Petroleum GIS *Perspectives*

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In This Issue

BLM Identifies U.S. Onshore Oil and Gas Resources with GIS

Inventory Directed by Congress Assesses Restrictions to Oil and Gas Exploration

By Richard Watson, U.S. Department of the Interior, Bureau of Land Management

Increasing demand for energy in the United States in recent years has fueled the debate about how much of the onshore oil and natural gas resources under federal ownership are available for exploration and development. On one side, the petroleum industry asserts that large areas of federal land are inaccessible or severely constrained due to numerous restrictions and mitigations to protect the environment. On the other side, environmental interest groups contend that nearly all federal lands are available for leasing and development with few restrictions.

To add clarity to the debate and assist energy policy makers and federal land managers in making decisions about oil and gas development, the U.S. Congress, in 2000, directed the secretary of the interior—in consultation with the secretaries of agriculture and energy—to inventory the nation's federal onshore oil and gas resources with regard to federal actions that inhibit access to these resources.

The secretary of the interior designated the Bureau of Land Management (BLM) as the lead agency for the inventory, and in 2008, the BLM released Phase III of the inventory, which is also known as the Energy Policy and Conservation Act (EPCA) report. It is the first national assessment of the restrictions and impediments to oil and gas exploration and development in the United States.

Understanding the Need for the Report

Access to federal lands is probably the most often mentioned issue affecting onshore domestic oil and gas exploration and production. The restrictions and impediments that limit access to federal lands often are complex and can preclude drilling, increase costs, or delay activity. These restrictions include areas unavailable for leasing and areas where the minerals can be leased but the surface of the land may not be occupied, thereby affecting recovery of the resources. There are also limitations on drilling activities due to a variety

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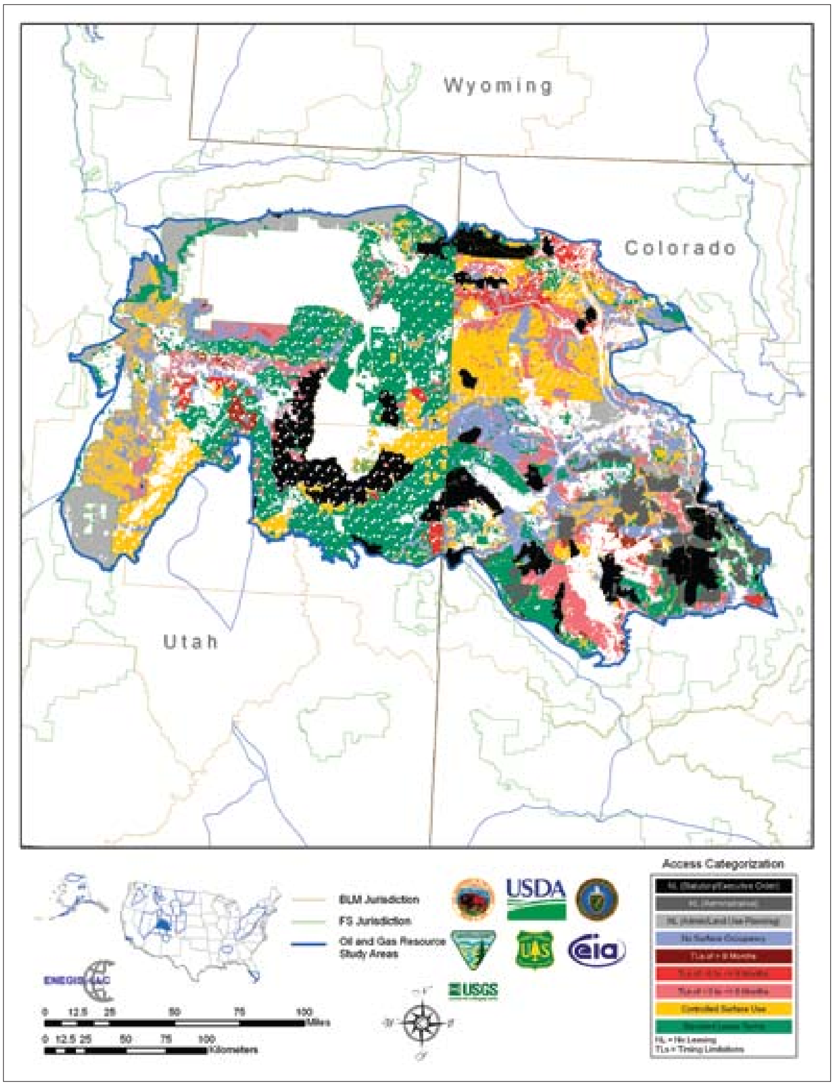

