surf forecasts, port approach maps, and advanced geophysical and acoustic analyses. The organization realized that traditional methods of delivering products and services using HTML-based web pages either took too long or did not dynamically generate data detailed enough for a small area.

The Solution

NAVOCEANO contracted with Radiance



US Navy customers can generate coastal ocean model surface temperature via a customized web interface.

Users can easily visualize bottom sediments data to aid in mine warfare missions.

Technologies, Inc., an Esri partner headquartered in Huntsville, Alabama, to develop NAVOCEANO Geospatial Data Services (NGDS). The geospatial technology-based enterprise SOA serves oceanographic data, models, and products quickly and provides an easy-to-use interface for finding information and requesting advanced analysis. The geospatial technology used was Esri's ArcGIS. The NGDS also manages workflow processes, enforces DoD metadata standards, and stores data in a centralized geodatabase.

NAVOCEANO can now provide US Navy coastal ocean models (NCOMs) on demand through a customized web interface that accesses Open Geospatial Consortium, Inc. (OGC), Web Map Services (WMS). These services now replace the generation of 15,000 soft-copy regional NCOM maps daily. This saves valuable high-performance computing time, allowing NAVOCEANO to run its complex ocean models more often. Using these web services and interfaces, DoD warfighters, researchers, and customers can customize the ocean model output display by defining their area of interest, selecting the desired ocean properties by depth and time period, and generating a product image. Using this interface, they can also download the image in various formats, including .png, .gif, animated .gif, or .kml. The final output of ocean current direction vector arrows overlaid on a surface temperature model image can then be incorporated into briefing presentations or GIS technologies.

Using the NGDS secure web-based system, war fighters and others can find and retrieve this environmental data using OGC WMS, Web Feature Service (WFS), and Web Coverage Service (WCS) clients such as Esri's ArcGIS Explorer.

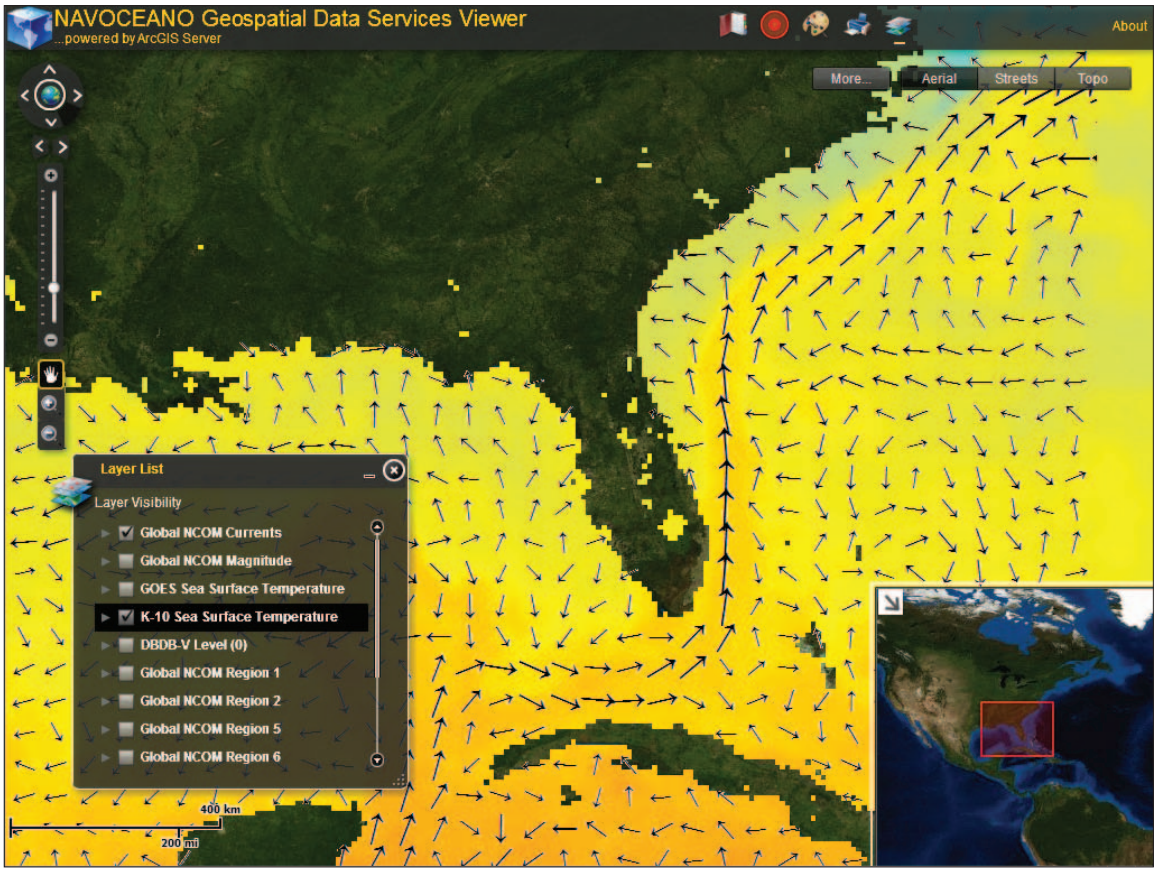
The Results

The ArcGIS Server software-based NGDS is hosted on both unclassified and classified networks. It delivers oceanographic information to NAVOCEANO production centers and authorized organizations through the use of OGC web services. This gives NAVOCEANO staff the ability to create, manage, and distribute GIS services over the web to support desktop, mobile, and web mapping applications, something they previously could not do. An added benefit of implementing an SOA based on ArcGIS Server is that authorized users can obtain NAVOCEANO oceanographic data from the National Geospatial-Intelligence Agency's (NGA) Geospatial Visualization Services (GVS).

continued on page 6

continued from page 5

Naval Oceanographic Office Launches Enterprise Geospatial Data Services



Quick and easy tools in the viewer can be used to calculate and visualize global NCOM data.

NGDS Services Available Now

The new NGDS disseminates more than 80 services that include

- Deep ocean forecasts of temperature, salinity, current direction and speed, and sea surface height
- Wave forecasts of significant wave height, mean wave direction, mean wave period, peak wave period, and height (tides)
- Sea surface temperatures derived from satellites
- Digital Bathymetric Database—Variable resolution (DBDB-V)
- Bottom characteristics important for mine warfare such as sediments, seafloor clutter, and bottom type

Services currently being developed include

- Nearshore ocean forecasts of temperature, salinity, currents, and tides
- Derived acoustic properties from NCOM
- Ocean drift and surf forecasts
- Ocean horizontal and vertical visibility
- Acoustic performance surfaces

The NAVOCEANO Esri ArcGIS Server software-based NGDS system proved to be integral in planning the navigation routes during the US government's massive response to deliver aid to the victims of the earthquake in Haiti in January 2010. NAVOCEANO production teams tapped into their geospatial databases to produce ingress/egress navigation routes for US hospital and supply ships that needed to deliver care and supplies to Haiti.

"It took four hours to produce one [navigation aid] product simply because the data was already in the system," said one production manager. He simply had to pull out and reuse existing data that was required for analysis and navigation planning. Without the system, it would have taken one or two days to produce the same navigational aid product.

Contact Information

Jennifer Hailes, Program Manager
NAVOCEANO Geospatial Data Services

Naval Oceanographic Office
1002 Balch Boulevard
Stennis Space Center, MS 39522
T 228-688-5682
jennifer.hailes@navy.mil

Keith Jester, Assistant Vice President
Intelligence/Geospatial Systems

Radiance Technologies
1103 Balch Boulevard
Stennis Space Center, MS 39529
T 228-688-3535
keith.jester@navy.mil

Extreme Cartography
World's Largest Atlas Produced with ArcGIS

The world's largest atlas made its debut at an appropriate venue—the Frankfurt Book Fair, the world's largest trade fair for books, held each October in Germany. The atlas, created by Sydney, Australia, publisher Millennium House and named *Earth: Platinum Edition*, measures 183 by 137 centimeters (6 x 4.5 feet), weighs 120 kilograms (264 pounds), and sells for US$100,000. Only 31 copies will be produced. The atlas contains 128 pages and more than 45 images of the finest contemporary maps, as well as images of famous landscapes, and is considered an artistic showpiece: a time capsule for collectors and institutions, including museums and universities. The last time an atlas close to this size was published was in the seventeenth century.

With regard to the images, the quality and resolution demanded for a book of this size has resulted in Millennium House sourcing some amazing images for the book. These images are created using the Gigapan process, which stitches together many images (sometimes hundreds) to create one massive image.

A team of cartographers around the world worked together to create the book. This process took two years from data collection to final production. Demap, one of Australia's leading custom mapping service companies, spearheaded the effort. Working as the chief cartographic consultant, Damien Demaj, former director of Demap, oversaw the collection and management of the data. Demaj was able to collect source map data from 60 collaborating cartographers around the world and manage it using ArcGIS.

Many cartographers were found through their affiliations with local chapters of organizations such as the International Map Trade Association (IMTA) and the International Cartography Association (ICA). "Just as we go to a person who lives in a particular location for a recommendation about a great restaurant in that place," explains Demaj, "we went to the local cartographers, since they know both the physical and political data of their regions the best."

Production of the atlas started from scratch. Cartographers were given style sheets and instruction booklets for how to prepare the data. Detailed questionnaires were prepared to understand the data that was available in each area. Where possible, national mapping organizations (NMO) in each country were consulted. If an NMO did not exist, data was checked against satellite imagery. Any questions that surfaced, such as the placement of political boundaries or correct location names, were brought to the attention of the local cartographer or academic organization for an unbiased decision.

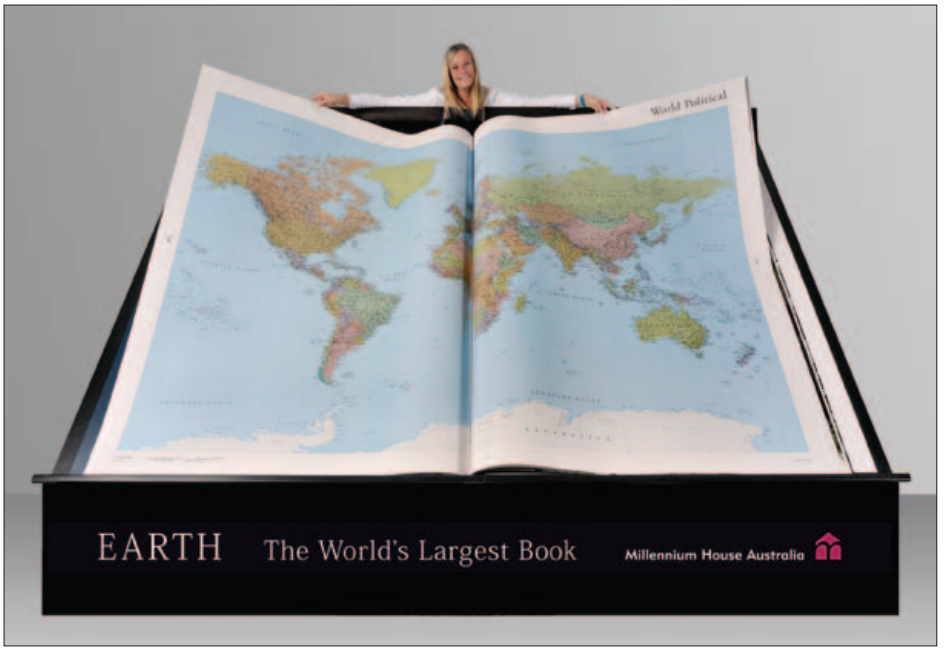
Demaj was able to bring the resultant map sheets, including line work, point data, and labels, together in a tiling process and merge them all using ArcGIS. "This was the best stable environment to use with such a massive amount of data," says Demaj.

