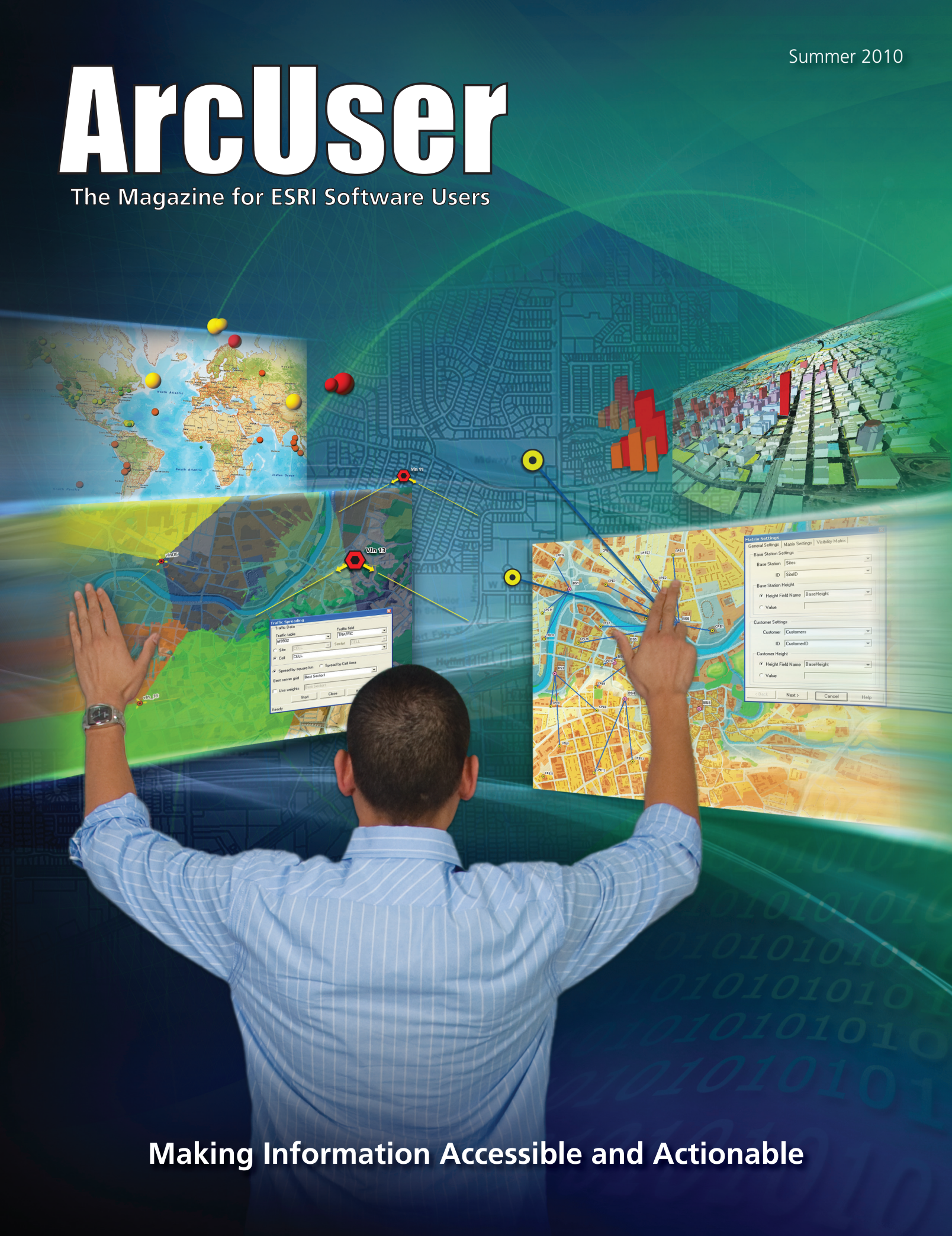
Summer 2010

ArcUser

The Magazine for ESRI Software Users



Making Information Accessible and Actionable

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In 1983 I co-pioneered high precision GPS at Trimble, introducing the four-channel Trimble 4000-S geodetic receiver. I single-handedly wrote its complete software. It was the first commercial GPS geodetic receiver and it changed the geodetic survey industry.

I founded Ashtech and in 1989 we introduced the first All-in-One, All-in-View 12-channel Ashtech L-12 GPS receiver, followed by Ashtech Z-12. These were the first truly portable geodetic receivers. We were also the first to integrate GPS and GLONASS satellites.

In 1998 I founded Javad Positioning Systems and introduced Legacy, Odyssey, and Regency GNSS geodetic products, followed by the 76-channel Prego and HiPer receivers. Other companies later copied HiPer. Today many GNSS receivers look like it.

In 2007 I founded Javad GNSS and introduced 216-channel TRIUMPH products and their OEM versions of ALPHA, DELTA, and SIGMA. We are again the first to commercially offer receivers which track current and future Galileo Satellites.

Javad Ashjaee

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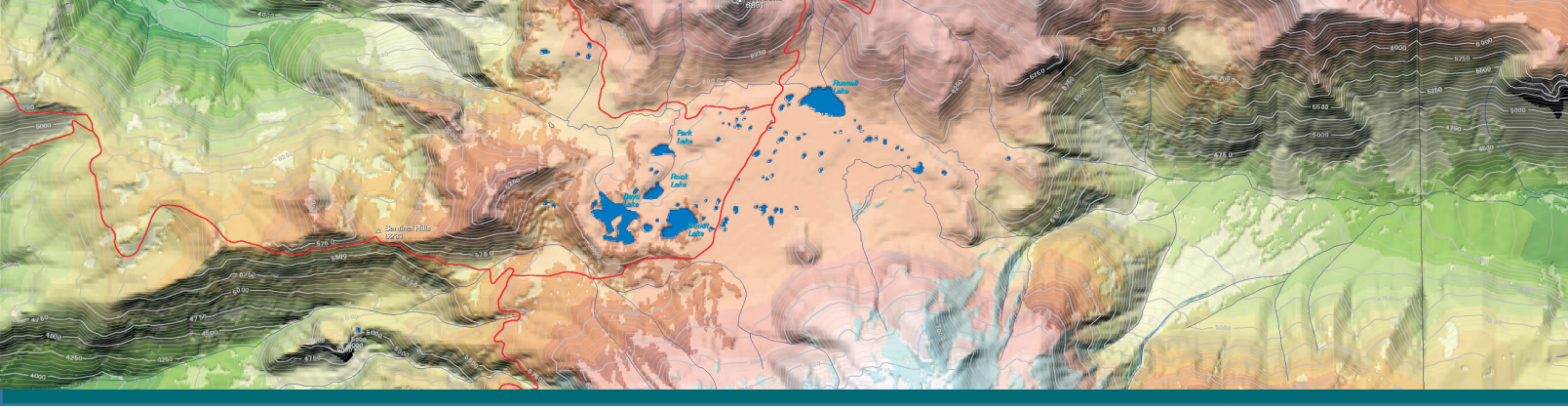

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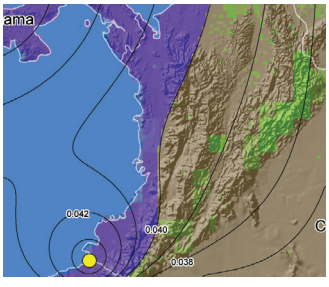
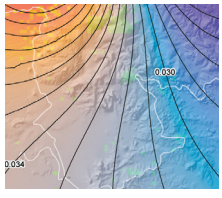
FOCUS

Making Information Accessible and Actionable





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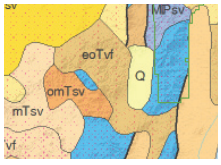

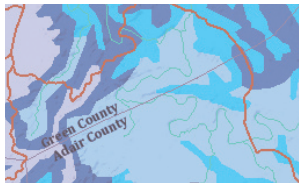

SPECIAL SECTION

Making Better Maps

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The World in Your Pocket

In 2010, our day-to-day lives have become so infused with and informed by geographic information that terms like "location-based services" have largely dropped out of the lexicon. GIS technology, operating on mobile devices and in Web applications, helps us find our way, find our friends, even find out what people we don't even know are doing all over the world *right this minute*. Fluttr, an Adobe Flex application created by designer/developer Daniel Bradshaw, mashes up ArcGIS online basemaps with live feeds from Twitter, Flickr, and YouTube and lets us peek into the lives of thousands of people.

Presenting information in a geographic context is more than just a convenience or a curiosity. Maps are powerful tools for changing minds. Just one map, the Waldseemüller world map of 1507, not only introduced the name *America* to the world (although affixing it to a continent we now know as South America) but tacitly refuted the assertion that Christopher Columbus had reached some part of Asia by depicting America as surrounded by water.

However, unlike the Waldseemüller map, which was lost for nearly 400 years, Web and mobile maps are almost universally available. Instead of having one map in your pocket, now you can easily access maps for virtually anywhere in the world, thanks to your smartphone or mobile device. The new ArcGIS for iPhone app consumes maps; contains functionality for query, find, and geoprocessing tasks; and provides access to services through ArcGIS Online or ArcGIS Server deployments.

The move to a design paradigm that employs the Web and the cloud amplifies the impact of GIS by making maps and geographic information nearly universally accessible. No longer is this information trapped in a database table, local drive, printed document, or in someone's head. Current, documented, and integrable information supplied by map services, combined with simple tools for finding and using information, is shaping our world by enhancing the decisions of organizations and individuals. This makes of even greater importance the work of GIS professionals who compile and create the authoritative maps that are served and consumed.

Monica Pratt
ArcUser Editor

editor's page

ArcUser
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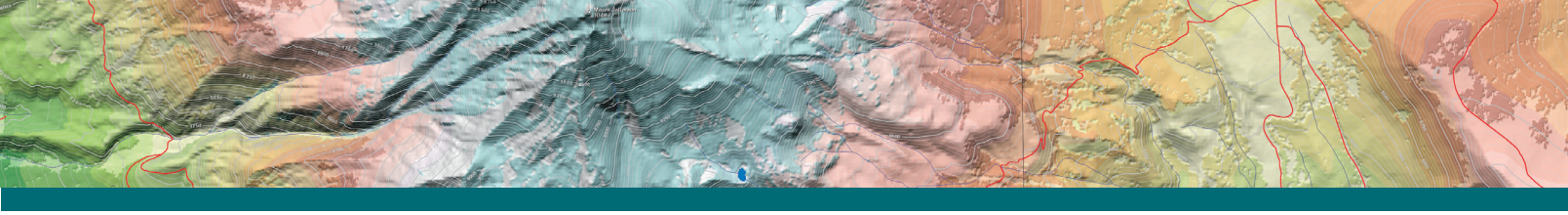
ISSN 1534-5467
ArcUser is published quarterly by ESRI at 380 New York Street, Redlands, CA 92373-8100, USA. *ArcUser* is written for users of ESRI software. *ArcUser* is distributed free of charge to registered users of ESRI software.

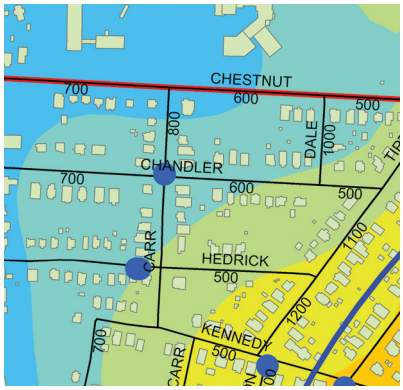


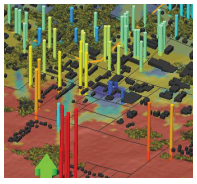
DEPARTMENTS

SOFTWARE AND DATA

MANAGER'S CORNER

DEVELOPER'S CORNER





HANDS ON

BOOKSHELF

USER

EDUCATION

END NOTES

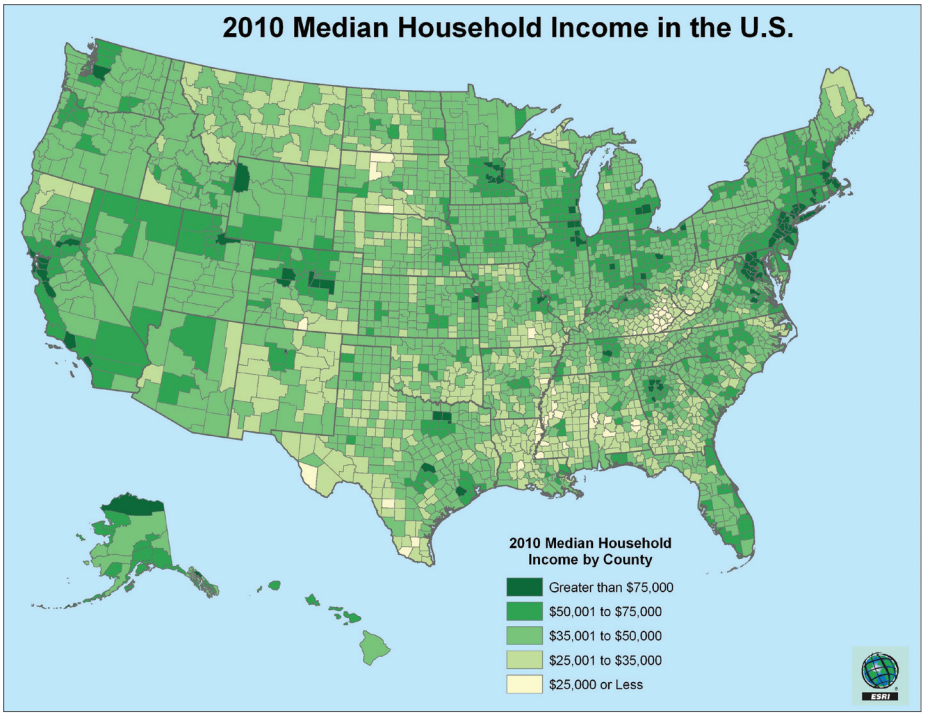
Variables Give Complete Picture of U.S.

2010/2015 Updated Demographics data forecasts and socioeconomic trends

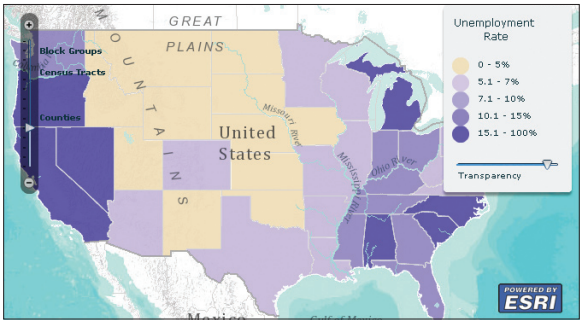
The 2010/2015 Updated Demographics data, which offers more than 2,000 data variables, including current-year estimates and 2015 forecasts for 11 different geographies from national to block group levels, has been released by ESRI. This data can help identify areas of high unemployment; adjustments in the housing market; and changes in vacancy rates, income, consumer spending, and population diversity. Agencies, businesses, and organizations can use the data to analyze trends, identify growth, and reveal new market opportunities.

The new data reveals significant changes and trends in the United States in 2010. For example, the data shows a pervasive slowing of growth and change in most markets due to decreased migration flows and fewer births. This information can be used to update marketing plans using the most current data available. Users can visit www.esri.com/data/esri_data/demographic-map.html to map the updated data and see what it shows in their area.

Updating data variables, such as population, housing, age, income, and home value, ensures that analysts can conduct research with the most accurate information available. Updated demographic data is being released on a flow basis. Currently, more than 60 variables are available in the Demographic & Income Profile Report from ESRI Business Analyst Online, ESRI's on-demand market analysis tool. All updated variables will also be available soon as ad hoc data and in ESRI Business Analyst (desktop and server).



This map of the United States by county illustrates ranges of median household income in 2010. This variable is included in ESRI's newly released Updated Demographics data.



Users can visit www.esri.com/data/esri_data/demographic-map.html to map the updated data using a Web application.

"ESRI pays close attention to economic and social trends and how they influence the needs of businesses, consumers, and citizens," said Lynn Wombold, chief demographer and manager of data development at ESRI. "For example, although signs indicate economic recovery from the recession, the impact on the average consumer continues to be very personal. Housing is down, foreclosures are up, income is declining, and population growth is slowing. The challenge of successfully weathering the current economy underscores the importance of having access to accurate information. Current data can track critical changes and preclude the cost of being wrong."

Data is available in a variety of file formats: ASCII (TXT or CSV), dBASE IV (DBF), Microsoft Excel (XLS), ESRI shapefile (SHP), ESRI Smart Data Compression (SDC), and ESRI file geodatabase (GDB). This data can be obtained via FTP site or on CD or DVD. Customers pay only for the data they need with pricing based on the variables and geographies included and number of people who will use it. For more information about ESRI's 2010/2015 Updated Demographics data, visit www.esri.com/datawhatsnew or call 1-800-447-9778.

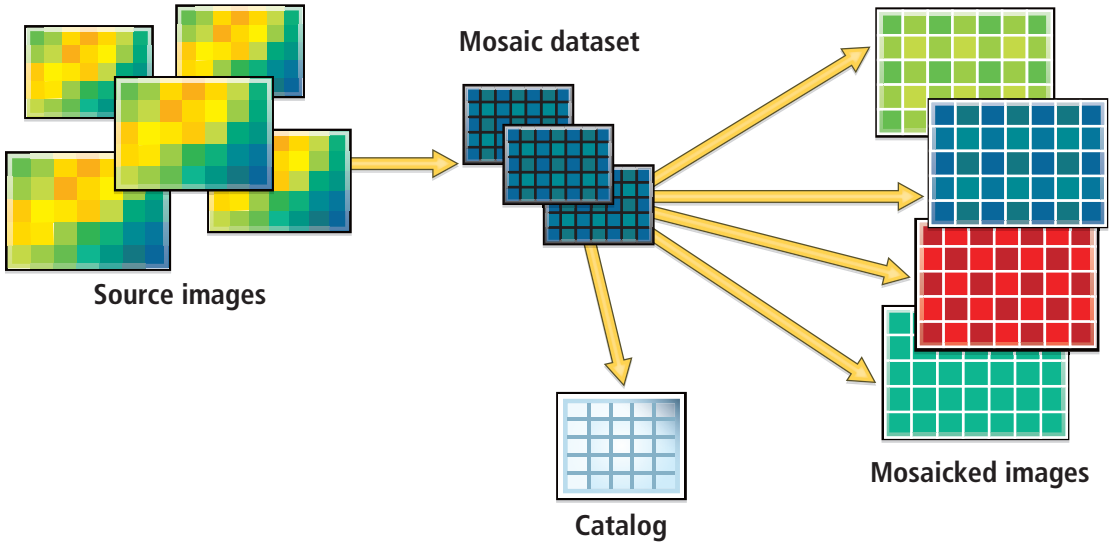
Compressing ArcSDE Geodatabase with Replicas

Learn best practices for handling system versions when compressing an ArcSDE geodatabase that contains replicas by reading the recently released white paper *Compressing ArcSDE Geodatabases That Contain Replicas—Best Practices.* It presents examples of how geodatabase replication works behind the scenes with system versions and discusses strategies for managing system versions to achieve an effective ArcSDE geodatabase compression. Readers should have an understanding of ArcSDE geodatabases, versioning, and geodatabase replication concepts before reviewing this advanced topic white paper. It covers ArcGIS 9.2, 9.3, and 9.3.1.

On-the-Fly Processing and Dynamic Raster Mosaicking

Mosaic datasets resolve many traditional raster management issues

By Colin Childs, ESRI Education Services



Sources, mosaic methods, and functions are used when creating a mosaic dataset. On-the-fly processing generates mosaicked images on demand.

ArcGIS 10 introduces

a powerful and exciting new geodatabase data model for managing raster data that reduces processing time; maintains information from overlapping imagery; and easily handles large, disparate datasets.

The mosaic dataset allows you to catalog collections of raster and image data as well as define and refine the metadata and processing applied to this data. These collections can range in size from a few rasters to collections that are large both in terms of total file size and in the number of raster datasets participating in the mosaic. Mosaic datasets can be directly accessed by users of ArcGIS Desktop or served as an image service to many users. Mosaic datasets are accessed as dynamically mosaicked images that can be controlled and refined by the end user, making all information content in the imagery accessible.

Dynamic Mosaicking

The mosaic dataset references the original pixels and stores detailed properties, metadata, and processing information about the imagery and references the original pixels. It can be stored in any geodatabase (file or ArcSDE) and is part of core ArcGIS 10 software. Although mosaic datasets can be accessed and viewed in ArcGIS with any license level, an ArcEditor or ArcInfo license is required to create or edit them. Serving mosaic datasets with ArcGIS Server requires the Image extension license.

Creating and managing a mosaic dataset follows a simple workflow that uses geoprocessing tools for creation and management and ArcMap for interactive editing and display. In addition, geoprocessing models and Python may be used to automate and manage mosaic datasets.

Raster data is added directly to a mosaic dataset, and the properties are stored in the geodatabase. By specifying a raster type, data can be directly incorporated from sensors or files that include detailed properties such as spatial reference metadata, acquisition dates, and sensor type as well as defined optional details for additional processing such as orthorectification. Note that raster datasets in a mosaic dataset can remain in their native format on disk or may be loaded into the geodatabase (if required).

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On-the-Fly Mosaicking

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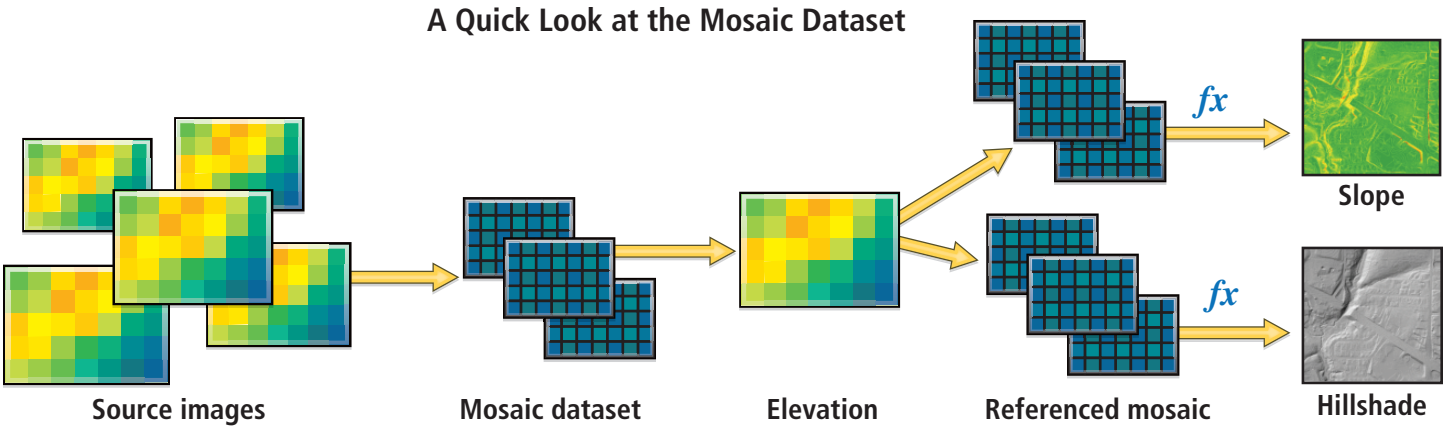
Term	Description
Function	On-the-fly, nonpermanent processing applied to one or more rasters as they are accessed.
Mosaic/ Mosaicked image	An image composed of multiple images fused together. A mosaic can be a static product, such as a map cache created from a single raster dataset, or a dynamic image created using a mosaic dataset.
Mosaic dataset	A collection of raster datasets (images) stored as a catalog and viewed as a mosaicked image that is dynamic. The properties of the original imagery are maintained, and overlapping imagery can be ordered as required.
Mosaic layer	A layer that references a mosaic dataset. It can be viewed in ArcMap as a group layer that consists of boundary, footprint, and image layers. It can also be used by geoprocessing tools to access pixel data.
Mosaic method	A rule for ordering overlapping rasters when viewing the mosaicked image so that the optimum image is displayed on top.
Overviews	Reduced-resolution datasets generated to improve the speed at which the mosaic is displayed.
Pyramid	A set of reduced-resolution rasters associated with a raster dataset that enables faster display of the raster at smaller scales.
Raster catalog	A collection of raster datasets defined in a table. Each record in the table represents an individual raster dataset in the catalog. A managed raster catalog can be used to store imagery directly in a database.
Raster dataset	Any valid raster format organized into one or more bands. Each band consists of a matrix or array of equally spaced cells (pixels) arranged in rows and columns. Each pixel in the raster dataset has a value. Raster datasets have associated properties, such as spatial reference, as well as metadata.
Raster footprint	Detailed extent of a raster dataset. Imagery outside the footprint is clipped from the viewed image.
Raster layer	A layer that references a raster dataset and may define additional processing or functions to be applied to the image.
Raster type	Identifies how to import detailed mosaic dataset properties and metadata, such as georeferencing, acquisition date, and sensor type, along with a raster format.

A brief glossary of mosaic dataset terms



Referenced mosaic datasets can generate different sets of products, each with specific mosaicking methods and mosaic dataset functions, from the same source.

Mosaic datasets represent a data model in the geodatabase. In this model, participating rasters may be accessed either as a dynamic mosaic composed of images processed on the fly or as a catalog with tables containing geometry and metadata. This provides multiple options for organizing/managing raster data. Functions can be applied to each input raster added to the mosaicked dataset to define how it is processed when creating the mosaicked image on demand. A mosaic dataset may also have associated mosaic methods that define the default ordering of the imagery.

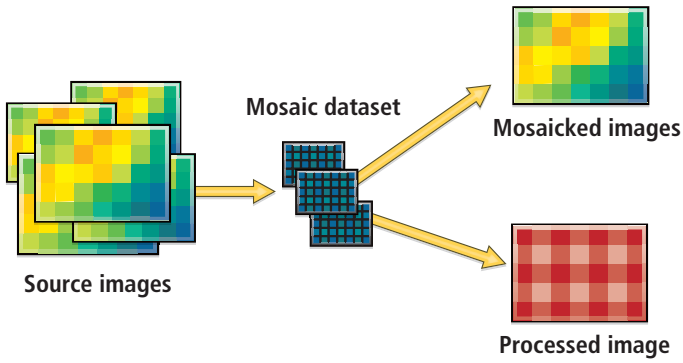
In addition, creating referenced mosaic datasets allows the generation of different sets of products, each with specific mosaicking methods and mosaic dataset functions, from the same source. A referenced mosaic dataset behaves like a regular mosaic dataset, but the records that define processing of individual rasters or metadata cannot be edited because they are referenced from the source mosaic dataset. For example, you could create a mosaic dataset to manage all your digital elevation model (DEM) data, then create a referenced mosaic dataset to produce a hillshade and another reference mosaic to define slope. Updating the elevation data automatically updates the hillshade and slope. Other patterns for managing very large image collections can involve creating a mosaic dataset that uses other mosaic datasets as input.

Mosaic dataset properties
Catalog/Library/Collection of ■ Imagery ■ Properties of the imagery ■ Associated image metadata ■ Raster processing functions
Geodatabase storage
Scalable
References original pixels as files or database
Authored in ArcGIS Desktop
Geoprocessing tools and ArcObjects for automation
Accessible as ■ Dynamically mosaicked image, processed on the fly ■ Catalog table with geometry and metadata

On-the-Fly Processing

Because mosaic datasets are dynamically mosaicked and processed on the fly, the processes for a mosaic dataset are transactional and executed on demand in contrast to traditional methods for handling rasters that deal with image processing and image mosaicking as separate and linear steps. When an image is required by a client application, the image processing functions and dynamic mosaicking are executed on the fly and the result served to the client. Essentially, the imagery is processed as it is accessed.

Mosaic datasets are aware of spatial and temporal information that is maintained as attributes of the source raster datasets. Thus, a mosaic dataset can easily handle data with varying resolutions (e.g., spectral, spatial, temporal, and radiometric).



There is no loss of pixel data or metadata when using mosaic datasets because the source pixels are never altered or converted.

There is no loss of pixel data or metadata when using mosaic datasets because the source pixels are never altered or converted. Users have access to the mosaicked image as well as the source data. Consequently, no data is lost when using overlapping datasets; all information in the imagery is preserved. Users can reorder imagery to ensure the most appropriate image is on top. This dynamic handling of overlapping imagery differs greatly from the traditional approach to processing and mosaicking imagery into new products that must be stored and maintained and results in significant storage requirements and information loss.

Creating a Mosaic Dataset

A mosaic dataset consists of a footprint feature class that acts as a catalog that details the extent of each raster and references the source pixels along with properties, metadata, and processing functions. It includes a boundary feature class that defines the extent of the mosaic dataset and property pages that reference default mosaicking rules and other properties defining how imagery and metadata are accessed. A mosaic dataset also contains a table for logging data loading and other properties. Optionally, it can contain a seamline feature class for seamline mosaicking.

Creating a mosaic dataset, even for terabytes of preprocessed imagery, is a straightforward process that can be as easy as pointing the system to the source directory. Note that mosaic datasets can also handle more complex data obtained directly from different satellite and aerial sensors. Advanced, sophisticated mosaic datasets can be generated that fuse imagery from multiple sources and sensors based on the decisions and considerations made while creating and modifying the mosaic dataset. These considerations include choosing mosaic dataset properties, mosaic methods, and mosaic dataset functions as well as the use of referenced mosaics and mosaic datasets that use other mosaic datasets as their source.

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On-the-Fly Mosaicking

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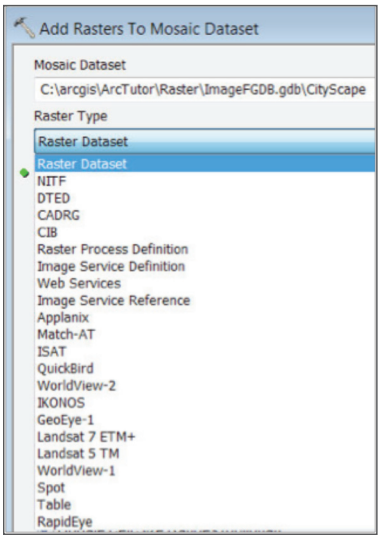
Follow these steps to create a mosaic dataset

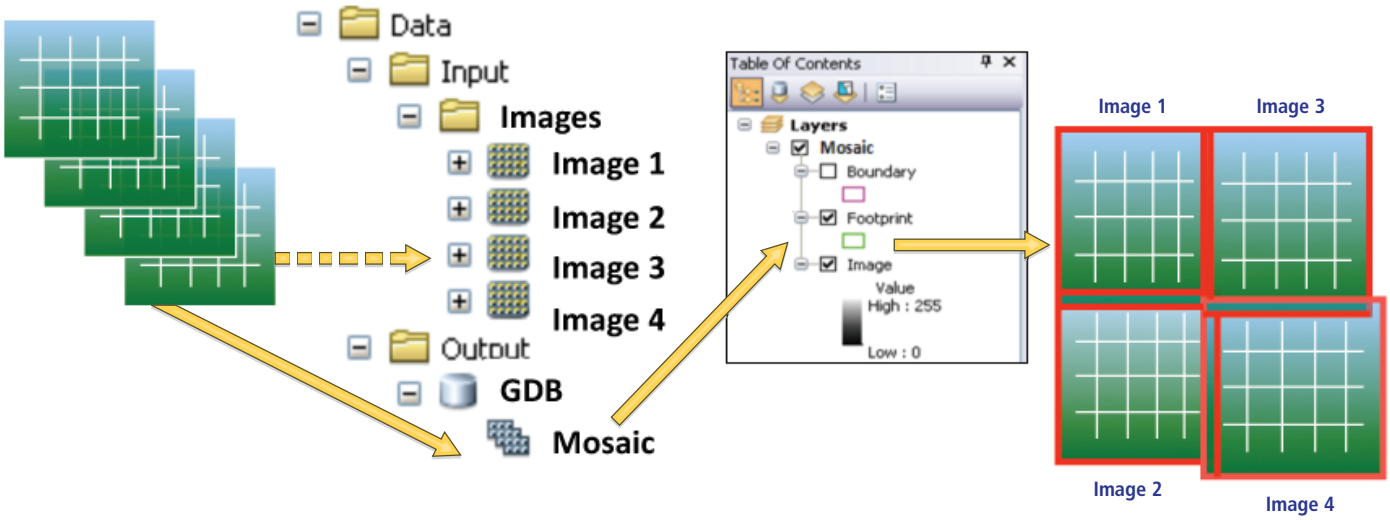
1. Create or locate a target geodatabase. If ArcSDE is not required, using a file geodatabase is recommended.
2. In ArcCatalog, right-click the geodatabase and choose New > Mosaic Dataset.
3. Specify the mosaic dataset name.
4. Specify the coordinate system that will be used for managing the mosaic dataset. Rasters may be in any spatial reference system.
5. Add rasters to the mosaic dataset.
6. Specify raster type in the Raster Type Properties dialog box. As raster datasets are added to the mosaic dataset, footprints are created for each raster dataset and the boundary is generated for the entire mosaic dataset. The overviews are generated for the entire mosaic dataset and are generally small when compared to the complete dataset. Instead of creating overviews, you can use other lower-resolution imagery if available or another imagery source such as ArcGIS online.
7. Optionally, expand Advanced Options and (if necessary) check the option to Build Raster Pyramids and Calculate Statistics, if necessary. Set the properties that affect how the mosaicked image will be presented to the client and how they can interact.
8. Right-click on the mosaic dataset in the catalog window to open the Mosaic Dataset Properties dialog box. From the Defaults tab, you can change default properties such as the compression method used for transmission, the default resampling method, and the default mosaic method. These properties are used when a mosaic dataset is accessed but can be changed by users depending on their requirements. From the Functions tab, you can add additional image processing functions that will be applied to the mosaic. These are functions applied to the image after it is mosaicked from multiple sources but before it is displayed. When done, the mosaic dataset is added to the table of contents and can now be used. The functions associated with each raster can also be modified (if required).