Land Access Categorization Example

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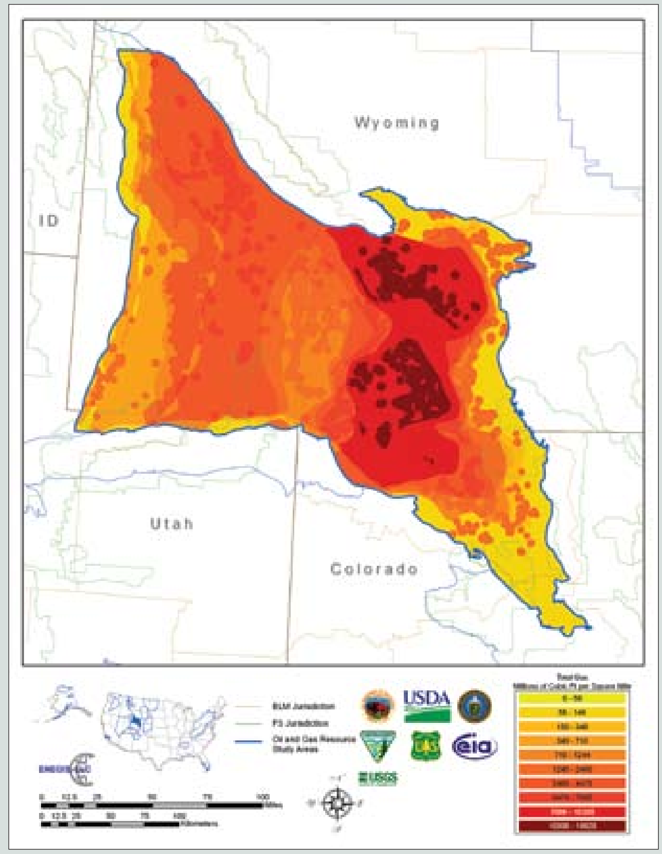


(Left) Natural Gas Resources Example

(Center) Oil Resources Example

(Right) Federal Lands Example

of environmental and socioeconomic considerations, typically manifested as lease stipulations and drilling permit conditions of approval.

There were other studies previous to the EPCA report that attempted to understand the impacts of federal land management decisions on access to oil and gas resources, but they were substantially less comprehensive. The EPCA report includes all onshore federal lands within the United States. The areas covered in detail by the earlier inventories were updated where needed, and six additional areas were analyzed in detail. The accessibility of the remaining onshore federal lands of the United States was extrapolated from the results of the detailed study areas.

The EPCA effort, using geospatial technology, comprehensively integrates oil and gas resources with federal land accessibility. Using ArcGIS, the federal lands were classified and mapped as a hierarchy of nine access categories, which were unioned with the oil and gas resources. The results show, in map and tabular forms, the areas of federal lands with respect to the nine access categories and the volumes of oil and natural gas underlying each category.

The inventory provides fundamental information to help resolve development issues, and it is useful to a range of interests. Agencies can use the inventory data to identify areas of high resource potential and examine federal land management decisions affecting access to energy resources. The EPCA report gives land managers information about the potential magnitude of oil and natural gas resources unavailable for development because of access limitations, and it can be used in conjunction with data about other resource values and the environment.

Spatial Data Development and Analytic Techniques

The inventory resulted in a geographic information system (GIS) database containing numerous layers of geographic data gathered from various agencies including the U.S. Geological Survey (USGS), Energy Information Administration (EIA), BLM, and U.S. Department of Agriculture Forest Service (USFS).

To study federal lands within a GIS framework, the inventory managers developed three specific data layers. The federal lands layer shows onshore federal mineral (oil and gas) ownership including federal lands and minerals from all surface managing agencies. The oil and gas resources layer was generated from data from the USGS National Oil and Gas Assessment. Included in this layer is EIA data on the nation's proved oil and gas reserves growth estimates. The inventory assembled and processed this data into a form useful for further analysis.

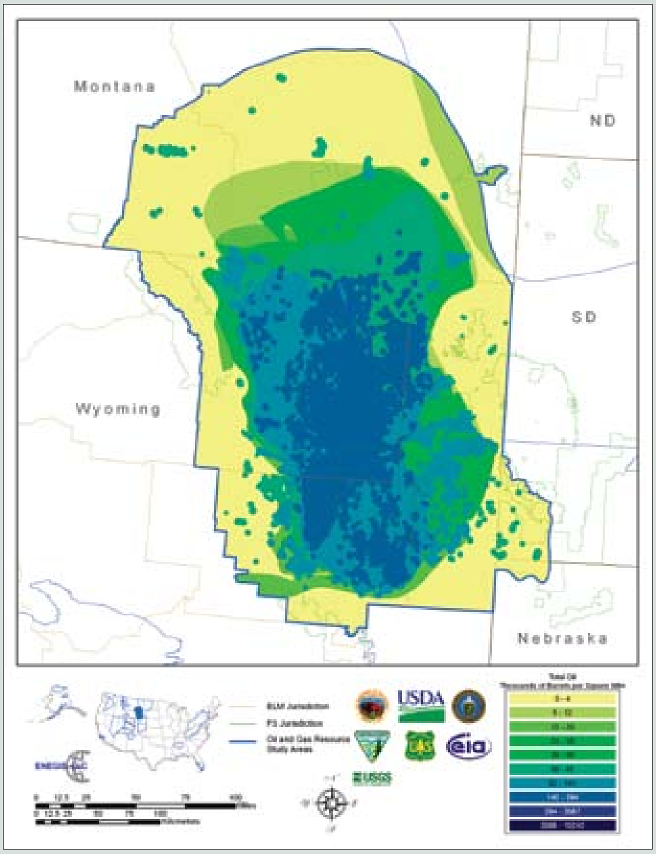
The third data layer in the inventory shows the access constraints (oil and gas land closures, lease stipulations, and drilling permit conditions of approval), which were obtained from the surface management agencies. The lease stipulations, as defined by the various land-use plans, are numerous, complicated, and overlapping. To simplify the spatial analysis, each unique stipulation was placed into one of nine access categories in a hierarchy ranging from most (no leasing) to least (leasing with standard terms) constrained.

