Esri News for Petroleum

Winter 2012/2013

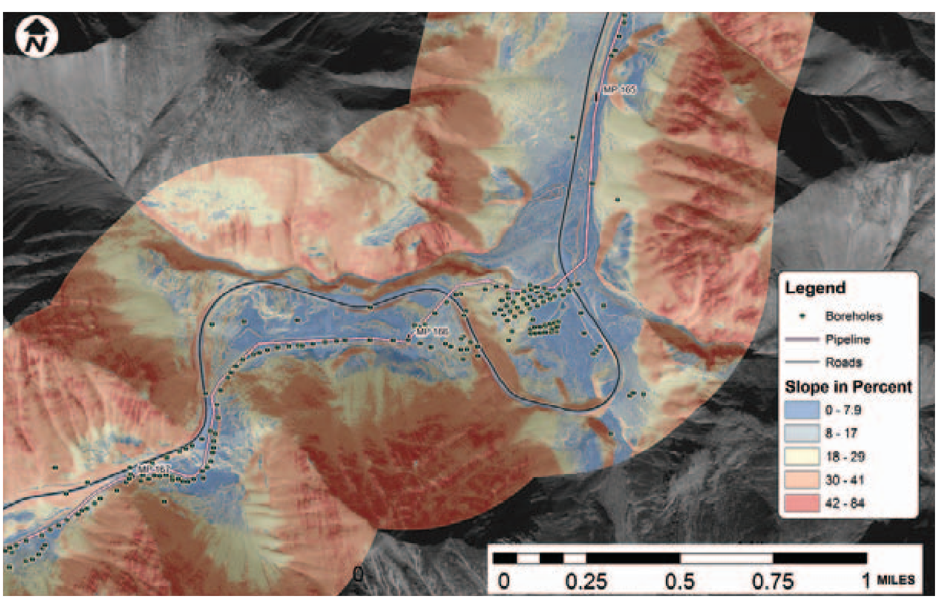
Locating the Best Site

North Slope Oil and Gas Data Is Solid

By Charles Barnwell, GIS Manager, Michael Baker Jr. Corporation, Anchorage, Alaska

The North Slope of Alaska is currently undergoing renewed oil and gas exploration activity throughout the region. Alaska's rugged terrain and diverse ecosystems challenge exploration and production (E&P). Pipeline engineers must consider permafrost, wetlands, soil stability, hydrography, water content, and wildlife in drawing their construction and land-use plans. North Slope oil and gas projects range from exploration in undeveloped areas to pipeline and facility development. GIS technology plays a key role in these arctic projects by providing a foundation for a wide range of upstream and midstream analysis from environmental impact to construction logistics.

Michael Baker Jr. Corporation (MBJ) has provided pipeline engineering and mapping services in Alaska for more than 45 years. The Trans-Alaska Pipeline was one of MBJ's early Alaska projects. To this day, MBJ is working to develop GIS solutions for this pipeline. An early adopter of Esri software, MBJ has heavily used geospatial technologies for at least 25 years and recently added lidar, mobile GIS, and cloud-based data distribution. MBJ engineers and planners use GIS to support pipeline planning, routing, engineering, design, and other applications. In addition, its geospatial specialists work with oil and gas companies' GIS teams to organize data and integrate solutions.



↑ Part of a pipeline routing analysis, this image is derived from lidar data and shows elevations and stream courses. A concentration of geotechnical boreholes (green dots) is in an area of greatest concern for the pipeline route. (Map courtesy of the Office of the Federal Coordinator)

In 2008, Enstar Natural Gas Company contracted MBJ to evaluate alternatives for a pipeline system to deliver natural gas from the oil fields of the North Slope's Prudhoe Bay to Alaskan consumers. Using Esri's ArcGIS MBJ evaluated the pipeline's feasibility and recommended the best pipeline corridor.

Although the technology MBJ GIS specialists use is cutting-edge, they emphasize adhering to basic design fundamentals when organizing data and building GIS solutions:

- Use GIS as the common ground for multidisciplinary applications. Typically, resource projects such as these involve many disciplines that require different types of data referenced to a common geospatial framework.
- Build an authoritative GIS foundation based on reputable and best available data.
- Establish GIS and data management standards and protocols early in the project. Get the entire project team on board with using these protocols and standards.
- Develop a road map to guide GIS implementation that includes phases.
- Designate a central point of contact for the GIS project who acts as a data custodian, steward, and manager; form a stakeholder user committee of contractors, engineers, and other experts; and meet regularly to discuss GIS needs and concerns.
- Design the GIS so it is accessible at appropriate levels, for example, managers, planners, permitting specialists, engineers, and scientists.
- Stay abreast of current technology and

continued on page 10

Contents

Winter 2012/2013

Esri News for Petroleum is a publication of the Business Solutions Group of Esri.

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

Visit the Esri website at esri.com.

View *Esri News for Petroleum* online at esri.com/petroleum or scan the code below with your smartphone.

Advertise with Us

E-mail ads@esri.com.

Submit Content

To submit articles for publication in *Esri News for Petroleum*, contact Geoff Wade, industry solutions manager, at gwade@esri.com or Barbara Shields, editor, at bshields@esri.com.

Manage Your Subscription

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

International customers should contact an Esri distributor to manage their subscriptions.