Raster data is added to a mosaic dataset by specifying a raster type.

Raster Types

Raster data is added to a mosaic dataset by specifying a raster type. Raster dataset, the default raster type, can be used for all standardized data sources such as GeoTIFF or MrSID files. The raster type can be used to facilitate the use of more complex data and identifies metadata, such as the acquisition date and sensor type, along with a raster format and optional additional processing to be applied to the rasters. Raster types can be easily customized and stored for future use to help automate adding similar data.



A mosaic dataset consists of a catalog that provides the source of the pixels, properties, metadata, processing functions, and footprints of the participating rasters; includes a feature class that defines the boundary; and applies mosaicking rules that define the default rules for dynamically mosaicking overlapping rasters.

Mosaicking Methods

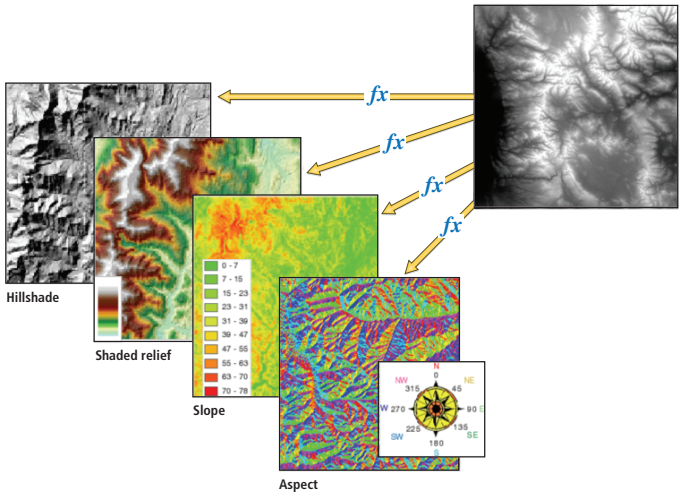
The mosaic method, defined as part of the mosaic dataset properties, defines how overlapping imagery is handled in the mosaic dataset. Mosaic methods define the order of the rasters that are mosaicked together to create the mosaicked image. The By Attribute mosaic method is commonly used to order imagery based on an attribute such as date. For example, Date can be set to 'Latest' or 'Closest to May 2001.' Alternatively, the same method can be used to set the order of imagery by other attributes (e.g., 'Highest Sun Angle'). Similar mosaic methods can be used to set the image orientation from the north, south, east, or west, which may improve the ability to see features such as the sides of houses in wide angle or oblique imagery. A default mosaic method is defined when the mosaic dataset is authored, but users can redefine the mosaicking method according to their requirements. Mosaicking methods are summarized in the accompanying table.

Mosaicking method	Description
By Attribute	Order images based on attribute defined in the table. It is used when imagery with specific properties is of most interest.
Closest to Center	Place the raster with center closest to the center of the area of interest on top. This is the default for most overlapping imagery with specific attributes.
Closest to Nadir	Compares the area of interest and the raster nadir point instead of the image center point. It optimizes imagery for the most vertical view.
Closest to Viewpoint	Chooses top image based on a direction specified by the client. It is useful for seeing the sides of buildings.
Lock Raster	Display only specified rasters despite any change in the area of interest.
None	No ordering specified. The order of imagery is based on the order in the mosaic dataset table, which may change.
North-West	Raster with center in the northwest corner is displayed on top. It is a simple way to fix the order of imagery.
Seamline	Fixes the order of the imagery based on an attribute and uses a special seamline geometry feature as the location to blend images together. It is used when it is necessary to create a static mosaic and minimize the transition from one image to the other.

Summary of mosaicking methods

Mosaic Dataset Functions

Mosaicking functions are operations that are applied on the fly to each raster in the mosaic dataset or to the contents of the mosaic dataset and deliver dynamically processed raster data to users. These allow multiple products to be created from a single raster source because imagery is processed as it is accessed.



Mosaicking functions applied on the fly to each raster in the mosaic dataset or to the contents of the mosaic dataset deliver dynamically processed raster data and allow multiple products to be created from a single raster source.

Some of the common processes applied to mosaic datasets via functions include

- Stretch, Extract Bands, Normalized Difference Vegetation Index (NDVI) (to enhance imagery)
- Clip, Mask (to exclude areas or classify)
- Orthorectify, Pan-Sharpen (to process satellite and aerial imagery)
- Slope, Aspect, Shaded Relief (when working with elevation data)

Functions can be added to the individual raster datasets or the entire mosaic dataset. The functions are managed within the mosaic dataset. Note that when specific raster data products (data from a satellite sensor, for example) are added to a mosaic dataset, some functions are automatically added because these functions were defined as part of a raster type. Specifying the raster type, therefore, allows the mosaic dataset to identify and apply appropriate functions to the source raster datasets of a mosaic dataset.

Here is a more detailed look at some functions that can be used when working with elevation data:

- Aspect function—Identifies the downslope direction of the maximum rate of change in value from each cell to its neighbors.
- Hillshade function—Generates a grayscale model of a terrain with the sun's relative position taken into account for shading the terrain.
- Shaded Relief function—Generates a shaded relief from an elevation model and color ramp.
- Slope function—Calculates the rate of change of elevation for each DEM cell.
- Stretch function—Enhances an image by changing properties,

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On-the-Fly Mosaicking

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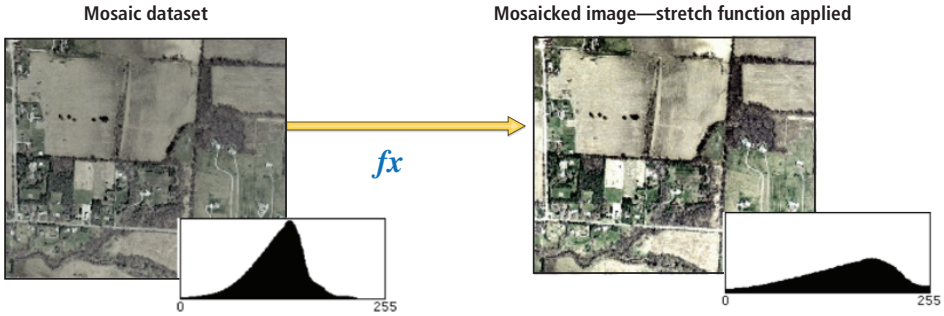
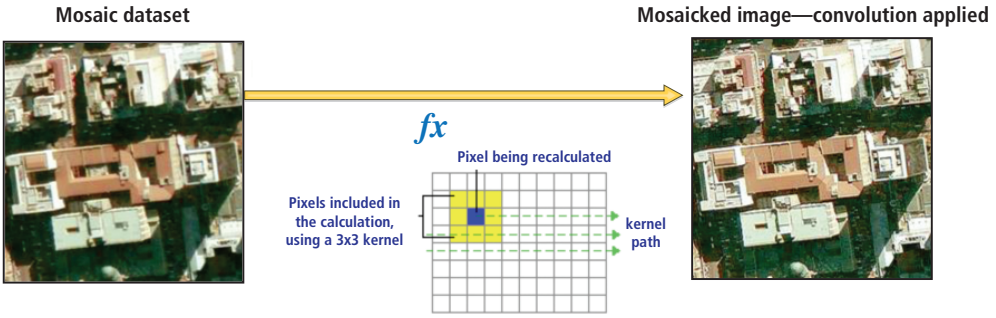
such as brightness, contrast, and gamma, through multiple stretch types.

- Convolution function—Performs filtering on the pixel values in a raster, which is primarily for sharpening an image. It can also be used for blurring an image, detecting edges within an image, or other kernel-based enhancements.

The mosaic dataset also includes an advanced color correction option to match the color of different images and remove lighting trends in the imagery to improve its visual quality. Color correction is defined using the color correction tool and determines for each raster a set of color corrections to be applied on the fly, enabling mosaic datasets to return imagery that is visually pleasing as well as scientifically correct from the same source without data duplication or extensive processing.





Stretches are generally used to enhance imagery as well as to convert imagery with high bit depths to the 8-bit depth required for display.

Serving Mosaic Datasets

Image services are a service provided by ArcGIS Server for the optimized serving of imagery. Any raster dataset or raster layer can be served as an image service so that it is accessible to a wide range of desktop and Web applications. These image services are dynamic. Client applications define properties such as the extent of the request, projection, and sampling method. When the server receives a request for imagery, it accesses and processes the imagery as required. Client requests can include information on the compression to be used for transmission. Setting a lower compression quality enables users to quickly access imagery over low-bandwidth networks (for example, for navigation purposes) and then set high quality to get imagery for analysis purposes. Image services can return imagery as a picture that can be used as a background for applications or as data values that can be used in analysis. Image services provide a one-to-many relationship between source raster datasets and image services. A single raster dataset can be served in multiple forms. The functionality, if further extended in client applications, can also define additional processing that is performed on the server.

The Image extension extends ArcGIS Server to serve mosaic datasets. This enables a many-to-many relationship so that a large collection of images can be served as a single virtual image in multiple forms. Using the Image extension, large collections of imagery become accessible. These image services can be accessed not only as an image but also as a catalog that enables applications to access the rich metadata or define selection queries to search or refine the imagery to be displayed. If a user requires imagery locally, either it can be exported to a specified extent and format or the original pixels can be downloaded.

Conclusion

Mosaic datasets resolve many of the traditional raster management issues by cataloging large collections of imagery and performing on-the-fly processing and dynamic mosaicking. The benefits of using mosaic datasets include

- Reducing processing time because imagery can be directly used without extensive preprocessing
- Maintaining information on overlapping imagery that is traditionally lost when creating a static mosaicked image
- Easily handling large disparate datasets such as imagery along pipelines or transportation corridors
- Handling datasets with different resolutions without the need to sample the imagery up or down
- Reducing resampling of source rasters thereby retaining image quality and integrity
- Reducing storage by removing redundancy traditionally created with multiple image products
- Easing maintenance because imagery can be added or changed as required
- Retaining valuable information by maintaining metadata

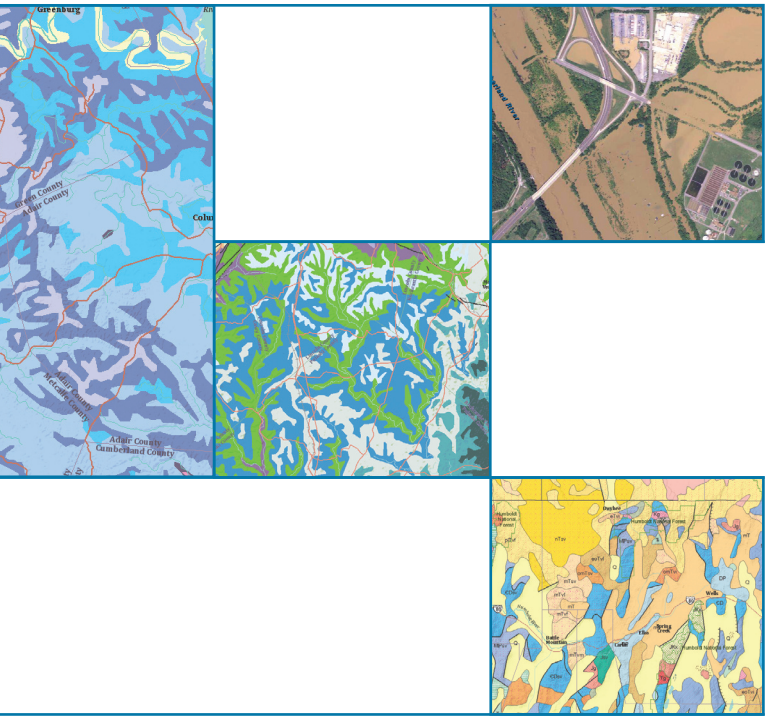
For more information, visit help.arcgis.com and search on "Essential raster data vocabulary."

Function	Description	Uses
Arithmetic	Performs an arithmetic operation between two partially or completely spatially overlapping rasters or a raster and one or more constant values.	Typically used to merge different bands of imagery together or apply conversions, for example, to compute radiance values.
Aspect	Identifies the downslope direction of the maximum rate of change in value from each cell to its neighbors.	This is used generally to help identify watersheds or side of hills that have more light.
Clip	Extracts or excludes an area in a raster according to a set of detailed extents.	Often used to efficiently exclude NoData areas or clouds from an image
Colormap	Transforms an index of pixel values to display as either a grayscale or a red, green, blue (RGB) image, based on a color map.	Used typically to render the results of a classification.
Colormap To RGB	Converts a single-band raster with a color map to a three-band (red, green, and blue) raster.	This enables color-mapped images to be correctly rendered together.
Color Model Conversion	Converts the color model of an image, for example, from either the hue, saturation, and value (HSV) to RGB or vice versa.	This function is often used in some image processing algorithms.
Complex	Computes magnitude from complex values.	Typically used with radar imagery.
Composite Band	Combines rasters to form a multiband raster.	Typically a multispectral image will be displayed as a composite of specific bands (e.g., 432 for false color infrared).
Constant	Creates a virtual raster with a single pixel value for all its pixels.	Used generally to simulate some input.
Convolution	Performs filtering on the pixel values in a raster.	Used for sharpening an image, blurring an image, detecting edges within an image, or other kernel-based enhancements.
Extract Band	Reorders or extracts bands from a raster.	Used to specify a single band from a multiband raster.
Geometric	Rectifies an image based on a geodata transformation.	This is used to orthorectify rasters based on a sensor definition and an elevation model or perform other geometric transformations.
Grayscale	Converts a multiband raster into a grayscale raster.	This is sometimes done to tone down an image so that overlaid vector data is more visible.
Hillshade	Generates a grayscale model of a terrain with the sun's relative position taken into account for shading the terrain.	Emphasizes the structure of terrain.
Identity	Default function required by all rasters in a mosaic dataset if there is no other function.	Identifies a raster.
Mask	Creates NoData by defining a range of pixel values. Any values outside the range will be returned as NoData.	This can be used to mask out clouds or other parts of an image on a pixel by pixel basis.
NDVI	Calculates the Normalized Difference Vegetation Index (NDVI) values using a two-band raster consisting of the red and near-infrared bands.	NDVI is very useful in identifying vegetation biomass or stress.
Pan-sharpening	Enhances the spatial resolution of a multiband image by fusing it with a higher-resolution panchromatic image.	Pan-sharpening is applied when visualizing imagery from many satellite and aerial imagery platforms to sharpen color images without increasing the data size or affecting the fidelity of the multispectral imagery.
Raster Info	Modifies properties of the raster, such as bit depth.	Useful when converting imagery used in conjunction with other imagery that is combined using a function.
Shaded Relief	Generates a shaded relief from an elevation model and color ramp.	This is similar to Hillshade but provides color for better cartographic representation.
Slope	Calculates the rate of change of elevation for each DEM cell.	This is most useful as an input to many elevation analysis applications.
Spectral Conversion	Applies a matrix to a multiband image to affect the spectral values of the output.	Can be used to convert a false color image to a pseudo color image.
Statistics	Calculates focal statistics for each pixel of an image based on a defined focal neighborhood.	Such statistics can be used to drive dynamic range adjustment to optimized display.
Stretch	Changes properties such as brightness, contrast, and gamma through multiple stretch types.	Enhances an image.

A detailed list of available mosaic dataset functions

The Next Step

Extending the role of GIS



The convergence of abundant, current geographic data and simple, fast, and focused GIS tools supplied via the Web is having a greater impact on the way organizations and individuals make decisions.

Empowering people to use maps and geographic information to support scientific research, government operations, public access to information, planning, and resource and landscape management has always been the goal of GIS.

At the same time GIS technology has become more ubiquitous, it has also become less discernible. Using location as a framework for accessing and organizing information is taken for granted and is the foundation of sites like foursquare, which helps locate friends, places to go, and places friends like to go. Geographic information, generated by geospatial technologies, is the foundation for this and other similar social networking applications. However, the people using them seldom realize this because Web-based applications such as these are simple to use and don't require any special software or training.

Building on New Technologies

The underlying technology used to build systems that deliver geographic information has gone through significant changes. ArcGIS is now moving from a client/server-centric system that relies on workstations to a Web-centric system that focuses on building and configuring—rather than developing—applications. These applications allow geographic information to flow through the system from desktop to server to the Web and mobile devices.

The implications of this change include the use of federated network architecture and an emphasis on developing simple, fast applications that deliver a superior user experience to more people. This doesn't mean that everything runs in a browser on the public Web. The work of GIS professionals using workstations for advanced analysis and compilations will be more—not less—important. Rather, Web concepts and technologies will continue to be integrated into ArcGIS to deliver better, expansive systems—whether those systems run on an intranet, private cloud, or public system.

Content Is Critical

The key element in these new systems is content. Content is shared using well-designed maps and map services. OneGeology exemplifies how GIS enables content sharing on a global scale. This initiative, coordinated by the British Geological Survey (BGS), involves 116 countries and makes geologic data residing on the servers of national geologic surveys available as a Web Map Service (WMS) through a Web portal created with the ArcGIS Server Geoportal extension. The portal, officially launched in 2008, is a series of virtualized servers provided and maintained by the French Geological Survey (BRGM).

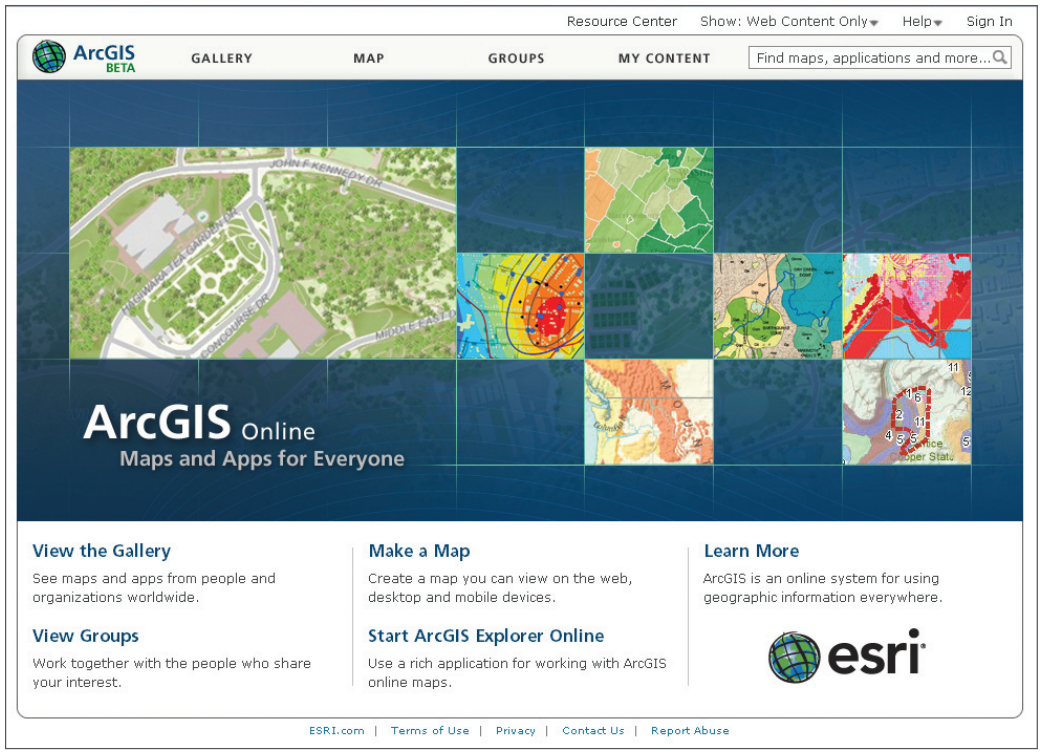
Making shared geologic data and maps readily available creates new opportunities for countries to work more closely together whether for scientific research, disaster management, or natural resource development. OneGeology makes geologic data from across the globe available at a scale of 1:1 million and, in some countries, at scales of 1:50,000. ESRI supports OneGeology with GIS technology and a grant.

Content is now also acquired not only through authoritative sources but also through collaborative activities such as community map projects and volunteered geographic information (VGI). For example, the ESRI Community Maps Program provides a repository for sharing and locating GIS basemaps and furnishes tools and templates to streamline the process. *[See "Creating Authoritative Online Maps: ESRI Community Maps Program makes sharing easier" in this issue.]*

Like the venerable Wikipedia and the much newer Wiki.GIS.com, VGI relies on user-generated content. OpenStreetMap is a well-known example of a VGI project that is creating a free editable map of the world using data from portable GPS devices, aerial photography, and local knowledge. Other VGI maps have a more finite mission. ESRI's Gulf of Mexico Oil Spill map incorporates links to online photos, Web sites, GeoRSS feeds, tweets, and YouTube videos about the massive oil spill that occurred April 20, 2010, off the coast of Louisiana. This information is combined with authoritative basemap data from ESRI's ArcGIS Online and government agencies like the National Oceanic and Atmospheric Administration (NOAA). It organizes, makes available, and places information in context in a manner that promotes situational awareness and further analysis. *[To learn more about VGI sites and how to set one up, read "Getting in Touch with Volunteered Geographic Information: Use a JavaScript API live sample to build a Web editing application" in this issue.]*

More Ways to Build Systems with ArcGIS

In addition to configuring and exploiting standard GIS applications such as ArcMap and ArcGIS Explorer, developers can build new applications and extend existing ones. ArcGIS provides extensive support for Web applications using REST, SOAP, and Open Geographic Consortium (OGC) services and employing JavaScript, Adobe Flex,



ArcGIS.com, the geospatial framework in the cloud, inaugurates a new way to use ArcGIS.

and Microsoft Silverlight APIs. Web applications can deliver rich user experiences, sophisticated analysis, and focused solutions to end users without requiring any specific GIS knowledge. These Web applications are making the benefits of a geographic approach to decision making readily available to both organizations and individuals.

Deciding where to site a business, allocate resources, or launch a marketing campaign all hinge on relating geography to current demographic and business data. A Web-based solution, ESRI Business Analyst Online, combines GIS technology with extensive demographic, consumer spending, and business data for the United States to deliver formatted reports and presentation maps on demand. A new tool available from ESRI Business Analyst Online, Smart Map Search, guides users through a streamlined process that simultaneously evaluates, ranks, and maps areas identified as best meeting up to five specified criteria. *[For more information, see "Smart Map Search: New ESRI Business Analyst Online decision support tool" in this issue.]*

The Walkshed Web site helps people take steps (literally) toward urban sustainability by travel on foot to neighborhood destinations such as markets, restaurants, and parks. The online application calculates the "walkability" of these amenities by performing a weighted overlay operation and graphically presenting the results as a heat map. The site, developed by ESRI business partner Azavea, currently models only New York and Philadelphia but may be expanded to other areas.

A Simple Interface

Everyone understands maps. They are useful, well-structured, and powerful vehicles for integrating and communicating geographic information that promote collaboration. Maps are broadly defined to include not only static paper maps but also Web maps, mobile maps, real-time maps, and analytical maps.

The mapcentric approach used by ArcGIS 10 is a highly intuitive method for accessing and using tools and information. ArcGIS is a unified system for managing and working with maps and geographic information that is powered by servers on premises or in the cloud and accessible through the Web, mobile devices, rich clients, and desktops. This environment enables the discovery, management, analysis, collaboration, and visualization and use of geoinformation.

ArcGIS 10 makes GIS available everywhere. In addition to local and enterprise servers, geoinformation and tools are available from the cloud, hosted by ESRI or by Windows Azure, Amazon, or another cloud provider. ESRI recently announced that users can now purchase a cloud-based annual subscription that supplies a preconfigured ArcGIS Server instance on Amazon's Elastic Compute Cloud (EC2) infrastructure. With this option, organizations can rapidly meet larger-than-average workloads and demand by scaling up or down the number of ArcGIS Server instances without investing in new on-premises hardware and increasing overall energy consumption. Users can begin publishing services and supporting Web mapping applications immediately.

The Central Web Gateway into ArcGIS

ArcGIS.com, the geospatial framework in the cloud, inaugurates a new way to use ArcGIS. It is a comprehensive Web-based interface to ArcGIS that extends and complements other aspects of ArcGIS. It connects users to all kinds of maps: basemaps from ESRI that feature high quality cartography and imagery, collaborative maps, live maps with APIs (services), and static maps (that package information). It is also a source of applications furnished as samples and templates from ESRI, contributed by user sites, and developed by business partners; demos; software development kits (SDKs); viewers; and focused applications for browser, mobile device, and desktop use. Services are also built into the site. These include services ESRI stands up and services that users stand up and manage. Resource centers, that show how to make the best use of ArcGIS, are part of this gateway. Finally, ArcGIS.com is shared and used by communities of users who have common interests and can find, share, organize, and use the maps, apps, and other resources available on the site.

With the release of ArcGIS 10 and the advent of ArcGIS.com, GIS becomes a more highly available, simple-to-use, and fast system that makes crucial information for shaping decisions both more accessible and actionable.

Creating Authoritative Online Maps

ESRI Community Maps Program makes sharing easier

The demand for high-quality basemaps that can be used for GIS projects and Web applications has steadily increased. However, it is often difficult to locate basemaps that have the level of detail required and cover the area of interest. GIS departments compile and maintain mapping data for their own jurisdictions, but adding this data to a repository of basemaps for use outside the organization presents challenges.

The World Topographic Map contains city-level detail supplied by local governments such as New York City data from 1:9,000 to 1:1,000 scale contributed by the New York City Data Mine and several New York city agencies, including the Department of City Planning, Department of Information Technology, Department of Parks, Landmarks Preservation Commission, and New York City Economic Development Corporation, and data from the University of Virginia Library.

The ESRI Community Maps Program provides tools and templates for authoring and caching maps that make it easier for organizations that use GIS and providers of geographic data to contribute authoritative content to online community maps.

Contributing geographic data through the Community Maps Program benefits user organizations by decreasing costs associated with setting up and maintaining data and providing a mechanism for making high-quality, authoritative content available globally.

Data provided through the program is checked to ensure that it improves on the existing data in the community map. ESRI requests permission to publish the data online as part of the community map, but does not take ownership of the data. Content that has been contributed and has been accepted is integrated into one of the existing community basemaps and published during the update cycle, typically twice a year.

What type of data is needed? Detailed basemap data for cities or regions at 1:5,000 scale (e.g., vegetation layers, building footprint data, parcel data), basemap data for counties or regions at 1:50,000 scale, detailed street network data at 1:50,000 scale or larger, and high-resolution imagery (i.e., 1 meter or better) that was collected in the past three years.

Many organizations worldwide have provided authoritative, current content to community maps such as the World Topographic Map, the World Street Map, and World Imagery. These popular maps are hosted and maintained by ESRI and can be used with ArcGIS Desktop, ArcGIS Explorer, any ArcGIS Server Web mapping application, or in a standard Internet browser. The goal for all these community maps is making the best available data from multiple government and commercial data providers available to the user community.

The Yosemite National Park Resource Management Division of the U.S. National Park Service has supplied data layers at 1:9,000 down to 1:2,000.

Organizations interested in helping prepare data for online publication can perform two important tasks: authoring high-quality maps and caching these maps. ESRI has created a number of downloadable map templates that ensure uniform, high-quality cartography. These templates also include map documents, sample data, and symbol style files. *[For more information on using map templates to improve cartographic quality, see "Superior Results in a Fraction of the Time: Map templates enhance productivity and skills" in this issue.]*

Once the map has been authored, a map cache is generated using the Bing Maps/Google Maps tiling scheme. ArcGIS Server can be used to create a map cache using the built-in tiling scheme. Alternatively, ESRI can create the map cache based on the authored map provided by the organization. The map cache is then blended into the appropriate existing community map and published for consumption.

Participation is simple. User organizations that are interested in contributing their data to the Community Maps Program just need to fill out a participation form and provide some information about their data, such as coverage area, resolution or scale, and a brief description. Once ESRI has received the data, it will review it to confirm its suitability and notify the user organization. To get more details about the program, visit www.esri.com/communitymaps to fill out the participation form and download map templates.

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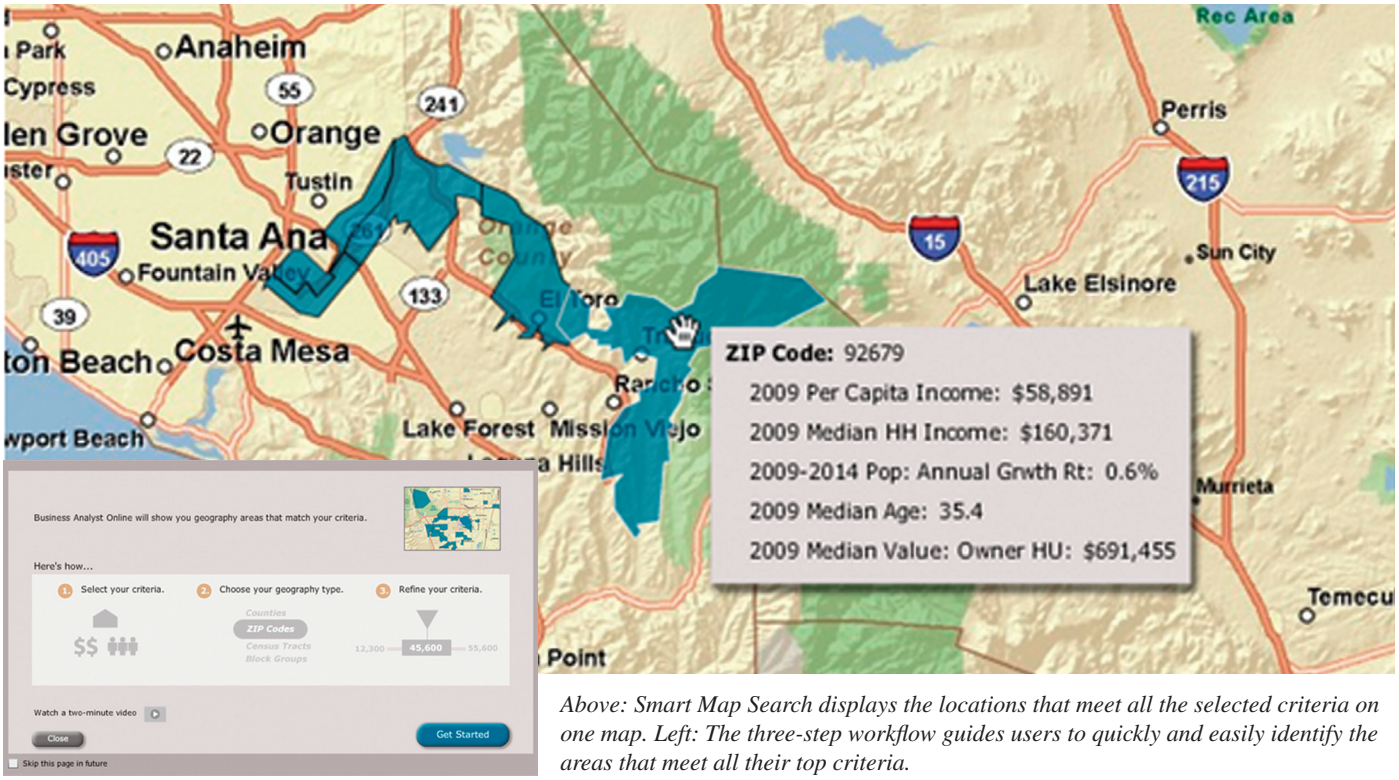
Smart Map Search

New ESRI Business Analyst Online decision support tool



Above: Smart Map Search displays the locations that meet all the selected criteria on one map. Left: The three-step workflow guides users to quickly and easily identify the areas that meet all their top criteria.

Decisions are only as good as the information that goes into them. The new Smart Map Search tool in ESRI Business Analyst Online (BAO) guides users to the best conclusions using new data and producing custom PDF maps.

Smart Map Search guides users through a three-step site selection workflow:

1. Select as many as five critical demographic, consumer, or business criteria (e.g., per capita income, median age).
2. Select the level of geography that will be used by Smart Map Search (e.g., states, counties, ZIP Codes, or census tracts).
3. Set the range of values for each selected criterion (e.g., per capita income greater than $40,000 or median age greater than 35).