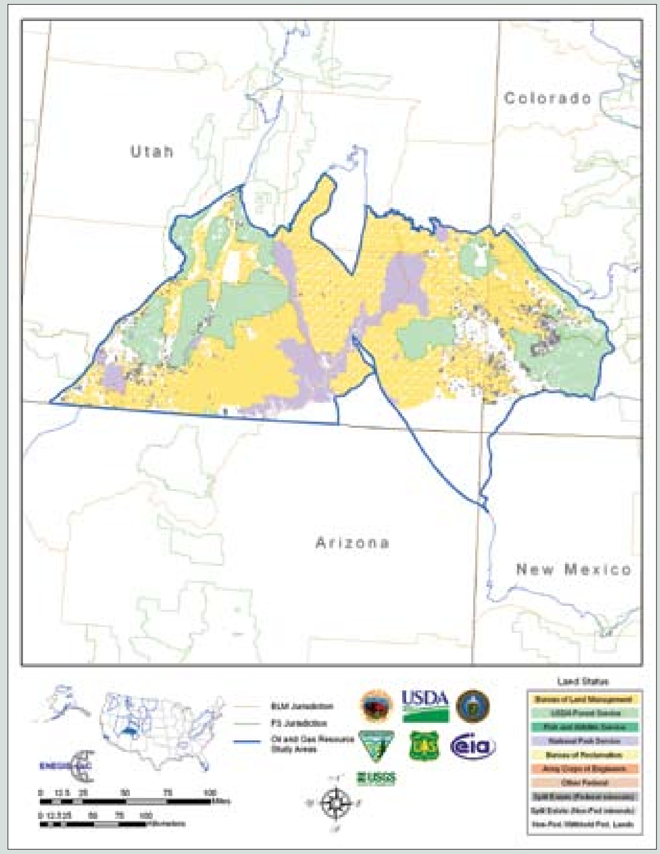
The nine categories can be further combined into three groups: (1) inaccessible, (2) available with restrictions beyond standard lease terms, and (3) available under standard lease terms. Using ArcGIS, the three data layers—federal lands, oil and gas resources, and access constraints—were compiled. From the resulting coverage, extracting the land access categorization enabled the creation of statistical tables and charts showing the federal land acreages in each of the access categories.

The compilers were able to do a similar extraction and create tables and charts of the oil and gas resource volumes under each of the access categories.

The permit conditions of approval data for the access constraints layer came from a stratified random sample of a database. The team looked at whether each drilling permit's conditions of approval had a negative effect on access. To extrapolate the random sample to the larger study areas, the team used a numeric method to produce a random scatter of 40-acre parcels. This method helped quantify the access effect on conditions of approval. The final results were adjusted accordingly.

Another nuance in the geospatial data model involved directional drilling. Directional drilling is used to reach subsurface targets that are not located directly underneath the drilling rig. One of the access categories includes lands that can be leased for oil and gas but where the surface cannot be used for operations. This lease stipulation is known as no surface occupancy (NSO). Local BLM and USFS geoscientists determined the distance beyond which directional drilling is unlikely and resources in the inventory are considered inaccessible.





The compilers included those NSO areas that had accessible resources in the inventory because doing so gives a more realistic estimate of oil and gas accessibility than if the NSO areas were assumed to be totally inaccessible.

Future releases of the inventory will benefit from lessons learned in this huge undertaking. The data collection for the inventory experienced delays and increased costs due to some agencies' reluctance to release data, the need to digitize some non-GIS formatted data, and weather-related emergencies such as hurricanes.