The atlas employed ArcGIS to not only prepare the data but do the publishing as well. Maps were given only final touches in Adobe Illustrator then printed. *Earth: Platinum Edition* uses a variety of projections throughout to present maps that are aesthetically pleasing. Working with such large maps presented many challenges, including trying to visualize and gain a perspective on how the design, style, and layout of the maps would look through 22-inch monitors.

"In the past, the publishing and GIS worlds haven't really understood each other," explains Demaj. "I've found through this process that GIS can be used to produce beautiful cartography and an extraordinary atlas. It's as though the GIS producers are listening to publishers and we are finally meeting in the middle."

A smaller version, titled *Earth Blue* (610 x 469 millimeters, or 18 1/2 x 24 inches), is also available and is on display in Esri's corporate headquarters.

For more information regarding the cartography, contact Damien Demaj at ddemaj@esri.com. For inquiries about *Earth: Platinum Edition*, contact Millennium at info@millenniumhouse.com.au.



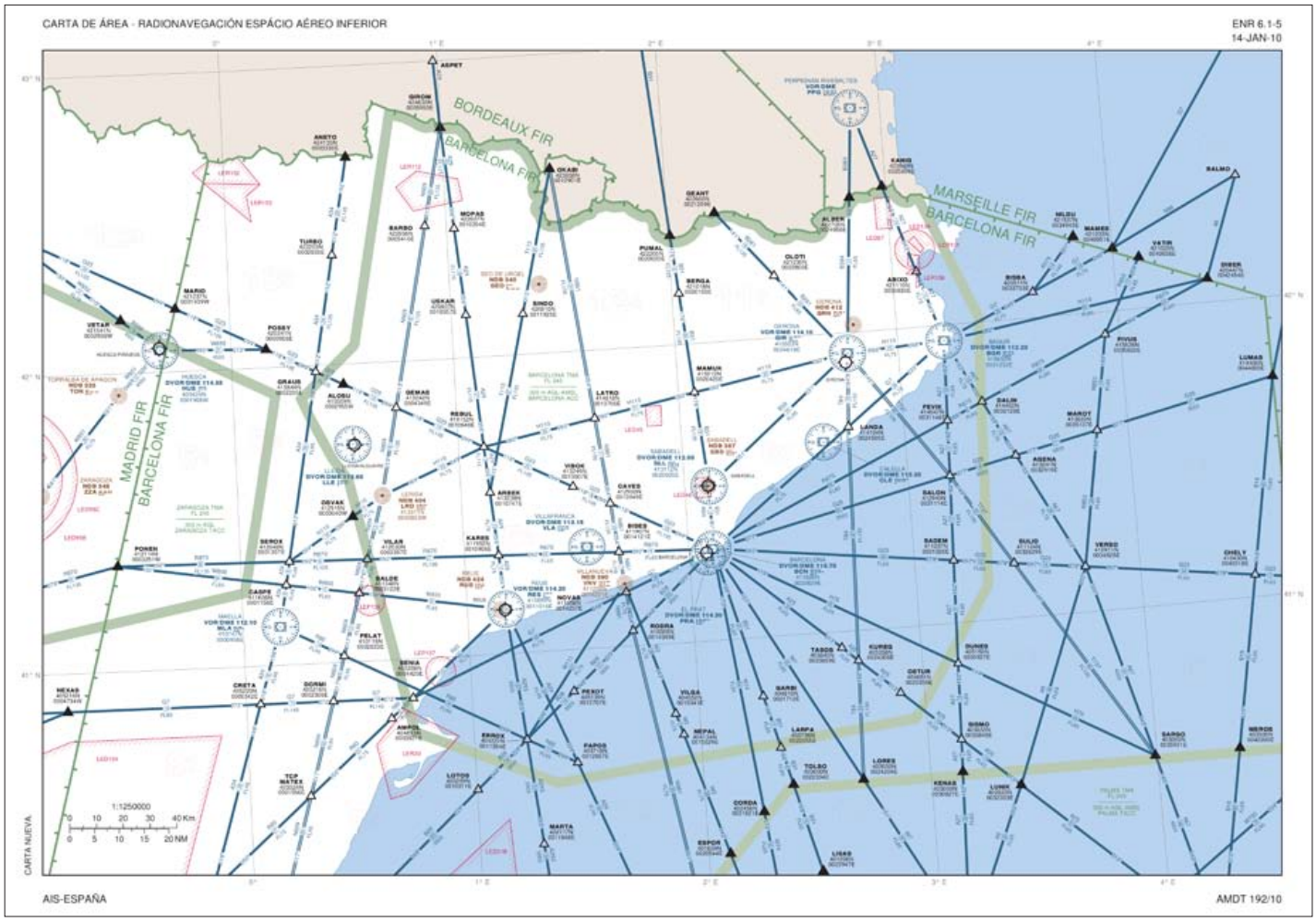
Spanish Airports and Aerial Navigation Improves Aeronautical Charting

More than 190 million passengers pass through airports in the country of Spain each year. Air transport in the country is managed by the Spanish Airports and Aerial Navigation (Aena) Public Authority, headquartered in Madrid, Spain. Aena's mission is to guarantee safe, fluid, effective, and economic air travel. The Aeronautical Information Service (AIS) at Aena is in charge of disseminating the crucial aeronautical information that is necessary for safe and efficient air navigation for the 47 airports across the state. This mission requires Aena to publish several cartographic products.

Aena maintains 1,000 charts that are updated every 28 days. These charts are published for Aena's AIS to deliver air navigation and safety-related data to pilots flying in Spanish airspace. Typically, more than 50 maps need to be updated every working week. A considerable amount of effort is spent on chart cleanup and quality check operations. Sometimes charts have to be delayed due to the lack of time and resources.

Aeronautical charts change frequently. Different aeronautical charts containing the same data must be provided to cover the needs of different end users. These requirements create editing tasks that are often highly repetitive and lengthy processes. Maintaining coherence between all the products is frequently very time-consuming. These tasks make keeping up with the current map production cycle among the biggest challenges Aena faces. The organization is under constant pressure to ensure that all products are accurate and up-to-date using the diverse information coming from various data originators.

Due to international agreements, producing and distributing paper aeronautical charts is still necessary. However, there is a growing demand for access to digital products, as well. Aena's legacy systems required separate systems for cartography and digital transmission of data in the industry interchange standard for aeronautical information, Aeronautical



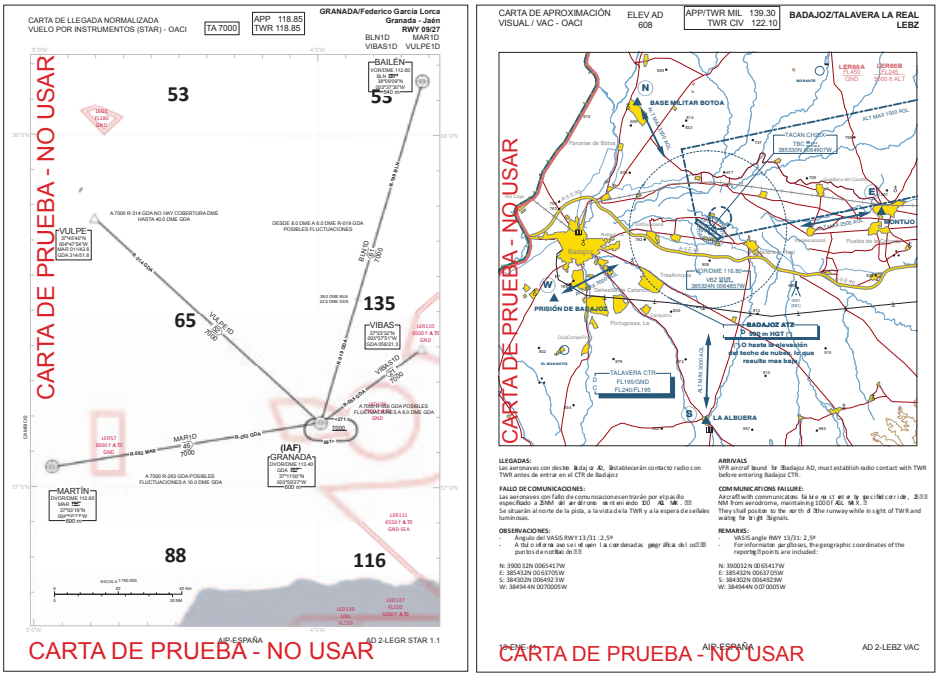
Aena relies on ArcGIS and Esri Aeronautical Solution to create environmental charts with detailed information for instrument flight.

Information Exchange Model (AIXM) format. Aena lacked a true central database that could manage both requirements. The organization needed a system to produce high-quality charts both digitally and on paper, as well as the ability to post the charts on the web for publication.

After researching available solutions, the Aeronautical Information Division at Aena selected Esri technology as part of the agency's aeronautical information management system, named INSIGNIA. The technology implemented includes ArcGIS and Esri Aeronautical Solution. The technology solutions provide Aena with the flexibility it requires to manage complex, critical aeronautical information in a spatial environment that is centered on an aeronautical geodatabase.

The system allows the design, production, and printing of high-quality charts to Aena specifications, conforming to International Civil Aviation Organization (ICAO) standards. These charts include detailed instrument approach procedures, which are documents to be followed by pilots for a particular type of approach to a runway. Prescribed altitudes and headings that are to be flown, as well as any obstacles, terrain, and potentially conflicting airspace, are depicted. Standard instrument departure charts can also be created and provide flight crews with information to facilitate their departures from airports. En-route charts provide detailed information that is used for instrument flight and includes information on navigational fixes such as waypoints, intersections, standard airways, airport locations, and minimum altitudes for flight. The system also supports interoperable messaging using AIXM.