Smart Map Search then displays all the areas that meet all selected criteria on the map. A table of the results is generated showing how each geographic area identified in the results ranks for the individual criterion selected. This table can be exported to Microsoft Excel.

This tool makes the decision-making process much more efficient by performing analyses of all criteria and mapping all results at the same time rather than performing a series of separate analysis and mapping operations, one at a time. Users can quickly and easily identify the best locations. Franchisers can find the best site for their next store, city governments can efficiently identify vulnerable populations, and marketing professionals can determine how to target campaigns.

The abundance of current and relevant data in BAO is vital to obtain the best conclusions. In addition to the 2009 and 2014 demographic data updates, data in BAO has been expanded to include thousands of new variables, including Consumer Spending, Market Potential, and Retail MarketPlace data.

The new Market Potential data measures the probable demand for a product or service. For each variable, users can map the expected number of consumers, the percentage of consumers, or an index that compares consumer behavior in an area to the national average. For instance, someone looking to open a baby boutique can find areas with a higher than average demand for baby furniture.

Consumer Spending averages and indexes, included for several spending categories, can be used to visually compare and rank geographic areas. For example, a marketing firm trying to determine where to target a campaign for a professional baseball team can look for areas with populations that have higher than average spending on sporting events.

Measures of supply and demand and the supply/demand gap can also be mapped using the new Retail MarketPlace data. This information illustrates where consumers' needs are being met and where new market opportunities exist. For example, a city government can assess the amount of customer leakage from area restaurants before deciding whether to allow a restaurant chain to open a location in the city.

Visualizing and sharing analysis is vital for effective decision making. BAO users can create custom PDF maps. In addition to the standard site maps, users can select any map created in the application—color-coded maps for any of the thousands of variables, Smart Map Search results, or Bing business search results—and create a custom PDF by simply clicking a button. Custom PDFs have the same look and feel as other BAO reports and can be easily integrated with other BAO analyses.

BAO is available at a variety of subscription levels from one-time-only reports to premium subscription packages and specialized development services. Nonsubscribers can purchase a day pass to take advantage of more than 50 preformatted reports and maps for 24 hours. For more information, visit www.esri.com/bao.

ORGANIZING A CENTURY OF DATA

Spatial data infrastructure created by world's leading gold company

By Matthew DeMeritt, ESRI Writer

As the largest gold mining company in the world, much of Barrick's stock market value depends on its reserve base (i.e., gold proven to be minable but not yet mined). With annual gold production of nearly 8 million ounces, Barrick must add at least that much gold to its reserve base each year or its stock market value will decline. Consequently, Barrick's geological data directly affects the company's bottom line.

Impressive Shelf Life

Geologic data has an unusually long life cycle. Because ore-forming processes act over millions or tens of millions of years, data collected decades ago is still relevant to any mining company. Barrick has more than a quarter century of self-collected and purchased data as well as more than 100 years' worth of data inherited from acquired companies. Effectively managing this rapidly growing collection of geology, geochemistry, geophysics, and remotely sensed data is crucial. To make best use of its impressive data archives, Barrick recently began an initiative to better organize and serve its data throughout the company, and a spatial data infrastructure (SDI) was born.

Within a mining company, different departments often have data that other groups can use. At Barrick, when surveyors collect as-built data for a mine site, that data can be of interest to the Mine Geology, Security, Health and Safety, and Exploration groups. An SDI simplifies the way spatial data is disseminated and accessed throughout an organization. "Although our vast store of exploration data was the catalyst for the initiative, the project grew to include Environment, Land, Security, and Health and Safety *[groups],"* said Iain Allen, global spatial data systems coordinator for Barrick. "Making every group's data available to everyone else eliminates the likelihood of duplicate data collection and/or purchasing."

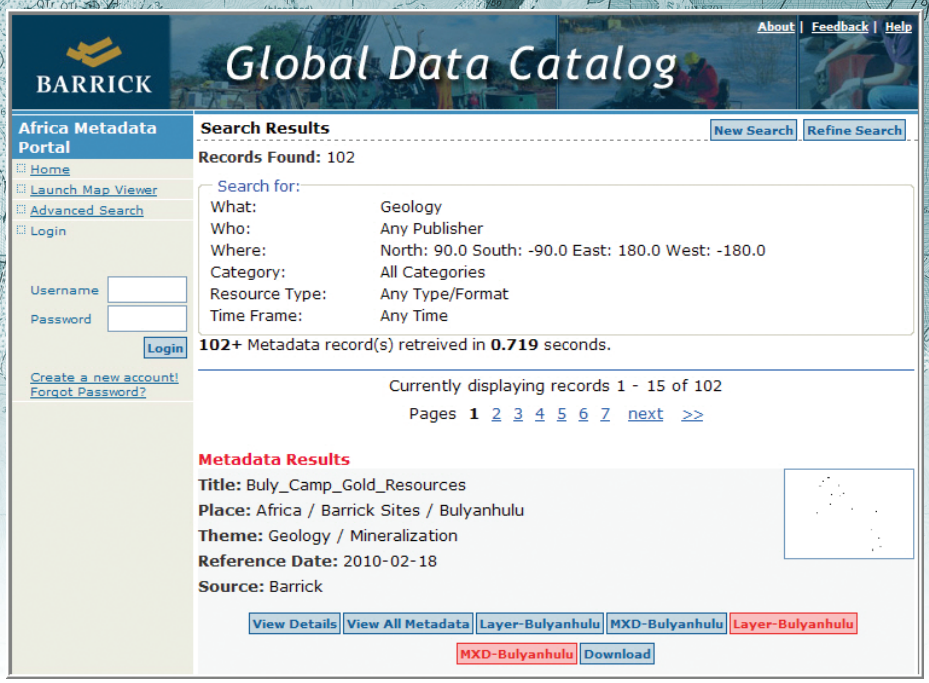
The Migraine of Fine Grain

The crucial first step in creating an easily searched data catalog is generating metadata for each dataset. However, as anyone who has created metadata knows, the devil is in the details. "Everything depends on metadata, but no one likes to do metadata," laughed Allen. "We use a custom metadata editor, MetaTools 5, by Peter Barrs of Data Arterial in Stanthorpe, Australia, which runs in ArcMap as well as ArcCatalog." Barrick standardized on 14 mandatory metadata elements and four optional ones. "We do not have dedicated data managers, so we depend on the end user for metadata. If it's too tedious, they won't do it. We tried to find a balance between everything we would like to know about a dataset and what we could realistically expect people to do."

The Barrick metadata editor uses pick lists for every metadata attribute. The pick lists automatically sync with a server-based Master Keyword Database every time the editor opens, ensuring everyone always has the most current set of keywords. Adding new keywords is done through a Web form, which adds them to the master database. The editor also facilitates the copying of metadata. Working in ArcMap, where the datasets typically have many common metadata attributes, can greatly speed metadata creation. The user completes all the common metadata elements for one dataset, copies them to all the other datasets, then completes the one or two remaining variable elements individually.

Publish or Perish

Detailed metadata is worthless if the data can't be queried and accessed. To publish the data, Barrick uses MXD Publisher, created to Barrick specifications by NGIS in Australia. MXD Publisher, which will not allow data



Search results from a Catalog search. The Layer and MXD buttons allow streaming from the portal server, or data can be downloaded.

to be published if it does not have complete metadata, creates a file geodatabase at a specified location on the network, also capturing all the layer files and creating a copy of the MXD that references the newly created file geodatabase. "This is our way of overcoming 'C-drive syndrome.' We find that a lot of data exists only on a particular user's laptop, so no one else even knows it exists," said Allen. "Through the MXD Publisher, all the datasets used in the published MXD are copied to the network drive. Data previously available only on their laptop is now also available, with complete metadata, on the network."

The final step in the Barrick workflow is SDE Publisher, another custom NGIS tool, that publishes the file geodatabase on the network to the enterprise geodatabase in ArcGIS Server. Each night a metadata harvester runs and updates the data catalog with the metadata for any new datasets (the data catalog uses the ESRI GIS Portal Toolkit *[now known as the ArcGIS Server Geoportal extension]* for presentation and ArcGIS Server with SQL Server for storage). Dennis Geasan from GIS Technologies in Anchorage, Alaska, was instrumental in setting up the back-end processes.

> "Everything depends on metadata, but no one likes to do metadata."
> —Iain Allen

Search results include links to the individual datasets and to the source MXD. The results are presented with selected metadata, and buttons allow users to either stream the dataset or complete MXD directly from the server to their desktop client or download the data directly. FME Server is used for the ETL (extract, transform, and load) function, giving Barrick the ability to deliver search results in any format desired. This is important because Barrick supports two desktop GIS packages.

Data Security

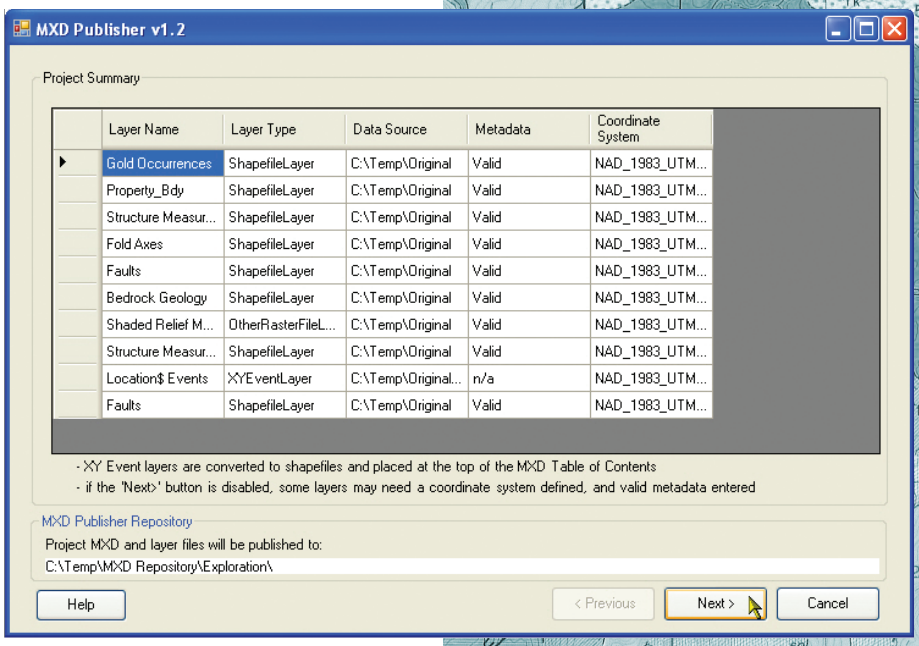
"People tend to be very protective of their data, so we have two 'data security' related metadata attributes," Allen said. One controls metadata visibility, the other controls data

Continued on page 22

ORGANIZING A CENTURY OF DATA

Continued from page 21

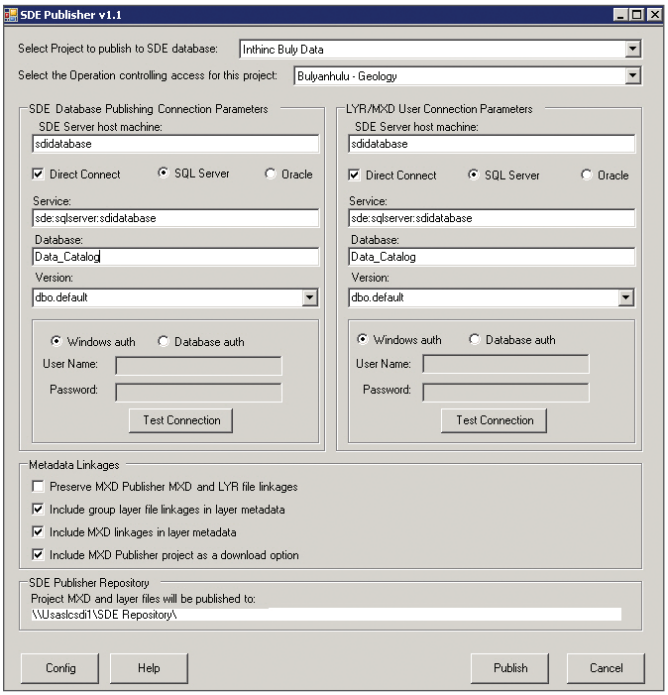
access. This gives Barrick the flexibility to let everyone know a dataset exists. When the metadata is added to the catalog, it will show up in search results. However, it restricts data access to the group most likely to need it. If others want access, they must contact the persons listed under the Responsible Party metadata attribute and make their case. For example, Barrick's land managers want people to know whenever there is land data available for their search area, but they do not want people to have access to that data without consulting a land professional. This procedure ensures that anyone using the data is made aware of any confidentiality or area of interest agreements associated with the land polygon.



In the first step in publishing data with MXD Publisher, all datasets are listed and checked for valid and complete metadata.

Future

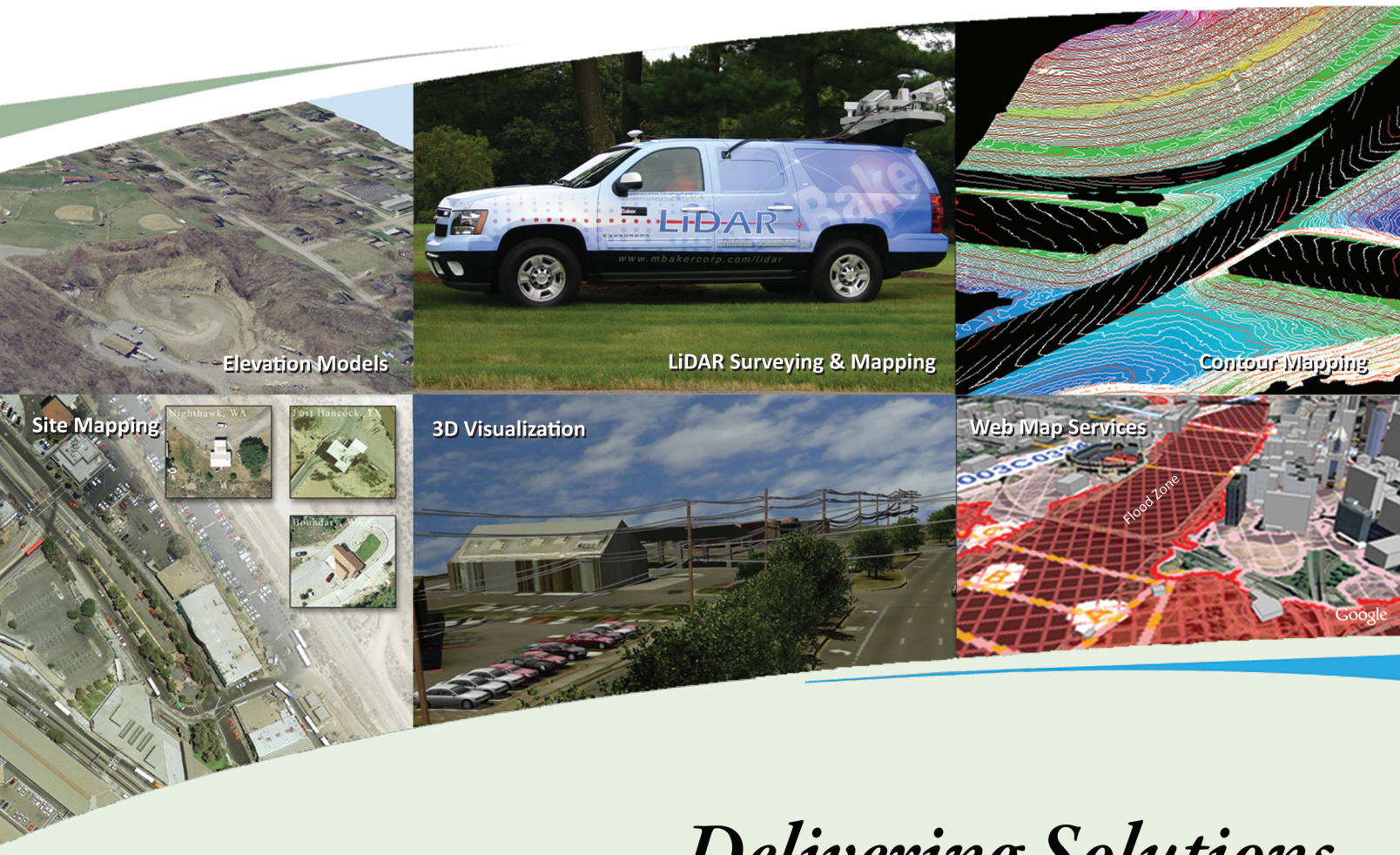
By tagging its huge store of geologic information with metadata, Barrick has taken a significant first step in increasing the value of this data. Future work will include incorporating spatial data stored in other repositories, such as acQuire from acQuire Technology Solutions for geochemical and drilling data and EQuIS from ESRI business partner EarthSoft for environmental data. Barrick will also serve data from the SDI to other applications. For example, for vehicle tracking applications, Web services from the SDI data provide context for vehicle movement.



SDE Publisher publishes the file geodatabase from the MXD Repository to the SDE Repository.

Creating Value...

Baker



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Keeping NATURE and MAN in Balance

GIS data portal enables ecosystem-based management

Visitors seine for fish and crabs in the shallows of the Hudson River, part of the Esopus Meadows, which has abundant aquatic wildlife and forest ecology.

By Katie Budreski, Stone Environmental, and Karen Richardson, ESRI

The deep-water harbor of Greenport has been a working seaport since the 18th century and continues to be a vital hub both environmentally and economically for the area.

An online atlas and geoportal makes more than 400 datasets available for managing the shoreline of the North Atlantic Ocean, estuaries, and portions of two of the five Great Lakes that are within the State of New York.

Developed by the New York Ocean and Great Lakes Ecosystem Conservation Council, the atlas and geoportal are used for ecosystem-based management (EBM). EBM is the study of activities within specific geographies with the goal of finding ways for humans and nature to coexist in a sustainable manner. Used mainly to study terrestrial environments, EBM has gained recent popularity in marine studies as communities search for solutions to ailing fisheries and ocean ecologies. Spatial data plays a key role in assisting communities practicing EBM because this management approach is place based and studies are focused on activities in specific geographies.

New York State uses EBM for managing the shoreline of the Northern Atlantic Ocean and its estuaries as well as portions of two of the five Great Lakes. To do this effectively, the state created The New York Ocean & Great Lakes Atlas (nyoglatlas.org) and geoportal (portalnyoglecc.nyoglatlas.org). The atlas is used by the general public as well as local, regional, and state decision makers to view and explore more than 400 datasets about the region. The GIS Portal Toolkit *[now known as the ArcGIS Server Geoportal extension]* helps visitors easily navigate the vast catalog of data accessed via the geoportal. The Geoportal extension includes a catalog service and a Web application.

An Innovative Way to Manage the Marine Environment

The New York Ocean and Great Lakes Ecosystem Council, created in 2006, is charged with protecting, restoring, and enhancing New York's ocean and Great Lakes ecosystems while taking into account sustainable economic development and job creation. The council is chaired by the commissioner of Environmental Conservation and composed of commissioners from Agriculture and Markets, Economic Development, and Transportation, as well as the secretary of state, the president of the New York State Energy Research and Development Authority, and the interim chancellor of the State University of New York.

Stone Environmental, an ESRI business partner based in Montpelier, Vermont, helped create the atlas. When launched in July 2008, the atlas was composed of a Web-based mapping application and more than 200 datasets. Users could view the datasets, download metadata and spatial data in multiple formats, and view attributes of the data. While the council had technically met its mandate, it was clear that an online catalog would be necessary to help navigate the available datasets.

Portal Makes Data Searchable

After reviewing several technologies, the council implemented the GIS Portal Toolkit because it had—out of the box—the functionality that the council required. Sophisticated searching capabilities, the ability to establish user accounts and data provider access, and flexible metadata authoring tools were very important and readily available in the software. In addition, ESRI's open software environment aligned with the council's vision for future enhancements outlined in its five-year strategy document.

The portal provides a robust way for users to search all the data holdings at the atlas. Users of the portal can perform metadata searches by keyword, data type, data category, date modified, and geographic location. Information for specific areas of interest can be easily found and compared in this manner. Once found, the search results can be

saved in several ways: to a user profile, to a GeoRSS feed, or as an HTML page or HTML fragment that allows users to embed a defined block of HTML inside documents at key locations. Data can also be downloaded in various GIS formats, including ESRI shapefile format, via an FTP link.

One-Stop Shop for Data

When Stone first began looking for relevant data, it discovered this was a huge task. To find the data included in the atlas, the company employed Web searches, phone calls, e-mails, and face-to-face conversations with staff from more than 300 organizations. Since the first launch, more data has been added for a total of nearly 400 searchable datasets.

Data includes administrative boundaries; elevations; cadastre; environment and geoscientific information, such as geology, groundwater, and soils; marine data, such as fish distribution and habitat, and invasive species; as well as cultural information including historic sites and settlement information.

Wetlands are among the most productive ecosystems in the world, comparable to rain forests and coral reefs. These wetlands located in Wilson, New York, on Lake Ontario are an example of one of the "biological supermarkets" that can be managed using The New York Ocean & Great Lakes Atlas.

Many datasets are from organizations that had never before distributed geospatial data widely. For example, the Facility Limit Measurement Violation data from the New York Department of Environmental Conservation (NYDEC)–Water Division provides information necessary for the Clean Water Act National Pollutant Discharge Elimination System Program that had been identified as a priority through a data needs workshop. The agency had resource and technical constraints with sharing the data internally. Providing the data via the atlas—without having to host the data—allowed this important dataset to be shared.

Publishers Control Data

When the Atlas Data Portal was first launched, the council published the data and metadata provided by the data providers. Moving forward, the council will encourage data providers to publish metadata records directly to the portal and, when possible, host their own data through subportals. Providing direct access will ensure that data is as current as possible for EBM planners and communities.

To make it easier, data providers have several avenues for easily publishing data using the portal. Records can be published by uploading metadata that has been created by a metadata editor based on Federal Geographic Data Committee (FGDC) and International Organization for Standardization (ISO) standards, like the metadata included within the Geoportal extension. Metadata can also be created using a Web form. Data providers can establish a data harvesting relationship with the portal through a subportal or Web-accessible folder. This allows the data portal to collect desired Web pages and extract necessary data.

The Tug Hill Commission GIS Data Portal (24.39.214.21/GPT9/catalog/main/home.page) is an example of a subportal. Tug Hill is a 2,100-square-mile area in a remote rural region of New York located between Lake Ontario and the Adirondacks mountain range. Several geospatial datasets were developed as part of an EBM demonstration project in the Sandy Creeks watersheds on the eastern shore of Lake Ontario. A separate data portal, the subportal, was developed so the Tug Hill Commission could manage its own geospatial data holdings but still make the data available to New York Ocean & Great Lakes Atlas users.

Next Steps

This year, the New York Ocean and Great Lakes Ecosystem Conservation Council will work with Stone Environmental to integrate the Data Portal and Data Viewer, currently two separate applications, by upgrading to ArcGIS Server. Additional enhancements will include the incorporation of thesauruses for enhanced searching and the use of Web Map Services (WMS) and Web Feature Services (WFS) for data dissemination.

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Protecting Air Quality

GIS tools increase efficiency and accuracy

By Elzbieta Covington
South Carolina Department of Health and Environmental Control

The Clean Air Act forms the framework for all efforts leading to the protection of air quality. The mission of the Bureau of Air Quality (BAQ) at the South Carolina Department of Health and Environmental Control (SCDHEC) is to "conserve and enhance air resources and ensure that ambient air quality is maintained at the highest level."

Projects/Applications at BAQ

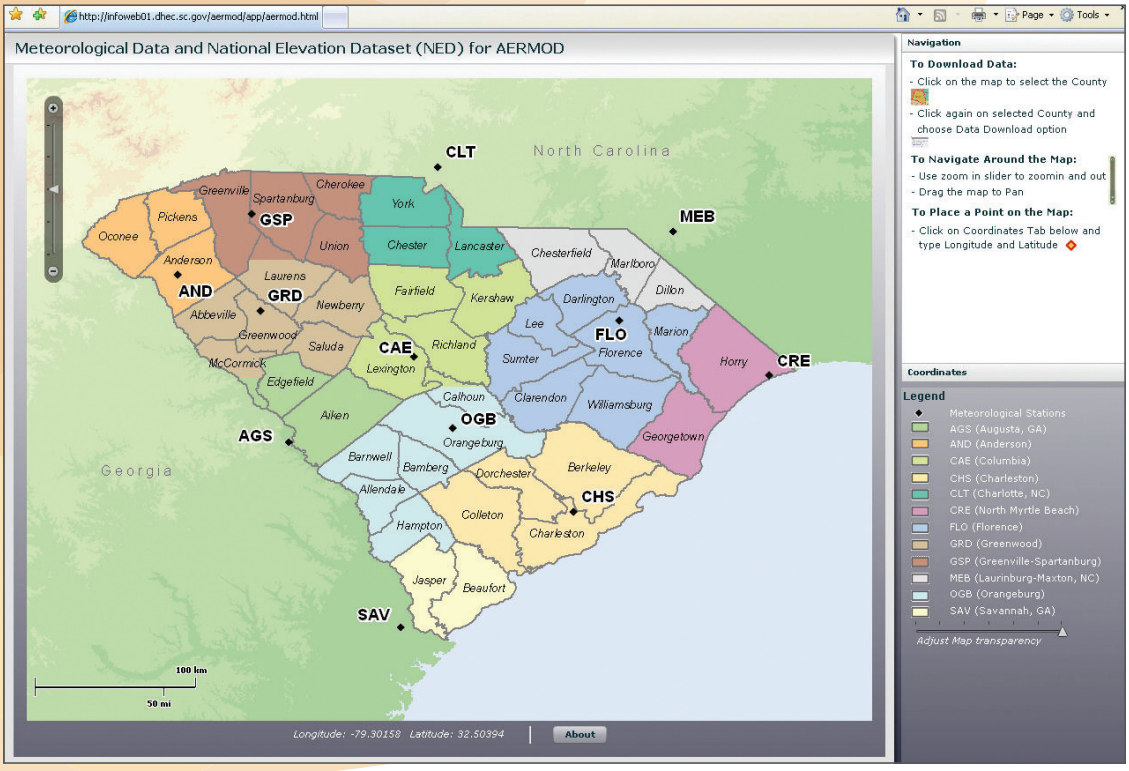
BAQ protects air quality through regulating emission sources, planning, education, and the implementation of various air quality programs. GIS has become an important tool to assist in environmental decision making at BAQ.

South Carolina Ozone Nonattainment Boundary

Ground-level ozone is an air pollutant formed by chemical reactions between oxides of nitrogen (NO_x) and volatile organic compounds (VOC) in the presence of sunlight. The ozone season in South Carolina begins on April 1 and lasts through October 31 of each year.

BAQ has developed an extensive ambient air quality monitoring network for ozone and other pollutants. In operation since 1959, the ambient monitoring network is used to establish general or background information in rural areas, determine the effects of NO_x and/or VOC emissions from specific sources on ozone formation, monitor pollutant concentrations in suburban and urban areas, and ascertain interstate and intrastate transport of pollutants. In 2008, there were 16 ozone monitors strategically located throughout the state that had at least three years of quality assured data. These monitors were located in accordance with United States Environmental Protection Agency (EPA) monitor siting guidance. Ozone concentrations are measured 24 hours per day, and 8-hour moving averages are calculated. The maximum 8-hour average is reported each day.

In March 2008, based on scientific evidence and human health studies, the EPA lowered the ozone standard to 0.075 parts per million (ppm). Areas where ozone levels violate national ambient air quality standards may be designated as nonattainment areas. BAQ was required to submit new nonattainment boundary recommendations to EPA. The factors considered in the recommendation designation of the new nonattainment boundaries were

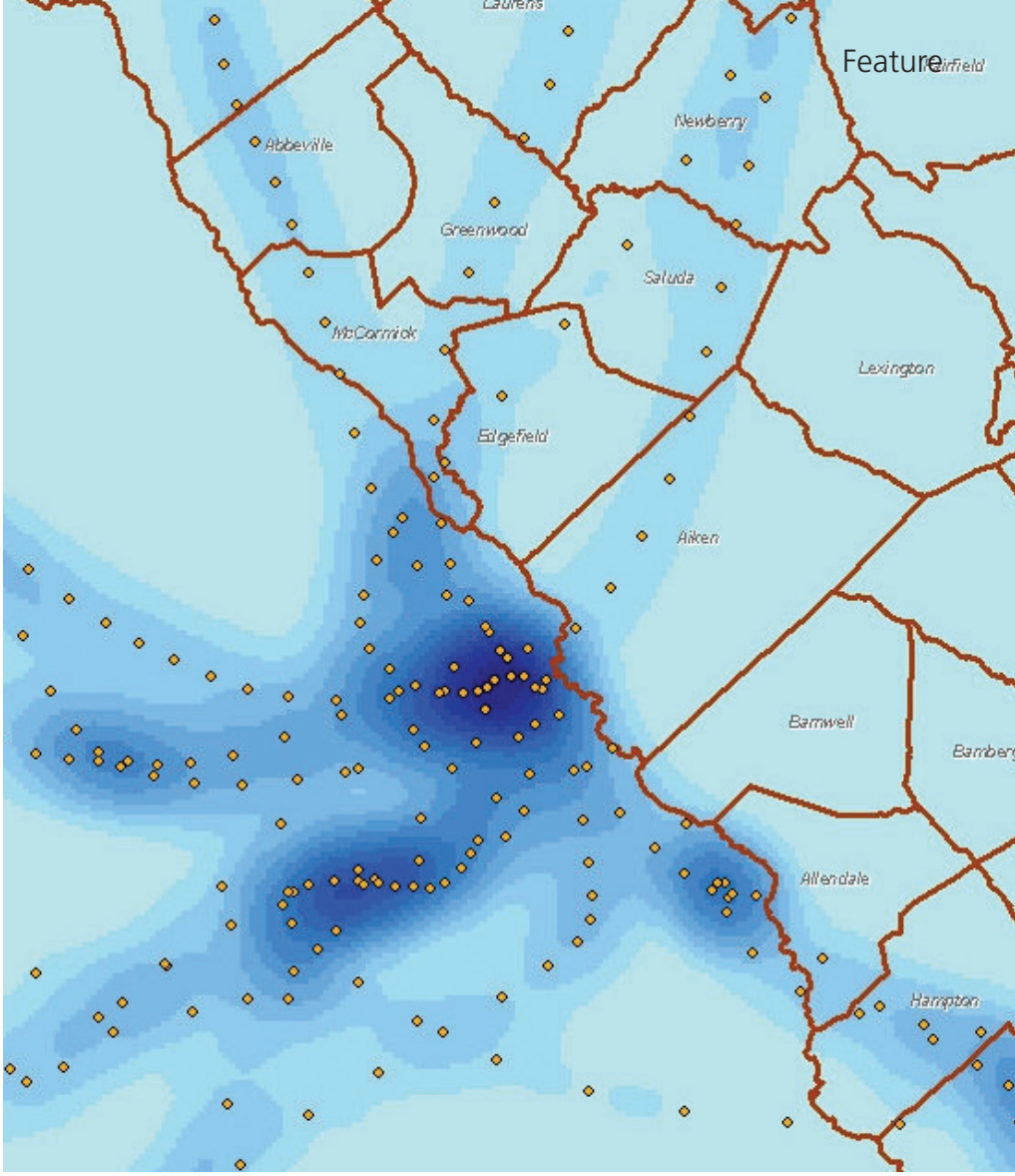


The AERMOD mapping application allows site visitors to download meteorological and National Elevation Dataset data.

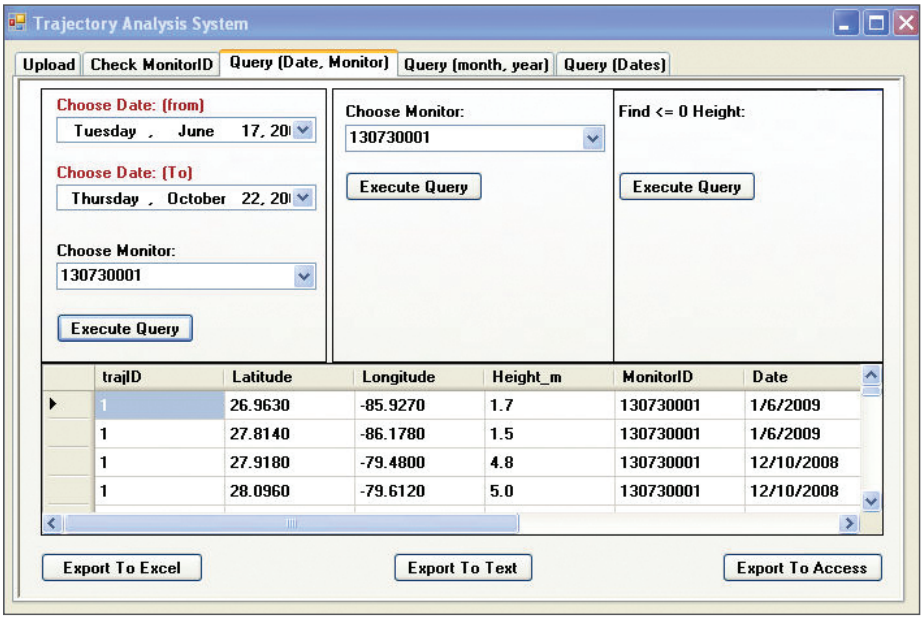
- Air quality data
- Emissions data
- Population density and degree of urbanization
- Traffic and commuting patterns
- Meteorology

The process of designating areas that meet or do not meet these standards is very resource intensive. It would not have been possible to accomplish this task without the use of GIS. BAQ uses ESRI ArcGIS 9.3 desktop and server products for performing spatial analysis, modeling, managing spatial data, creating maps, and disseminating the geographic information via Web services.