Inventory Results

The inventory identified a total of 279 million acres of onshore federal lands with the potential for oil and gas occurrence. These lands contain an estimated 31 billion barrels of oil and 231 trillion cubic feet of natural gas. Of that, 62 percent of the onshore federal oil and 41 percent of the onshore federal natural gas are inaccessible. The study found that 30 percent of the oil and 49 percent of the natural gas are accessible subject to restrictions beyond the standard lease terms. It also found that only 8 percent of the oil and 10 percent of the natural gas are accessible under standard lease terms.

The inventory could not have been completed within a reasonable amount of time without the use of GIS technology. Compilation of this information into a geospatial database enables further analysis as new questions are asked about the accessibility of onshore federal oil and gas resources.

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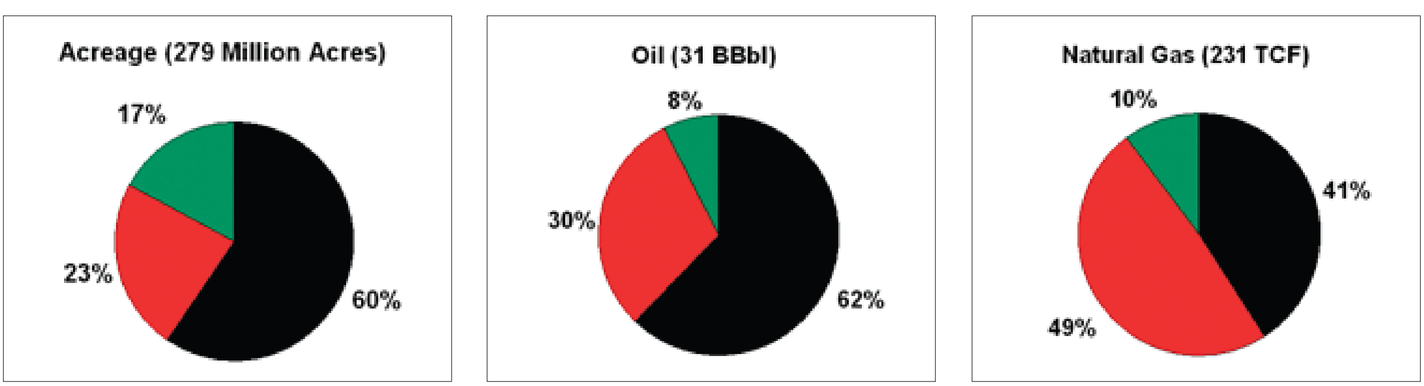

EPCA Phase III Results Summary

Using Geospatial Technologies to Quantify Environmental Sustainability Performance

By Chris W. Baynard, Ph.D., University of North Florida Department of Economics and Geography

Sustainable business practices are becoming increasingly important in industry as consumers, stakeholders, and regulators demand reductions in environmental and social alterations related to industrial activities. Potential large-scale and permanent landscape changes related to exploration and production (E&P) operations, coupled with a long-term business outlook in the energy industry, are leading many multinational energy companies to monitor and minimize environmental alterations.

Adopting sustainable business practices is good for business. They reduce air, water, and soil pollution and can prevent costly litigation, political protests, and negative press coverage. Best practices can attract more consumers, investors, and a professional workforce for whom sustainability is important. They can also offset impending regulations, providing a competitive advantage to early adopters of cleaner technologies and practices.

While improving environmental performance provides important benefits, it is hard to assess and compare practices, even across one industry. Data is often self-reported, missing, weighted differently, or selected by what an organization wishes to report rather than what should be reported in terms of sustainability.

Evaluating Environmental Sustainability Performance

Various indices and guidelines exist to evaluate oil companies' environmental sustainability performance. These include the International Organization for Standardization, such as 14301; the International Petroleum Industry Environmental Conservation Association and the American Petroleum Institute; the Global Reporting Initiative; and the Pacific Sustainability Index, among others. However, none has been systematically adopted for the oil and gas industry.

One emerging sustainability index is the Ecological Footprint (EF). This resource accounting tool relies on simple quantifiable measures to determine the amount of regenerative biological capacity required by a given human activity—measured in global hectares. But in terms of assessing environmental alterations at site-specific extractive industries, this index has limitations. First, the unit of analysis for oil and gas operations is landscape level, not global or even national hectares. Second, the EF does not account for habitat fragmentation, loss of biodiversity, and new human settlements in previously inaccessible areas, which often result from E&P activities. Third, and perhaps most important, the EF methodology does not utilize GIS and remote-sensing techniques. This is surprising given the important and growing use of spatial data and processes in the oil and gas and other extractive industries.

GIS and remote-sensing techniques address this problem and can indeed improve sustainability accounting, monitoring, and reporting through the Landscape Infrastructure Footprint (LIF) proposed here. The LIF considers the type and pattern of visible infrastructure features related to extractive industries such as energy development. It uses five quantifiable landscape ecology metrics to address the loss or disturbance of bioproductive land to rank environmental performance.