Publishing the data using ArcGIS Server in a geodatabase makes it possible for Aena to use Open Geospatial Consortium, Inc. (OGC), standard technologies, like Web Feature Service (WFS), to provide the ability to publish maps and charts via the Internet without fear of users changing the data. This opens the door for a completely new range of products and services, allowing an improved, more efficient, and safer use of aeronautical information. Aena uses this ability to transition from the product-centric services it provides today to the data-centric services of tomorrow.



Crucial aeronautical information needed for safe flights at 47 airports throughout Spain is managed by a geoenabled AIS.

The transition to GIS for data management and cartography was a major cultural shift for the organization. Despite this, Aena is already receiving benefits from its improved processes and workflows. For example, performing the obstacle analysis used to produce some aeronautical charts for the four runways at Madrid Barajas Airport took only one day instead of the six it did before.

The ArcGIS geoprocessing tools and geodatabase-centric map production have automated tasks and improved workflows, leading to reduced production hours and dramatically increasing cost-effectiveness by improving the overall data management and usage. Aeronautical Solution has allowed high-quality cartographic products to be generated using more automation from the central geodatabase. This improves the coherence between products and allows Aena to create more and more tailored products that meet the specific needs of its clients. With the ArcGIS system, Aena has gained the flexibility needed to generate new cartographic products and deliver spatial services throughout the organization. It is able to do this with the same resources and is finding new commercial opportunities, creating a healthy business model.

For more information, contact Javier Fenoll Rejas at jfenoll@aena.es.

continued from page 1

Swiss National Mapping Agency Breaks New Ground in Geodata Products

TOPGIS Streamlines Data Production

TOPGIS is used to capture, update, and administer the TLM and DTM. The system was created by ESRI Schweiz AG, a distributor of Esri's products in Switzerland, and is based entirely on ArcGIS, including desktop, server, and mobile GIS components. Stereo photogrammetry is fully integrated through Stereo Analyst for ArcGIS from ERDAS, Inc., which gives swisstopo stereo collection capabilities inside the ArcGIS environment.

TOPGIS was designed to solve the challenges swisstopo faces in data production. Workflows need to be addressed, because up to 50 users may be working on several delivery versions of TLM in parallel. Operator productivity and system performance are crucial. Compared to the previous VECTOR25 landscape model used at swisstopo, the operators need to capture significantly more detailed data in a shorter amount of time. The production of a primary 3D model must also be addressed. This means that each vertex of each object must have accurate z-values.

As the national base landscape model, the TLM is seamless and covers all of Switzerland. It consists of 10 thematic categories ranging from land cover to man-made objects and, once complete, will contain approximately 20 million objects. These objects and all related information are stored in a geodatabase. Every vertex of the TLM objects has x-, y-, and z-coordinates, so objects in the TLM can and should stay consistent with the DTM. Originally captured by a lidar sensor, the DTM includes mass points and breaklines and is photogrammetrically updated simultaneously with the updating of the TLM.

3D Data Capture

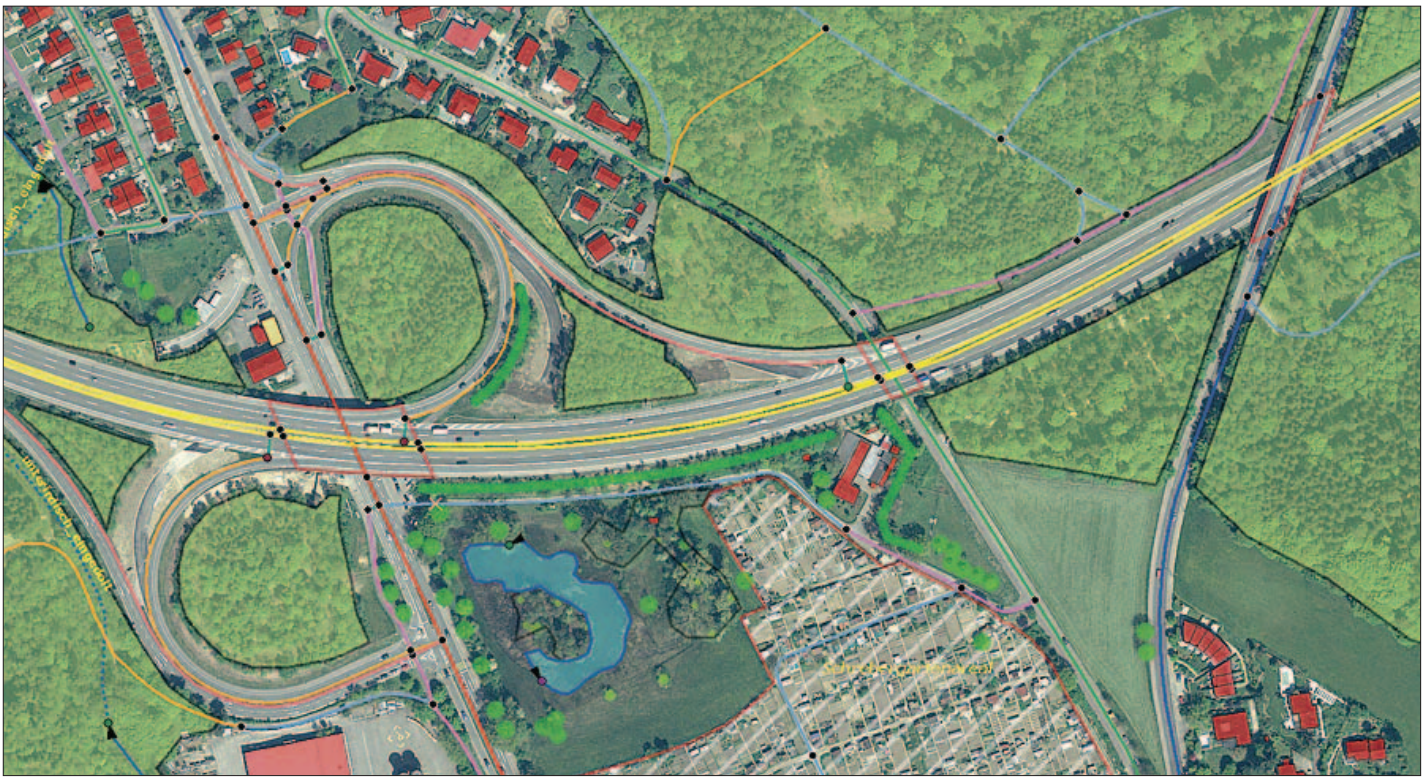
The third dimension of the TLM is captured either photogrammetrically based on high-resolution ADS40/ADS80 stereo imagery or, alternatively, by monoplotting using orthophotos and the DTM.

Twenty-inch planar stereo screens are used for stereo viewing. The polarized left lens of the glasses blocks light from the top monitor, while light from the lower monitor is blocked by the right lens. This technology allows flicker-free operation under any office's ambient light.

Three-dimensional stereo mode is used in many situations, such as when capturing objects that form or shape the terrain, for example, waterways, roads, and railways; to edit the DTM; and to capture the heights of objects, such as roofs, electric poles, and bridges.

Although the TLM is 3D, not all objects are edited in stereo mode. This is because they "sit" on the terrain, so they assume their z-values from the underlying DTM. Some examples include hiking trails, land cover, and boundaries.

In TOPGIS, mono and stereo capture are seamlessly integrated. To change modes, the operator simply moves the cursor from the 3D screen to the 2D screen or vice versa. All objects are always visible on both screens.



TLM Data Overlaid on an Orthophoto (© 2009 swisstopo)

Parallel-Release Cycles of Products Are Possible

Using the geodatabase allows swisstopo to create and maintain multiple parallel-release cycles of the TLM. Within each release cycle, the operators' work is organized into work units that define a perimeter within which a defined set of layers can be edited. Automated batch jobs reconcile the operators' daily work with the release cycle during the night, which helps prevent uncontrolled growth of the database state lineage tree.

During the reconciliation step, conflicts may be detected between the edits of different operators. For example, a road object extending over more than one work unit may have been edited by several users. The system will first try to automatically resolve conflicts. If automatic resolution is not possible, TOPGIS assigns the conflicts to a work list that is subsequently checked and manually resolved by an administrator.

Periodically during data collection, and particularly when a release cycle is completed, a multilevel, rule-based quality assurance system ensures that a predefined level of quality is met. This modular, high-performance QA system was built especially for TOPGIS and includes 3D tests.

One step in the TLM production chain is improving and completing the TLM data in the field using ruggedized handheld Tablet PCs and GPS receivers. The data is checked out from the central database in the office and subsequently edited in the field. Because Tablet PCs are used, the full functionality of ArcGIS is available to the field topographer. The GUI differs only slightly from the office mono clients. Support for GPS data capture and GPS postprocessing is supplied by the GPS Analyst for ArcGIS extension from Esri partner Trimble Navigation Limited.

Increased Productivity

To minimize the number of mouse clicks, mouse movements, and menu calls, special tools and mechanisms were built.

All relevant editing tools are available on a configurable toolbar for direct access. This toolbar can also be displayed as a pop-up menu at the current cursor position. A number of specialized tools were developed, for example, for automatically adjusting complex geometries to each other.

As the user selects which object to capture next, TOPGIS automatically sets all the edit properties (e.g., snap settings, z-capture rules, and default attributes) based on the type of object behind the scenes. These settings are predefined by an administrator and loaded automatically depending on the actual context. The operator can override the defaults if needed.

A rule engine enforces a set of consistency rules at each edit operation, helping the user prevent errors while editing. The rule engine is designed in a way that the user is not distracted by any delay.

Because TOPGIS integrates desktop, server, and mobile GIS, as well as digital photogrammetry, no data conversion steps are necessary to traverse system boundaries, as it used to be with previous solutions. Conversion is only necessary when data from third parties is imported, such as road authorities or national mapping agencies of neighboring countries, or when products are exported for customers. An individually developed component called DataHub, based on Esri partner Safe Software's FME, is used to do import and export jobs.

The hardware and software infrastructure supporting the productivity of TOPGIS is designed to ensure short response times even with the large data volumes used. To ensure availability, a DBMS failover mechanism is used. (Failover is the capability to switch over automatically to a redundant standby database.)

In operation since 2008, TOPGIS successfully marries GIS and digital photogrammetry, providing the infrastructure for the production of the TLM and DTM. This modern infrastructure has a strong emphasis on productivity and workflows, allowing swisstopo to efficiently produce an up-to-date, primary 3D dataset designed to serve as the basis for a variety of products—not just maps.

For more information, contact Martin Suter, ESRI Schweiz AG (e-mail: m.suter@esri.ch).