For a directory of distributors, visit esri.com/distributors.

Circulation Services

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

ELA in Colombia Grows GIS for Petroleum and Pipeline

Colombian petroleum and pipeline company Ecopetrol has signed an enterprise license agreement (ELA) managed by Esri distributor Procálculo Prosis S.A. Ecopetrol is the largest company in Colombia, one of four principal petroleum companies in Latin America, and ranked among the 40 largest petroleum companies in the world.

Ecopetrol continues to grow, producing more than 60 percent of Colombia's domestic oil and providing the largest part of the network of oil pipelines and multiuse pipelines in the country. The ELA enables Ecopetrol to grow the capacity of its GIS by providing a platform for future expansion.

An Esri ELA is a contract in which the customer commits to a fixed annual payment for a specified period of time in exchange for a set of unlimited software and maintenance. Services and training are typically included. Having entered into the Esri ELA agreement with Procálculo Prosis, Ecopetrol can now deploy unlimited quantities of current versions of core Esri products.

In addition to Colombia, Ecopetrol has a presence in exploration and production activities in Brazil, Peru, and the United States (Gulf of Mexico). It will use its ELA to extend the value of its enterprise GIS throughout its organization.

For more information about the Esri ELA, contact your Esri account manager at your local Esri office or call 800-447-9778 in the United States. International customers can contact their in-country Esri distributor.

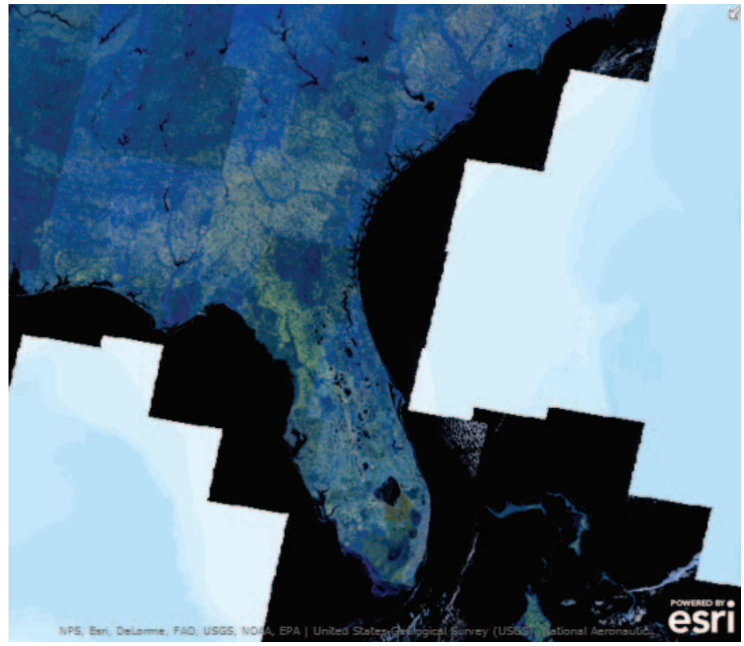
↓ GIS helps the Ecopetrol oil company with operation management.

Use Landsat Data on ArcGIS Online

Landsat imagery is one of several datasets geophysicists use to search for surface indicators that are clues to subsurface oil and gas. ArcGIS Online image services provide quick and simple access to free United States Department of the Interior's US Geological Survey (USGS) Landsat data. These image services are based on the Global Land Survey (GLS) datasets created by USGS and the National Aeronautics and Space Administration (NASA). Landsat data supports global assessments of land cover, land-cover change, and ecosystem dynamics such as disturbance and vegetation health.

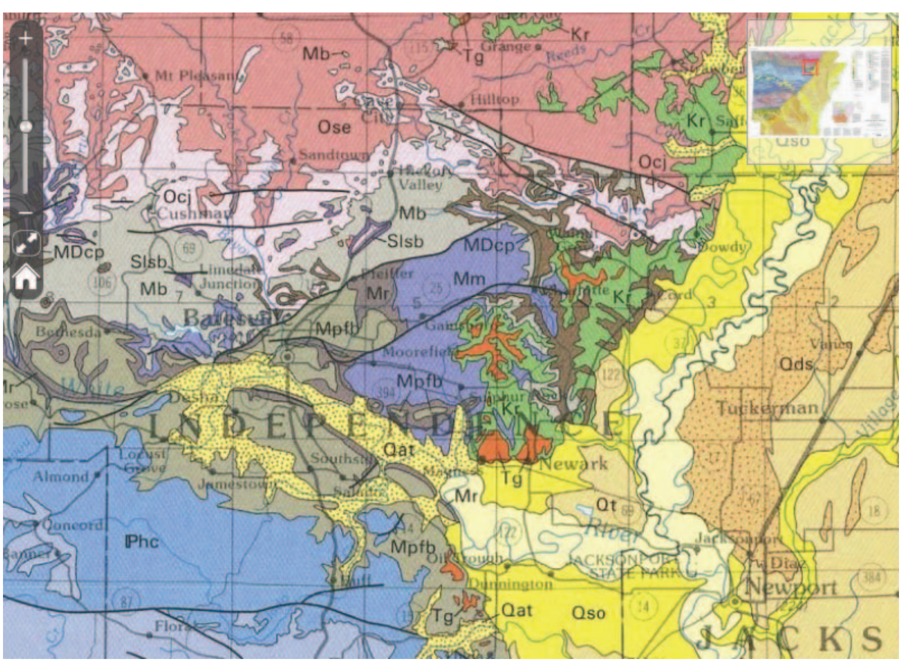
Esri provides Landsat image services that enable users to explore important imagery information such as band combination analysis for natural color, infrared, vegetative change, and the Normalized Difference Vegetation Index (NDVI). The user can also compare many years of imagery to see changes over time.