This article focuses on four heavy oil belt (HOB) operations in eastern Venezuela for three time periods. As productivity decreases in traditional wells, the HOB with its 270 billion barrels of recoverable heavy oil is becoming the frontier of onshore E&P in Venezuela. The methods presented here can be used to plan subsequent operations, as well as compare environmental performance among similar industries, leading to a sustainability index that can be incorporated into sustainability benchmarks and reporting.

Methods

The LIF uses the landscape ecology perspective of the land mosaic—as infrastructure features slice the landscape into patches and corridors, they lead to habitat fragmentation. These actions result in habitat loss and decreased and disconnected bioproductive land, the features of which can be measured with geospatial techniques. The five metrics used to develop the LIF are vegetation change, infrastructure density, edge-effect zones, core areas, and number of rivers crossed. The software used for this analysis was ArcInfo with an imaging software extension for ArcGIS. This study only examines infrastructure features related to E&P. Naturally, other economic activities and land uses (such as agriculture) are evident in a given landscape or concession area. They too can be measured using these methods.

Change detection involved first creating subset images of the oil operations for three time periods using rectified Landsat and China-Brazil Earth Resources Satellite (CBERS) imagery. The time periods were chosen because they allowed a baseline measure: 1990 was before E&P operations were approved, 2000 was an early production period when operations were under way, and 2005 was a period of full production when the heavy oil upgraders were operational.

Creating subset images involved using shapefiles of the oil operations as areas of interest in the imaging software. Clouds were masked out, but due to excessive cloud cover and missing data, one operation was excluded and the CBERS 2005 imagery was not used for this measure.

ESRI's ArcInfo simplified the production of change detection maps and permitted quantifying the remaining four metrics. With the imag-

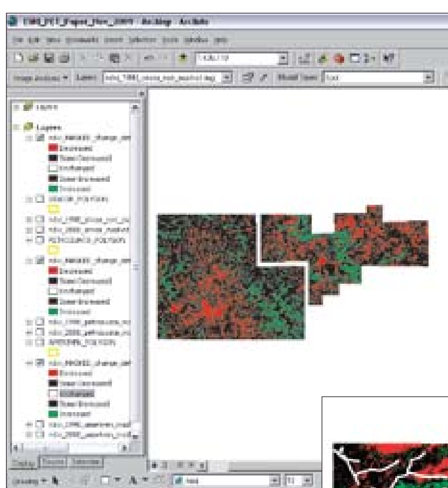

Figure 1. Vegetation change detection based on the NDVI between 1990 and 2000. Green indicates gains; red shows losses.

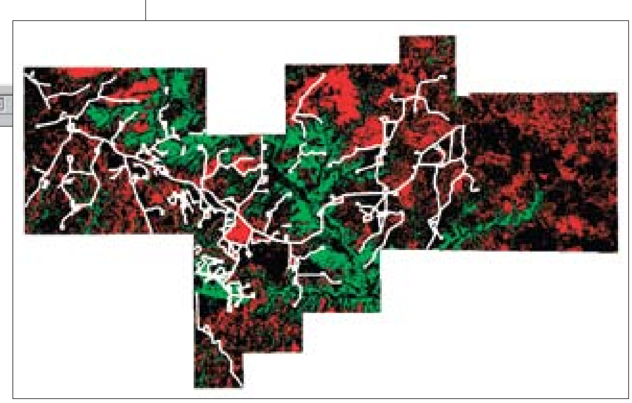

Figure 2. A change detection image based on the NDVI overlaid with energy infrastructure features in white. Gains in vegetation cover appear in green and losses in red.

Figure 3. The pattern of energy infrastructure features appears in red, occupying 29 percent of the concession area in the full production phase of 2005.

Figure 4. The pattern and size of the edge-effect zone appear in red, while the patches of natural habitat, or core areas, appear in green.

ing software extension for ArcGIS, Normalized Difference Vegetation Index (NDVI) images were created for two time periods (1990 and 2000). The NDVI provides an indication of healthy biomass and has been widely used in vegetation-change studies. Then by image differencing, subtracting these NDVI images for each operation, land-cover change could be measured. Gains appear in green and losses in red (see figure 1).

Calculating infrastructure density came next. This first required on-screen digitizing of infrastructure features visible in the Landsat and CBERS imagery of the study area for 1990, 2000, and 2005. The resulting polyline shapefiles showed the petroleum infrastructure features (petroscape) pattern increasingly expanding in each operation during the three time periods. Additionally, placing the infrastructure shapefiles on top of the NDVI images allowed a visual check of the relationship between the loss of vegetation cover and the expansion of the petroscape (see figure 2).

Infrastructure density was calculated by dividing the total number of linear features by the area of each operation. Also known as road density, this common metric assesses the potential impact of roads and infrastructures across landscapes. And because it is a density measure, the length of linear features is normalized by the concession size. Hawth's Analysis Tools for ArcGIS were used to create a grid, which, after clipping to the concession size (with ArcToolbox), enabled the overlay of infrastructure features. Then, through spatial queries, the areas in the grid that were intersected by infrastructure features were selected and exported as new shapefiles (see figure 3).