European Cadastres and National Mapping Agencies
Underpinning Land Management and Sustainable Development

A traditional cadastre is an official record of the dimensions and value of land parcels, used to record ownership and assist in calculating taxes. Today's cadastre, however, has evolved into a multipurpose land information system, as well as a foundational component of a nation's spatial data infrastructure (SDI). In most European countries, for example, the cadastre not only provides information about the ownership and value of land but may also include information on land use; legal restrictions; regulations concerning how land can be used; and the registration of important assets or infrastructure, such as utilities.

As the demands on Europe's national mapping and cadastral agencies (NMCAs) increase and their role continues to broaden, the fundamental importance and value of using GIS also grows. GIS technology allows NMCAs to not only run their core business national cadastre effectively and efficiently but also integrate it with other themes of information in the national SDI. In so doing, NMCAs can meet many other requirements for land and geographic information, particularly in the context of sustainable development and better land management.

Esri's GIS technology is the preferred platform of many of Europe's NMCAs. Cadastral and land registration systems vary across Europe, reflecting different historical backgrounds, cultures, legal frameworks, and organizational models. The following examples show how Esri is supporting successful cadastral systems across Europe.

Green represents European cadastral and national mapping organizations using Esri technology.

European Cadastres and National Mapping Agencies Using Esri Technology

Albania	Greece	Republic of Macedonia
Austria	Hungary	Romania
Azerbaijan	Iceland	Russia
Belarus	Ireland	Serbia
Belgium	Italy	Slovakia
Bulgaria	Latvia	Slovenia
Croatia	Lithuania	Spain
Cyprus	Luxembourg	Sweden
Czech Republic	Malta	Switzerland
Denmark	Moldova	Turkey
Estonia	Montenegro	Ukraine
France	Netherlands	United Kingdom
Georgia	Norway	
Germany	Portugal	

Lithuania's Cadastre, Valuation, and Address Management System

Lithuania's State Enterprise Centre of Registers (SECR) is responsible for the nation's real property cadastre and register, address register, and register of legal entities. It also performs real estate valuation for taxation purposes. SECR uses Esri technology for computer-assisted mass appraisal and to update, manage, and distribute cadastral and real estate information for some 2 million land parcels, 700,000 buildings, and 500,000 engineering constructions and utilities.

All of Lithuania's real estate records and cadastral data are integrated into one system. The digital cadastral map contains a wealth of information on administrative boundaries of counties, municipalities, cities, and settlements; centerlines of streets and roads; cadastre units and blocks, land parcel boundaries, and reference point coordinates; centroids for buildings and addresses; centerlines of engineering utilities; valuation zones of real properties; topography; and orthoimagery.

Prior to registration in the real property cadastre and register, SECR's 11 branch offices use the KADAGIS cadastre GIS application to remotely update the cadastral map. Using ArcGIS and the .NET Framework, KADAGIS has more than 50 user-friendly functions that efficiently control and speed up operations, such as data entry, editing, quality control, and updating of the central cadastral database. Updated cadastral parcel boundaries are entered from either coordinates or vectorization of scanned and georeferenced maps. Parcel areas and distances between boundary vertices are automatically checked. Additional attribute information is either entered manually, such as survey type and name of surveyor, or generated automatically, such as cadastral unit and block codes, municipality code, and parcel centroid coordinates. The system supports 700 checkouts for disconnected editing each day.

Providing access to the wealth of information managed by SECR is a critical and important task, as users—including private surveyors, banks, real estate agents, and citizens in general—demand more and better land information services. SECR has taken advantage of ArcGIS Server technology to support a number of applications, from browsing and viewing data to updating and integrating new data in its central registers.

A cadastral maps web application allows users to obtain information on real property cadastre and register data, property addresses, and valuation zones by searching by unique identifier, address, or geographic location. Private surveyors can also use the application to upload new cadastral (parcel) surveys in a variety of formats and compare them with existing registered parcels to ensure that parcel boundaries are correct.

SECR has also launched a lightweight web browser application that allows private surveyors and SECR staff to enter new data directly into the central cadastre database. This ArcGIS Server application eliminates the need for a desktop application to produce cadastral survey documentation. With just a web browser and a variety of editing tools on the web, a surveyor or SECR staff member is able to submit cadastral data electronically without paper cadastral files and manual data input. The system also includes digital signatures, which are already used by notaries who approve real estate deeds and other administrative documents.

Further operational efficiencies are being realized through the Address Register application, implemented using ArcGIS Server—Java, which allows municipalities to update address data, along with coordinates, directly to the central address database.

ArcGIS is also an important component of SECR's mass appraisal system, supporting taxation of real property. Because the system is GIS driven, it is possible to compute property values using a range of different characteristics, such as valuation zones, land use, area, year of construction, and building materials used. Tax formulas can be automatically applied and computed, and periodic revisions due to changes in law or tax fees can be easily accommodated. Through the application of GIS technology, SECR is able to largely automate the process, minimizing human intervention, saving time and costs, and ensuring repeatable and reliable results.

Sweden's Automated Cadastral Workflow

Lantmäteriet is responsible for Sweden's cadastral services, managing information for approximately 3.2 million properties. The

continued on page 14

continued from page 13

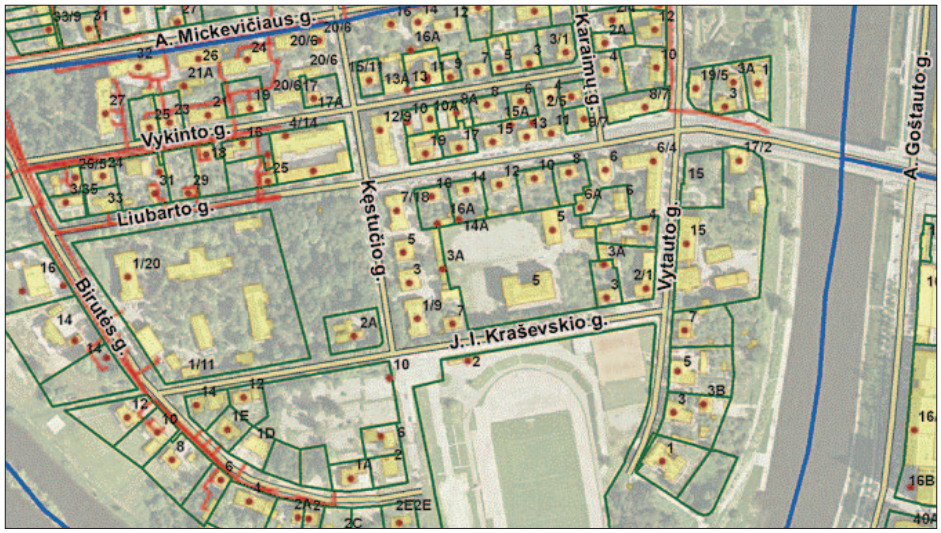
European Cadastres and National Mapping Agencies

Swedish cadastral system is well regarded worldwide for its effective land legislation and administration. Since the late 1990s, ArcGIS has been an important component of the overall system. It supports many aspects of land administration in Sweden, including surveying and mapping; real property formation; production of cadastral maps; public utilities mapping; property valuation and tax assessment; and national, regional, and local planning.

Through the implementation of ArcGIS software with other technologies, such as GPS, and new working methods, Lantmäteriet has been able to improve the efficiency of its cadastral procedures. These efficiency gains have been partly realized through better workflow and job management. Using GIS, the system ensures that legally defined procedures are followed in a unified production line. Users are taken through each stage of the process, from fieldwork and computation through data processing and documentation to the final storage of the data. Commands from a job are automatically stored to be available the next time the job is opened.

Recently, Lantmäteriet initiated a new project to deliver further efficiency through the implementation of a new case handling system that brings all property information together—both text registers and cadastral index maps—into an integrated GIS. The goal is to create an efficient cadastral procedure with which most customers can create their own cases (subdivisions) and automatically validate them against the property formation rules stored in a GIS database.

This new cadastral case handling system is part of a service-oriented architecture, whereby more general systems (e.g., financial and document systems) are connected. A central component of the system is the process engine, which has the ability to hold a cadastral case together throughout the process. The GIS solution is based on ArcGIS. The data in the GIS database comes from different sources



Lithuania's State Enterprise Centre of Registers relies on its ArcGIS software-based KADAGIS. The system features more than 50 user-friendly functions that speed up operations, quality control, and data entry into the cadastral database.

and is validated among other controls with the topology rules built into the GIS database environment. In parallel with building up the new case handling system, an ongoing project at Lantmäteriet stores and delivers object-oriented land and property information in a central database. The new cadastral case handling system will, along with other registration systems, deliver changes to and retrieve them from the central database.

Once the new system is in full-scale production, it is anticipated that process times will be reduced by 20 to 30 percent and that maintenance costs for the more integrated system will be lower.

Belgium's National Cadastre Supports E-government

The national cadastral system of Belgium is maintained by the Patrimony Documentation Department inside Federal Public Service (FPS) Finance. It contains the records of the country's 9.4 million land parcels and 1 million registered strata or condominium units. Its cadastre was initiated more than 200 years ago during the French Revolution, when Belgium's land tax and the general cadastre procedures for governing land information were created.

In 2003, FPS Finance began implementing a new cadastral system called CadMAP. The purpose of CadMAP was to migrate from old analog cadastral map sheets to a digital cadastral map files system, supporting the update and management of the vector cadastre map files and improving the quality of the cadastral maps.

To meet these goals, ArcGIS was deployed in FPS Finance's central office, as well as 10 provincial cadastre offices and 300 local survey offices. FPS Finance set up a web software solution using ArcGIS to give users intranet access to digital cadastral maps inside the new centralized file management system.

With a customized GIS application at their fingertips, staff at local offices can now create and update local cadastral plans and submit them to the provincial offices. Concurrently, provincial offices can use a customized interface to make extensive modifications and quality enhancements to the plans submitted by local offices. Meanwhile, the central office uses its own customized interfaces for official cadastral extraction and cadastral sheet printing.

Attributes and layers in CadMAP include cadastral boundaries, parcel numbers, build-

ings, administrative boundaries, streets, rivers, bridges, parcel monuments, and municipality monuments. Managing a database with 39,000 cadastre map sheets, 200,000 changes per year, and several hundred users was a challenge, but CadMAP was successful, and FPS Finance migrated from the old paper management to the new digital system while updating and continually enhancing the quality of the cadastral data.

Following the success of CadMAP, FPS Finance launched the second phase of the project. This extension to CadMAP involved migration from the desktop file system of separate map sheets to an ArcGIS geodatabase with extended web solutions, providing improved access for existing intranet users and wider access over the Internet for external users, such as notaries, surveyors, and the citizens of Belgium.