Two Landsat viewers are available online—the LandsatLook Viewer from USGS and the ChangeMatters viewer from Esri. Both of these viewers use ArcGIS technology to serve Landsat as web services, accessing many terabytes of imagery.



↑ Landsat bands 7, 5, and 4 data is the most useful for geological studies. It is available on ArcGIS Online.

National Database under Construction



↑ The USGS map service accesses a map showing the geology of Arkansas.

Since its beginning in 1995, the US Geological Survey's (USGS) National Geologic Map Database (NGMDB) project has evolved into a highly respected geoscience resource. Furthermore, its impact on the evolution of digital geologic mapping standards and guidelines, in the United States and internationally, has been highly significant. The NGMDB is undergoing a reconstruction of its infrastructure that will make the database easier to search and to view.

Users can search more than 90,000 maps and reports provided by 600 publishers. A new web application, MAPVIEW, is already launched and available. The interface makes it easy to see geologic data as newest, bedrock, and surficial. Users can view data in detail and download it from the various publishers that contribute to the database. MAPVIEW is built using Esri ArcGIS for Server and ArcGIS for Server Image extension.

See MAPVIEW at ngmdb.usgs.gov.

Esri Career Opportunities

Esri's petroleum team helps petroleum companies worldwide make better decisions using geospatial technology. Join Esri in making a difference in the petroleum industry. These positions are currently open:

- Petroleum Specialist—Industry Solutions
- Account Executive—Petroleum Operations
- Account Executive—Oil Field Services
- Account Executive—Dubai

esri.com/careers

Attend the Esri Petroleum GIS Conference

The Esri Petroleum GIS Conference puts you at the heart of the petroleum, gas, and pipeline GIS user community. Attend presentations given by industry GIS professionals to learn how you too can improve your company's bottom line. See best-of-breed hardware, software, and services designed to meet your company's needs.

- Grow your GIS implementations for exploration; production; pipeline; downstream; and HSE domains.
- Learn best practices for implementing GIS in petroleum.
- Build your network of GIS professionals in oil and gas.
- Discover what is trending in GIS technology.
- Get your questions answered in person by Esri staff and partners.

Esri Petroleum GIS Conference
George R. Brown Convention Center, Houston, Texas
May 7–9, 2013

esri.com/events

Esri on the Road

Mark Your Calendar

Esri International Developer Summit
March 26–29, 2013
Palm Springs, California, USA
esri.com/devsummit

Esri Petroleum GIS Conference
May 7–9, 2013
Houston, Texas, USA
esri.com/petroleum-energy

European Association of Geoscientists and Engineers (EAGE)
June 10–13, 2013
London UK
www.eage.org/events/

Esri International User Conference
July 8–12, 2013
San Diego, California, USA
esri.com/uc

3P Arctic Conference & Exhibition
October 15–18, 2013
Stavanger, Norway
www.3parctic.com

Clean Gulf
November 12–13, 2013
Tampa, Florida
www.cleangulf.org

Analyze an Outcrop Using Photo-Realistic Modeling

By Lionel White, Geological & Historical Virtual Models

Geologists who study outcrops in search of potential oil reservoirs can measure a geological outcrop from an office chair. Using a photo-realistic model of a geological feature in ArcGIS, geologists can interact with a 3D image and measure the entire outcrop. A photo-realistic model of a geological outcrop is a digital replication of the outcrop that is accurate in scale and appearance. This is done by draping high-resolution photos (to 1 mm per pixel) onto a TIN mesh of a lidar-derived model to create an accurate, lifelike replica of the outcrop.

The geologist imports this model into ArcScene and uses GeoAnalysis Tools, created by Geological & Historical Virtual Models, LLC (GHVM), to study the outcrop in GIS. The outcrop model is either georeferenced or geo-oriented so that measurements are comparable to those the geologist would make in the field.

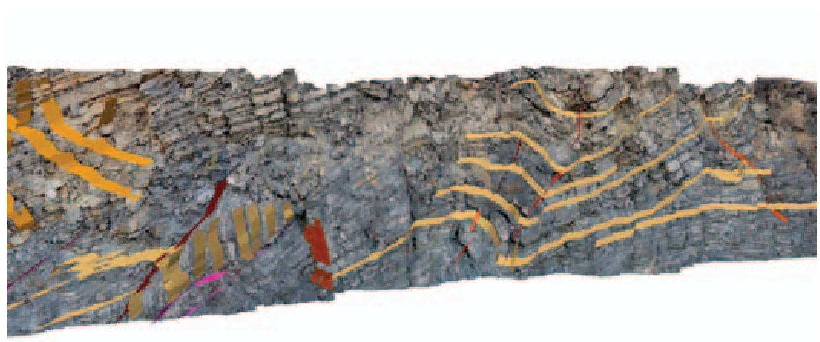
After importing the model as a multipatch file into the database, the outcrop image is closely inspected. By rotating the image, one can see all sides of the outcrop and zoom to see specific features. Geologists can also measure feature orientation and dimensions, create down-plunge cross sections, identify and annotate sedimentary facies, make rapid bed thickness measurements, and add stratigraphic columns and hyperlinks to the data table.