The data layers used in nonattainment boundary designation were acquired from a number of sources. South Carolina state agencies maintain GIS database repositories and provide data via Web services or data download option. BAQ maintains Microsoft SQL Server and Oracle databases of air quality and emissions inventory data. The locations of all ambient air monitoring stations were acquired as GPS coordinates that were differentially corrected.



A trajectory density map of the Aiken area shows high ozone days.



Trajectory Analysis System allows users to load trajectories into a Microsoft SQL Server database and query the data.

Facilities in South Carolina must obtain operating permits based on the quantity of the pollutants to be emitted. The locations of permitted facilities are provided as either GPS coordinates or mapped using county orthophotos or 1:24,000-scale National Aerial Photography Program (NAPP) digital orthophoto quarter quadrangles (DOQQs). For areas containing an ozone monitoring station that showed an exceedance, that area and the neighboring counties were carefully evaluated using the nonattainment criteria. U.S. Census data from the American Community Survey (ACS) was helpful in analyzing the population to determine the degree of urbanization and understand commuting patterns.

Since motor vehicle emissions are a significant contributor to ozone formation, the daily vehicle miles traveled were collected by the South Carolina Department

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Protecting Air Quality

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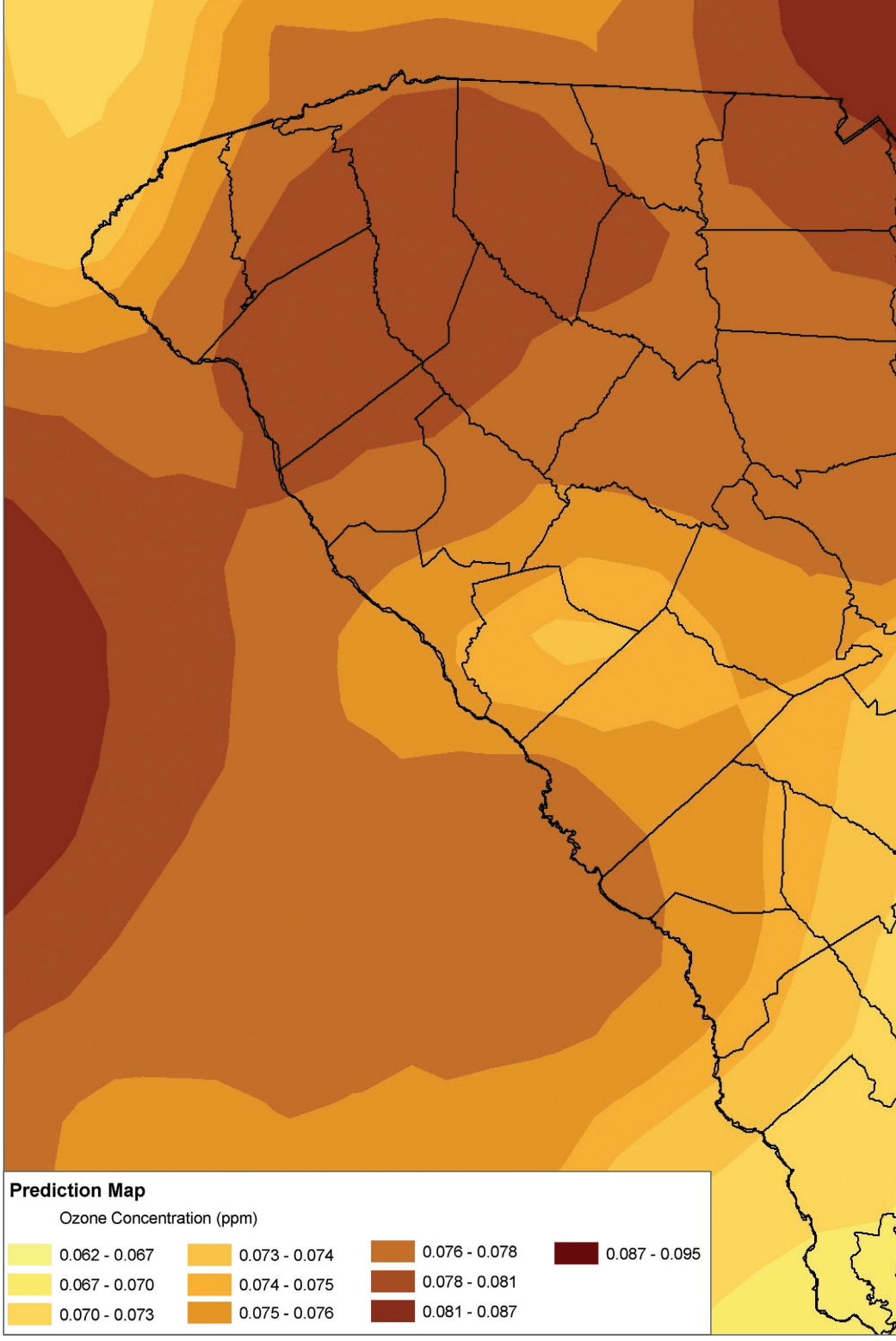
of Transportation, and traffic counts were calculated for each area. ACS data helped in understanding driving patterns and estimating the percentage of people who use public transportation. Major emission sources with VOC and NO*x* quantities were mapped to understanding how they may have contributed to ozone exceedance in each area. Wind roses were created for the ozone season to look at the dominant wind direction. Based on the existing data and analysis, five nonattainment ozone boundaries were delineated.

Interactive Map for AERMOD Modeling

AERMOD is a steady-state plume model that is used to predict pollutant concentrations at selected downwind receptor locations. The model was developed by the American Meteorological Society (AMS) and EPA. Facilities applying for an air permit in South Carolina must demonstrate compliance with applicable air quality standards. AERMOD is the current EPA-recommended refined model to be used for this purpose.

AERMOD contains two input data preprocessors that are part of the regulatory modeling system: AERMET and AERMAP. AERMET processes meteorological (surface and upper-air) characteristics data. Its output is input directly into AERMOD. AERMAP processes digital terrain data and requires as input either National Elevation Dataset (NED) or digital elevation model (DEM) data. The terrain data is used primarily to establish the elevations of the model receptors and the topography in the modeling domain.

To make the modeling process more efficient, BAQ developed an application that allows users to download AERMET and NED data from the BAQ Web site through an interactive map. Data can be obtained for each county. The mapping application was created using the ArcGIS API for Flex. Flex was chosen because it gives the user rich interactivity and has a robust development environment. The application can be viewed at infoweb01.dhec.sc.gov/aermod/app/aermod.html.

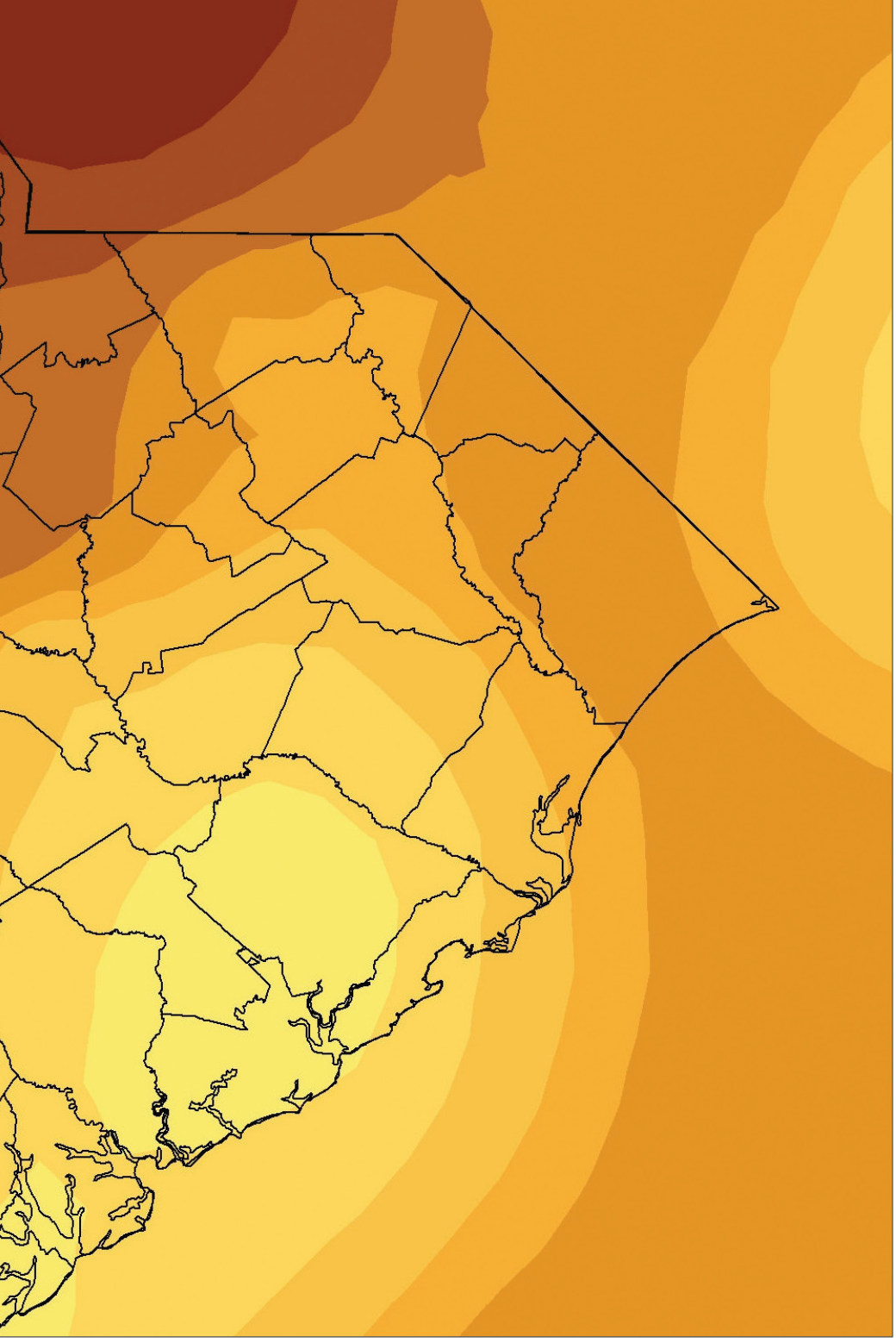


Trajectory Analysis

A trajectory is a three-dimensional view of the path an air parcel travels based on meteorological data. To understand air movement, trajectories are created and analyzed for every 8-hour ozone exceedance day. Trajectories are created using the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model from the National Oceanic and Atmospheric Administration (NOAA). Detailed information regarding the trajectory model can be found on the NOAA Web site at www.arl.noaa.gov/ready/hysplit4.html.

Output files from the model contain the longitude and latitude for a parcel of air. Frequently, back trajectories are analyzed because they provide clues about the origin of air masses and assist in determining possible meteorological conditions during elevated ozone episodes. Each trajectory runs back in time for a 36-hour time period. The Trajectory Analysis System and ArcGIS tools were created by BAQ to aid the analysis process. Trajectory Analysis System is a simple .NET application that is used to load the trajectory output files from the model to a Microsoft SQL Server database. The data can be queried by locations, date range, height, and hour and displayed in ArcGIS to be analyzed further.

Back trajectories were queried for days when the maximum 8-hour ozone concentration exceeded 0.075 ppm at the Jackson (Aiken County) ozone monitoring station through



An ozone prediction map shows predicted ozone concentration.

the years 2006–2008. The 300-meter and 500-meter back trajectories showed transport just south of the Atlanta area, eastward into the central Savannah River area of South Carolina. Exceedances of the 8-hour ozone standard occurred across the Atlanta area on May 2 and May 3, 2007. Ozone precursors from the Atlanta area moved into the central Savannah River area on May 3, 2007, and this, combined with meteorologic conditions, resulted in an ozone exceedance at the Jackson site.

Ambient Air Monitoring Network Assessment

BAQ is mandated by EPA to perform air monitoring network assessment every five years. The assessment determines if the new monitoring sites are needed and whether some of the existing sites can be terminated. The current assessment is in progress and has to be submitted to EPA in 2010.

There are many steps involved in performing network assessment. With the use of ArcGIS, site-by-site analyses were completed and the individual monitors ranked based on the number of parameters monitored at each site, measured concentrations, and the population and area served. Population and area served were represented by Thiessen polygons. Ranking gave insight into the importance of each monitoring site. Site-by-site analyses don't evaluate the entire network, and each monitoring site is scored independently from the others.

To understand the overall network and determine the deficiencies, further analyses were performed to examine the phenomena that influence high pollutant concentrations. The ArcGIS Geostatistical Analyst extension provides interpolation methods for producing surfaces based on the data samples. Kriging was used to produce the two raster surfaces—a map of predicted ozone values and a map of standard errors associated with ozone predicted values. Prediction standard error, distance to roads, population, NO*x* emissions, and VOC emissions grids were input to the weighted overlay analysis.

The rasters were reclassified to a common scale of 1 to 10 (with 1 being the least suitable and 10 being the most suitable location for placing new monitors). Each raster was assigned percentage weights. The weighted overlay allows the user to look at the areas with the lowest suitability and where the uncertainty of the network is the greatest and place new monitors if needed. The model was built with ModelBuilder to ensure that the whole process could easily be repeated.

Conclusion

GIS and the tools developed by BAQ increased productivity and led to greater efficiency and accuracy. It became easy to query and analyze millions of records and display only relevant information. Since GIS has become an integral part of the BAQ's daily operations, it is possible to make informed decisions and provide better services for the public.

About the Author

Elzbieta Covington is a GIS manager at the Bureau of Air Quality at the South Carolina Department of Health and Environmental Control. She came to the department in 2006 after working for 12 years at Earth Sciences and Resources Institute at the University of South Carolina.

Hershey kiss streetlights line Chocolate Avenue.

A Formula for Revitalization

Using ESRI Business Analyst for planning project

By Matthew DeMeritt, ESRI Writer

Hershey, Pennsylvania, experienced a sudden and unexpected loss of visitor and resident patronage in its downtown. In 2008, Hershey Entertainment and Resorts, an entertainment and hospitality company dedicated to preserving the legacy of Milton S. Hershey, hired a GIS consulting firm to help attract consumers back to the area.

Retail trade area analysis is a necessary part of any civic development plan. To find a target market and gain knowledge about local consumers, geographic information must be carefully considered. Because GIS software specializes in extracting and aggregating geographic data, it is an ideal platform for conducting this analysis. ESRI Business Analyst, which incorporates the Huff model (a tool for formulating and evaluating geographic business decisions), was instrumental to the process of successfully reenvisioning Hershey's downtown.

Location-Based Problem

The town of Hershey was originally designed by Milton S. Hershey to serve the needs of chocolate factory employees and their families. Built in the early 1900s, the original town included housing for factory employees as well as schools, churches, recreational facilities, and a trolley system. By the early 1930s, downtown Hershey had grown to become the center of activity for Hershey residents, with a bank, theater, department store, hotel, amusement park, and community center.

As the town grew and the number of visitors increased, Pennsylvania enhanced the local highway system to accommodate the increase in traffic volume. However, enhanced highways had the unintended effect of directing commerce away from downtown Hershey, enticing residents and visitors to shop in suburban shopping centers.

A New Vision

In 2005, Hershey Entertainment and Resorts drafted plans to revitalize the downtown. The revitalization effort started with the restoration of a prominent downtown building originally constructed in 1916 for printing candy labels. The newly renovated building opened in the summer of 2006 and is now home to two new restaurants on the ground floor, with the Hershey Entertainment and Resorts corporate offices occupying the two upper floors. Later, an interactive museum, the Hershey

Story, was located adjacent to the renovated press building.

In 2008, Hershey Entertainment and Resorts contracted Delta Development Group, Inc., a community planning firm located in nearby Mechanicsburg, Pennsylvania, to conduct the next phase of revitalization. With design assistance from EDSA, a landscape architecture and urban design firm from Baltimore, Maryland, Delta began a yearlong process of creating a new vision for the downtown area.

In keeping with Milton Hershey's original vision for downtown Hershey, the revitalization plan was based on the needs of the community while reestablishing a balance between the downtown and the surrounding resort, school, medical, and commercial areas. The goal was to make downtown Hershey serve the community so residents and visitors wouldn't need to go elsewhere.

An Integrated Formula

As Delta assessed the ability of Hershey's market area to support revitalization, EDSA evaluated the downtown's physical opportunities and constraints in preparation for creating conceptual designs. The ultimate challenge facing the team was creating a design concept with the right mix of appropriately sized uses clustered to capture the opportunities presented by the local market. The first phase of analysis would be to profile and measure the local market for real estate uses such as retail, residential, office, and public spaces.

In running demographic reports for comparative analysis, the most difficult task for Delta was determining the geographic trade area for downtown Hershey that would be used as a basis for estimating the amount of retail and restaurant space that could be supported. "The big question we needed to answer was, 'How far would people be willing to drive to shop and dine in downtown Hershey?'" said Debbie Tollett, senior associate at Delta Development Group. "To answer that question, we used the original Huff gravity model in Business Analyst." The Huff model is an analytical tool that measures the probability that a consumer will drive to a proposed new development site based on the distance they would have to travel to get there, the attractiveness of the development, and the area competition. It is assumed that the probability that consumer will travel to the site increases as

A statue of town founders Milton and Catherine Hershey on the campus of Milton Hershey School.

Many Hershey factory employees reside in neighborhoods like this located in the town of Hershey.

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A Formula for Revitalization

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The Hershey Press Building on Chocolate Avenue was recently renovated.

the size of the site increases and as the distance or travel time for the consumer to the site decreases. *[The Huff model was developed by Dr. David Huff of the University of Texas and first published in 1963. To learn more about the Huff model, see "Parameter Estimation in the Huff Model" by David L. Huff in the October–December 2003 issue of* ArcUser *magazine.]*

Once Delta established the geographic market area, it could conduct a more detailed evaluation of consumer spending and identify target retail tenants for further analysis. However, at this juncture, the analysis had focused on general retail spending. With an estimate from EDSA regarding the contiguous land area in the downtown that was available for development, the Delta team approached the analysis by assuming that this land could be developed into Hershey Square, a town center with leasable retail space that could compete with surrounding suburban retail centers.

$$\text{Consumer Probability} = \frac{\text{Potential Gross Leasable Area of Hershey Square} \div \text{Distance from Consumer to Hershey Square, Multiplied by a Distance Decay Factor}}{\text{Sum of Gross Leasable Area of Hershey Square AND of Competitive Centers} \div \text{Sum of Distance from Consumer to Hershey Square AND to Competitive Centers, Multiplied by a Distance Decay Factor}}$$

The Huff model modified with Hershey-specific assumptions

Bringing the Formula to Life

Applying Hershey-specific assumptions to the Huff model gave a clearer picture of the local market. Those assumptions and the Delta team's input for the model included the following five components:

1. The Huff model substituted ESRI's census block group polygons as the "consumers" and used the estimated total annual consumer spending for retail goods from Business Analyst's demographic data as the data field to be summarized for each block group in the model results.

2. EDSA provided a preliminary assumption of the number of square feet that could physically be developed on the available contiguous parcels identified for redevelopment in the downtown area. This estimate represented the attractiveness factor, the potential Gross Leasable Area (GLA) of Hershey Square in the formula shown to the left.

3. ESRI's shopping center data layer was used to identify and select competitive retail centers: the 14 retail shopping centers located within 15 miles of Hershey, including a 246,000-square-foot outlet center within a quarter mile of Chocolate Avenue. As with Hershey Square, the GLA field was identified as the attractiveness factor for the competitive centers in the above formula.

4. Business Analyst calculated the linear distance from each "consumer" to the proposed location of Hershey Square, and to each of the 14 competitive retail centers. These calculations are represented on the right side of the divisor in the formula.

5. Linear distance between consumers and shopping center locations represents only one distance consideration in the Huff model formula. The distance a consumer is willing to travel to shop is also influenced by other considerations such as the type of goods sought. For instance, consumers would be more likely to drive a longer distance to shop for furniture than to shop for groceries. The Huff model provides a distance decay constraint that can be entered in the model account for this factor. The appropriate constraint is entered as an exponent between 1 and 2. A smaller exponent represents shopping activities for which consumers will travel farther, such as furniture purchases. Since the Hershey model is based on total retail spending and represents a variety of types of retail goods, an exponent of 1.5 was used in the model assumptions.

Results: Local Market Defined

Based on these inputs and calculations, the Huff model provided spending probabilities by block group that allowed the Delta team to identify a defensible trade area. This resulted in a conceptual design and scale for downtown Hershey that was driven primarily by the local market.

While the Huff model requires the user to have at least a conceptual understanding of how the model works and how various input components impact the model output, Business Analyst's user-friendly interface allowed the Delta team to access precise analytic capability that would otherwise be outside the realm of its expertise. "Before discovering the Huff model operations in Business Analyst, I tried to do the equation on paper," laughed Tollett. "All the variables that need to be plugged into the formula ate way too much time. Performing the operation in an integrated environment made all the difference in getting the quick and accurate results we needed."

Is Data Driving Your Fire Engine

Finding, understanding, maintaining, and mapping spatial data for public safety

By Mike Price, Entrada/San Juan, Inc.

Editor's note: The author is the president of Entrada/San Juan, Inc., a natural resources and public safety consultancy. He is a licensed engineering geologist with more than 30 years of experience. For the last 12 years, he has been writing articles for *ArcUser* magazine that help GIS users understand, manage, model, and use data. Although this article targets managers of GIS data for fire departments and others involved in public safety, this data framework can be used throughout local government.

Public safety service providers everywhere are tasked with serving populations that are growing (or at least remaining static) as budgets decrease and resources become more scarce. In this budgetary environment, cost containment measures may include reducing staffing; redeploying apparatus; closing stations; and—in some cases—ceasing to serve some areas. Nonetheless, agencies still strive to provide the highest level of service through improving internal operating efficiencies, implementing interagency agreements, and creating regional authorities.

I am often asked by public safety mapping and administrative staff which datasets are necessary to perform various mapping and analytical studies. They are especially interested in the order of importance of these datasets. I keep careful notes on these essential public safety datasets and have noted which datasets provide the best value, how incorrect or inappropriate data can damage or derail a study, and what the best sources are for essential information.

In public safety, we perform many mapping and analytical tasks that include resource allocation and deployment, dynamic response modeling, historic incident analysis and reporting, and mapping of affected populations and values. These tasks combine to support large studies such as strategic, capital, master, and Standard of Cover plans. In this article, I have summarized my thoughts on and findings about public safety data. Public safety data is a very broad theme. In this article, I introduce and discuss framework data, as defined by the Federal Geographic Data Committee (FGDC).

Kent Fire/Fire District 37 in southern King County, Washington, protects an area of approximately 49 square miles that encompasses urban, suburban, and rural areas. Here an engine travels to the City of Covington to a new station that provides a high service level in the eastern portion of the district.

Kent Fire/Fire District 37 is a career, rather than a volunteer, department in southern King County that protects a population living in approximately 49 square miles that encompasses urban, suburban, and rural areas. The district includes large warehouses and light industrial development. The district lies on a major north–south interstate freeway and a second high-speed arterial, and major north–south railroads traverse the city's downtown core. The district lies immediately southeast of SeaTac International Airport and approximately 10 miles from Port of Seattle's Duwamish seaport. Their fixed facilities include eight staffed fire stations and a Fire Prevention Bureau. In 2009, emergency responses exceeded 15,000 calls. Of these, approximately 76 percent were rescue and emergency medical service (EMS) calls; 5 percent were fire, explosion, and Hazmat calls; and 19 percent were service and other calls. The department serves a total population of more than 138,000 and protects assets that were assessed in 2009 at approximately $18 billion.

The Valley Communications Center (Valley Com), the region's dispatch center, is upgrading software and services. The district actively participates in the development of regional public safety datasets for deployment on mobile mapping and communication platforms.

Framework Data for Public Safety

FGDC, through the National Spatial Data Infrastructure (NSDI), has developed a framework for assembling and supporting geographic data on a nationwide basis to serve a variety of users. The seven key data elements identified by the FGDC are (listed in order): geodetic control, cadastral, orthoimagery, elevation, hydrography, administrative units, and transportation. These familiar datasets are typically developed, maintained, and used by public and private organizations within a specific geographic area. Public safety mapping uses data from all these framework data types. For more information about the FGDC Data Framework, visit www.fgdc.gov/framework/frameworkoverview.

My First Choice—Transportation

To create and maintain time-based emergency response networks, current, accurate transportation data is essential. Detailed street data that supports both time-based travel and incident geocoding is essential. Geocoding incidents also supports risk analysis by allowing historic incidents to be posted on maps. To start a study, I first look for the best available street dataset(s). Sometimes, the same street dataset will support both functions, but often two street sets, obtained from the same or similar sources, are enhanced, then maintained separately to support each task.

High-quality street data is available from commercial vendors. Reasonably current and accurate data is also available without charge from vendors and through the U.S. government. In many cases, locally constructed and maintained streets provide the most current, accurate, and adaptable solution.

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For streets inside the district, Kent City Public Works maintains current streets for geocoding and, with minor enhancements, for emergency routing. For areas outside the district and throughout the South Valley, King County GIS provides regional streets. Valley Com is building a composite regional street dataset to support its dispatch and communications software implementation. County agencies provide their best street sets, which are being merged and standardized by a consultant. *[For more information about network streets, download "It's All about Streets" at www.esri.com/news/arcuser/1009/networkstreets.html. To learn more about geocoding, check out "The Call Comes In" at www.esri.com/news/arcuser/0410/mp_geocoding.html.]*

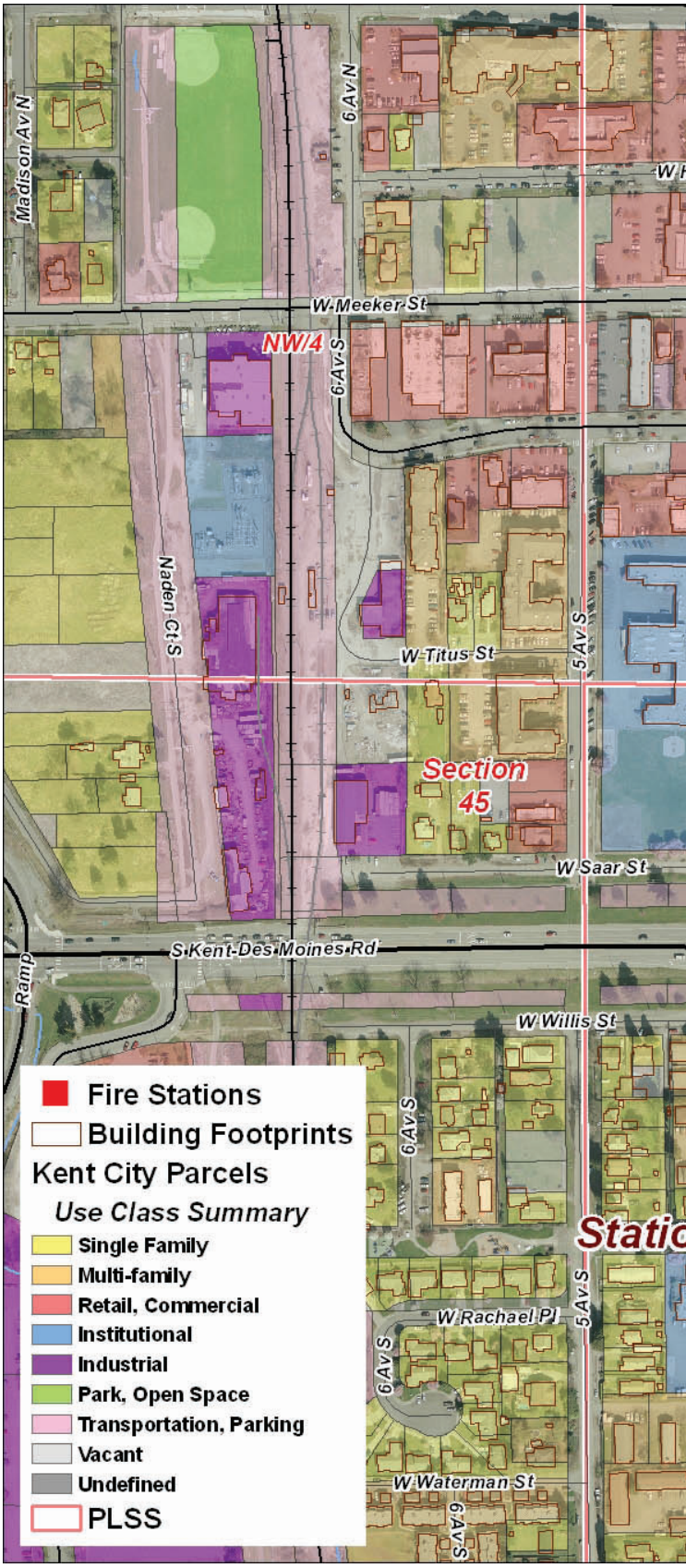
The U.S. Census Bureau is updating its MAF/TIGER Database (MTDB) for the 2010 Census. These streets should be available after they have been finalized. TIGER 2009 streets can also be downloaded from www2.census.gov/cgi-bin/shapefiles2009/national-files. Since 2000, there have been many significant changes in TIGER streets. Positional alignment has been improved, and addressing is more complete. Although TIGER 2009 streets provide a good address geocoding reference, they do not include the network impedence values or appropriate directionality and crossing relationships needed for performing time-based analysis. While it is possible to build a network dataset from TIGER 2009 streets, it requires considerable effort and extensive local knowledge.

Second Pick—Cadastral

Next on my public safety wish list is county assessor parcel data. Parcels are constructed on the broader cadastral framework. County assessors typically use the Public Land Survey System (PLSS) to catalog and store parcel information. The availability, content, and spatial representation of assessor parcels varies considerably by jurisdiction. In the best case, attributes may include owner/occupant information, occupancy and use type, appraised and assessed valuation, and structural information. A robust, current assessor parcel dataset will support hazard and value mapping throughout a county. Obtaining this data can necessitate developing a relationship with the county assessor, which can take time and require the appropriate introductions.

Since property values can quickly change in either direction, obtaining parcel data for several years may help. Assessor parcels are a key dataset when defining and structuring agency consolidations and developing or updating an agency's revenue stream. Also, with sufficient single-family and multifamily residential information, the occupancy percentage and average family size can be estimated prior to the release of Census 2010 data.