Bulgaria's Unified Information System of the Cadastre and Property Register

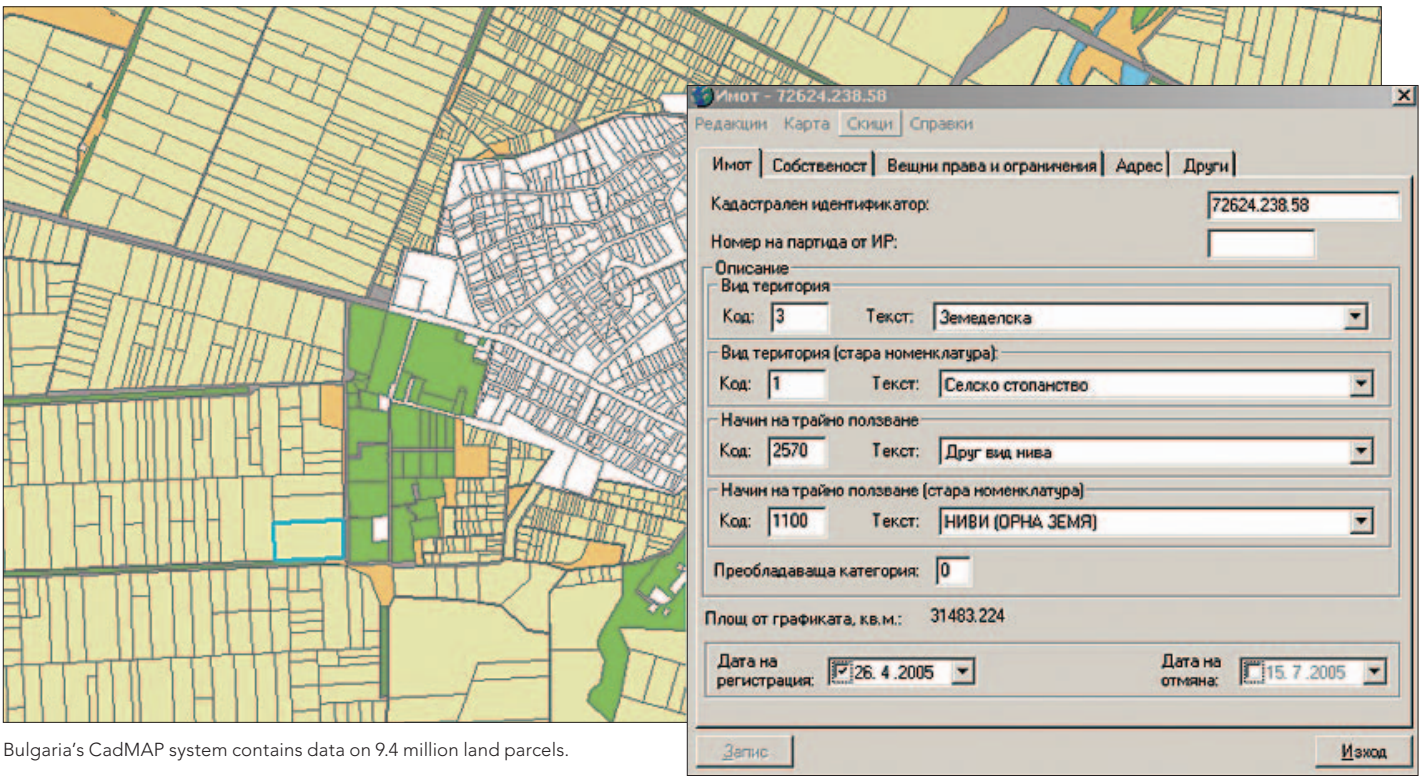
In Bulgaria, the cadastre and property registers are the responsibility of two different organizations—the Agency of Geodesy, Cartography, and Cadastre and the Registers Agency. In some European countries, the two responsibilities are combined within a single agency, but in Bulgaria, a different organizational approach is taken. The two functions continue under different administrations, but through the implementation of an integrated information system for the cadastre and property registers, the two agencies are able to realize many of the benefits of having a unified agency.

In 2003, the Agency of Geodesy, Cartography, and Cadastre selected ArcGIS technology for its cadastral information system and implemented the solution in its central and 28 regional offices. The system supports all aspects of the cadastral workflow, from data input (from CAD files) through data management, visualization, and extraction of statutory documents in either hard or soft copy to ongoing maintenance of the cadastral data, including the full history of changes.

Subsequently, this agency initiated a joint project with the Registers Agency to implement a new integrated cadastre and property register system. The new system combines the cadastral parcel data with the ownership and legal information for each property within one database at the central level while allowing distributed updating from the local cadastre and registry offices.

This partnership approach has delivered a number of cost efficiencies and other more qualitative benefits. For example, all users now have access to the same land and property information, and all can be confident that they are working with the latest version of the data. The new integrated system is now of great importance to many GIS developments and users within Bulgaria and is laying the groundwork for much greater cooperation between public administration and private business.

For more information, contact Nick Land, Esri (e-mail: nland@esri.com).



Bulgaria's CadMAP system contains data on 9.4 million land parcels.

ArcGIS for INSPIRE

New Software Portal Supports Compliance, Data Sharing, and Discovery

GIS is valuable to government and is used extensively in many integrated applications, such as natural resources, land management, law enforcement, and economic recovery. Government is evolving to adapt to new technology changes, and more and more services are focused on web and mobile applications. New media, such as real-time data, social networks, mashups, and Web 2.0, are speeding up this change. Those who are ready embrace these changes and see new opportunities.

One change emerging in this new information society is the Infrastructure for Spatial Information in Europe (INSPIRE), the legal framework created to guide Europe's spatial data infrastructure. INSPIRE addresses pan-European issues surrounding standardized data models, services, and metadata that need to be resolved to create a geospatial platform that supports a large community of users and applications. Essentially, it will provide a road map to authoritative datasets, geospatial services, catalogs outlining content, an application program interface (API) for developers to create value-added applications, and core geospatial applications that can be used throughout Europe.

Through the INSPIRE framework, European Union (EU) member nations hope to better address issues and challenges they face in the environment, through climate change, in maintaining the health and safety of their populations, with transportation issues, and more. The ability to create these new solutions through this framework will be open to everyone: government, data infrastructure developers, the research community, application developers, data infrastructure innovators, and the general public. INSPIRE aims to integrate all levels of government by supporting open access, collaboration, and harmonization and is the core pillar of the European geospatial information society driving the adoption of geospatial data.

To support this community, Esri has adapted the ArcGIS system to provide a common platform for GIS applications throughout any European organization. This solution, ArcGIS for INSPIRE, extends ArcGIS and provides discovery, view, and download services for INSPIRE-compliant data, as well as the ability to create metadata and data models for those who need it.

Sharing Geospatial Data across Europe

ArcGIS for INSPIRE helps EU member nations share harmonized geospatial data across Europe. Sharing can take place between countries, at various levels of government, and in the private and research sectors. The economic benefits of creating data once, sharing it, and using it multiple times are exponential and can be done easily through collaboration and mashups available via modern technology. ArcGIS for INSPIRE upholds the vision of INSPIRE not as an isolated activity but as a baseline that supports the geospatial enabling of a variety of domains. Using ArcGIS for INSPIRE, data can be available when it is needed in an interoperable manner. This helps streamline decision-making processes and allows organizations to react helpfully to situations where it is needed, such as environmental emergencies. For example, the European Environmental Agency (EEA) is able to share data, as well as reports, as it provides information that supports policy making across Europe. Such reports as EEA's "Mapping the Impacts of Natural Hazards and Technological Accidents in Europe" address hazards and offer explanations as to why they occur based on research. Researchers and others can in turn take this data and do their own research for a more intimate look at regional challenges.

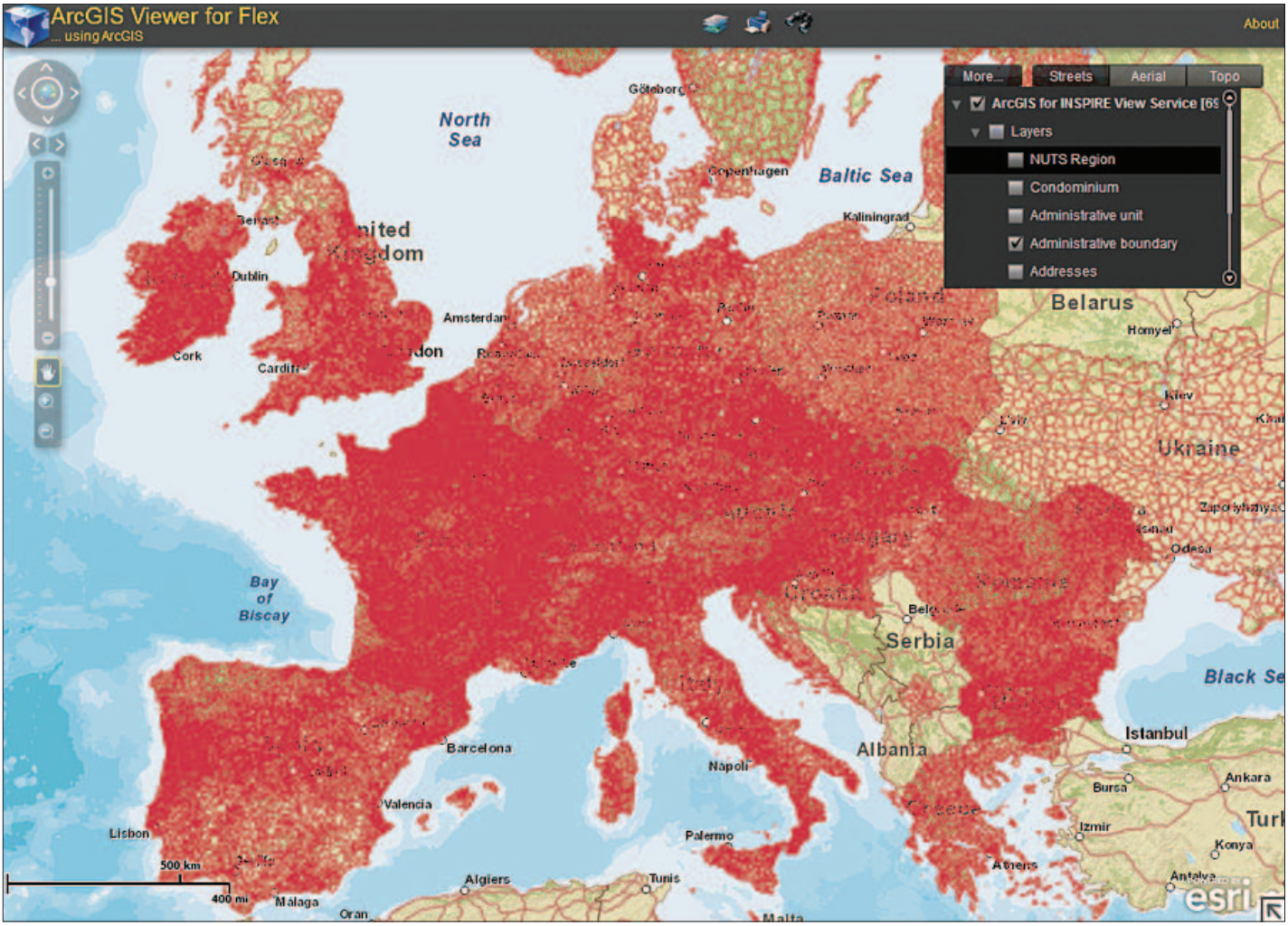
While exciting, INSPIRE compliance can also be challenging. Data owners must publish their data, and member nations are responsible for organizing their data so others are able to apply it to their own needs. Specifications for data publishing can be complex, and there are strict conformance requirements. ArcGIS for INSPIRE helps organizations more easily and quickly comply with INSPIRE.