The third measure, edge-effect zones, refers to areas that experience significant ecological effects extending outward from infrastructure features. Based on a literature review of roads (road ecology), as well as energy infrastructure disturbance to wildlife, a 600-meter buffer was chosen and a spatial query used to locate all the affected grid squares; these were exported as new shapefiles. The buffer increased the amount of land in each operation affected by the petroscape and made the pattern of habitat fragmentation more apparent.

The fourth measure was core areas. These intact habitat areas, or patches that remain after petroscape features have fragmented the landscape, varied in size and shape. Smaller and fewer core areas indicated a more disturbed landscape and reflected a greater loss of biodiversity as species became isolated. Figure 4 shows the core areas remaining after the edge-effect zones had been discounted from one of the concessions.

The final measure was number of rivers crossed. Here, reducing the number of river crossings lessens the disturbance of aquatic and riparian ecosystems and minimizes potential contamination. This calculation first required digitizing the rivers in each concession (using Landsat imagery). Next, the Intersect Lines tool in Hawth's Analysis Tools was used to create points where rivers intersected infrastructure features and tabulate them (see figure 5).

Finally, the environmental performance of each operation was ranked based on results of all five metrics. The lowest score represented the best performance in terms of reduced environmental alterations related to E&P. The distinct metrics allow E&P operations to address specific concerns, but more important, companies know where to make changes and can improve their environmental performance operation by operation.

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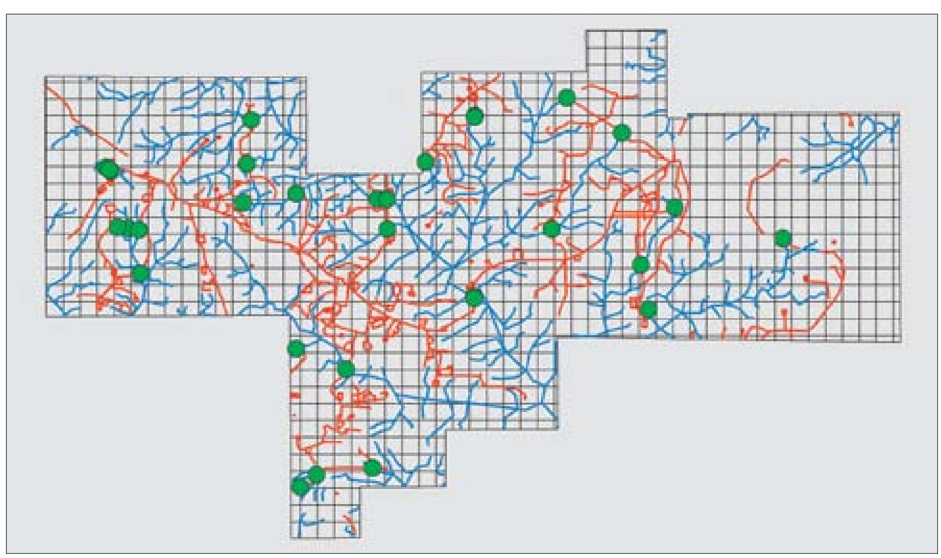


Figure 5. Infrastructure features crossing rivers appear as green dots. Reducing such crossings lessens aquatic and riparian ecosystem disturbance and reduces pollution.

A Data Management Challenge–Integrating GIS Data after a Company Merger

After Joining Forces, Two Energy Companies Merge Their Spatial Data

From the early 1970s, the Norwegian energy companies Statoil and Norsk Hydro have been key players in the petroleum industry through their activities on the Norwegian Continental Shelf. In October 2007, Statoil merged with Norsk Hydro's oil and gas division. The new company was temporarily named StatoilHydro, and it reached a size and strength for considerable international expansion. In November 2009, its name changed to Statoil. With more than 30,000 employees worldwide, operations in 40 countries, and strong international growth, Statoil has emerged as an innovator in petroleum technology.

GIS technology plays a large role in Statoil's business processes. Company-wide, there are more than 800 registered ArcGIS users, not only in Norway but also throughout North and South America, Africa, Asia, Europe, and the Middle East.

Statoil uses GIS software in all phases of its business processes that have a geographic component including business development, exploration, field development, production, and downstream in retail. For Statoil, geography is important because knowing where things are located and predicting where things happen are fundamental to the success of the organization.

With advances in the technology that have broadened its capabilities, made it easier to use, and increased awareness of GIS, the number of GIS users has grown dramatically. From mapping and analysis to remote sensing and data management, GIS activities at Statoil are integrated into every division that deals with spatial data. Exploration activities include international regional studies, basin modeling, and seismic surveys. Also, facilities development, installation and operational support, pipeline inspections, marine surveillance, and environmental studies are current activities with a GIS component.