At Kent Fire/Fire District 37, assessor parcels provide information about new subdivisions and construction and changes in values and building occupancies. They define and support tax rates and are used for updating the Fire Benefit Charge. Parcel data can provide a reasonable estimate of street width and define candidate locations for proposed easements and new access. This data can also provide a framework for Fire Prevention Bureau staff as they perform inspections and update prefire plans. *[Fire Prevention Bureaus provide public education, inspection and code enforcement, and detailed plan review.]*



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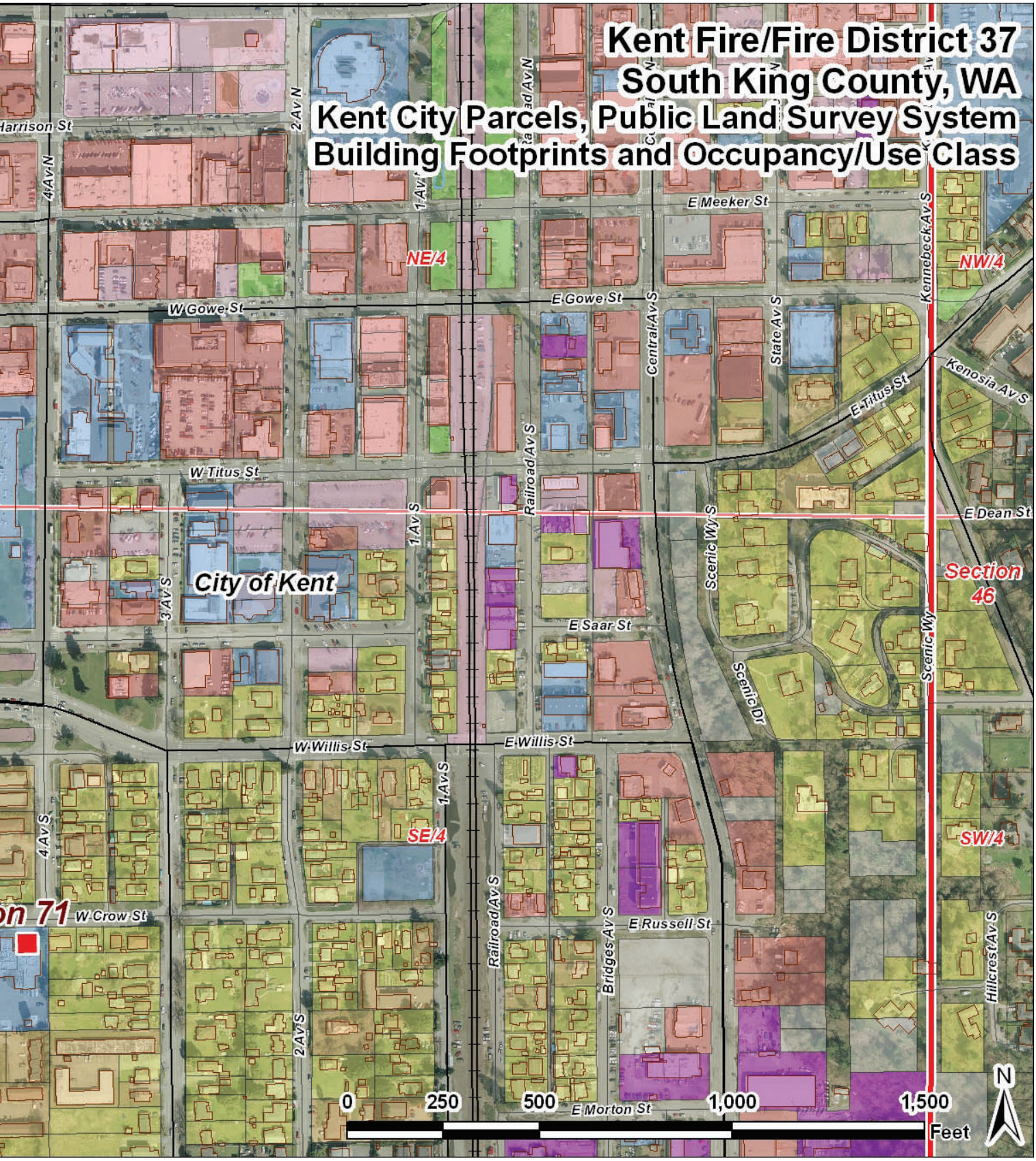

Fire District 37 GIS technicians use current high-resolution imagery to update live maps showing parcel-based occupancies, values, hazards, and essential facilities.

Is Data Driving Your Fire Engine?

Continued from page 36

There is one more use for assessor parcels: if you convert the parcel polygons to centroid points and associate the highly accurate and standardized assessor site addresses, you have an excellent, reasonably current E-911 geocoding point file! *[See "The Call Comes In" in the Spring 2010 issue of* ArcUser *for more information on geocoding point files.]*

The district uses traditional cadastral data to define and map Fire Demand Zones (FDZs) and design response zones (or Fire Boxes). FDZs are defined by quarter section aliquots in PLSS. *[An aliquot part is a standard subdivision of the area of a section based on an even division by distance along the edges, rather than equal area. Half section, quarter section, or quarter-quarter section are examples of these units.]* In Washington State, the PLSS is administered by the Washington Department of Natural Resources. In your state, the land subdivision could be administered by the U.S. Bureau of Land Management or other agency. For additional information and to download PLSS data in the western or central United States, go to www.geocommunicator.gov/geocomm/lsis_home/home/index.shtm.

Assessor parcels, high-resolution imagery, transportation systems, and the Public Land Survey System (PLSS) combine to map parcel and building-level occupancies in the City of Kent.

Third Choice—Orthoimagery

With street alignment and parcel boundaries on a map, the next step is checking those layers against imagery. Imagery is the third item on my list because it can be used for visually validating the streets and parcels in coordinate space. Current, high-resolution imagery is an invaluable tool for viewing and understanding many aspects of a street dataset including street alignment, lane count, intersection geometries, road width, and new construction. Aerial imagery shows the relationship between street edges, street centerlines, and parcel edges. It also shows the placement and orientation of structures on parcels. This is especially helpful when mapping and addressing apartments or condominiums that have many residential units on a single tax parcel.

At the wildland-urban interface, imagery provides a quick way to visualize fuels and measure the distances separating hazardous fuels from structures. In these areas, it is best to obtain two recent imagery sets—one with leaves on trees and one with leaves off trees.

In the district, recent, high-resolution imagery that was carefully rectified was used for validating the location, orientation, and footprint area for structures; the preferred method of access for large parcels; points of building ingress and egress; placement options for fire apparatus; and even fire hydrants. Public safety mappers are highly visual people who are continually finding new uses for aerial imagery. Kent City updates its high-resolution imagery every one or two years. In addition, a contractor provides biannual updates of registered vertical and oblique imagery. District staff is just starting to use the oblique imagery for prefire planning, building inspections, and tabletop scenarios.

Fourth on My List—Administrative Units

With streets and parcels mapped and studied, administrative boundaries can now be refined. Boundaries, including county lines, city limits, fire districts, and Urban Growth Areas (UGAs) *[boundaries designed to contain urban sprawl]* are defined and maintained on a cadastre. The county clerk/recorder or surveyor often maintains this data at the local level. Regional boundary information may be recorded by state agencies (e.g., transportation, public lands, environmental). Federal agencies, such as the U.S. Forest Service, Bureau of Land Management, and Federal Emergency Management Agency (FEMA), can also provide boundary information.

At the Kent Fire Department, municipal and district boundaries are maintained by King County and Kent City. King County also maintains county, special district, and other boundaries countywide. Examples of special district boundaries for natural hazards and areas of environmental sensitivity are defined and maintained by the Washington Department of Ecology, Washington State Emergency Management District, FEMA, and other agencies.

The district includes regions of rapid urban and suburban growth. State-defined UGAs are essential, as they predict where and when additional services will be needed. During the 2009 reaccreditation, UGA-based growth projections provided key planning information. In a broad sense, all strategic/master plans and capital facility plans are guided by growth boundaries.

Fifth and Sixth—Elevation and Hydrography

As an old firefighter and geologist, I have combined these two framework pieces and placed them toward the bottom of the list. However, in areas with certain natural hazards, these datasets should probably be listed first. Digital terrain data, including 10-meter digital elevation data, is available nationally from the U.S. Geological Survey (USGS) Seamless data site (seamless.usgs.gov). Digital hydrography is available nationally from the National Hydrography Dataset at nhd.usgs.gov/data.html. Riverine inundation data may be previewed at FEMA's Map Service Center at msc.fema.gov. Data may be ordered from this site or it may be available without charge through your county or state emergency manager. Other terrain and water-based hazard information could be available through county or state emergency or engineering agencies.

In the district, 10-meter USGS terrain data provides a regional base. The Puget Sound Lidar Consortium provides terrain data as grids with 6-foot pixel resolution throughout the southern county. By combining high-resolution terrain with imagery, hydrography, geol-

Current, accurate transportation data is essential to support time-based travel. Geocoding incidents also supports risk analysis.

ogy, and transportation, district staff model new construction, flooding, critical slopes, winter operations, and travel slowdown on steep roadways. By combining different types of framework data, district personnel can model, understand, and solve many complex problems.

And Finally—Geodetic Control

Public safety mappers perform spatial mapping and analysis in a carefully defined and controlled coordinate-based world, though they tend not to focus on positional and spatial accuracy and instead are more concerned with getting trained personnel and sufficient and appropriate emergency equipment to incidents as efficiently and safely as possible. Behind the scenes, mapping data is carefully connected to a precise system of points and arcs that includes benchmarks, survey control points, and regional traverses. Local agencies rely on federal, state, and county agencies to establish and maintain the control net. For most agencies, the county surveyor is the resident expert.

Accurate and extensive survey control supports all that emergency response personnel do. Survey control is important and becomes more so as regional response models and communication protocols are developed. For now, public safety mappers should get acquainted with their county surveyor and engineer!

Special Data—Shape of Things to Come

This article briefly summarized seven types of framework data that are used every day by public safety mappers. There is an extensive set of essential information that does not fit directly into framework categories. Here is a short list of special data used for risk/hazard/protection/value mapping:

Fixed and Portable Facilities (Protection)
Apparatus
Personnel
Special Services
Other Essential and Critical Facilities (Protection, Value)
Historic Incident Data (Risk)
Water Supply (Protection)
Land Use/Zoning (Hazard, Value)
Growth Management (Hazard, Value)
Special Hazards and Occupancies (Hazard, Value)
Industrial
Natural, Environmental
Cultural
Census Demographics (Value)
Communications, Command and Control (Protection)

Acknowledgments

The author thanks the staff and administration of Kent Fire/Fire District 37 and their contributing agencies. Special thanks to Kent City Public Works, Valley Com, and the Zone 3 mapping group. Through partnering and mutual commitment, great things are possible.

A Growing Community of GIS Developers

Strong attendance at the 2010 ESRI Developer Summit

If success is measured by the din of collaborative exchange, then the 2010 ESRI Developer Summit, held March 22–25, was a triumph. One could barely walk 10 feet without overhearing attendees exchanging ideas about how they had improved their work with GIS tools. The conference demonstrated how sharing individual innovations can inspire the development of solutions that extend the reach of GIS to the world.

Last year, user presentations were added to the Developer Summit. This year, the number of presentations by developers doubled and covered a wide range of topics. Many presentations packed the largest rooms at the venue and were followed by spirited and informative Q&A sessions that were continued in the lobby of the Palm Springs Convention Center where the conference was held.

User presentations were selected by ESRI based on their usefulness in tackling everyday problems. Vish Uma of Timmons Group was a standout among user presenters. He gave two presentations on common obstacles that developers face. His first presentation, on continuous integration (CI), highlighted the commonality in workflows across a dauntingly wide spectrum of software and organizations. *[CI is an approach to quality control in software development that reduces integration problems by having team members integrate their work frequently so errors will be detected as quickly as possible.]* Uma shared best practices for overcoming the challenges posed by the GIS software development process and explained how he optimized his workflow through automation.

"One of my big revelations with the last release of ArcGIS was how many tasks I could eliminate from my schedule by simply automating them," said Uma. "All of a sudden, building and deploying solutions became more fun and opened new avenues of inspiration. That's why CI is so important." One attendee commented that he had no idea how much time he wasted with manual configuration and now sees how he can automate key aspects of his work.

In his second presentation, Uma demonstrated how he overcame current Web client printing limitations. He shared the architecture behind a printing service he built for Timmons. The service was invaluable in overcoming well-known limitations, such as the inability to print multiple map services over a basemap.

"Talking to ESRI technicians over the years has helped me find workable solutions to real problems," said Uma. "It's rewarding to be able to pay ESRI back for their assistance by helping my peers. It's what Jack Dangermond means by 'GIS community.'"

More than half the user presentations were about using ESRI's APIs in a multitude of scenarios. Many were excellent. Brenden Collins and Steven Andari from Blue Raster software gave a presentation on their ArcGIS Server/Flex "super-mashup" for the Southern Forest for the Future Project. Their project integrated YouTube and Flickr, as well as Web Map Services (WMS) and KML, into a rich Web application that uses dynamic map caching to create a time series showing urban sprawl. "The service raises awareness about the invaluable resources that forests provide, like fresh water, timber, and recreation," said Collins.

This was Collins' first ESRI Developer Summit, and he was overwhelmed by the availability of ESRI staff on the showcase floor. "I found myself gravitating to the Flex and geoprocessing teams with all my nagging questions and getting immediate answers," he added. "That was enormously helpful and a pleasant surprise."

Developers responded to the 2010 Mashup Challenge with many novel entries. The guidelines were simple: build a mashup using ESRI's ArcGIS online content and Web APIs, publish the related URL, and post a video describing the application on YouTube. Dave Bouwman, CTO and lead software architect at DTSAgile of Fort Collins, Colorado, took the top prize of $10,000. His Executive Compensation Mashup compared top U.S. executive salaries with the total income for selected counties in the United States.

Presentations by Bouwman and his DTSAgile colleague Brian Noyle were some of the most well attended of the conference. One of Bouwman's presentations, Ruby-fu: Using ArcGIS Server with Rails, explained how Ruby on Rails, the popular Web development platform that powers Twitter, Hulu, and Basecamp, can be configured to work with ArcGIS Server.

One of Noyle's presentations covered writing iPhone and Android

"As a software developer—as anyone who cares about code—you ought to think in a big way about cloud platforms."
—David Chappell


Keynote speaker David Chappell

apps without learning Objective-C code. Noyle demonstrated the design and implementation of a geocoding-enabled site for location-based feedback within a user's local community.

Many developers made a beeline for the technical sessions, especially the ones that previewed the capabilities of ArcGIS 10. ESRI's Jeremy Bartley and Keyur Shah demonstrated how to create maps; execute queries; perform geoprocessing, geocoding, and geometry operations; access tiles; and generate KML using the REST API. Attendees learned how to use the REST API in a variety of mashups that also used JavaScript, HTML, Google Earth, Python, and other Web technologies.

"I noticed that the really popular sessions focused on extending servers through .NET and Java," said Bartley. "One of the exciting developments at ArcGIS 10 is that it supports writing custom server object extensions that can be consumed in both SOAP and REST services, which is hugely significant to developers."

Bartley also kicked off the Plenary Session with the unveiling and demonstration of ArcGIS.com, an online resource for finding and using geographic content from ESRI and many other sources. ArcGIS.com will give developers a platform to share applications through links and through code. "From a developer perspective, this is exciting because programmers can share their information securely within groups. It also includes all the Web APIs—Flex, JavaScript, and iPhone as well—which are integral to building solutions today," said Bartley.

Scott Morehouse, ESRI's director of software development, provided an overview of the impending release, ArcGIS 10, during the plenary. Morehouse also introduced ArcGIS.com, which he described as a "Web gateway into the ArcGIS system." When ArcGIS.com goes online, it will serve as an online GIS resource where visitors can find basemaps created by ESRI and the ArcGIS community, make maps and create mashups, search the Web or GIS servers for additional content for the maps, share maps, view sample applications, and download source codes.

Keynote speaker David Chappell, principal of Chappell and Associates, delivered an engaging address on cloud platform development. He differentiated between cloud computing applications and platforms, discussed new and future trends on this platform, and explained the importance of building and deploying GIS applications in the cloud.

Chappell observed that in the last 50 years, only five platforms have emerged for business computing: mainframes, minicomputers, personal computers (PCs), PC-based servers, and mobile phones. "We are right now, I believe, witnessing the birth of the sixth platform type. It is cloud platforms," he said. "As a software developer—as anyone who cares about code—you ought to think in a big way about cloud platforms."

Despite a wheezing economy, the turnout for the 2010 ESRI Developer Summit, now in its fifth year, was stronger than ever. Once again, this year's summit brought GIS developers and ESRI software development teams together to develop better tools, applications, and practices.

Remix Those Sample Viewers

Elevate your RIA and stand out from the crowd

By Brian Noyle and Dave Bouwman, DTSAgile

Ladies and gentlemen, we are facing an epidemic…an epidemic of "sameness."

ESRI has provided the development community with starter kits for ArcGIS Server. These sample viewers, available for the JavaScript and Flex APIs, are a great starting point for creating map-centric Rich Internet Applications (RIAs). The pluggable nature of starter kits facilitates significant reuse of components. There are dozens of plug-and-play components available to developers in the ESRI code galleries.

While the speed and ease with which these sites can be built and deployed is excellent, the downside is the wave of cookie-cutter sites emerging on the Internet. It is clear that in many cases, little or no thought has been given to originality, branding, or how the user should interact with the site.

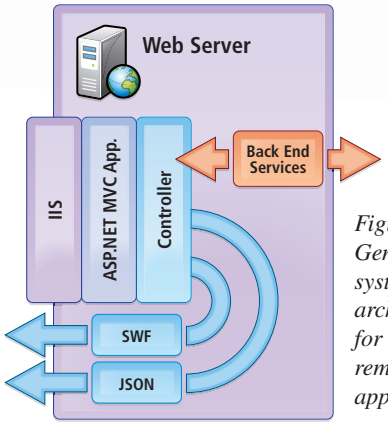

Figure 2: Generalized system architecture for our remixed application

In comments made on a blog post on this topic by one of the authors (see blog.davebouwman.com/index.php/2009/11/re-mixing-the-flex-sample-viewer/), Stu Rich reminded us that the power of the sample application is that it proves the critical path and provides us with many different tools to choose from when building applications in the RIA space.

At the same time, the job of the thoughtful designer/developer is to choose just the essential tools and design them so their use will be intuitively obvious. At the same time, the designer and developer should take care to make each site distinctive. Sites should reflect the brand and intent of the organization. You wouldn't lift someone else's site en masse for your corporate site, so why would you simply copy another site's mapping apps?

Since ESRI has done most of the heavy lifting and provided very pluggable, reusable frameworks in multiple Web technologies free of charge to the development community, we assert that a little extra time and effort is all it takes to elevate offerings to the next level and provide a thoughtful, attractive, and unique experience to users. In this article, we'll point out a few of our beefs with cookie-cutter sites and illustrate the results of our efforts to take a starter kit and remix the interface to produce a more highly polished site.

Remix from a Wish List

As we've noted in our published articles, blogs, and presentations, we like our applications to be as focused as possible. Every mouse click and drop-down menu that we can remove from an application improves the user's experience. Here are some items selected from our (incomplete) user interface (UI) and application behavior wish list.

- We want top-level menu items that do something on-click as opposed to always revealing a pull-down menu. A top-level print menu should open the print dialog box when it is clicked rather than reveal a single menu item that is also called Print.
- Many RIAs rolling out the door these days are information exploration tools. In the age of Google, search is king. A search box should always be available and occupy a prominent place in the UI at all times.
- If this site will have a full bleed or wall-to-wall map, we want a full-width banner with plenty of room for commonly used top-level items.
- We want a limited set of basemaps available and want them displayed as top-level icons on the menu. Clicking them will turn on the layer. The active layer should have a glow indicating that it's…well…active.
- We never want to hide navigation down a level in the application. Navigation and bookmarking should be front and center.
- We want widgets that can be set to never close. We've frequently seen cases where users can't figure out how to reopen a widget that has been closed.
- In numerous other usability rants, we've expressed the philosophy that map content should be limited to a basemap and some minimum number of operational layers so that legends and layer lists become superfluous. If they must be shown, table of contents features should be inconspicuous.
- Whichever starter kit is chosen, the look and feel must be customized for each client or delivery. It's not enough to simply replace the ESRI logo and move on. If possible, use custom icon packs and unique skins.

The Remix in Action

In our example scenario, we'll start with the Flex Starter Kit and build a data visualization application that allows foresters and policy makers to explore data pertaining to the effects of common forest pests in the United States. Conversations with target users convinced us that navigation should be minimal and search is paramount. In addition, we're willing to sacrifice map space to accommodate a panel on the right side due to the richness of the data. Finally, since we've been around the block a time or two, we've got some ideas for a novel way to visualize pest impacts on the landscape in time series so that needs to be worked in as well. This example isn't going to use all the items in our wish list, but we'll pull a few of the ideas in and let the rest of the list serve as fodder for future sites.

Sketch It Out

Whenever we start out on a new project or new set of features for an existing project, we like to develop wireframes (among other things) for the simple reason that debugging and accommodating changes on paper is much cheaper than fixing things once the site is built. Depending on the project and client, we'll create pencil and paper sketches or use Microsoft Visio or products like Balsamiq or the Pencil Project to create mockups. Figure 1 shows how our Flex Starter Kit remix looked on paper.

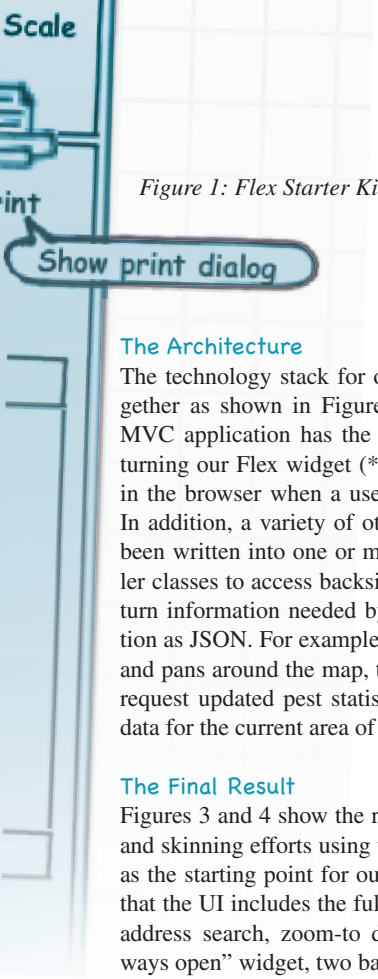

Figure 1: Flex Starter Kit remix on paper

The Architecture

The technology stack for our remix came together as shown in Figure 2. Our ASP.NET MVC application has the primary job of returning our Flex widget (*.swf) for rendering in the browser when a user lands at our site. In addition, a variety of other resources have been written into one or more MVC Controller classes to access backside services and return information needed by the Flex application as JSON. For example, as the user zooms and pans around the map, the application will request updated pest statistics and additional data for the current area of interest.

The Final Result

Figures 3 and 4 show the results of our remix and skinning efforts using the Flex Starter Kit as the starting point for our application. Note that the UI includes the full-width banner, the address search, zoom-to drop-down, an "always open" widget, two basemap icons, and a top-level print widget. The tiles in Figure 3 are from the CloudMade Midnight Commander cache. Figure 4 is a map of Colorado based on OpenStreetMap tiles. Note the Pest Conditions Explorer widget including options for changing the year of the data being displayed as well as selecting an individual pest map to display.

Our Conclusions

In an environment where getting up and running in the RIA space quickly is easier than ever, differentiating your application from the cookie-cutter sites on the Internet is critical in distinguishing your organization or client's site from all the others. As developers, we can dramatically improve the impact of sites based on the ArcGIS Server Web API starter kits by spending a little time identifying where the user experience can be improved by undertaking a modest development cycle, dedicating resources to UI mockups, and making efforts to skin and brand sites. ESRI has done the bulk of the heavy lifting to make development against ArcGIS Server easy, efficient, and reusable. What's left is for the development community to spend some time remixing the current starter kit offerings and elevating the content and quality of the sites produced.

Once the developer has gotten used to working with an ESRI starter kit, a more concerted effort can be made to do a fully custom implementation. After releasing the publicly accessible site described above, we went back and built a customized site that fully leveraged the richness of the data available. Key data exploration features include a dynamic vertical bar chart showing both total acres affected and the total number of counties affected by major forest pests. Up to five pests can be shown at any given time. The bar chart includes a slider control allowing the user to change the year for which data is being viewed. When a user is viewing the entire United States, clicking on a region polygon generates a dynamic vertical bar chart of total acres and total counties affected by major forest pests. As the user zooms in on the map, more granular detail is shown. Region and county selection can be done via the map or via pick lists in the search pane located at left pane. Data summaries and links to external information are also shown in the left pane. Included in the tabular data summaries in the left pane is a function to generate a chart showing pest damage trends for all years in the system and view information on pests of interest.

What's nice about the application now is that the user does not need to go digging around in a menu system to access the functions to efficiently explore data. The template we've come up with will likely be the starting point for many other focused applications. "Do one thing and do it well" is the mantra. Keeping critical functionality up front and conveniently located is of paramount importance.

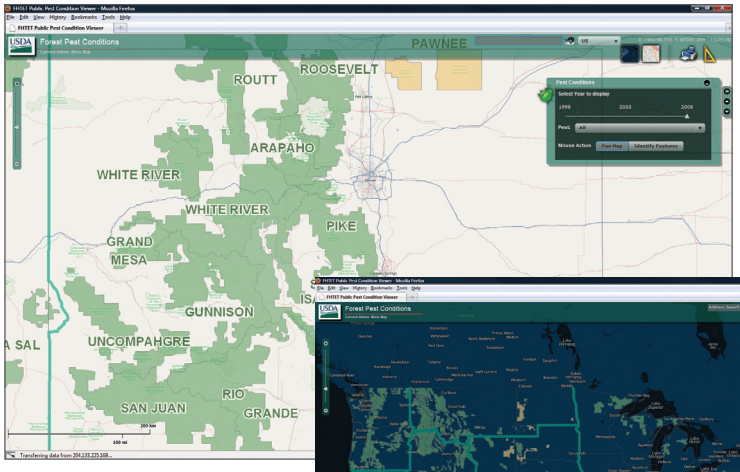

Figure 3: Nationwide view of Pest Data Viewer Flex Application shows regional-scale data.

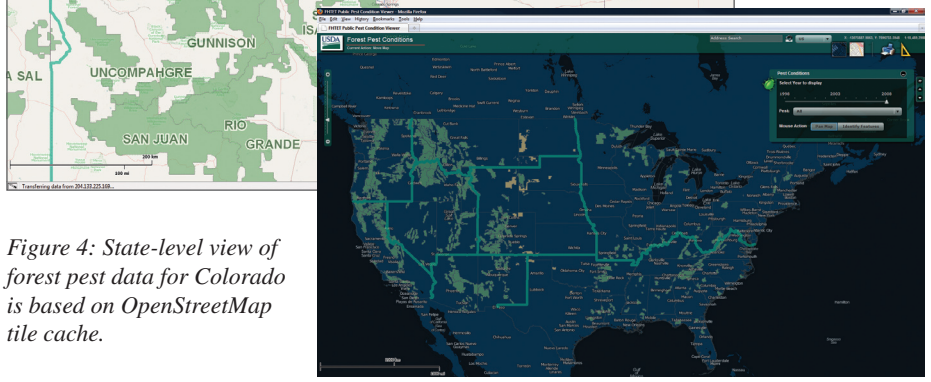

Figure 4: State-level view of forest pest data for Colorado is based on OpenStreetMap tile cache.

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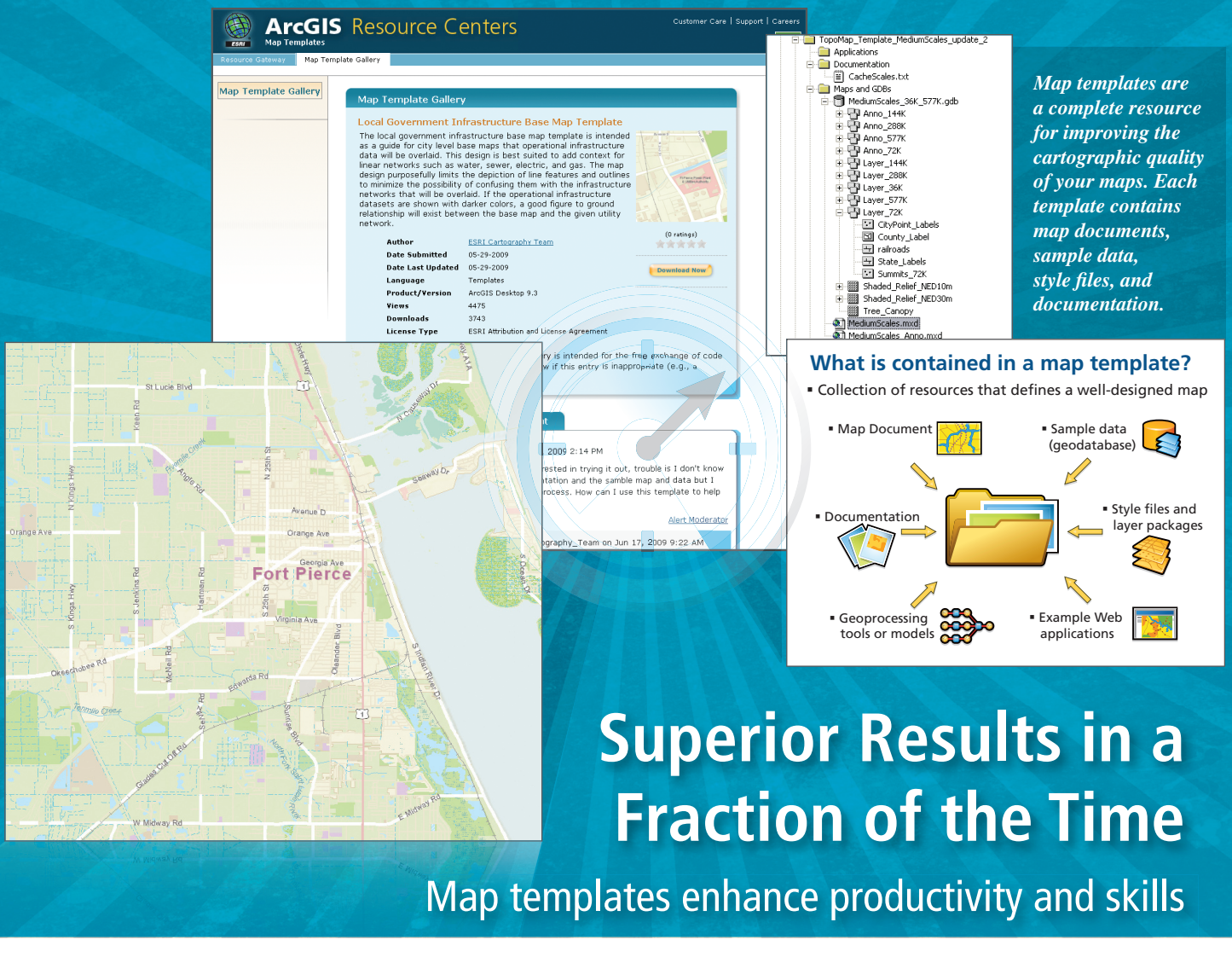
About the Authors

Brian Noyle, originally trained as a global change biologist and tundra botanist, has nearly 10 years of experience as a GIS software developer and architect. His professional and technical interests are primarily focused on moving clients toward more standard architecture and development practices and patterns to facilitate a closer integration of GIS with the standard IT enterprise. Noyle has extensive experience in full software lifecycle management with a focus on delivering through Agile project management methods.

Dave Bouwman has been designing and developing GIS software for the last 12 years with projects ranging from small Web sites to statewide enterprise forest management systems. Over the last few years he has been leading a team of developers in the pursuit of great software built in a sane manner. The combination of an Agile process with pragmatic development practices taken from extreme programming has led to a highly optimized methodology of creating solid software.



Map templates are a complete resource for improving the cartographic quality of your maps. Each template contains map documents, sample data, style files, and documentation.

Superior Results in a Fraction of the Time

Map templates enhance productivity and skills

The professionally designed map templates produced by the ESRI cartography team can help you quickly improve you own map designs and become more productive with ArcGIS.

For GIS professionals, mapmaking is an important—sometimes a daily task. Designing a great map that communicates effectively requires experience, skill, and time. The cartographic quality of your maps is important because maps that are well designed bring your organization's GIS information to life and communicate that information more effectively.

Cartographers at ESRI have created resources that not only provide immediate results but also, over time, help you learn how to be a better mapmaker. These are working examples of professional quality maps that capture best practices and present that information in an easily understood way that can be implemented by both new and experienced users.