INSPIRE is very diverse, covering data, metadata, and discovery of the data, as well as access, sharing, monitoring, and reporting. Data themes can be open-ended depending on the needs of those who create the data. EU member nations are required to have metadata and discovery views of their data according to INSPIRE regulations by the end of 2011. The next milestones in the INSPIRE implementation road map include the download and transformation of data, as well as the ability to create INSPIRE-compliant Annex I data. The INSPIRE Directive addresses 34 spatial data themes needed for environmental applications. These themes are subdivided into three annexes for the directive. Down the road, the ability to continue supporting new iterations of data (e.g., Annex II and III data) will be required for INSPIRE compliance. ArcGIS for INSPIRE provides a GIS foundation for the INSPIRE platform, evolving to continue to meet requirements, that can support the entire supply chain, from data providers to consumers. Taking the complexity out of INSPIRE compliance means that more business needs can be met as extensible INSPIRE-compliant solutions are delivered.

Helping European Organizations Become INSPIRE Compliant

ArcGIS for INSPIRE meets the core requirements of INSPIRE, including

- Managing and publishing INSPIRE-compliant data
- Managing INSPIRE-compliant metadata
- Transforming existing data into INSPIRE-compliant data
- Providing INSPIRE-compliant view services



Flex Viewer Consuming an INSPIRE View Service Displaying INSPIRE Data (This product includes intellectual property from European national mapping and cadastral agencies and is licensed on behalf of these by EuroGeographics.)

- Providing INSPIRE-compliant discovery services
- Consuming INSPIRE-compliant geospatial data and services

ArcGIS for INSPIRE is an extension to ArcGIS software. ArcGIS for INSPIRE includes INSPIRE data models and allows organizations to manage INSPIRE data, metadata, and web services in the ArcGIS Desktop environment. ArcGIS Server includes INSPIRE view and download services, a geoportal solution, and INSPIRE discovery services and provides a means to manage INSPIRE metadata. ArcGIS Server client APIs are available to create and customize web applications that consume INSPIRE services.

ArcGIS for INSPIRE also facilitates data sharing. Existing information from storage systems can be integrated into business processes and transformed into INSPIRE-compliant data by using ArcGIS for INSPIRE data models and web services in a data repository for spatial datasets optimized for INSPIRE data specifications. This INSPIRE-compliant data can then be delivered via INSPIRE network services through what is, in essence, a European spatial data infrastructure.

Discovering data using ArcGIS for INSPIRE is straightforward as well. Using multiple discovery services, ArcGIS for INSPIRE supports harvesting or federated searches. These discovery services are part of the software and include an open source geoportal solution. Rich desktop and web-based editors support INSPIRE metadata. Discovery service client add-ons and widgets included in the software connect producers and users throughout Europe. ArcGIS for INSPIRE also consumes INSPIRE services by allowing users to view INSPIRE services in ArcMap and various web clients.

Services Meet Management and Analysis Needs

Furnishing Raster Data for Projects Large and Small

The University of Montana supplies raster services for a variety of projects on platforms ranging from desktop computers to web browsers and mobile devices. Users access the university's raster data from locations across Montana and as far away as Alaska; British Columbia, Canada; and Kamchatka in the Russian Federation.

As part of a growing need for geospatial products, it has become critical to serve raster data in a timely and accurate manner. However, interacting with raster sources that vary in format, bands, data type, resolution, and extent can be challenging. In delivering raster products, it is also important to access raw raster values, not just a scaled-down representation or image of the data. By adopting ArcGIS Server 10 with the Image extension, the university was able to meet these challenges. The ArcGIS Server Image extension not only serves raster data to end users with ArcGIS capabilities but can also serve raster data in Open Geospatial Consortium, Inc., Web Mapping Service (WMS) or Web Coverage Service (WCS) formats to other user communities without duplicating the source or the service.

The ability to serve large raster datasets in a virtual environment using the mosaic dataset framework is one of the most important aspects of the ArcGIS Server 10 Image extension. The University of Montana has taken full advantage of the capabilities of this extension. It adopted this virtual platform because it offered scalability and ease of maintenance. When developing imagery services on this virtual platform, it was easy to transition from the development to the production stage and meet the raster data needs of projects not only on the local campus but also forest management projects and projects carried out on a subglobal scale.

Assisting Salmon Conservation

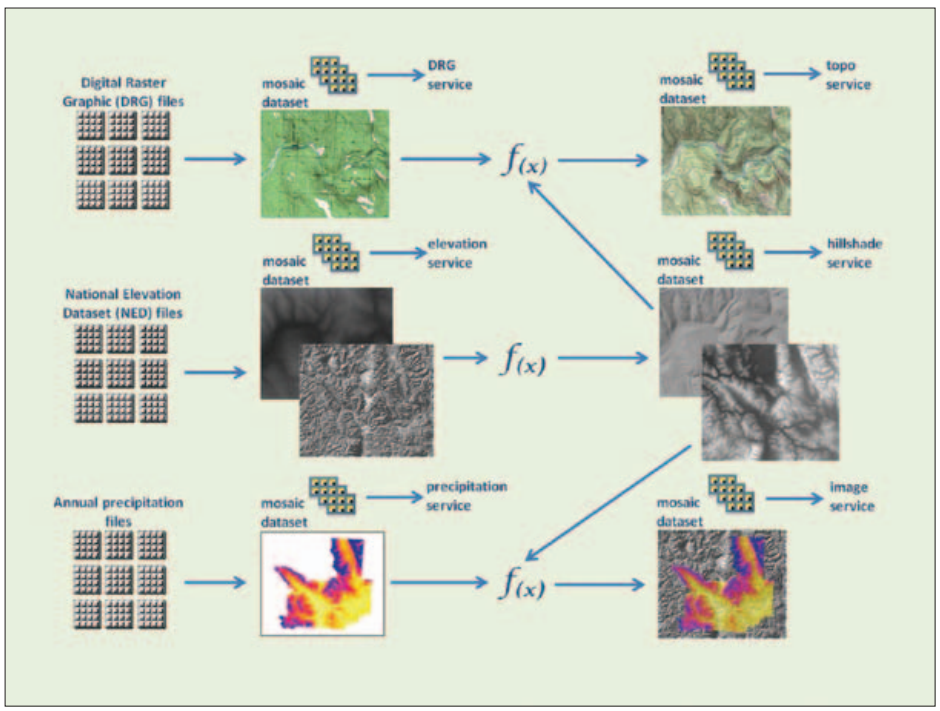
The Riverscape Analysis Project (RAP) provides a comprehensive geospatial database to document, assess, and compare the physical complexity of large salmon rivers across the North Pacific Rim. The two main components of this hydrological GIS analysis are satellite multispectral imagery and digital elevation models. The data includes seamless mosaics of Landsat Thematic Mapper (TM) imagery and Shuttle Radar Topography Mission (SRTM)-based digital elevation data that cover the entire domain and DigitalGlobe's nested finer-scale QuickBird multispectral satellite imagery of regional floodplain observatory sites distributed throughout the region.

The RAP system includes a North Pacific Rim domain that encompasses major North Pacific watersheds of the western United States and Alaska; British Columbia and Yukon, Canada; and the Kamchatka Peninsula in the Russian Federation.

The project objectives require seamlessly serving imagery and raster data for this vast geographic area to both internal and external clients. This data also must be served at two scales: the North Pacific Rim scale (Landsat TM and SRTM DEM data) and the floodplain scale (QuickBird data). The ArcGIS Server Image extension and the integration of the mosaic dataset let RAP view and analyze these image services. Specific examples include providing imagery and raster data for basemaps, watershed and floodplain data analysis, and time series analysis.

The RAP system uses a web-based GIS decision support system (DSS) based on the ArcGIS Server 10 framework to serve this extensive geospatial database to a broad user community. The DSS provides end users with a system for conducting real-time analyses and comparing watershed, riverine, and landscape features across the North Pacific Rim that is designed to assist in wild salmon conservation.

RAP DSS can create interactive ranking maps of freshwater physical habitats and salmon production potential. These ranking maps,



A workflow of raw data files to mosaic dataset to service does not replicate the disk storage of the raw files.