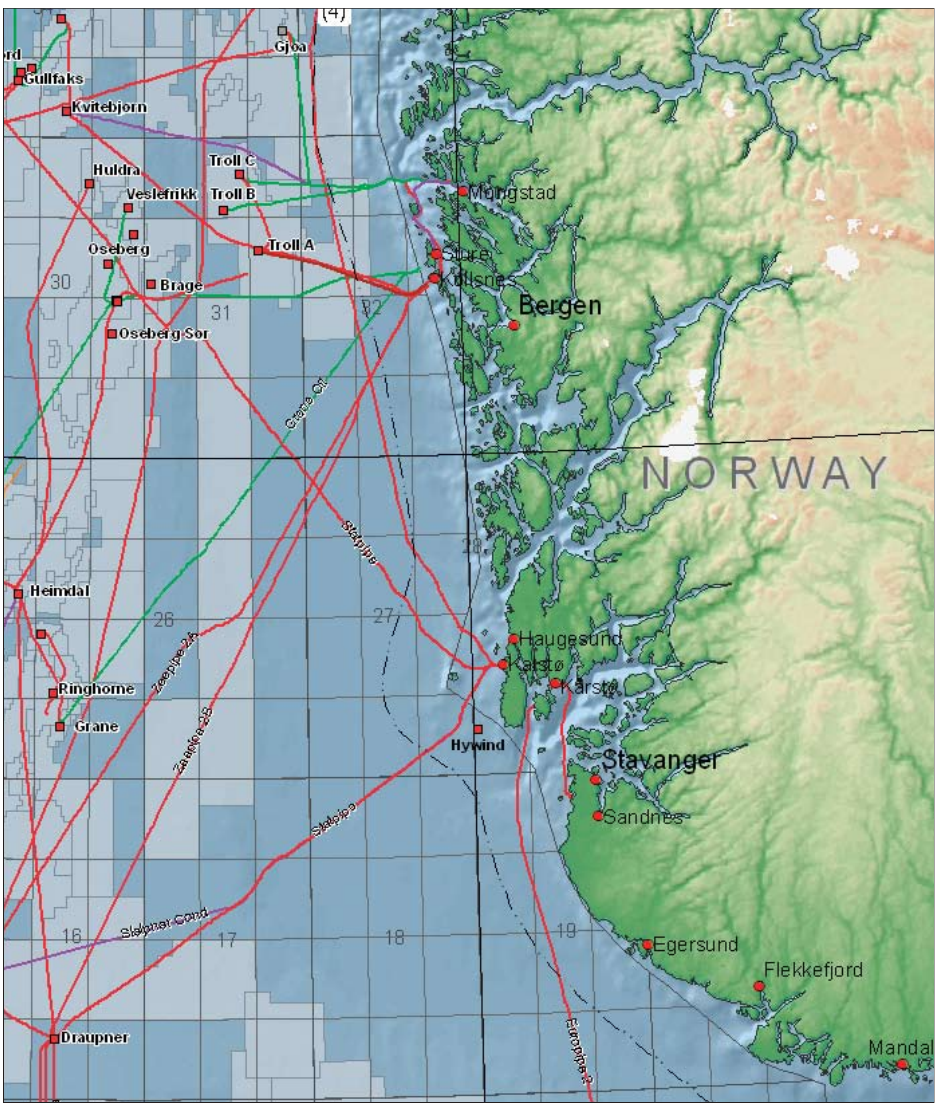


Figure 1. Petroleum infrastructure, such as pipelines and installation data, is managed by GIS users and made accessible with other base data through ArcGIS.

Integrating GIS Data

Before the merger, both companies had extensively used GIS technology for many years. As a result of the merger, data management and storage issues became major concerns for the growing number of GIS users.

To ensure a smooth transition, the newly formed company established a working group on GIS integration to conduct an assessment of the strengths and weaknesses inherent in its current work processes. The group focused on data integration, data delivery, and data access. To evaluate the situation, members examined datasets, dataflows, resources, tools, and workflows and looked for redundant data sources and other inefficiencies. Input from key GIS users helped identify issues such as flexibility, distribution, and performance. The group studied possible solutions for integrating Statoil and Hydro spatial data, standardizing GIS applications, and improving data management processes.

Opportunities and Constraints

Some of the shortcomings the group found were that GIS data was stored in many folders and databases and that duplicate datasets existed. Metadata was often missing or undocumented, and data management was not centralized; often, databases were managed on an individual basis. Procedures for cleanup and updating were not standardized, and many users who needed immediate access to data found response time to be slow.