In ArcScene, the user can inspect the rock, whether it has a height of 100 meters or 2 meters.

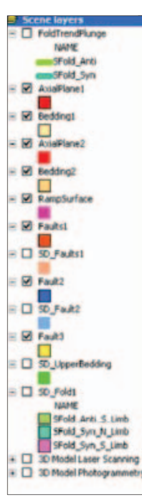
For more information about GHVM, contact Lionel White at lswhite@gvhmodels.com.

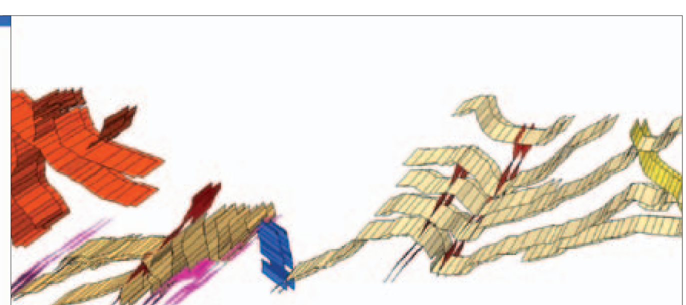
Learn more about ArcGIS for Desktop at esri.com/products.

↑ A photo-realistic model representing a geological outcrop can be turned, measured, and analyzed in GIS.

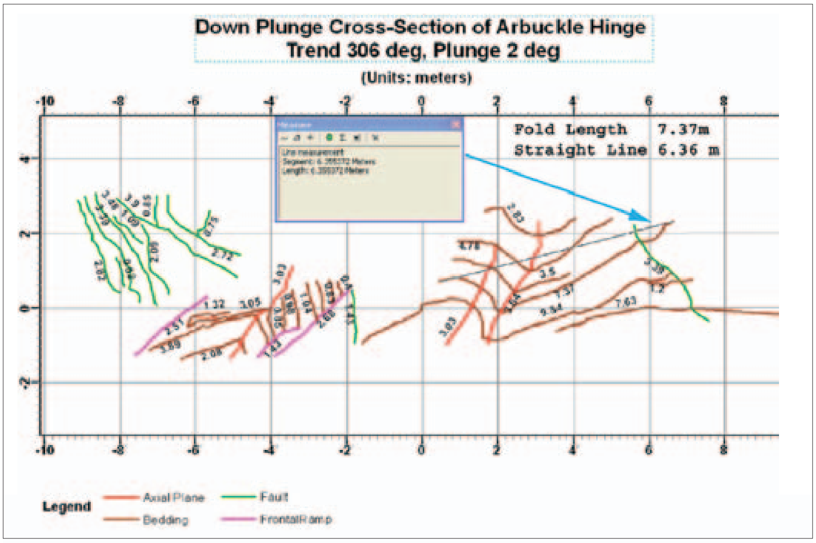


↑ GeoAnalysis Tools highlight the folded, fractured, and faulted bedding of the outcrop. The region around the anticline-syncline fold is shown with more of the bedding delineated. Axial planes for each fold are shown up to the top of the outcrop. A décollement surface is demarked with magenta. The folded bedding to the left is riding on top of the décollement slip surfaces.