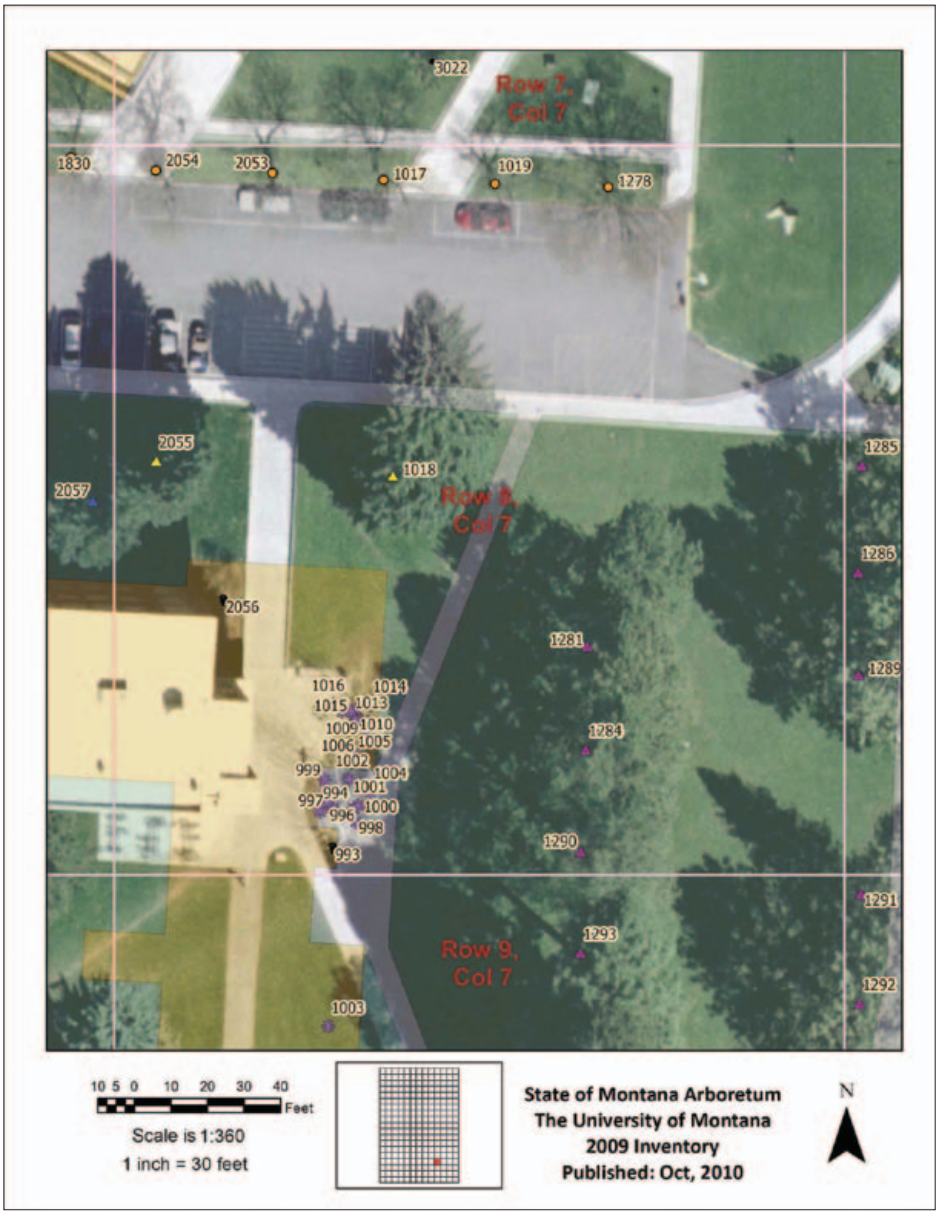
based on a set of physical metrics derived from the satellite imagery, digital terrain, and other ancillary geospatial data, describe watershed, floodplain, inland water body, and river channel complexity. RAP DSS also provides tools that allow dynamic database queries and retrieval of geospatial, raster, and tabular data from the RAP database through ArcGIS Server geoprocessing tools utilizing ArcGIS Server Image extension basemaps. It also provides imagery viewers using ArcGIS Viewer for Flex applications that display Landsat basemaps, floodplain QuickBird scenes, airborne imagery, and QuickBird time series.

Interactive DSS Tool

The Subwatershed Delineation Tool is one of the main interactive features of the RAP DSS. This Python-based ArcGIS Server geoprocessing tool allows end users to dynamically delineate subwatersheds anywhere in the North Pacific Rim domain. The use of server-side geoprocessing allows simultaneous user inputs through a web browser interface that takes advantage of a multicore virtual server architecture.

This tool requires an image basemap so the user can accurately pinpoint the mouth of a given subwatershed. A Landsat TM near-infrared band image mosaic basemap served through ArcGIS Server fulfills this need. This tool allows individuals to interact with the RAP DSS from a remote device in the field where there may be limited Internet connectivity and effectively access the RAP hydrological database, conduct fine-scale analyses, and inform on-the-spot data collection or management decisions.

The RAP system includes a diverse user group drawn from national and state agencies, universities, foreign institutions, researcher organizations, and corporations that have found the imagery services of the RAP helpful in identifying habitats, channel morphology, channel complexity, and land-cover change. RAP DSS, with its underlying geospatial data and the ArcGIS software framework, is flexible, modular, and designed to evolve as new data is acquired and user needs change.



This inventory map for the State of Montana Arboretum on the University of Montana campus integrates a high-resolution image service with a campus basemap service.

Delivering Framework Layers

Montana Spatial Data Infrastructure (MSDI) efforts are directed at advancing 13 statewide framework layers. The federal government, in cooperation with other government and private sectors, has identified 7 geospatial framework data layers for the nation. In addition to these, the State of Montana designated 6 other layers.

Two of these framework layers, elevation and orthoimagery, are raster dataset products. ArcGIS Server 10 with the Image extension is the preferred mechanism for delivering this content to users. The University of Montana, which distributes and utilizes elevation and imagery products, often prototypes deployment strategies in advance of enterprise deployments throughout Montana.

continued on page 20

continued from page 19

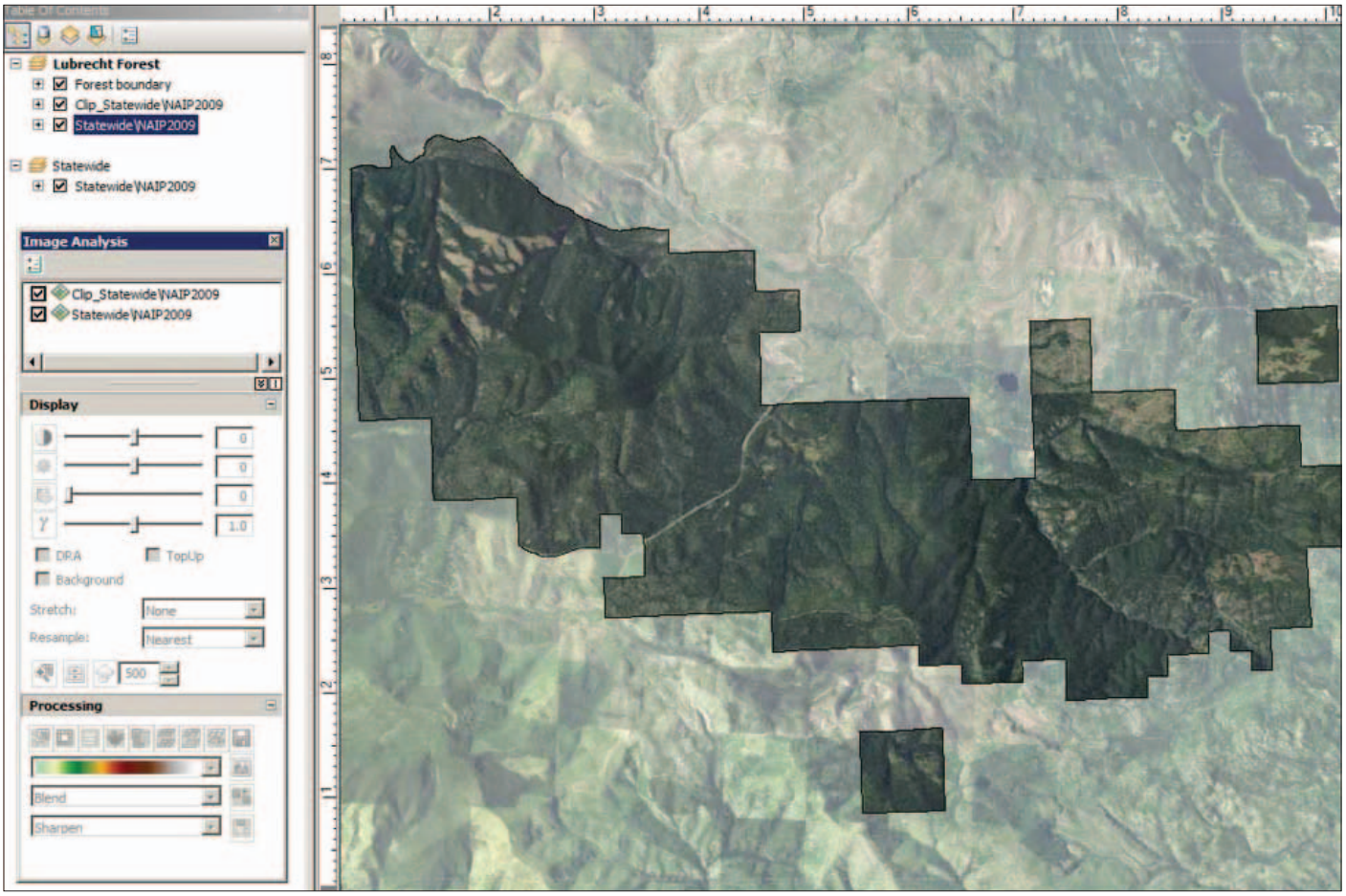
Services Meet Management and Analysis Needs

These services are built from traditional sources, such as the National Elevation Dataset (NED) raster dataset and National Agriculture Imagery Program (NAIP) imagery. However, the University of Montana also utilizes many other raster data sources. Montana strives to develop the best framework product and make that product easy to obtain. The University of Montana often collaborates with other entities in the state on strategies for optimizing the utilization of software products like the ArcGIS Server Image extension. This collaboration often extends to neighboring organizations such as Inside Idaho, Idaho's geospatial data clearinghouse, which also employs ArcGIS Server for delivering services.

Statewide or regional raster dataset products typically require extensive storage capacity. The university utilizes the services architecture of ArcGIS Server to minimize data duplication while still meeting the analytic and display needs of users. From a storage management perspective, the ArcGIS 10 environment offers the ability to move effortlessly from raw raster files to a mosaic dataset to an image service with no duplication of files. It requires little overhead to deliver seamless statewide raster products. Using the mosaic dataset, generalized overviews at varying scales can be generated from a collection of raster files and served using the ArcGIS Server 10 Image extension. This provides a visual presentation of the full extent of the source data while still making raw values available for analysis or query.

Through the Image Analysis window in ArcGIS Desktop and other geoprocessing tools, users can manipulate the raw raster values served through ArcGIS Server as if the data resided locally. Using the tools in the Image Analysis window to create a subset of data from a service is far more intuitive than working with the complex processes associated with handling raw image files. Users aren't constrained; their analytic or display needs can be met using these raster-based services.

The ability to develop new services by integrating existing services is an important aspect of this service-based architecture. Alternative outputs are derived in real time from the same source. Slope, aspect, hillshade, and topographic convergence services can be derived from a single elevation service without duplicating data. This concept of reference mosaic



This inventory map for the State of Montana Arboretum on the University of Montana campus integrates a high-resolution image service with a campus basemap service.

datasets extends to combining a hillshade service with a simple basemap service to create a topographic basemap service. This service of services approach is not only highly efficient, it retains the workflow. If one of the components in the workflow is enhanced, all downstream components immediately benefit from that enhancement without having to be re-created. Image services published through the ArcGIS Server Image extension are also a recognized data type within the mosaic dataset.