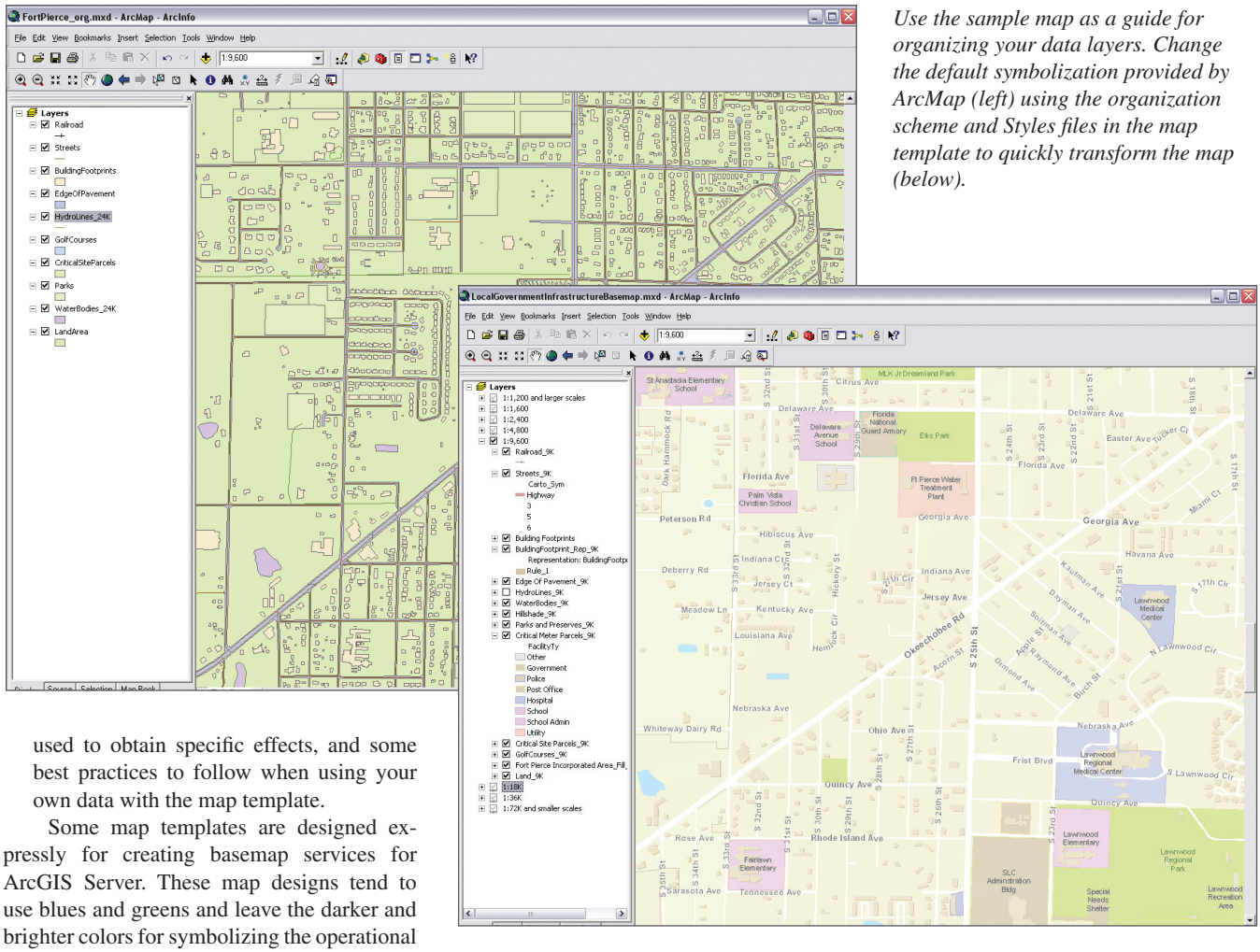
The map templates available online from the ESRI Resource Center (resources.esri.com/maptemplates/) should not be confused with ArcMap template (MXT) format documents that define the look and feel of map layouts and were developed for sharing map standards and tools in an organization.

Map templates are a more complete resource. Each template contains map documents, sample data, style files, and documentation (and in some cases, tools, models, and applications) that help you quickly create maps. Various templates address the different ways you can publish maps: printed maps, maps for mobile devices, and maps for maps services published on ArcGIS Server.

Steps for Using Map Templates

Once you have located a map template that meets your needs and downloaded and unzipped its archive, follow these steps to familiarize yourself with the contents so you can better apply it to your own data.

1. Determine what ArcGIS software is required for using that map template. Most require ArcGIS Desktop 9.3 or 9.3.1. The ArcInfo license level allows you to make full use of all components of a map template as well as providing the Maplex extension. However, to explore a template and use it with data you already have, an ArcView license may be adequate. Additional extensions, such as the ArcGIS Spatial Analyst extension and ArcGIS 3D Analyst extension, may be required to process or display some types of data.
2. Open the template's map document to see how the map is organized. Pay special attention to the way Group Layers are used to organize data by scale, type, or both. Open the layer properties for layers to inspect scale dependencies and other parameters that affect how the map is displayed. Explore individual layers to see how the information has been labeled and symbolized.
3. Explore the sample geodatabase in ArcCatalog to learn how the data is structured and consider how you can use your own data.
4. Inspect the Documentation files to understand the purpose of the map, the data used, and other aspects of its design. The Getting Started document lists the resources included in that map template, the methods



Use the sample map as a guide for organizing your data layers. Change the default symbolization provided by ArcMap (left) using the organization scheme and Styles files in the map template to quickly transform the map (below).

used to obtain specific effects, and some best practices to follow when using your own data with the map template.

Some map templates are designed expressly for creating basemap services for ArcGIS Server. These map designs tend to use blues and greens and leave the darker and brighter colors for symbolizing the operational layers that will be placed on top. This is the same design used by ArcGIS online basemaps and facilitates the creation of mashups. Using these templates standardizes maps so they can be shared back to the GIS community on ArcGIS online.

Making a Template Your Own

Once you have become acquainted with the resources in the map template, you can start using it with your own data. Because map templates are quite versatile, what you do with them depends on the output you need (e.g., printed map, Web map, shared layers) and the data you have. While it is possible that you might be able to immediately begin working with your own data in the template, that will probably not be the case.

From looking at the sample geodatabase, you can determine the similarities and differences between it and your data and the data schema used. You can decide how you might modify your data to better work with the map template. You might consider adding fields that mimic the template data structure as one way to accomplish this goal. However, this does not mean that you must completely redesign your data to conform to the sample geodatabase.

When you are ready to start adding your data to a new map, let the map document in the map template be a guide to organizing your data into multiscale layers. Chances are that you will not need all the scale levels present in the map template, so just use those scales that make sense for your map. Set scale dependencies for those layers you do use. If you are publishing a map service, make sure those scales match your tiling scheme. Each of those scale levels will be used to create a map cache.

With your data layers loaded and organized, the next step is to use the styles that came with the map template to quickly and correctly symbolize features. In ArcMap, choose Tools > Styles > Style References, click Add, and navigate to the Styles folder and choose the appropriate style for your layer. Now change the default symbolization provided by ArcMap using the Styles file just added to the document. This process involves nothing more than pointing and clicking to use the symbology that has already been developed and refined for this map.

Refer to the documentation for the map template for any additonal parameters, such as layer transparency, that need to be set and for information on techniques that can be employed, such as cartographic representation.

Finally, apply the labels needed for your map. Click the Labels tab, click Label Styles, and scroll down to access the label styles that were included with the map template. Several map templates include both labeling and annotation versions of the map, so if annotation has already been created, it can be fine-tuned and used in the map. Refer to the map document that came with the template to note any strategies that were used to more clearly identify features such as using map classes.

Conclusion

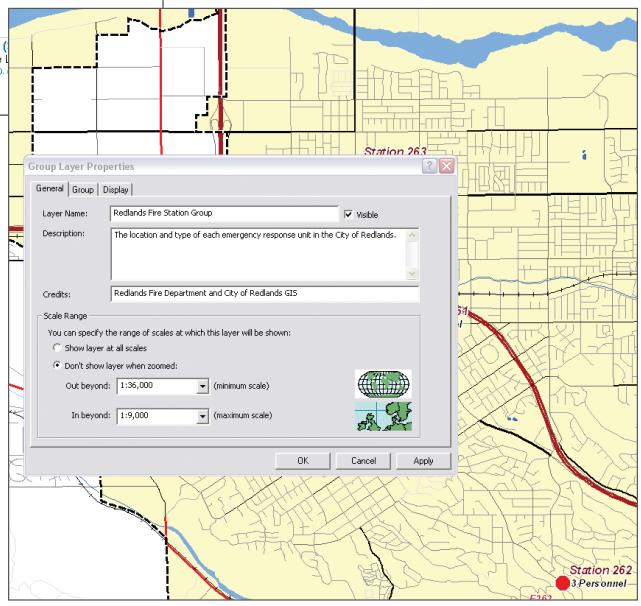
You can see that applying the resources in the map template can significantly reduce the time (and consequently, the money) required to produce an effective, professional-looking map. You started with data and a default map and transformed it into a well-organized, appropriately symbolized and labeled map.

Making Map Content More Usable

Best practices for sharing layer packages and map services

Sharing maps and map content saves time and money for organizations, and it's easily accomplished with layer packages or map services or a combination of the two using tools in ArcGIS. However, taking a little time to tweak and document the source map that will be used for layer packages or map services will make these products more valuable because end users will better understand the data and purpose of the map and be able to use them more effectively.

Maps authored in ArcGIS Desktop can be shared as layer packages and shared on ArcGIS online. Layer packages can also be distributed via e-mail, CD, or network drive.



Before sharing maps, take time to document the map and layers to ensure that those who use the map will understand the map's data and purpose.

Layer packages, introduced at ArcGIS 9.3.1, are a single, ready-to-use file that encapsulates the source data, cartography, and other properties of the layer that was authored in ArcMap. Layer packages are easy to share—they can be e-mailed, published on CDs and DVDs, placed on network drives, or shared via ArcGIS online. Like a ZIP file, a layer package (LPK) can be downloaded, unpacked, and used immediately or can be added to a geodatabase. Creating a layer package requires nothing more than right-clicking on the layer and choosing Create Layer Package. Layer packages work well when sharing locally held data of a limited size. A useful way to ensure that all the data is saved as part of the layer package is to use a file geodatabase as the data source for the map layer.

For sharing maps that use many layers with associated datasets and/or that incorporate basemaps from ArcGIS online, map services are a better choice. A map service is used to publish maps to the Web using ArcGIS and makes maps, features, and attribute data available inside many types of client applications. ESRI provides .NET, Java, SOAP, and REST interfaces for working with map services. Map services are often used to show business data on top of basemap tiles from ArcGIS online, Bing Maps (formerly Microsoft Virtual Earth), or Google Maps.

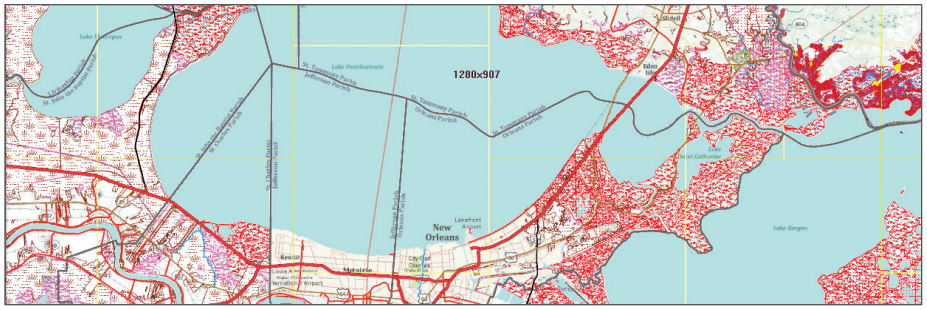
Publishing a map service is also straightforward. Tools in the Map Service Publishing toolbar in ArcMap can be used to optimize and tune map documents and saved as a map service definition (MSD). To support optimized map services using MSDs, ArcGIS includes a high-performance, scalable mapping engine, which can generate dynamic, high-performance maps on the fly (as well as cached map services) using the advanced cartography designed in ArcMap.

To share map content that uses local operational data and basemaps, layer packages and map services can be combined. If map content will be published online mashed up with other sources, it may be a good idea to consider using a different coordinate system. If it will be used with online basemaps, those from ESRI, Bing, or Google, Web Mercator may be a better choice of map projection.

No matter the method used for sharing map content, maps should be prepared before sharing them. Taking some time to document the map will ensure that those who use the layer will understand the data and the map's purpose.

1. Right-click on the layer to be packaged, open the layer properties for that layer, and begin by clicking the General tab.
   a. Update the layer name from the default name (which is the same as the layer source) to a name that is more useful.
   b. Add a description for the layer. The description will automatically appear with the shared content. Making an effort to include useful names and map properties in the description will make layer packages easier to discover.
   c. Include any copyright or source information in the Credits field.
   d. Adjust the Scale Range (if desired).
2. Click the Display tab.
   a. Adjust transparency (if applicable) and adjust layer visibility to show symbols or sublayers.
3. Click the Symbology tab.
   a. Update Labels with user-friendly names.
   b. Update the symbol properties so that all items of the same type (points, lines, polygons) are represented in a similar way. Uncheck the All Other Values option because it is not needed and will appear in the final legend.
   c. Make any other necessary adjustments to the symbology.
4. Click the Fields tab.
   a. Uncheck fields that are irrelevant to the user or that do not provide essential information.
   b. Enter aliases for any checked fields that do not have user-friendly names.
5. Click OK to apply these changes.

Another way to improve the "shareability" of maps is to improve the overall cartographic quality of those maps. Map templates downloaded at no charge from the ESRI Resource Center (resources.esri.com/maptemplates) not only speed up the process of creating maps but enhance map design. Because these map templates are the same ones ESRI uses in developing content for ArcGIS online, using map templates standardizes maps so they are



ArcGIS.com makes maps and layers, such as this map of the Gulf oil spill, available via many methods including ArcGIS Explorer Online.

more easily shared. A companion article in this section, "Superior Results in a Fraction of the Time: Map templates enhance productivity and skills," describes how to use free map templates available from ESRI to design more professional-looking maps quickly.

A Platform for Sharing Maps and Map Content

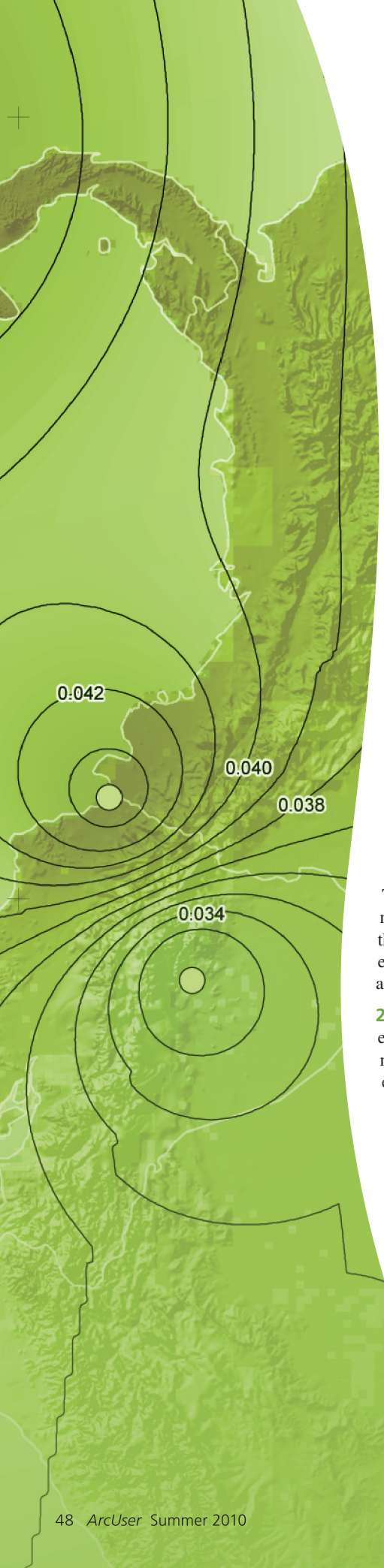
For the last several years, ArcGIS online has provided a common platform for ArcGIS users to discover and share geographic content and build GIS applications. Users can directly connect to maps, layers, tasks, and tools published by ESRI and other ArcGIS users.

Users can collaborate with other users who share a common interest and develop Web applications using ArcGIS Web Mapping APIs and ready-to-use ArcGIS online content that is continually updated. ArcGIS online is hosted by ESRI and powered by ArcGIS Server. Every ArcGIS user has 1 gigabyte of free storage.

ArcGIS online is evolving from a destination to an integrated and integral aspect of the ArcGIS user experience for providing data, tools, and sharing. Content can be shared with the entire GIS community or specific groups and it is available 24/7, hosted by ESRI. ArcGIS.com is a new platform that will give GIS users an easy way to find, use, and share content from ESRI and other users and employ services, such as geocoding, gazetteer, and routing. All ArcGIS.com resources will be available at no charge to current ArcGIS users for internal and noncommercial use. Basemap galleries make it easy to locate ready-to-use imagery, street, topographic, and thematic maps from ESRI. The tools available at ArcGIS.com include Web mapping applications, Web GIS applications, mobile applications, ArcGIS Explorer Online, and code and application templates. JavaScript, Flex, and Silverlight APIs; ArcGIS online applications such as Business Analyst Online; and cloud services are also available at the site.

Resources

For more information on sharing GIS resources, visit the ESRI Resource Center (resources.esri.com/maptemplates) and the ESRI Mapping Center (mappingcenter.esri.com). An ESRI instructor-led class, *Creating and Publishing Maps with ArcGIS,* is also available. Visit www.esri.com/training to learn more about this class.



Faster, Easier METADATA

Less time and less typing to document project information

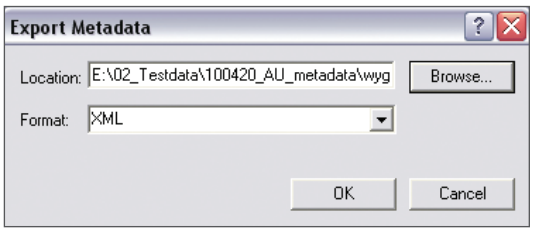
Metadata is critical to GIS data sharing. Without metadata, how do you know how the data was collected, what it can be used for, or how current it is?

However, writing metadata for feature classes or other data created for a project can be a labor-intensive, time-consuming, and tedious process. Fortunately, using the ArcCatalog Metadata toolbar can streamline and speed the process of documenting your files.

Before the ArcCatalog Metadata toolbar, when you had to document several datasets, you selected one of the files, opened the Metadata Editor in ArcCatalog, filled in the required fields, closed the editor, selected another file, and repeated the process.

Often, you entered the same characteristics over and over again. **It doesn't have to be that way. Just follow these steps.**

1. When you begin to add metadata for a project, identify those characteristics common to all the project's feature classes. These common items might be the project name and number, contact information for the organization, the project's spatial reference information, and information on data access and use constraints.



After filling in metadata items common to all files in the project, click the Export button on the Metadata toolbar in ArcCatalog and export the metadata in XML format.

2. Use one of the ArcCatalog metadata editors (e.g., FGDC ESRI, ISO) to create metadata for one of the project's files, but enter only the characteristics you identify as common to all project data. Once this information has been entered, export the metadata just created to XML format by selecting the item in the ArcCatalog tree, clicking the Metadata tab in the right pane, and clicking the Export button on the ArcCatalog Metadata toolbar, then browse to the output folder and choose XML as the type of file to export.

3. This exported XML file, containing metadata common to all the files in your project, can be used to populate those metadata files for all project materials—feature classes, imagery, and maps. To add this metadata to a file associated with the project, select the file in ArcCatalog, click the Metadata tab, and click the Import XML button.

4. Repeat the process of importing this XML for every feature class or other file in the project.

5. Now open each feature class and complete the metadata by adding the information that is unique to that feature class (e.g., abstract, description, status, and keywords).

This exporting/importing XML strategy will speed the process of adding metadata and eliminate much of the typing associated with this process. Remember, metadata can be created and attached in this manner to the maps, charts, and photographs associated with a project, as well as GIS datasets.

Make Your MAPS Better

Individual map consultations available at 2010 ESRI UC

Have your map evaluated in a one-on-one session with a professional cartographer.

Map Critique Station hours of operation

Day of week	Date	Hours	Activities
Monday	July 12	4 p.m.–8 p.m.	Only answering questions and scheduling
Tuesday	July 13	9 a.m.–6 p.m.	Map critiquing and scheduling
Wednesday	July 14	9 a.m.–6 p.m.	Map critiquing and scheduling
Thursday	July 15	9 a.m.–1 p.m.	Map critiquing

For the past four years, ESRI has provided a unique way for you to improve your cartographic skills. At the Map Critique Station, you can sit down with an experienced cartographer and review your printed or digital map. This year, the Map Critique Station will be held in the Sails area at the 2010 ESRI International User Conference (ESRI UC) in San Diego, California.

"I pride myself on my maps and put a lot of effort into them, but both years I have gotten feedback that has enabled me to improve," said Jacob Thornton of Vanderbilt University, a Map Critique Station participant. "These guys are seasoned professionals and are very knowledgeable."

The Map Critique Station was started to help users create more professional-looking maps and learn how to take advantage of the cartographic tools in ESRI software. Professional cartographers will spend 5 to 10 minutes with you, evaluating your map, offering a constructive critique, and making suggestions for improving your map. You are encouraged to bring a hard-copy map so comments can be documented, but maps designed for screen display or online use can also be evaluated. (No on-site printer will be available.)

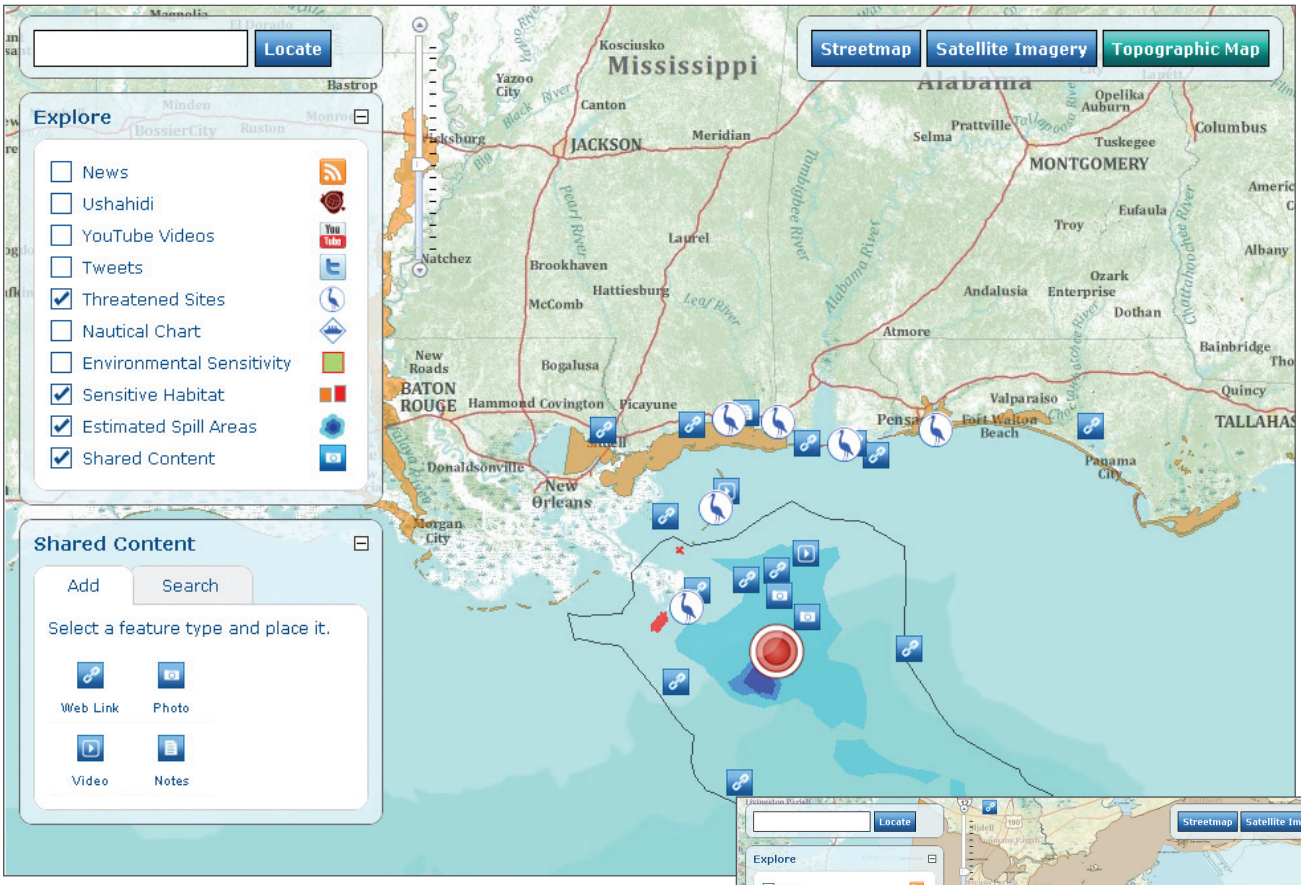
"I felt like every area criticized was done in a way that outlined how to make it better, as well as why it makes it better," said Shane Willard of the Bureau of Indian Affairs who participated in last year's Map Critique Station.

To schedule an appointment at the Map Critique Station during the 2010 ESRI UC, send an e-mail to mapcritique@esri.com.

Getting in Touch with Volunteered Geographic Information

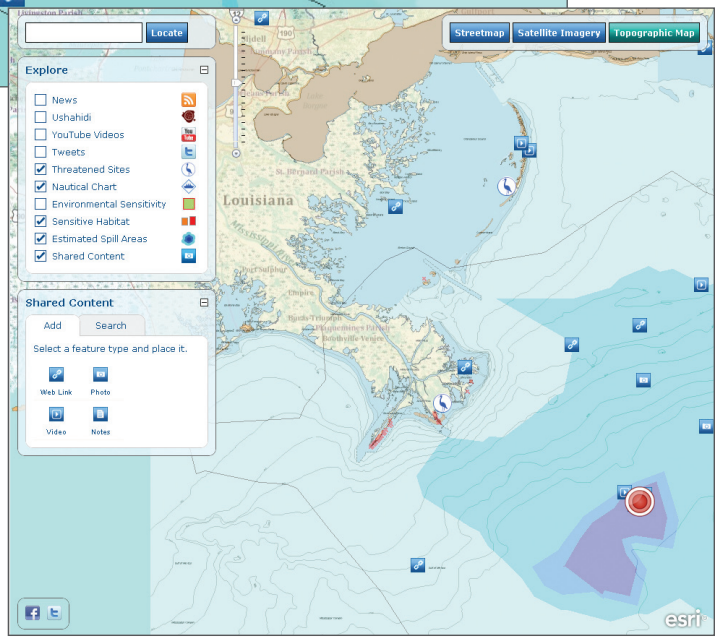
Use a JavaScript API live sample to build a Web editing application

By Bronwyn Agrios and Keith Mann, ESRI



ESRI's Gulf of Mexico Oil Spill map demonstrates volunteered geographic information (VGI) in action. VGI is a term applied to geographic information that has been voluntarily gathered and entered by individuals. This site focuses on the massive oil spill that began on April 20, 2010, as the result of an explosion and fire on board a semi-submersible drilling rig.

VGI Web sites facilitate the creation, assembly, and dissemination of user-generated content. On the basemaps provided, users can define their own content based on firsthand knowledge of local geography. The Oil Spill map application is powered by ArcGIS Server 10 beta hosted in the Amazon Web Service infrastructure. It incorporates VGI-supplied information such as links to online photos, Web sites, GeoRSS feeds, tweets, and YouTube videos that are combined with authoritative basemap data that includes streetmap coverage, satellite imagery, topographic maps, navigational charts, and data on environmentally sensitive sites. Visitors can place new information on the map by choosing a feature icon, clicking on the map, and linking to the content to be added. Learn more by visiting the site at http://www.esri.com/services/disaster-response/gulf-oil-spill-2010/index.html.



ESRI's Gulf of Mexico Oil Spill map demonstrates VGI in action.

VGI is a specific example of the community-based information collection model that features content developed by end users. Amazon and Trip Advisor are familiar examples of sites that incorporate user community comments. These comments provide information from real consumers with direct knowledge of the subject and assist potential purchasers in making decisions. You are probably also already familiar with sites that promote geocollaboration and community mapping. Open Street Map and WikiMapia are examples of this type of site. These and other similar geocollaboration sites provide access to informal sources of data and local knowledge about the geography of a place.

All sites that depend on user-generated content must motivate people to act voluntarily. Contributors need to understand how the content they collect supports the site's overall goal. Also, sites that let end users enter information must be managed by an administrator to ensure that the content posted is credible, relevant, and not offensive in content or language and to avoid copyright infringement issues. When end users have been successfully motivated and are contributing to the map, administrators filter the map's geometry to avoid clutter that could make the map illegible. For example, in places that have poorly detailed map coverage or out-of-date or expressive mapping, the rapid entry of information by the user community may result in maps that have overlapping shapes. Site administration is discussed more fully later in this article.

Requirements for Building a VGI Site Using ArcGIS 10

Creating a VGI site requires not only assembling people and software but also designing a workflow, data schema, geodatabase, and map template. A discussion of these requirements follows.

People

The process of designing, constructing, implementing, and administering the site and implementing Web editing will require one or more GIS professionals with knowledge of ArcSDE, geodatabase design, and the use of ArcMap for Web map design and familiarity with publishing services using ArcGIS Server. One or more persons will also be needed to act as site administrators to maintain content credibility. Optionally, the role of the administrator can be limited to setting up a security policy for ensuring that the data is only accessed and/or edited by a select group of people. However, the most important factor to the success of the site is a user community willing to volunteer information.

Required Software Components

The Web application for collecting data should use ArcGIS 10 and one of the ArcGIS Web Mapping APIs that has been configured so all components for editing geographic data are enabled. The following components, configured as described here, are required when setting up a VGI site:

- ArcSDE geodatabase containing features set up for handling Web edits
- An ArcMap document that references one or more feature classes from an ArcSDE geodatabase
- A feature template that defines the properties required for creating a new feature
- The map document and its associated template, published as a map service with feature access
- A Web application with UI controls for making edits to geometry and/or attributes

Designing the Workflow of the ArcSDE Feature Class Schema

Start by preparing the ArcSDE feature classes that will participate in the editing workflows. Keep in mind that the fields and their names (or aliases, if provided) will be visible to the end user of the editing application. Once the feature class has been added to ArcMap as a layer, table properties, such as alias name and visibility, can be tuned further. Please note that the order of the fields can only be defined in the feature class table, so they should be in the order you want the end user to see them in the Web application. Some other things to consider at this stage of data preparation include

- Creating a separate geodatabase feature class to support Web editing if content also exists in the authoritative geodatabase
- How you want the attribute data represented to users who may not be familiar with GIS?
- Defining subtypes and domains (whenever possible) to simplify the attribute editing experience
- Deciding if data can be registered as versioned or edited in a nonversioned environment (Feature classes that participate in nonsimple data types, such as topology or network data, must be registered as versioned.)
- Configuring the feature class to support attachments in the geodatabase. (A feature class that has been configured to use attachments must be added to and published with the map document.)

Preparing the ArcSDE Geodatabase

When preparing the ArcSDE geodatabase, remember that all data that will be added to the map document for editing must come from a single ArcSDE geodatabase and must be registered with that geodatabase. Examine the database connection file to determine whether access to feature classes will be controlled using operating system authentication or database authentication.

Defining Layer and Table Properties in ArcMap

The feature symbology and layer names defined in the map document will be exposed to the Web application end user. Take great care to choose symbols that will be meaningful to non-GIS users and create aliases for all layers.

- When designing the symbols that will be used when editing features, temporarily add the basemap layers that will also be used with the Web application so you can see how features will appear in the legend and on the map when the Web application is in use. In ArcMap, you can further modify how editable layers will appear in the Web application to end users.
- Create aliases for all table fields exposed in the Web editing

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Getting in Touch with Volunteered Geographic Information

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interface either in the geodatabase or in ArcMap by changing the attribute table for that feature class. You can hide fields by changing their visibility in ArcMap. Do not hide the Shape field—doing this will prevent the geometry for that layer from displaying in the Web application. Fields can also be made read-only. The order of the fields is defined in the feature class schema—not in ArcMap by changing the layer properties.

- When publishing the map document that will be the source for the editing service, include only layers that will be edited in the Web application. Basemap layers and operational layers that will not be edited in the Web editing application should be published to separate services and mashed up with the editing service in the Web application.

Creating a Feature Template

A feature template packages the settings that have been defined in ArcMap and makes them available to the Web service that will be used for editing. Feature templates define the feature editing experience as well as the information required to create a new feature whether editing in the desktop or the Web. This information includes the layer where the new feature will be stored, the attributes a new feature will be created with, and the default tool used to create that feature. New feature templates are created, and existing ones are edited in ArcMap. Feature templates are saved with the map document used to create them.

When creating a feature template, you will notice that ArcMap layers that are symbolized with either unique value or categorical renderers will have each symbol category exposed as a separate layer in the feature template (and subsequently in the Web editing user interface). When the feature class is also subtyped, each category in the feature template will also maintain the default attribute values as defined for that subtype. If you are not using subtypes, set the default field value for each feature template where appropriate. This makes the attribute editing experience intuitive for end users.

Publishing the Map and Enabling Feature Access on the Service

Finally, the map document is published to ArcGIS Server with both the mapping and feature access capabilities turned on. Both the mapping capability and the Feature Access capability create URLs for the services generated. While a map service serves an image of features, a feature service allows you to serve features over the Internet. Editing on the Web works through a new type of service available with ArcGIS 10: the feature service. In addition to serving features, the feature service also uses the symbology defined in the map document to render the features. Feature service operations include editing and querying.

Defining the User Experience

The end-user experience is directly affected by the design of the feature class, map document, and feature template. The out-of-the-box Web Mapping API components for editing include the Template Picker, Attribute Inspector, and Attachment Editor.

- ***The Template Picker*** displays a gallery of templates from one or more feature layers. For each template, the symbol and label defined in the map document is displayed. Note that the application developer can overwrite these symbols in the code.
- ***The Attribute Inspector*** displays the attributes of selected features from one or more feature layers. If the layer is editable, the feature attributes will be editable. The Attribute Inspector widget honors the domains and subtypes that were defined by the feature service.
- ***The Attachment Editor*** supports viewing attachments for feature layers that have attachments enabled. If feature layers are from a feature service, the attachment editor will include the ability to create, view, and delete attachments. The application developer/configurer can also determine which API editing components to include in the Web editing application to tailor the editing experience to the end user and type of content being collected.