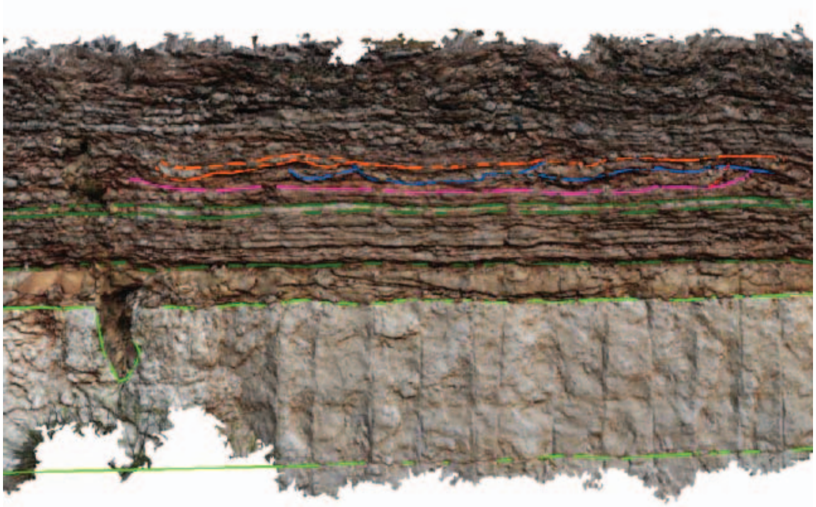




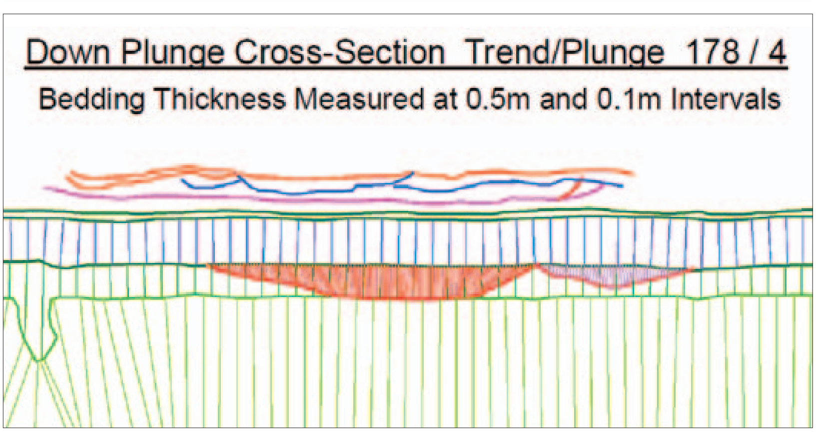
↑ Here the model is turned off to highlight the folded bedding to the right and the décollement to the left, with the top and bottom slip surfaces shown in magenta. The bedding of the décollement has been folded, and the axial plane of the folds are shown in red. The blue surfaces are fault surfaces that are not aligned with other faults in the outcrop.



← A by-product of the delineation of the beds, axial planes, and faults is the creation of a down-plunge cross section of the outcrop. The user specifies the trend and plunge that define the down-plunge cross section, and then a projection plane is created. Line traces are projected onto the plane, exported to a 2D shapefile, and imported into ArcMap. ArcGIS annotation tools are used to create the grid, label the length of the line traces, and add titles and explanation to the diagram.



← This screen capture of the Eagle Ford Shale outcrop in south Texas delineates the feature's bedding. The geologist used the ArcGIS Auto Bedding Thickness tool on the down-plunge cross section to characterize the thinning and thickening of the beds. The down-plunge cross section was exported to ArcMap. The user selected two traces of bedding and activated the Auto Bedding Thickness tool by specifying the interval at which the bed thickness was to be measured. Note the multiple channels indicated in the beds.



← The results are saved in a polyline shapefile, and the values are stored in the attribute table of the shapefile. The different sets of measurements can be classified and shown in different colors.

New IPAS System Integrates with ArcGIS for Improved Energy Site Assessment

By Chad Cooper and Malcolm Williamson, CAST, University of Arkansas

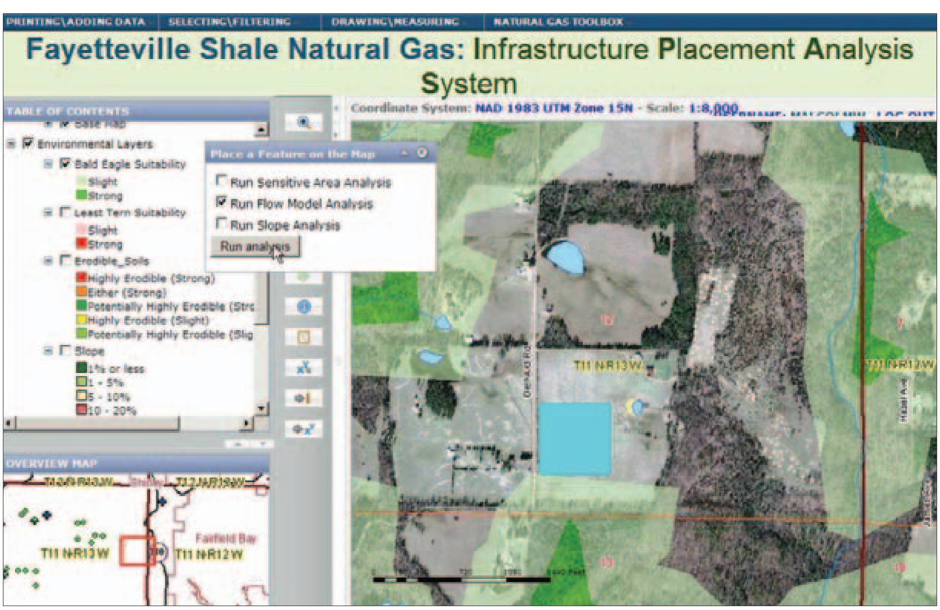
Energy companies want to make sure that their construction projects have a minimal level of impact on an area's environment and habitat. With good data and models, GIS creates pictures of environmental outcomes that help planners select optimal project sites. Geospatial specialists at the University of Arkansas Center for Advanced Spatial Technologies (CAST) have designed a system that integrates models into ArcGIS, runs authoritative data, and creates geospatial visualizations for determining the level of a project's impact.

Throughout the industry, engineers use a variety of modeling software. CAST's Infrastructure Placement Analysis System (IPAS) integrates these models into Esri's ArcGIS. Engineers can use IPAS to assess the level of an area's environmental sensitivity and see ways structures and extraction methods will impact an area. The GIS web-based environmental modeling tool is useful for planning the placement of well pads, gathering lines, lease roads, and more. IPAS can help companies make the best possible choices that have the least environmental impact.