The University of Montana also hosts the Montana Climate Office, which is pursuing the delivery of statewide climate products. Time is a component of climate, and the ArcGIS 10 environment supports time at both the desktop and server levels. Delivering raster-based time series climate data gives the end user the capability to query the service based on time. The Montana Climate Office is anticipating the production of statewide climate products on a daily basis. Meeting user expectations would be extremely difficult without time-enabled raster services provided through the ArcGIS Server Image extension and the efficiency of ArcGIS Desktop products in utilizing those services.

Support for Smaller Projects

The deployment of raster services does not always have to be large in extent or complex. The University of Montana also hosts the State Arboretum on the Missoula campus. The arboretum uses the City of Missoula's 4-inch resolution imagery, as well as historic imagery, to document change over time.

Correctly configuring image services for even small raster collections can boost delivery performance for end users. Through image services, imagery can be provided to other campus users in other domains without giving them direct access to source files. In addition, the same mosaic dataset used as input to an image service can also be used as input to a map service. This provides the foundation for delivering services that merge lower-resolution imagery outside the extent of the City of Missoula imagery. From the user perspective, this provides a seamless visual context and leverages high-resolution or higher-quality imagery where it exists. In the near future, this same foundation will support delivery to mobile devices and even virtual tours of the State Arboretum.

The Lubrecht Experimental Forest is a 28,000-acre operational and research forest dedicated to the advancement of natural resource knowledge through research and education.

The University of Montana also hosts the Lubrecht Experimental Forest, a 28,000-acre operational and research forest. This location has limited Internet connectivity, so the ability to provide offline access to cached imagery is an important consideration for field operations. Even more important is the ability to deliver operational information via services hosted on the main campus. An extensive lidar research effort produced high-resolution raster datasets for ground surface, canopy cover, and canopy height. These high-resolution datasets can be delivered to remote operations even though both Internet and intranet connectivity is less than ideal.

The use of ArcGIS offers a software environment that reduces the overhead in delivery of raster datasets that vary in format, bands, data type, resolution, and extent. It provides a richer experience to end users who operate under a wide variety of conditions and enables a foundation of services that can be leveraged as new needs arise.

About the Authors

Michael D. Sweet is a research and information systems specialist at the University of Montana. He is a GIS analyst and principal architect of geographic information server applications for the College of Forestry and Conservation. Sweet is also an analyst for the Montana Climate Office, where his current research interests include the efficient delivery of time-series climate data for decision support.

John Lucotch is a research associate in GIS and geospatial analysis at the University of Montana. He is currently overseeing administration of ArcGIS Server for the Flathead Lake Biological Station and the Riverscape Analysis Project. His research includes the development of Python ArcGIS geoprocessing applications and web mapping applications for web-based GIS decision support systems.

The Riverscape Analysis Project can be found online at rap.ntsg.umt.edu.

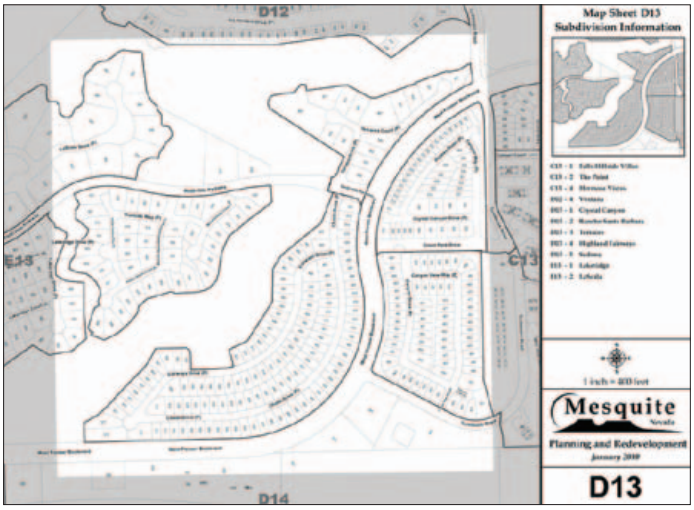
Big Benefits for Small Organizations

Automating Map Production Saves Time and Money

Adopting workflows that standardize and automate the creation of cartographic outputs from a GIS benefit not only large enterprises that create thousands of map products but also smaller organizations that regularly create map books, atlases, or other cartographic products for both internal and external customers.

Mesquite, Nevada, a city with a population of slightly more than 21,000, found cost savings by implementing ArcGIS and Esri Production Mapping. The city first published its *Address Map Book* in 1996 in CAD format. Although the *Address Map Book* was appreciated by end users, producing it was extremely labor intensive. Each year, the map book took three weeks or more to complete. Because it had become the standard reference guide for local utilities, land developers, real estate professionals, and outdoor enthusiasts, the city wanted to produce the book more quickly and easily.

The city has been using Esri GIS since 1995. Mesquite began using Esri Production Mapping in 2008 to create the *Address Map Book* because it offered the cartographic functionality not available in CAD. This included selecting features in the area of interest for each map page, dynamically placing text on the map page, and producing dynamic inset maps for each page. Using Production Mapping, the city could create the three-section *Address Map Book* illustrated with basic reference graphics and tables for each city grid tile and detailed graphics for the city's 145 subdivisions.



GIS staff in Mesquite, Nevada, now create a sophisticated map series product in two days instead of three (or more) weeks.

Instead of visiting the county offices of San Mateo, residents can download county maps as PDFs from the website.

The *Address Map Book,* a sophisticated map series product, is now created by the GIS staff in two days instead of three or more weeks using the city's GIS. There is no need for duplicate CAD or other legacy files, so these files can now be archived and removed from the server, which promotes more efficient server management and file organization structure.

With Production Mapping, map book templates can be easily modified to serve the specific needs of the police, fire, and public works departments. The city has been able to partially offset its annual software maintenance costs by charging a modest fee for printed or digital deliverables. Nearly 300 printed copies of the *Address Map Book* were requested during 2009, and the city made digital copies available in 2010. Delivering quality products is increasing the recognition for the GIS program. Using Esri Production Mapping has resulted in significant time savings for Mesquite.

When creating map products is a central service provided to an organization, it is important that the software used to create those map products fits in with the information technology department. Esri's ArcGIS platform with Production Mapping is based on accepted standards, which ensures a high level of interoperability across platforms, databases, development languages, and applications.

The county of San Mateo, California's Information Services Department (ISD) assists approximately 20 departments within the county. San Mateo County GIS, a group in ISD, maintains accurate geographic data that is used by county employees.

County GIS produces map atlases that have two predefined scales based on a grid system. Each map atlas contains between 40 and 160 map sheets. The map products include 1:800-scale basemaps, 1:400-scale aerial maps, and 1:400-scale contour maps. Until the 1990s, these map products were created using

non-GIS technology purchased at the county office. Although the county adopted enterprise GIS in the early 2000s, large-scale map atlas production was not standardized and remained a cumbersome process that required staff to build and maintain several workspaces for each map product.

The county decided to move to a web-based system but wanted to have a standardized map product first. County GIS engineers evaluated Production Line Tool Set (now known as Esri Production Mapping). The user interface for generating map atlases was more intuitive than the map plotting utilities previously used. With Esri Production Mapping, map products were standardized and their production streamlined. The county now builds a workspace for one map product and reuses the information for the others. A single layout can be used as a template to batch generate multiple maps rather than manually creating individual layouts—a significant time savings.

County GIS now provides its map products over its website, www.co.sanmateo.ca.us/portal/site/gis. The products are updated on a semiannual basis. Instead of visiting a county office, people who want county maps can download PDFs from the website and print them.

Esri Production Mapping helps organizations of any size create map products ranging from map books to advanced high-end cartography in a shared work environment that improves the quality and value of both geospatial data and cartographic products. Database-driven cartographic production—automating maps and charts based on the information stored in the GIS—makes Production Mapping a powerful tool for achieving cost savings by managing and publishing accurate data and cartographic products more efficiently. For more information, visit esri.com/productionmapping or e-mail productionmapping@esri.com.

Esri Online

Listen to New Podcasts

Visit esri.com/podcasts to hear the latest Speaker and Instructional Series podcasts.

Become a Fan

Join thousands of others from around the world in an online community on Facebook and Twitter.

Check out these Facebook pages:

- Esri
- Esri UC
- Official Esri Developer Network
- Esri Developer Network
- Esri Press
- GIS Day

Follow Esri and participate in conversations on Twitter with these hashtags:

- #Esri, #Esriuc, #Esrimobile, #ArcGIS

Follow Mark Cygan, Esri industry manager for map, chart, and data production and SDI, at @Mark_Cygan_Maps.

Follow Steve Snow, Esri industry specialist for map, chart, and data production and SDI, at @steve_snow_.

Follow *Compass Points* newsletter editor and team writer Karen Richardson at @mudmo.

Follow the map, chart, and data production and SDI industry team at @EsriMAPS.

Fall Lineup on Esri TV

Tune in to the latest videos, such as *Make a Map in ArcGIS.com,* by visiting youtube.com/esritv.

Find Resources

Visit resources.esri.com to find the information you need including help documentation, tutorials, videos, ArcGIS templates, models, and scripts.

Attend a Free Online Training Seminar

Live training seminars bring the GIS instruction you need to your desktop. Technical experts lead these hour-long sessions, which are streamed live. Should you miss the interactive presentation, you can access the recording online. Visit training.esri.com for more information.

Compass Points E-newsletter

Compass Points is also a quarterly e-newsletter that provides information for GIS users working in national mapping and charting, SDI, and cartography. To subscribe, e-mail nationalmapping_info@esri.com.

Compass Points is a publication of the Map, Chart, and Data Production and Spatial Data Infrastructure Group of Esri.

To contact the Esri Desktop Order Center, call
1-800-447-9778
within the United States
or
909-793-2853, ext. 1-1235,
outside the United States.

Visit the Esri website at **esri.com**.

125996
DUAL1.5M6/11tk

Advertise with Us
E-mail ads@esri.com.

Submit Content
To submit articles for publication in *Compass Points*, contact Karen Richardson, editor, at krichardson@esri.com.

Manage Your Subscription
To update your mailing address or subscribe or unsubscribe to Esri publications, visit esri.com/manageyoursubscription.

International customers should contact an Esri distributor to manage their subscriptions. For a directory of distributors, visit esri.com/distributors.

Circulation Services
For back issues, missed issues, and other circulation services, e-mail requests@esri.com; call 909-793-2853, extension 2778; or fax 909-798-0560.

Esri Contacts

Mark Cygan
Map, Chart, and Data Production Industry Manager
E-mail: mcygan@esri.com

Steve Snow
Map, Chart, and Data Production Industry Specialist
E-mail: ssnow@esri.com

Elianne Lozano
Map, Chart, and Data Production Industry Coordinator
E-mail: elozano@esri.com

380 New York Street
Redlands, California 92373-8100 USA