Administering Ensures the Quality of User-Generated Content

A VGI Web site can become unusable if it is not moderated by an administrator. An administrator eliminates offensive language, inaccurate data, content not related to the site's purpose, and content that could constitute copyright infringement. A best practice for VGI sites is the creation of a simple application that allows non-GIS users to monitor the volunteered content and modify it as needed. Security is another administrative function. Consider implementing ArcGIS Server service security to restrict access to the editable feature service. Remember that the security level is defined at the service level, not feature by feature.

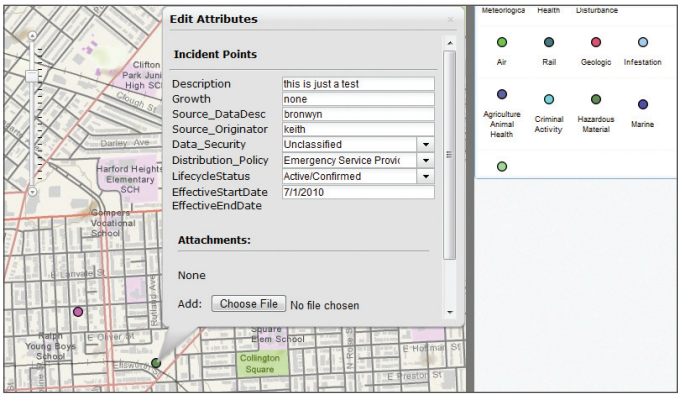
Do It Yourself: Use an Existing VGI Sample to Create Your Own VGI Site

Follow these steps to use a sample Web application that contains feature editing functionality as a template for creating your own VGI site. This hands-on exercise does not require that you have ArcGIS Server 10 but it does require

- A Web browser and access to the Internet
- A Web server running on your machine (Microsoft IIS is used in this example.)
- A text editor (Microsoft Notepad is used in this example.)

View the Live Sample of a Basic VGI App

1. Go to the ArcGIS JavaScript API Resource Center at http://help.arcgis.com/en/webapi/javascript/arcgis/.
2. Click the Samples tab and, under JavaScript API Samples, expand the Editing book.
3. Click the first sample, Default Editor.
4. Click the View live sample link in the Description area and explore



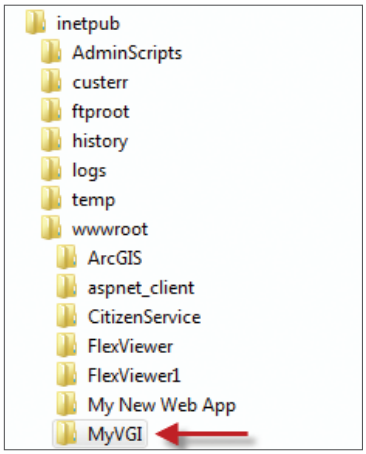
This interactive sample is used to demonstrate basic Web editing functionality. Developers can use the sample code to add Web editing to custom Web applications.

how the sample works.
5. Leave the live sample open.

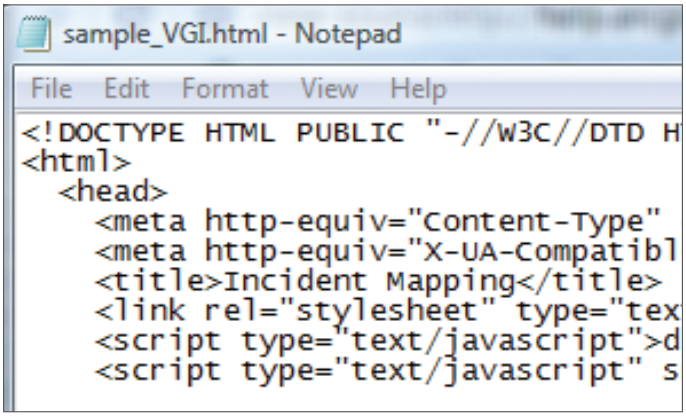
Copy the Application Source Code

The Default Editor widget lets you create and edit features. It includes a Template Picker, an Attribute Inspector, and an Attachment Editor. In these next steps, you'll steal the code for the entire sample so that you can incorporate those functional components into a VGI site hosted on your machine.

1. First, create a folder called MyVGI under the root of your Web server (i.e., C:\inetpub\wwwroot\MyVGI).
2. Next, in the browser containing the live sample for the Default Editor, right-click below the Template Picker (located to the right of the map) and choose View Source (or View Page Source, depending on the Web browser used). Select all page source text, right-click, and click Copy.
3. Now, open Microsoft Notepad and paste the contents into a new Notepad file. Save the file to the MyVGI folder and name it sample_VGI.html. Change the Save as Type to All Files so that the file does not try to save as a (.txt) text file.
4. Finally, navigate to your MyVGI folder and double-click the sample_VGI.html file that you just created to open the application again—this time you will open the file from the code on your machine. Editing functionality will not work properly at this point, but you will fix that in the next step.



Create a folder named MyVGI in your wwwroot folder.

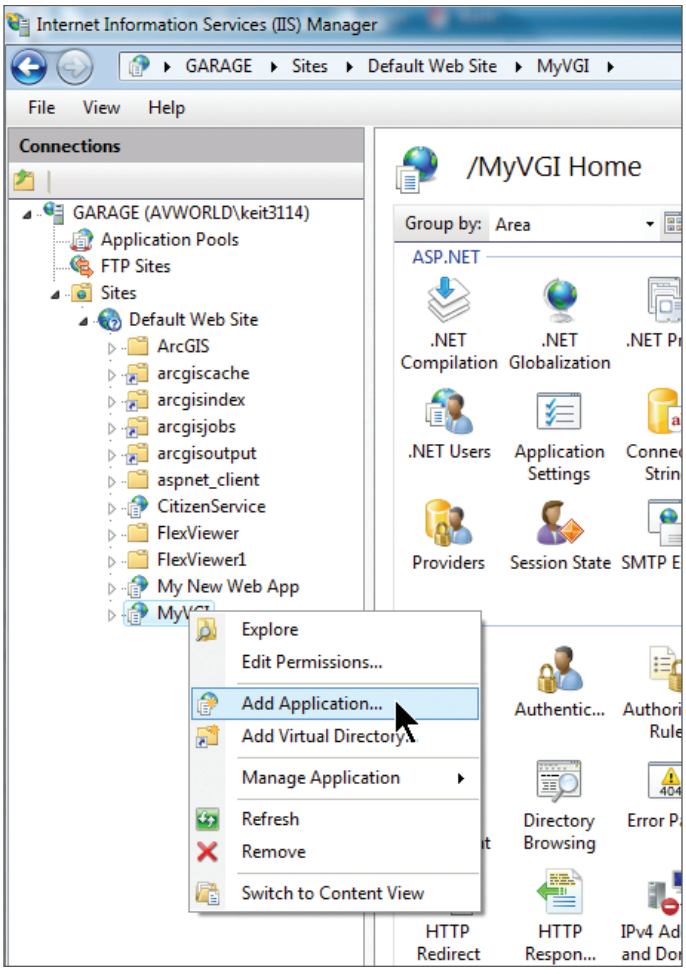


Copy the sample application source text and paste it into a new Notepad document.

Make MyVGI Folder a Web Application Using IIS

In this step, you will use Microsoft IIS to create a Web application from the MyVGI folder.

1. Open your Control Panel, double-click Administrative Tools, then double-click Internet Information Services (IIS) Manager.
2. Although the IIS Manager may look slightly different for XP, Vista, and Windows 7 operating systems, the task is the same for all three—expand the IIS tree structure to expose your MyVGI folder that will be located in the Default Web Site folder, then either add or create the application.
3. For Vista, in the Default Web Site folder, right-click the MyVGI folder and click Add Application. In the Add Application dialog box, name the alias MyVGI and, if necessary, define the Physical path by clicking the ellipses button and navigating to your MyVGI folder. Select it and click OK, then click OK again to close the Add Application dialog box.



In the Windows Vista IIS Manager, click Add Application to add your MyVGI folder.

4. For XP, in the Default Web Site folder, select MyVGI and choose properties. From the Directory tab under Application Settings, click Create. Click OK.
5. Close the IIS Manager.

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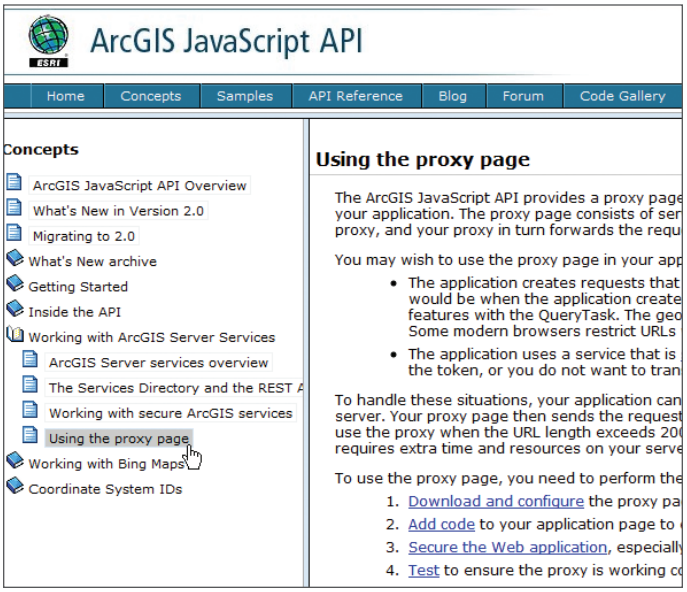
Modify the Application Code

Now that your application is recognized by your Web server, you'll make a few minor changes to the application code so that it will work on your local machine.

1. First, in your Web browser, go back to the ArcGIS API for JavaScript Resource Center and click the Concepts tab. Expand the Working with ArcGIS Server Services book and click Using the proxy page.
2. Click the Download and configure link (in the body of the Topic text) and click proxypage_net.zip to download the zipped file. Save it to your MyVGI folder.



The proxy page consists of server-side code that runs on your Web server.

3. Extract the proxypage_net.zip to the MyVGI folder.
4. In Notepad, open your sample_VGI.html file and find the section that begins,

```
function init() {
```

Change the path in the line

```
esri.config.defaults.io.proxyUrl = "/arcgisser-
ver/apis/javascript/proxy/proxy.ashx";
```

to

```
esri.config.defaults.io.proxyUrl =
"http://<your_machine_name>/MyVGI/proxy.ashx";
```

Save and close sample_VGI.html.

Note: Be sure to replace <your_machine_name> with the name of your machine.

5. In Windows Explorer, navigate to your MyVGI folder, right-click the proxy.config file, and open it in Notepad.
6. Find the following line (near the top) and change "true" in the line

```
<ProxyConfig mustMatch="true">
```

to "false."

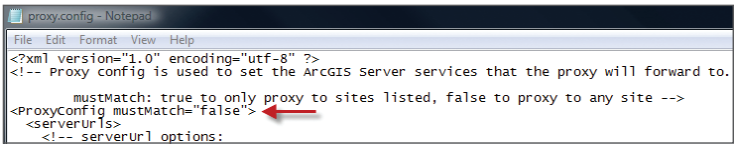
```
<ProxyConfig mustMatch="false">
```

Save and close proxy.config.

7. Open a Web browser and go to your MyVGI Web app:

http://<your machine name>/MyVGI/sample_VGI.html

Remember to replace <your machine name> with the name of your machine.



Change ProxyConfig mustMatch to False.

The appearance and functionality of the application will be exactly the same as the sample in the JavaScript API Resource Center, except that now it is hosted on your machine.

Replace the Feature Service with a Different Feature Service

Now that you're hosting the MyVGI app, you will replace the feature service it uses with a different feature service. This action represents what you might do if you were to use your own feature service hosted on your ArcGIS Server. In this case, you will borrow a different feature service from ESRI.

In your Web browser, go to

http://sampleserver3.arcgisonline.com/ArcGIS/rest/services

This page is the ArcGIS Services Directory for sampleserver3 at ESRI. The Services Directory is part of any ArcGIS Server implementation and is a way to explore and access the REST endpoints of ArcGIS Server services. Keep in mind that the services on sampleserver3 are for demo purposes only and should not be used in your production applications.

1. Click BloomfieldHillsMichigan to expose the services in that folder. These services were created using the process described in the first part of this article.
2. Click BloomfieldHillsMichigan/LandusePlanning (FeatureServer) to expose a list of the layers of this service. The service contains three layers: Land Use Points of Interest, Land Use Linear Features, and Land Use Planning Areas.
3. Click Land Use Points of Interest (0) and copy the URL from the address bar of the browser to your system clipboard.
4. If necessary, open your sample_VGI.html file in Notepad again and find the line that begins as follows (near the middle of the file):

Replace the original feature service with a different feature service.

```
var operationsPointLayer = new esri.layers.
FeatureLayer
```

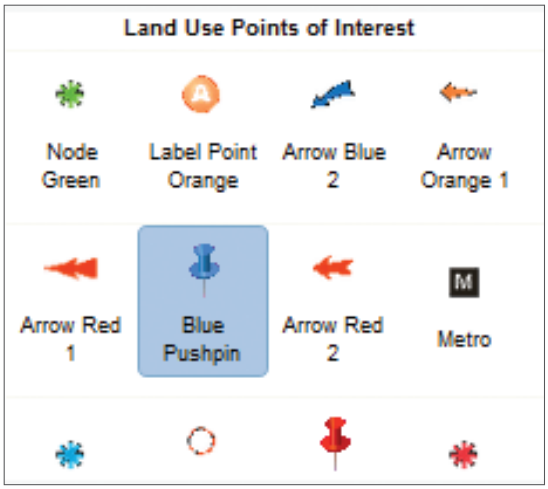
Replace the URL for this feature layer with the URL you have copied for Land Use Points of Interest (0).

5. Repeat this process for the remaining two feature layers, copying in the URLs for Land Use Linear Features (1) and Land Use Planning Areas (2) and replacing the URLs for operationsLineLayer and operationsPolygonLayer, respectively. Save the file.
6. In your Web browser, open your sample_VGI app again (e.g., http://<your machine name>/MyVGI/sample_VGI.html) or, if you still have it open, refresh the page by pressing F5.

Now the map has been cleared of the VGI content that accumulates in the ArcGIS API for JavaScript sample app, and a new set of feature symbols has replaced the previous set in the editing template.

Take a few moments to add new content to the map.

Keep in mind that while this app is hosted on your machine, the feature are stored in a geodatabase hosted by ESRI. To make this app truly your own, you need to create your own feature layers as described in the first part of this article.



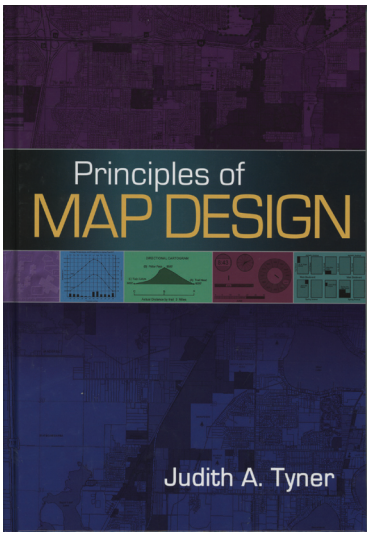
Your sample_VGI app now uses the feature editing template for the BloomfieldHillsMichigan feature layers.

Conclusion

This exercise stepped you through the process of setting up one of the editing samples on your local machine and updating the references to the feature service to change the content that will be edited by the application.

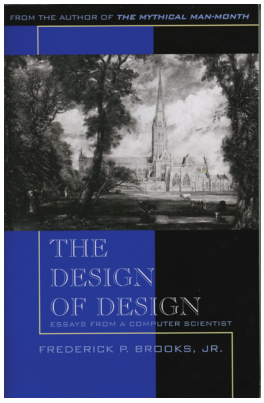
```
        var operationsPointLayer = new esri.layers.FeatureLayer
("http://sampleserver3.arcgisonline.com/ArcGIS/rest/services/BloomfieldHillsMichigan/LandusePlanning/FeatureServer/0", {
          mode: esri.layers.FeatureLayer.MODE_ONDEMAND,
          outFields: ["*"]
        });
        var operationsLineLayer = new esri.layers.FeatureLayer
("http://sampleserver3.arcgisonline.com/ArcGIS/rest/services/BloomfieldHillsMichigan/LandusePlanning/FeatureServer/1", {
          mode: esri.layers.FeatureLayer.MODE_ONDEMAND,
          outFields: ["*"]
        });
        var operationsPolygonLayer = new esri.layers.FeatureLayer
("http://sampleserver3.arcgisonline.com/ArcGIS/rest/services/BloomfieldHillsMichigan/LandusePlanning/FeatureServer/2", {
          mode: esri.layers.FeatureLayer.MODE_ONDEMAND,
          outFields: ["*"]
```

New URLs for the feature layers



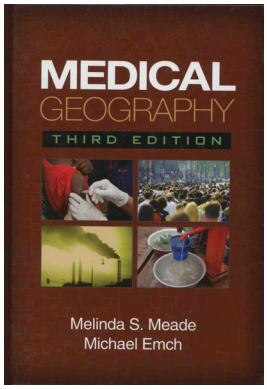
Principles of Map Design
By Judith A. Tyner

This clearly written textbook focuses on the principles of making maps. Not a how-to book, its goal is translating and summarizing current cartographic thought and practice and making this information accessible to students. The design referenced in the title is not narrowly defined as layout or aesthetic considerations but in the broad sense of a decision-making process that encompasses choosing data, an appropriate projection, and symbolization to design an effective map. Topics covered include Web mapping, animated maps, interactive maps, and maps for the visually impaired. "Chapter 5: Critique of Maps" contains a series of map makeovers that show how maps can be modified to better reach the intended audience. The author, a professor emeritus of geography at California State University, Long Beach, taught courses in cartography for 35 years before her retirement. The Guilford Press, 2010, 259 pp., ISBN: 1606235443



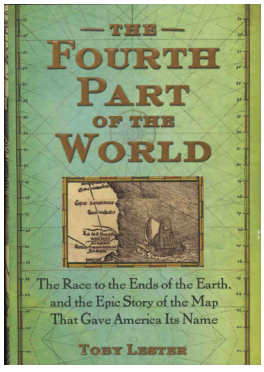
The Design of Design: Essays from a Computer Scientist
By Frederick P. Brooks, Jr.

The author's goal is to "prod designers and design project managers into thinking hard about the process of designing things, especially complex systems." Rather than discussing what is "good design" versus "bad design," this book discusses the process of design, the nature of design problems, the reality of design activities, and fundamental concepts of design. He characterizes the two areas of design—computer architecture and software architecture—with which he has had the most professional experience as having "short histories and modest reflections," so he also draws on examples from a field with a much longer history: the functional design of houses. Seven case studies round out the book and provide concrete examples of points made in the essays. Brooks, who received the National Medal of Technology for his work on IBM's Operating System/360 and the A. M. Turing Award for his "landmark contributions to computer architecture, operating systems, and software engineering," is also the author of *The Mythical Man-Month*. Addison-Wesley Professional, 2010, 448 pp., ISBN: 0201362988



Medical Geography, Third Edition
By Melinda S. Meade and Michael Emch

"Geography is destiny," declared the researchers who analyzed the delivery of health care and the outcomes of medical treatment for *The Dartmouth Atlas of Health Care*. The authors of *Medical Geography* provide an inclusive survey of the field of medical geography and introduce students to geographic concepts and methodologies. According to the authors, the term *medical geography* has grown to encompass the geography of both health and disease; it overarches the biological, environmental, and social sciences; and it uses both qualitative and quantitative methods. Chapters address how geography can be used to analyze the effects of climate and weather, pollution, the occurrence of noncommunicable diseases, the diffusion of communicable diseases, and the delivery of health care. This new edition of a standard text in the field incorporates updated and more extensive coverage of the use of GIS for modeling health and disease throughout. The concluding chapter focuses on scale, spatial analysis, spatial statistics, and geographic visualization. The Guilford Press, 2010, 498 pp., ISBN: 1606230166



The Fourth Part of the World: The Race to the Ends of the Earth, and the Epic Story of the Map That Gave America Its Name
By Toby Lester

The purchase of the Waldseemüller map by the Library of Congress in 2003 for $20 million spawned a new wave of books chronicling the intriguing story of the map that gave America its name. That is the story that author Toby Lester set out to write, but the resulting book is much more. It not only tells the fascinating tale of how the map was made but also explores the convergence of ideas and events that made it possible. Like *Connections,* the popular BBC television series from the 1970s created and hosted by science historian James Burke, Lester's book teases out the seemingly isolated (but actually interconnected) events that helped create the world we know. This macrohistory is organized around the Waldseemüller map. Each chapter focuses on a small portion of the map and brings the history behind it to life. Illustrated with numerous historic maps, it has been called "a masterpiece of cartographic literature that will be of lasting importance" by Simon Winchester, author of *The Map That Changed the World: William Smith and the Birth of Modern Geology*. Free Press, 2009, 462 pp., ISBN: 1416535314

gis Bookshelf

Solve Data Alignment Mysteries

In a perfect world, every GIS dataset you received would have the correct coordinate system and information about that coordinate system would be reflected in the metadata. *Lining Up Data in ArcGIS: A Guide to Map Projections* by Margaret M. Maher helps you deal with the less than perfect world in which you work. Dealing with data that should display correctly—but does not—is a common aggravation for GIS users. The author has spent years with ESRI's support services helping GIS users solve problems associated with map projection and data conversion. This book grew out of the countless e-mails she has written explaining how to identify mystery projections, perform transformations, and get data layers to line up correctly.

This book is a reference for troubleshooting common problems associated with data misalignment that focuses on the coordinate systems used in the United States. Each chapter addresses specific problems and can stand alone. The basics of working with coordinate systems and map projections, as well as understanding and applying geographic transformations, are covered. Many chapters provide best practices that will help users avoid problems.

The topic of using CAD is extensively treated. Three chapters target the many special challenges associated with using CAD data including handling CAD data that

- Uses nonstandard units of measurements, local coordinate systems, and rotated data
- Has features turned off or locked so they are not drawn in ArcMap
- Uses ground coordinates
- Is stored in binary CAD files that have file names with spaces so that projections cannot be directly defined

"Chapter 5: Aligning CAD Data—Modifying a Standard Coordinate System" supplies guidelines that can be given to CAD operators who provide data to GIS departments. Following these guidelines will avoid common problems caused by the methods used when creating and saving CAD data. The text also describes how custom projection files can be created to deal with the unique situations often encountered when using CAD data.

With more than 4,000 projection files available in ArcMap, being an effective projection detective requires a systematic method for identifying the correct coordinate system when presented with data lacking correct or any documentation. As Maher notes, "The key to this process is the extent of the data. The data extent can be viewed and analyzed when the data is added to ArcMap. Data can be created in geographic, projected, or local coordinate systems. By examining the extent of the data in ArcMap, you can identify the type of coordinate system used to create the data."

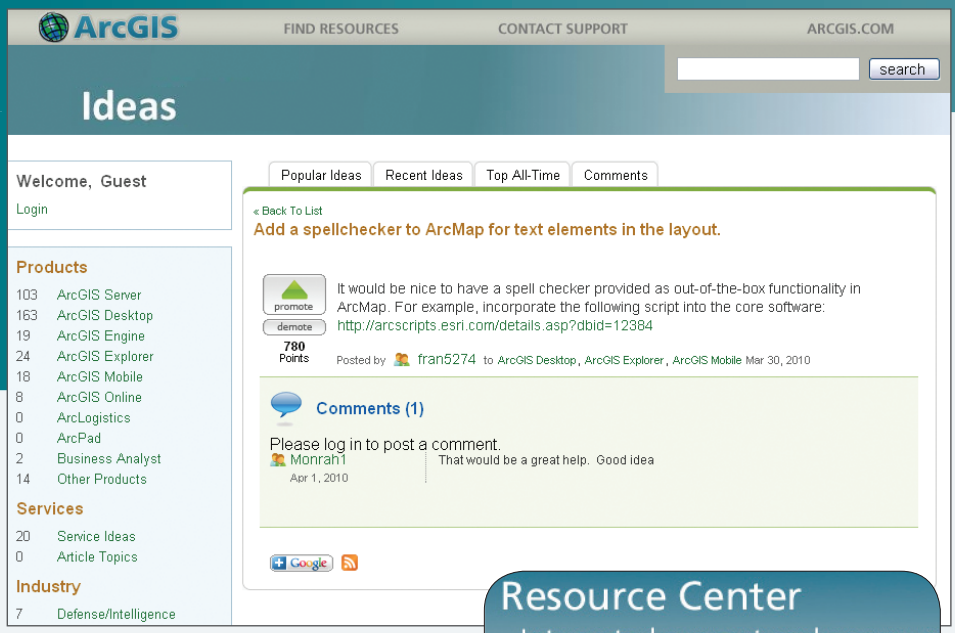
The author, who specializes in projections and data conversion in support services at ESRI, has personally closed more than 12,000 incidents related to problems with map projections and data conversions and has written numerous articles on map projection and data conversion topics for the ESRI Support Services Knowledge Base.

This is a tremendously useful book for both experienced and novice users. It can be purchased from esripress.esri.com or from booksellers in the United States and Canada. ISBN: 9781589482494

More Content, Community,

New ESRI Support site provides more features

The new interface for the ESRI Support site (support.esri.com) is search-centric and more tightly coupled with the ESRI Resource Centers. The site, incorporating Web 2.0 features, made its debut in April and will continue to roll out new functionality through July 2010. The new design makes announcements, common issues, support resources, and other relevant information handy.



Locate existing data and solutions easily using the new large Search Support Pages bar. This search is powered by a new Google Search Appliance (GSA). Keyword search results are displayed in a new quadrant-based search page that identifies relevant search results from different data repositories (e.g., Documents, Communities, Service Packs and Patches, and Bugs).

Resources on the site are easier to find and use. Icons located on the top, right-hand side link directly to tech support features. Make a new support request by clicking New Support Request. My Support Requests is currently available only to ESRI international distributors but will be available to users with valid support contracts by the 2010 ESRI International User Conference (ESRI UC). The Contact Technical Support button provides information for contacting tech support. The ability to chat with an analyst online is coming soon. Links to articles on common issues and up-to-date information on bug-related announcements, patches, and service packs are listed directly below the icons.

The blue Find Resources bar, located under the site login, links directly to the new ArcGIS Resource Centers that organize information on ESRI products including Web help and knowledge base articles. Knowledge base articles are also directly accessible from the Support Center site. (Because of changes to the support site, previously created links or bookmarks will no longer work. The most effective method for locating knowledge base articles will be to search for them using the article ID number.)

Links to ESRI online communities, familiar ones and some new ones, are grouped under the Community Content heading. Links to the Support Blog and Data Model pages are located here. This section also contains links to new items such as the Forum, wiki.GIS.com, and the ArcGIS Ideas portal.

New Improved Forums

The new, improved Forum makes it much easier to locate a post and link to social networking sites like Digg and del.icio.us. It provides a customizable user experience.

Members can subscribe to forums organized around products, functions (e.g., data models, geoprocessing), user communities (e.g., land records, petroleum), and solutions (e.g., ArcLogistics, PLTS). Members can also subscribe to threads and join groups with others who share an interest area.

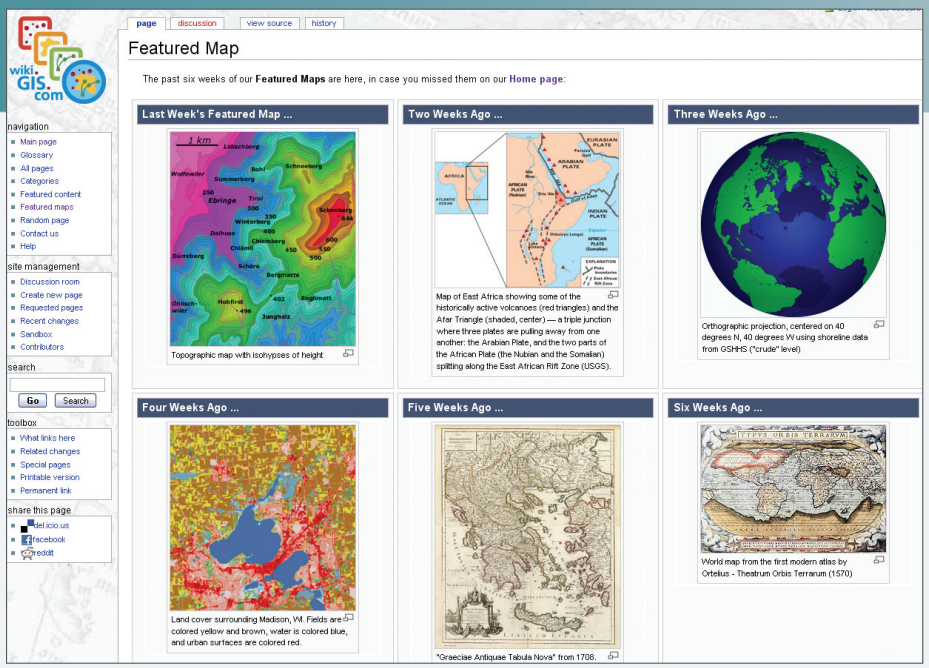
Forum members have publicly viewable profile pages. Messages can be posted to these pages. Members can control privacy settings; add signatures, avatars, or profile pictures with posts; and upload albums and pictures. Lists of friends and contacts are maintained through the site, and members can send private messages. The Quick Links menu in the navigation bar at the top of each page (available only to logged-on, registered members) provides direct access to today's posts; networks of friends, contacts, groups, pictures, and albums; the control panel; and other personal items. After only six months of operation, nearly 8,500 users have become members of these new forums.

Building a Great Source of GIS Knowledge

Launched in December 2009, wiki.GIS.com is envisioned as a free encyclopedia that will serve as a comprehensive repository for factual, unbiased GIS knowledge. It is free, available to anyone, and moderated by the GIS community. The collaborative nature of a wiki is especially well suited to the rapidly evolving field of GIS technology.

Wiki.GIS.com started with just 2,000 pages of content that encompassed both GIS and geography. In the first three months, it grew by nearly 7,000 pages and was receiving more than 3,000 visitors per week. A high percentage of visitors to this site participate. Regular contributors to the site may be

and Collaboration



Envisioned as a free encyclopedia that would serve as a comprehensive repository for factual, unbiased GIS knowledge, wiki.GIS.com is free, available to anyone, and moderated by the GIS community.

invited to be moderators. Unlike its inspiration, Wikipedia, which is wide in scope but not deep in detail, wiki.GIS.com aims to be deep, rather than wide. As a knowledge sharing platform, content at the wiki.GIS.com site is a useful resource for both experienced and beginning GIS users that is organized by category and includes a glossary and featured maps section.

Sharing Ideas for Improving Software

The ArcGIS Ideas portal, part of the ArcGIS Resource Centers, gives ESRI software users a place for sharing ideas and collaborating to improve GIS. Ideas on enhancements to functionality, services, and workflows are submitted to the site. A search mechanism helps eliminate duplicate suggestions. The GIS community can refine these suggestions by commenting on them. All enhancement requests will continue to be logged. However, voting on suggestions posted on the ArcGIS Ideas portal will help those suggestions gain traction.

The site can be accessed at http://ideas.arcgis.com or http://resources.arcgis.com/content/more-resources. Participating at the site requires nothing more than a free ESRI Global account. Go to www.esri.com or http://support.esri.com to create an ESRI Global account.

Working with Evolving Technology

Product engineer talks about her career at ESRI

One of the things ESRI employees enjoy about their career is the opportunity to work with evolving technology. In this interview, Sabine Barrera, a product engineer on the ArcGIS Mobile development team, talks about her role in product development.

Sabine Barrera, product engineer on the mobile team, uses a laser range finder to collect data while colleague Jianwei Dou edits the data using ESRI's ArcGIS Mobile application for Windows.

How did you end up at ESRI?

Barrera: I was working for ESRI's international distributor in Colombia and applied for an internship at ESRI so I could explore product development. Because I was already part of the company, I was able to come to Redlands for an extended internship. This was about 14 years ago. As a Windows user, I was building applications with Visual Basic, which was rare because UNIX was being used here at the time. They liked my work, and I've been here ever since.

What's a typical day like for you?

Barrera: When we are in development mode, my days are basically spent looking at the API that we are working on and helping our developers add functionality. I write samples for developers to see how our API works, how our work flows. Sometimes I'm able to find bugs, so I debug the problems and work with the developer to fix them. Other days, I go into our user forum to see what people are entering there, help them, and respond in the forum. Sometimes I need to talk to my team and figure out a problem a person is having if we're not able to reproduce it here. Basically, we need to support our developers outside.

What is it about your job that keeps things interesting?