IPAS has three major components. The first is a back-end database with highly secured access and robust data versioning. Data accessible to one company is not available to users in another company. IPAS makes intracompany user collaboration easy. Subcontractors and regulators can select from tightly controlled external data sharing options. The second is an easy method to plug external models into ArcGIS, thereby expanding the range of analyses offered through web-based GIS. The third is a mechanism for incorporating data uncertainty into models, allowing the best available data to be used even when its scale and accuracy vary from other accepted datasets.

As a pilot project, IPAS was used to study how proposed facilities would impact the Fayetteville Shale play in north central Arkansas. Registered users started the process by using a suite of customized digitizing and editing tools to create proposed infrastructure features (e.g., well pads, gathering lines) over basemap layers. Users entered unique attributes while the system self-populated several geospatially derived attributes, such as production unit, nearest town, and nearest well. Any changes to features were recorded as versions in the database. Users could then revert to earlier versions if desired. Once the proposed features were entered, users could then select from a menu of several available models to analyze their data.

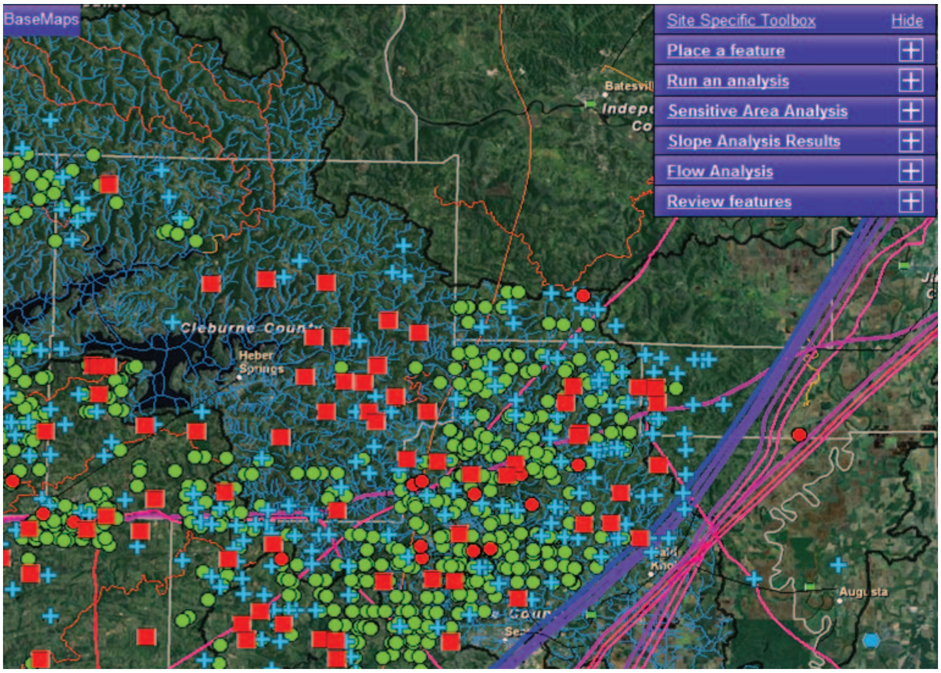
The principal model runs each proposed infrastructure placement for environmental sensitivity analysis. At its surface, this appears to be just a simple layer intersection model, where each feature is tested for intersection against several authoritative environmental data layers, such as potential bald eagle habitat or highly erodible soils. However, early feedback from industry stakeholders emphasized the problems presented by this typical GIS approach: untrained readers of impact model output will frequently fail to consider the accuracy of each data layer used.



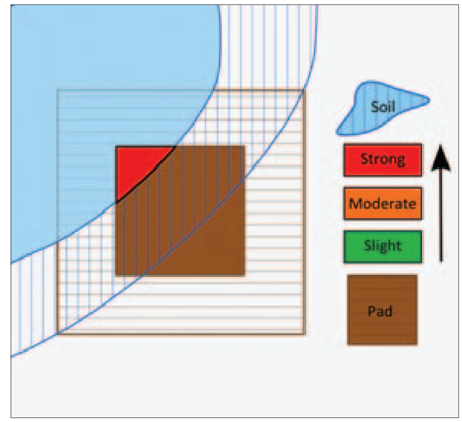
↑ Viewing infrastructure and environmental layers shows impact areas.

Uncertainty zones indicate data accuracy.

To make it possible for users to consider the accuracy of each environmental data layer, the team of developers at CAST created a unique model. It allows the assignment of "uncertainty zones" to the boundary of each input data layer. Rather than a solid line indicating a yes/no decision at the edge of each data feature, the model uses a zone, the width of which depends on the spatial accuracy of the data, to provide a more fuzzy boundary. The team applied National Map Accuracy Standards (NMAS) to determine these spatial accuracy limits. Users may also apply data-specific assessments. Digitizing scale and basemap accuracy introduces uncertainty to the data. IPAS users can consider the spatial accuracy of user-placed infrastructure features via the model's qualitative descriptors: slight, moderate, strong, or no chance of an intersection. These descriptors more accurately convey the uncertainty associated with all geospatial data.



↑ Engineering software is integrated with ArcGIS to run engineering models from the toolbox.



↑ IPAS incorporates data uncertainty into models, allowing the best available data to be used in rating environmental impacts.

Another important assessment for proposed development in the Fayetteville Shale is the sensitivity of a particular location to accidental spills, such as from a breached reserve pit. An engineer wants to determine the nearest body of water into which a spill would flow. IPAS incorporates an implementation of the D-Infinity surface flow model written in MATLAB, a popular mathematical modeling software, to calculate the outcome.

After analysts decide on the best site, they use IPAS to share results with regulatory agencies and streamline the permitting process. A regulator can potentially see the same data and the same view as the engineer and even run the same models. Regulators and energy companies can then collaborate on the placement of various infrastructure such as gathering lines, access roads, and natural gas wells.

Looking Ahead

IPAS easily incorporates the latest ArcGIS tools and various models, ensuring up-to-date technology and cutting-edge algorithms and maintaining consistent user interface.

Through funding from the Houston Advanced Research Center's Environmentally Friendly Drilling (HARC/EFD) program, CAST developers used the IPAS framework to model environmental impacts in the Haynesville Shale play, which is in Louisiana, Texas, and southern Arkansas. The multistate nature of this play forms a new level of challenges, as data and regulations must be acquired and updated from each state. Nevertheless, the flexibility of the IPAS framework made this possible.

CAST is also collaborating with researchers at Texas A&M's Blackland Research and Extension Center to integrate the modeling software Soil and Water Assessment Tool (SWAT) into IPAS, allowing a quantitative analysis of the impact of gas projects in a large watershed. By incorporating monthly precipitation data through the University of Oregon's parameter regressions on independent slopes model (PRISM) program, IPAS can be used to assess the potential impact of a proposed water withdrawal prior to its occurrence. In Arkansas, state regulators are very interested in incorporating this tool into their surface water permitting process, providing a more quantitative foundation for their decisions.

Funding for IPAS has been provided by the National Energy Technology Laboratory (NETL) and the Houston Advanced Research Center through the Department of Energy's Research Partnership to Secure Energy for America (RPSEA). Collaborators include Argonne National Laboratory and the University of Arkansas Department of Chemical Engineering.

To get more information about IPAS, contact CAST geospatial specialists Chad Cooper at chad@cast.uark.edu and Malcolm Williamson at malcolm@cast.uark.edu.

Learn more about ArcGIS at esri.com/products.

how to apply it in an appropriate and cost-effective manner.
- Focus on business drivers for GIS, mainly ensuring better decision making, particularly when location is critical.
- Use GIS to create intelligent maps that provide real value and satisfy workflow requirements rather than just to create pretty maps.

One of the most powerful benefits of GIS is its ability to organize data and even people. When the data is better organized, the company is better organized. The impact of GIS on an organization is often overlooked. If managers understand the value of GIS, they can better coordinate different groups and activities.

Finding quality data for analyzing arctic

They looked at pipeline corridors from all angles.

conditions is truly an act of data mining and maintaining ancillary related data collected by contractors and others. Much North Slope data is not published widely. However, because MBJ has been working with oil and gas companies in Alaska for decades, it has acquired a large amount of quality data from public sources, particularly in the geotechnical and terrain mapping areas. This data has formed the foundation for building other derived layers and has contributed to the success of the company's many projects.

Over the years, MBJ has assembled a GIS library that is organized around Esri's basemap data model. Library data is categorized by purpose, for example, transportation, habitat, and soil type. It is also categorized by region, for example, arctic, interior, and south central. The data model structures the data in a consistent way and enables the dependable growth of GIS.

↑ The Alaska North Slope coastline is the largest oil and gas play in the United States. (Image courtesy of ExxonMobil)

By creating a solid data model at the beginning of each project, MBJ has been able to perform data mining that targets relevant sources. For instance, in 2009, the Office of the Federal Coordinator (OFC), an agency that is charged with overseeing large oil pipeline development, contracted MBJ to develop a GIS prototype. OFC addresses a large variety of data, including environmental, engineering, and land, in its processes and coordinates with more than 50 agencies. Before launching the project, MBJ's geospatial experts invested a lot of time in working with the client's project manager, GIS team, contractors, and technical staff to develop a high-quality foundation geodatabase and an authoritative basemap on which to layer other agency data. Using the map as a prototype, OFC teamed with the State of Alaska to fund a publicly available, high-resolution lidar basemap for the main Alaska pipeline corridor.

An example of good GIS planning is the ExxonMobil Pt. Thomson project in the northeast part of the North Slope, a major, multibillion dollar project. During the project preplanning phase, MBJ worked with ExxonMobil's project manager Terrance Setchfield to develop a foundation geodatabase for ExxonMobil's GIS suitable for the project. Together, they met with contractors to define project boundaries, agree on data needs, and develop standards. The contractors' subject matter experts were consulted to ensure the best possible data in a given field was used. Good data was not available when the project started. A GIS committee was formed and met weekly in the first six months to discuss data sources, data needs for the project, and GIS issues. Getting quality data for environment sensitivity analysis was critical. The result of this preplanning effort was a robust data model and geodatabase that became the foundation for permitting, hydrologic analysis, and so forth. Good geodesign can result in savings of millions of dollars and contributes to greater project efficiencies.

As described in the Pt. Thomson project example, environmental constraints have to be fully addressed in many oil and gas projects, and thus the geodatabase has to include layers ranging from fish, whale, and bear to different types of bird habitats. For instance, polar bear habitat data includes sites and species' movement throughout the habitat area. Much of this data is publicly available such as that from the US Fish and Wildlife Service, Alaska. MBJ has a strong relationship with the service and the people performing the wildlife studies, and it is confident the data is credible.