Barrera: ESRI is an incredibly active organization in terms of variety of products and how fast our product offerings are created. This means that we never stop learning and never stop being challenged. When I started at ESRI, I joined the MapObjects team. Later, I worked with ArcGIS Desktop, and then I focused on map servers, which led me to work on the Web ADF team. I have been working on the ArcGIS Mobile team since the beginning of the project. This has required knowledge of ArcGIS Server, C++, C#, WPF, Objective-C, and Java programming. This is interesting because I am always facing challenges in technology.

What kind of skills does someone need if they want to join your team?

Barrera: You need to have some programming skills, because we basically provide an SDK so we have an API for developers to use to build their own applications. You need design skills, not only on the user interface side, but also on the API side. This is so that you can help developers add functionality and determine what the best way is to do it, what parameters we need to provide, etc. I also think that having a passion and excitement for working with this technology is one of the most important qualities that you need.

What does ESRI offer to employees that sets it apart?

Barrera: What makes ESRI a unique company is that it is a cultural gathering. We have people from all over the world. Also, people here are very knowledgeable. People share what they know and, because of that, everybody grows. The focus is to do your job well. I think this makes a big difference. Things have to be done and done well. I think that's very important, and that's what makes ESRI a unique company.

What do you like about living in the Redlands area?

Barrera: When I first moved from Colombia to Redlands, it was a little bit difficult because I was coming from Bogotá, and there are about 8 million people. I was used to the rush and traffic and the culture and all this life. But once we moved here, we realized it was only 45 minutes to get to the ski resorts, one hour to get to the beach, one hour to Los Angeles, then we could come back to Redlands and sleep well. Also, there are plenty of biking and hiking trails that are amazing and beautiful. I love riding when I have a chance.

What message do you have for other experienced GIS professionals that might inspire them to work here?

Barrera: If you're a geographer and you like programming, or you are interested in geography, or you want to focus on development, this is the perfect place to work. Also, the work you do here and the tools you write are used by many people in the world, and you see that. For example, I've worked at the User Conference when somebody from South Africa comes and asks you a question; someone from Korea, Japan; from Iceland; from many places in the world, and you are able to help them. That makes it a very inspiring place to work.

New ESRI Authorized Instructors

The Authorized Training Program (ATP) is pleased to acknowledge the newest class of ESRI Authorized Instructors. These candidates have passed all ATP requirements and have been granted authorization to teach the specified ESRI courses within the United States and United States Territories, excluding Puerto Rico. These instructors join a network of over 250 Authorized Instructors. To locate an Authorized Instructor in your area, visit www.esri.com/atp, contact ATP by e-mail at atp@esri.com, or call 909-793-2853, extension 1-2111.

Abbreviations for each course authorization are listed in the accompanying table. The course authorizations shown with each instructor listed indicate only the most recent authorization(s) received by that instructor. Visit the ATP Web site for complete information on all authorizations held by an instructor.

Course Abbreviations

AG1	Introduction to ArcGIS I (for ArcGIS 9)
AG2	Introduction to ArcGIS II (for ArcGIS 9)
AGD1	ArcGIS Desktop I
AGD2	ArcGIS Desktop II
AGD3	ArcGIS Desktop III
AGSA	Working with ArcGIS Spatial Analyst
BGDB	Building Geodatabases
IAGS	Introduction to ArcGIS Server
LGAD	Learning GIS Using ArcGIS Desktop
MGDB	Introduction to the Multiuser Geodatabase
PAO	Introduction to Programming ArcObjects with VBA
PAOJ	Introduction to Programming ArcObjects Using the Java Platform
PAON	Introduction to Programming ArcObjects Using the Microsoft .NET Framework
PYTH	Introduction to Geoprocessing Scripts Using Python

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phoebe.mcneally@geog.utah.edu
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University of Wyoming
Wyoming Geographic Information Science Center
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caffrey@uwyo.edu
AGD1

ArcGIS 10 Courses

More immersive approach used in classroom courses

Learn how to become more productive with the new tools in ArcGIS 10 by taking advantage of training resources from ESRI. Instructor-led courses updated with new content for ArcGIS 10 are available at ESRI learning centers nationwide and online through the Virtual Classroom.

Students who have previously taken ESRI instructor-led courses will notice that the course format has changed. A new, more immersive, experiential approach to learning will be used for more than 20 ArcGIS 10 courses that will be offered beginning in August. The balance of instructor-led courses will be updated with this approach in early 2011. Courses available that support the transition to ArcGIS 10 include

Desktop

ArcGIS Desktop I: Getting Started with GIS
ArcGIS Desktop II: Tools and Functionality
ArcGIS Desktop III: GIS Workflows and Analysis

Special Functions

Data Production and Editing Techniques
Introduction to Geoprocessing Scripts Using Python
Managing Imagery Using ArcGIS—*New course*
Working with 3D GIS Using ArcGIS—*New course*

Geodatabase

Building Geodatabases
Data Management in the Multiuser Geodatabase

Server

Introduction to ArcGIS Server
ArcGIS Server: Web Administration Using the Microsoft .NET Framework
Building Web Applications Using the ArcGIS API for Flex—*New course*
Building Web Applications Using the ArcGIS API for Microsoft Silverlight/WPF—*New course*

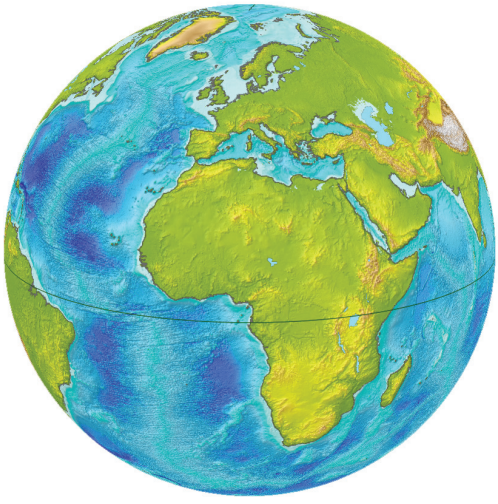
Free Seminars

Free live training seminars provide a focused look at specific functionality and features in ArcGIS 10. Go to www.esri.com/lts to view the schedule and request e-mail reminders of upcoming seminars.

Visit **www.esri.com/training10** to view the complete course list. For a period of time, ESRI will offer some courses in both ArcGIS 10 and 9.3 to ensure that all customers have access to essential training.

If the Earth

When global rotation stops, the massive oceanic water migration would cease and sea level would be at different locations, completely changing world geography.



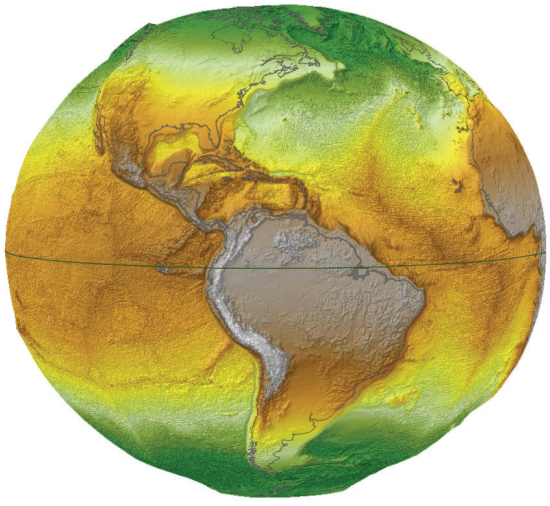
The world as we know it. The obvious demarcation of land and ocean is indicated by the contour of 0 elevation.

The longer, equatorial axis of Earth's ellipsoid is more than 21.4 km (or 1/3 of 1 percent) longer than the polar axis. The flattening of the ellipsoid shown on this map was intentionally exaggerated.

Stood Still

Modeling the absence of centrifugal force

By Witold Fraczek, ESRI



The gravity of the still earth is the strongest at the polar regions (shown in green). It is intermediate in the middle latitudes and weakest at the high altitudes of the Andes, close to the equator.

The following is not a futuristic scenario. It is not science fiction. It is a demonstration of the capabilities of GIS to model the results of an extremely unlikely, yet intellectually fascinating query: What would happen if the earth stopped spinning? ArcGIS was used to perform complex raster analysis and volumetric computations and generate maps that visualize these results.

Continued on page 64

If the Earth Stood Still

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The most significant feature on any map that depicts even a portion of the earth's ocean is the spatial extent of that water body. Typically, we do not pay much attention to the delineation of the sea because it seems so obvious and constant that we do not realize it is a foundation of geography and the basis for our perception of the physical world.

The line separating oceans from continents outlining the spatial extent of both land and water is the most fundamental contour. It is zero elevation because it signifies the sea level. Why is the sea level where we currently observe it? What controls the sea level? How stable are the forces that determine the sea level? This article does not refer to the climate change and the potential increase of the water level in the global ocean but rather to the geometry of the globe and the powerful geophysical energies that determine where oceans lie.

Sea level is—and has always been—in equilibrium with the planet's gravity, which pulls the water toward the earth's center of mass, and the outward centrifugal force, which results from the earth's rotation. After a few billion years of spinning, the earth has taken on the shape of an ellipsoid (which can be thought of as a flattened sphere). Consequently, the distance to the earth's center of mass is the longest around the equator and shortest beyond the polar circles. The current difference between the average sea level as observed along the equator and the distance to the earth's center of mass from the sea level at the poles is about 21.4 kilometers (km).

What would happen if the earth's rotation slowed down and finally stopped spinning over a period of a few decades? ArcGIS lets us model the effects of this scenario, performing calculations and estimations and creating a series of maps showing the effects the absence of centrifugal force would have on sea level.

The extent of a hypothetical northern circumpolar ocean over the territory of North America is shown. The orange color indicates areas with elevation higher than 3,000 meters above the level of the northern ocean. Red dots represent some of the biggest cities of the continent.

If earth ceased rotating about its axis but continued revolving around the sun and its axis of rotation maintained the same inclination, the length of a year would remain the same, but a day would last as long as a year. In this fictitious scenario, the sequential disappearance of centrifugal force would cause a catastrophic change in climate and disastrous geologic adjustments (expressed as devastating earthquakes) to the transforming equipotential gravitational state.

The lack of the centrifugal effect would result in the gravity of the earth being the only significant force controlling the extent of the oceans. Prominent celestial bodies such as the moon and sun would also play a role, but because of their distance from the earth, their impact on the extent of global oceans would be negligible.

If the earth's gravity alone was responsible for creating a new geography, the huge bulge of oceanic water—which is now about 8 km high at the equator—would migrate to where a stationary earth's gravity would be the strongest. This bulge is attributed to the centrifugal effect of earth's spinning with a linear speed of 1,667 km/hour at the equator. The existing equatorial water bulge also inflates the ellipsoidal shape of the globe itself.

The bulge defines the final shape of the globe by establishing the uniform sea level in gravitational equilibrium, which is used as the standard reference for describing the shape of the earth. It is the geometry of this very shape that geodesists were trying to calculate for more than a century. Their efforts were finalized by the acceptance of the ellipsoid referred to as World Geodetic System 1984 (WGS84) by the international community in Washington, D.C., in 1984. The ellipsoid WGS84 approximates the shape of the earth more accurately than many other ellipsoids that were previously proposed.

If the earth stood still, the oceans would gradually migrate toward the poles and cause land in the equatorial region to emerge. This would eventually result in a huge equatorial megacontinent and two large polar oceans. The line that delineates the areas that hydrologically contribute to one or the other ocean would follow the equator if the earth was a perfect ellipsoid. However, due to the significant relief of both the continents and the ocean floor, the hypothetical global divide between the areas that hydrologically contribute to one or another ocean deviates from the equator significantly.

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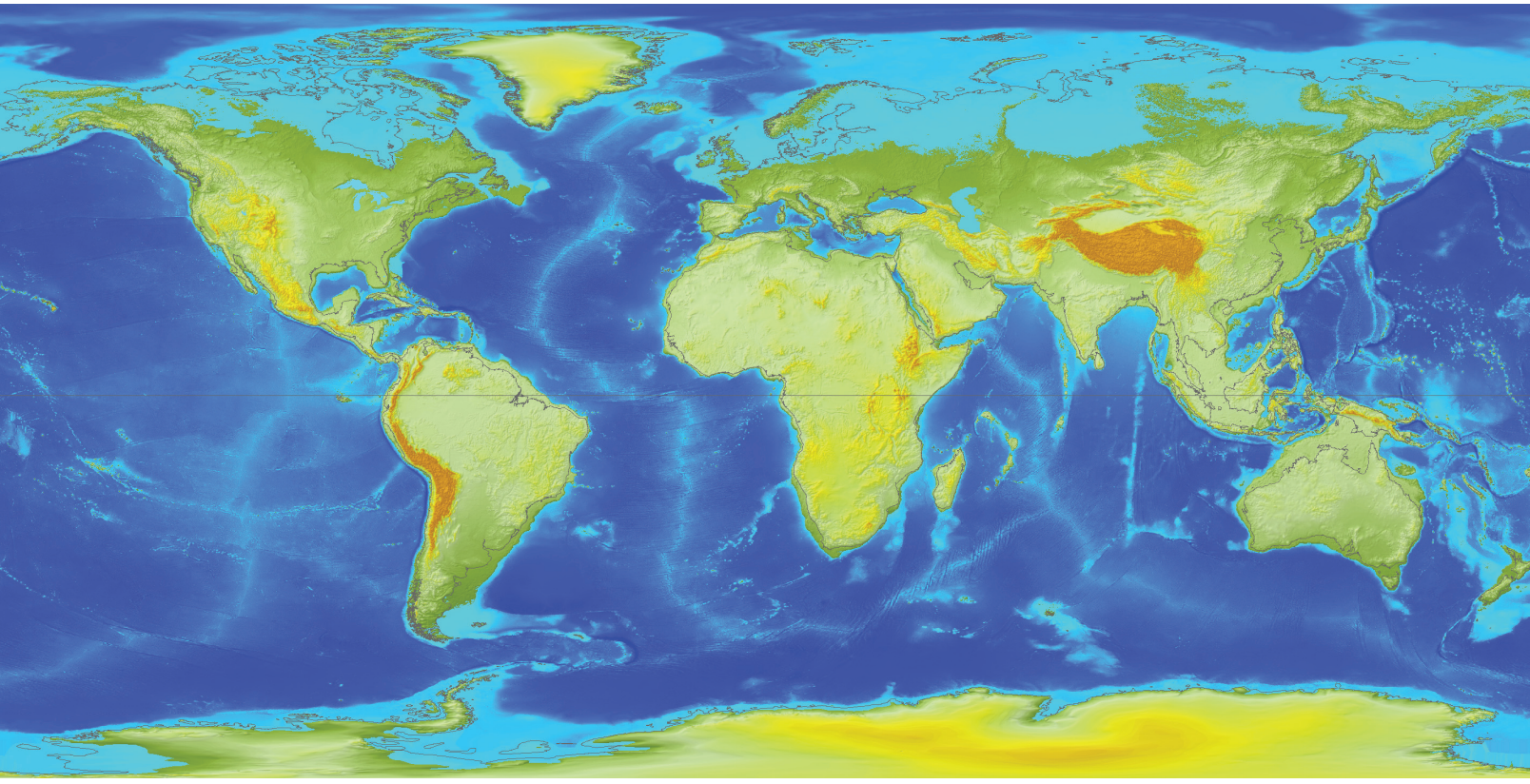
Analogous to the well- known U.S. Continental Divide, this would be the border separating two giant hemispherical watersheds of the new circumpolar oceans. Interestingly, the highest point on this global divide would not be the highest altitude on the entire globe. The highest elevation of the global divide in the Colombian Andes would be about 12,280 meters, whereas the altitudes of the famous equatorial volcanoes of Chimborazo (Ecuador) and Kilimanjaro (Tanzania) would be 13,615 and 12,786 meters, respectively. Both volcanoes happen not to be located on the global divide line. The lowest point on the new global dividing line, with an elevation of 2,760 meters, would be situated southwest of Kiribati Island in the western Pacific.

Due to the unique relief of the earth's surface at the beginning of the slowdown, the most significant changes to the outline of land versus water would occur at the high latitudes of the northern hemisphere where the swell ocean would quickly expand over the flat and vast territories of northern Siberia and northern Canada. At the same time, changes to the continental outlines at low latitudes would be barely perceptible because (with a few exceptions) equatorial waters are deep, and a decrease in water level by a few dozen meters would not cause large areas of land to emerge. Toward the end of the slowdown period, when the main geographic features of oceans and land would have already adjusted to the ellipsoidal shape of the globe and the new distribution of gravity, relatively small changes would occur. This can be attributed to the ellipsoidal shape of the globe, which overwhelms the effect of the diversity of the earth's geographic relief.

Today, all three world oceans are connected. This creates a global ocean with basically one sea level. As a consequence of rotational slowdown, the outline of the global ocean would continuously undergo dramatic changes. Equatorial waters would move toward polar areas, initially causing a significant reduction in depth while filling the polar basins that have much less capacity. As regions at high latitude in the northern hemisphere become submerged, the areal extent of the northern circumpolar ocean would rapidly expand, covering the vast lowlands of Siberia and northern portions of North America. The global ocean would remain one unit until the rotation of the earth decreased to the speed at which ocean separation would occur. The interaction between the inertia of huge water bodies and decreasing centrifugal force would be very complicated. As the consequence of steady slowdown of earth's rotation, the global ocean would be gradually separated into two oceans. Obviously, the last connection will be broken at the lowest point of the global divide line, located southwest of the Kiribati Islands. Since the current western Pacific Ocean is a plane, land would emerge quickly because there would be no chance that water would be exchanged between the two circumpolar oceans after the initial split. The area of final separation between the two oceans would be the simultaneous emerging and drying of territory extending for hundreds of kilometers.

The slowdown would continue after the separation of the two oceans and cause further migration of the ocean water toward the poles. Surprisingly (despite Antarctica's elevation), the southern polar basin has a larger capacity than the northern one. Given the fixed volume



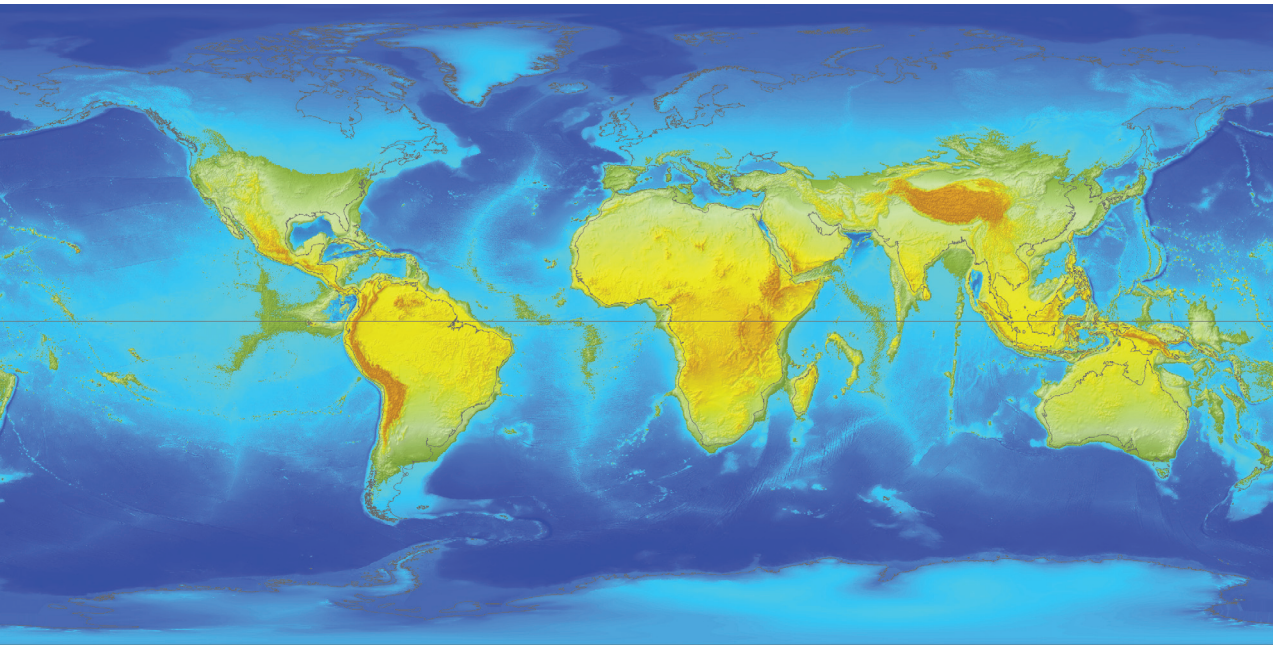
While gravity pulls more water toward the Arctic Ocean, the lowlands of Siberia and northern Canada would become submerged. The corresponding movement of water away from the equatorial region combined with the shallow continental shelf waters southeast of Asia and north of Australia will cause land to emerge.

of water in both hemispheres, the more capacious basin of the southern pole would result in an overall lower sea level than the northern ocean. According to volumetric calculation performed with the ArcGIS 3D Analyst extension, the difference between the sea level of the two oceans should be 1,407 meters. However, the data accuracy does not warrant this level of precision, so the elevation difference between the sea level of the two oceans used was 1,400 meters.

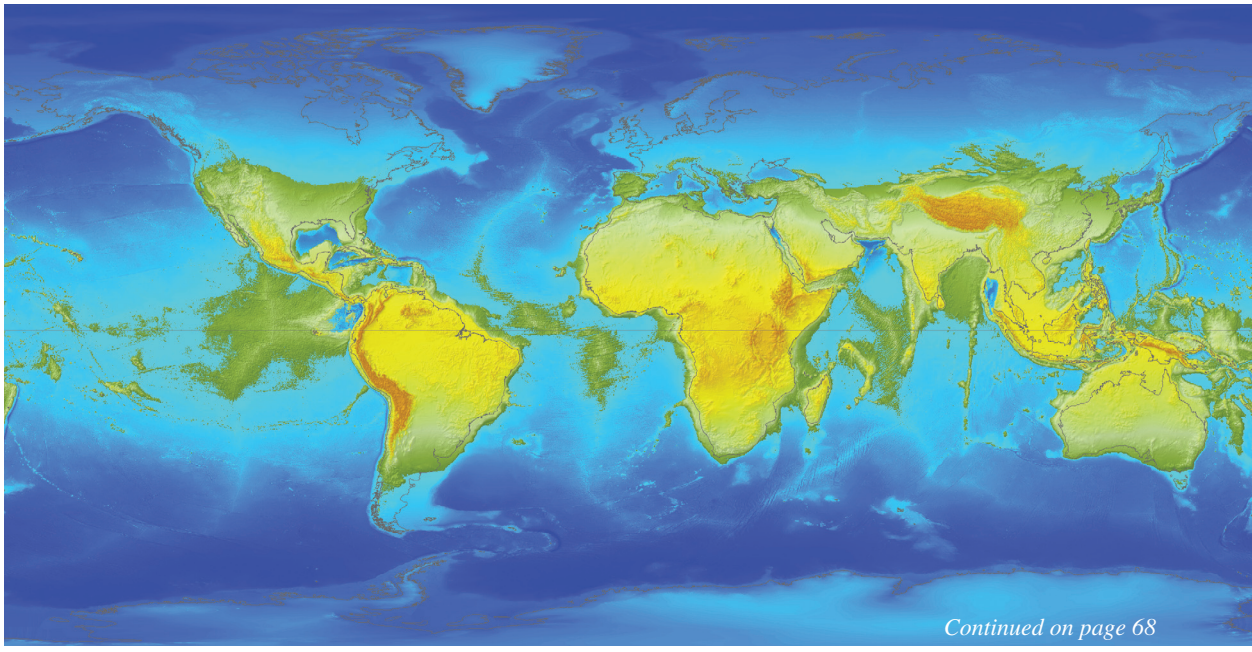
The series of maps illustationg this article depict the intermittent stages during this migration of the earth's oceans and changes in land extents, topographic elevation, and bathymetric depth caused by the decreasing speed of the earth's rotation. These maps demonstrate the intermediate stages of transitional geography from a rotating to a stationary world. They show the effects of the gradual reduction of centrifugal force from its current level to none, leaving gravity as the only force controlling the ocean's extent.

The actual slowdown of the earth's rotation has been observed, measured, calculated, and theoretically explained. As newer methodologies are developed and more precise instruments are constructed, the exact rate of the slowdown may vary between some sources. Reflecting this very gradual slowing, atomic clocks must be adjusted to solar time by adding a leap second every so often. The first leap second was added in 1956.

Most scientists agree that the solar day (related to the speed of rotation) is continuously getting longer. This minimal increase of the day length is due mainly to the oceanic tidal friction. When the estimated rate of the slowdown was projected back to past geologic



A deepening Arctic Ocean would lead to the further expansion of water over the northern plains of Asia, Europe, and North America. Greenland and Antarctica, despite their high elevations, would become significantly smaller in size. New archipelagos emerge from the southern seas. The Great American Lakes, the biggest freshwater reservoirs in the world, dissolve into the ocean.



All Antarctica would be under water at this point. The north polar waters and the water over the vast, recently submerged territories in Siberia and Canada would be getting deeper. At the same time, equatorial waters would be getting more shallow.

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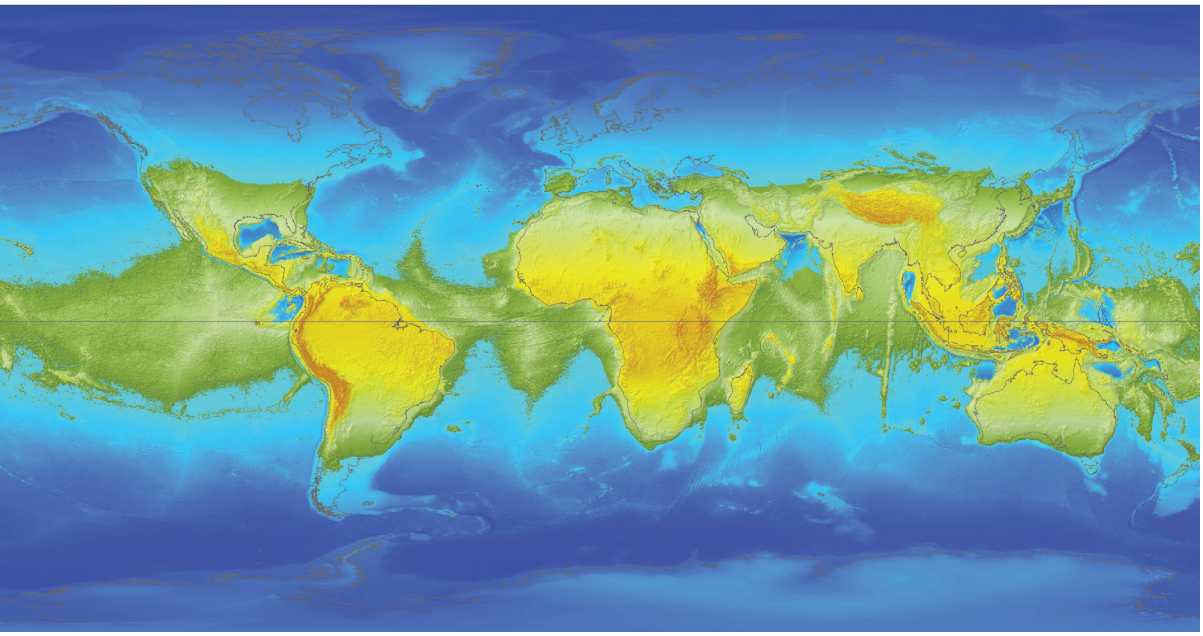
eons, it showed that the length of a day was several hours shorter than today.

Consequently, during the Devonian period (400 million years ago), the earth rotated about 40 more times during one revolution around the sun than it does now. Because the continents have drifted significantly since that time, it is difficult to make estimates of the land versus ocean outlines for that era. However, we can be certain that—with a faster spinning speed in the past—the equatorial bulge of oceanic water was much larger then than it is today. Similarly, the ellipsoidal flattening of the earth was also more significant.

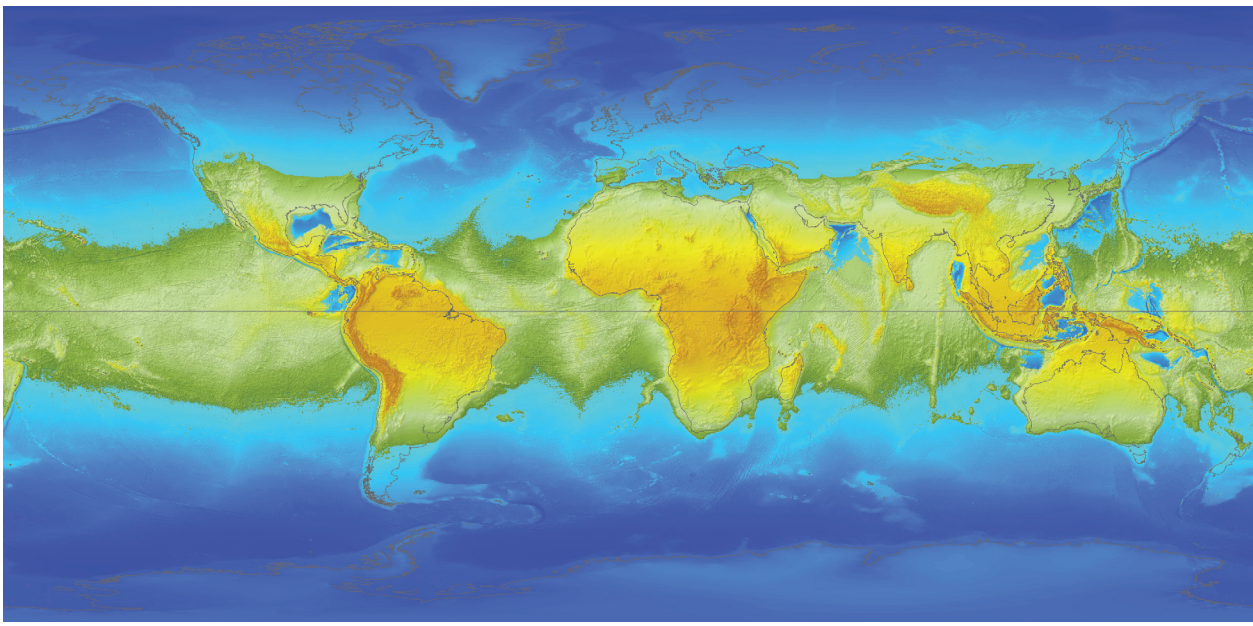
The influence of the rate of the earth's rotation has a dominant effect on the geometry of the globe, in terms of the globe's overall shape as well as the outline of the global ocean. The earth's physical relief is only a secondary factor controlling the delineation of oceans. The slowdown of earth's rotation will continue for 4 billion years—as long as we can imagine. The slowdown infinitesimally—but steadily—changes the globe's geometry and makes it dynamic. The net result of these dynamic adjustments is that the earth is slowly becoming more and more like a sphere. However, it will take billions of years before the earth stops spinning, and the gravitational equipotential creates a mean sea level that is a perfect sphere.

About the Author

Witold Fraczek is a longtime ESRI employee who currently works in the Application Prototype Lab.



Large land areas near the equator continue growing and join with each other. By now, nearly all of Canada, Europe, and Russia are covered by a northern circumpolar ocean.



As the last water connection between the two large neo-oceans is broken, an equatorial megacontinent is formed. Ocean areas in proximity to the continent are becoming more shallow while the waters of the polar areas are getting deeper and deeper. Former abyssal plains and oceanic trenches become inland seas within the new continent.

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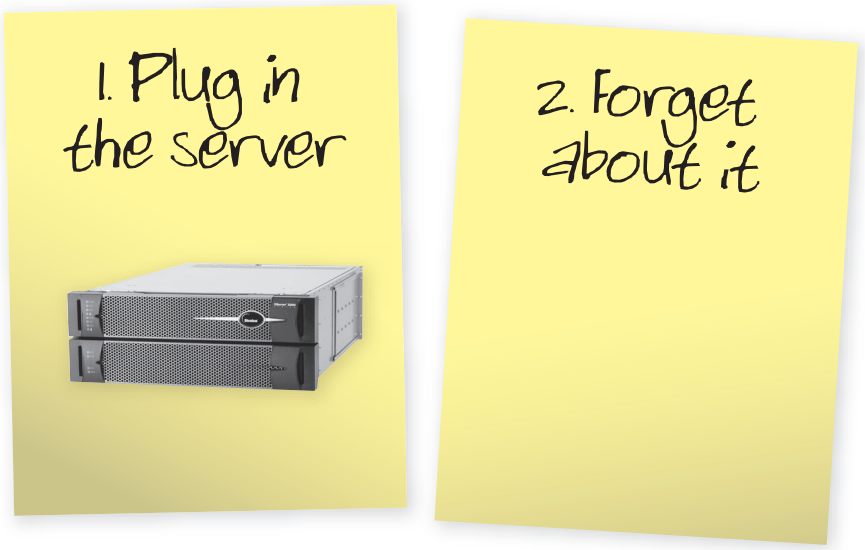

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