In addition to typical GIS data elements, such as wetlands, hydrography, and cultural data, MBJ has used high-resolution lidar data to create images of bare earth surfaces and analyze information about vegetation, water bodies, and the moisture content of the earth. Derivative mapping products from the lidar were generated and the point cloud data formatted as LAS files. This made the data usable in different software programs and ensured it could be used in the future. For example, LAS files can be used natively in ArcGIS, which saves having to spend time and effort in converting the data to GIS-specific formats.

Using lidar data in ArcGIS 3D Analyst, the GIS team constructed surface visuals that provided a beautiful sense of the 3D nature of the earth. For instance, hydrology land features are shown in 3D, which is useful for planning stream crossings and understanding the route a spill would take and the bodies of water it would impact. Engineers could look at a proposed pipeline corridor from all angles and see how pipe would run above- and belowground.

Getting a complete picture of the project based on quality data is the best way to ensure a clean planning process that meets client needs, environmental concerns, and regulatory compliance.

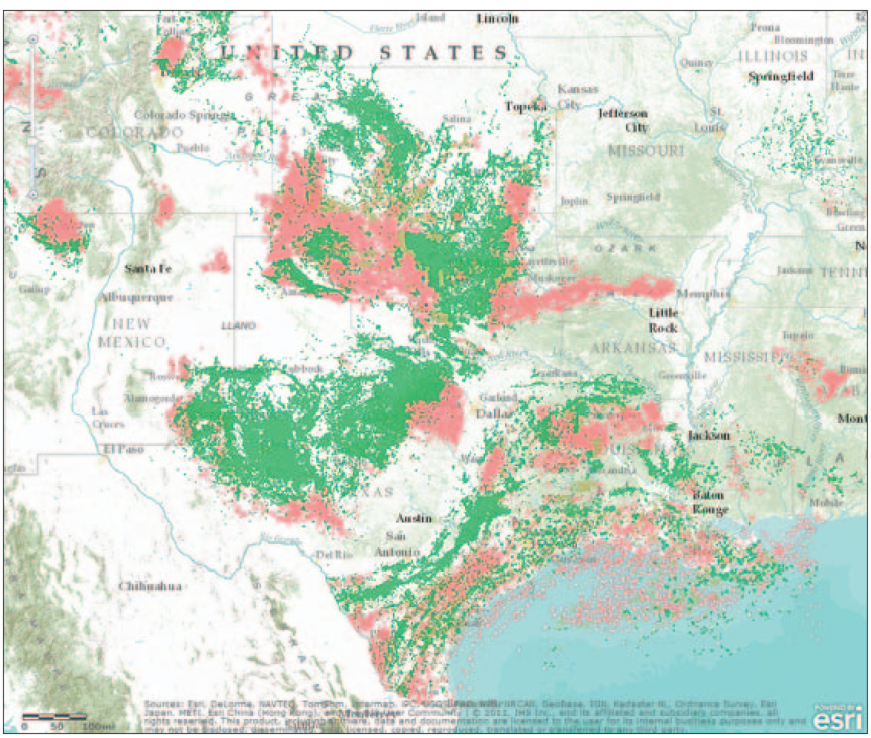
Contact Charles Barnwell for more information at cbarnwell@mbaker.com.

IHS Energy Map Services Connects You to Energy Data

Energy businesses rely on IHS for analysis, critical information, and analytical software to make high-impact decisions and develop strategies with speed and confidence. IHS enables users to integrate comprehensive energy, defense, risk, and security spatial data into a single view for informed decision making. When viewed through IHS and Esri applications, IHS spatial information provides the context required to gain a better understanding of an area of interest, resulting in the best possible decisions. Compatible applications include ArcMap, ArcGIS.com web map viewer, ArcGIS Explorer Online, IHS Enerdeq Browser, and IHS Energy Map Services.

IHS Enerdeq Browser provides an online, single point of access to IHS well and production information using a map-based interface with a set of reconnaissance, reporting, and analysis tools for downloading, querying, and processing current information.

IHS Energy Map Services enables your Esri mapping software to show the latest IHS energy information by connecting directly to the IHS Energy Spatial Database. It includes access to US Well and Production layers and Field Outlines, as well as International E&P, Basins, and Midstream Essentials layers. Map Services enables you to easily combine IHS spatial data with your other data sources to produce compelling maps.



↑ IHS Enerdeq Browser allows your people to access well production information and create their own maps. This map shows current drilling and surface wells and provides specific well data.

Thank You, Esri International User Conference Sponsors

aerometric

CartoPac™ FIELD SOLUTIONS

COLER & COLANTONIO INC ENGINEERS AND SCIENTISTS

IHS The Source for Critical Information and Insight

Pictometry Intelligent Images

spatial dimension

380 New York Street
Redlands, California 92373-8100 USA

133569 QUAD11.9M1/13tk

ArcGIS Online

Maps made better.

(Some assembly required.)

Creating your own map from maps published by other users is just one of many ways to take advantage of the rich collection of data and resources ArcGIS℠ Online makes available to you.

Welcome to the new frontier in geographic information systems.

30-day free trial: esri.com/agol