Statoil and Norsk Hydro each brought assets from which the data integration project could benefit. The HydroGIS tool from Norsk Hydro structured data into ArcGIS and complied with industry standards. Statoil's GisMap plug-in provided easy access to data and consisted of an organized set of layer files for common datasets. It was standards based with naming conventions and was convenient to use for map layouts. The

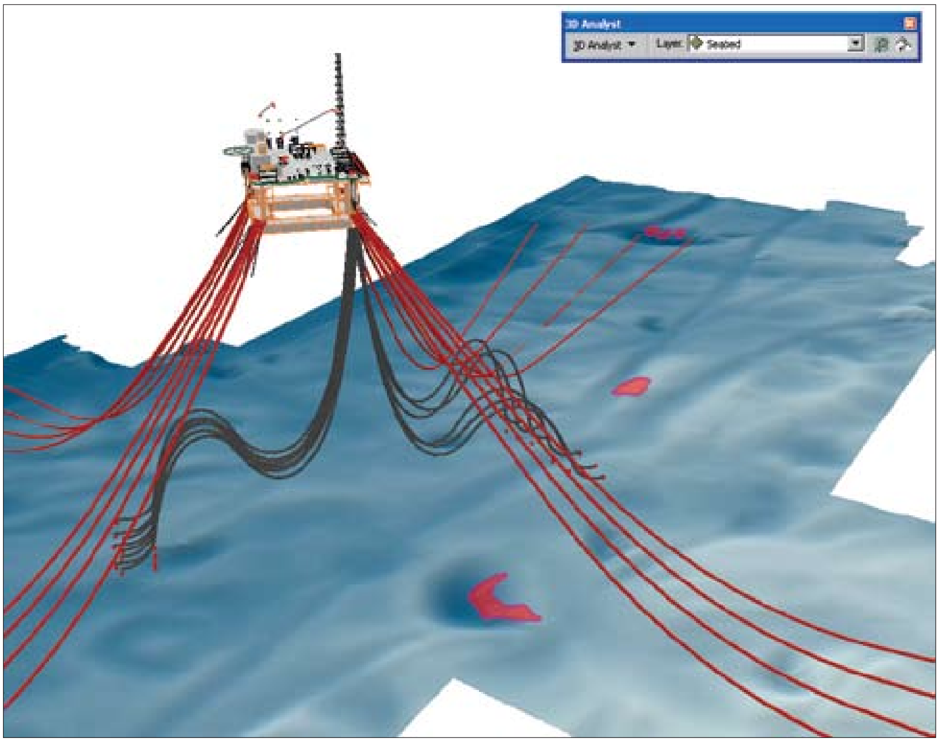


Figure 2. ArcGIS helps to visualize a platform in 3D with risers and anchoring system along with seabed topography.

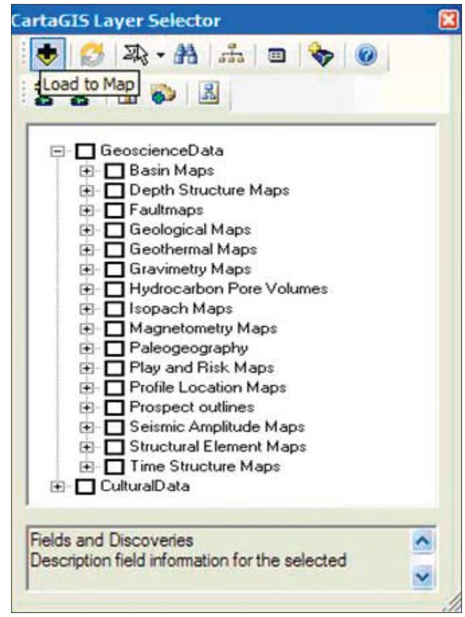


Figure 3. ArcGIS Desktop plug-in gives users immediate access to updated geoscience and cultural basemap data.

merger brought together many highly skilled GIS users who were motivated to improve GIS data management, and they had the commitment from management to address the database issues.

Prioritizing and Implementing Recommendations

The working group recommended synchronizing and integrating ArcGIS data to enable easy access to accurate updated information, loading or indexing sources into a redefined Statoil GIS database, establishing corporate-wide data management routines, providing a raster data storage and distribution solution, and improving IT support for GIS. The goal of these recommendations was to provide new tools for GIS users that would increase efficiency, improve productivity through the centralization of data sources, and establish one common enterprise GIS.

The current project work focuses on locating duplicate sources, refining the database schema, prioritizing datasets for upload, documenting dataflows, and establishing automatic tools for data loading. The group is also working toward developing interfaces with other databases including ArcGIS Server, securing storage, controlling access, and implementing raster data storage. A raster data strategy has also been included in the project scope including defining image services for satellite data and using a raster catalog for visualizing detailed bathymetric and topographic data.

Quality assurance is a main concern for Statoil, and to address that, users have begun to prioritize datasets including seismic navigation data, basin modeling data, interpreted surfaces, prospects, selected cultural data, and imagery and raster data. Currently, some datasets have been made available, and resource requirements are being evaluated.

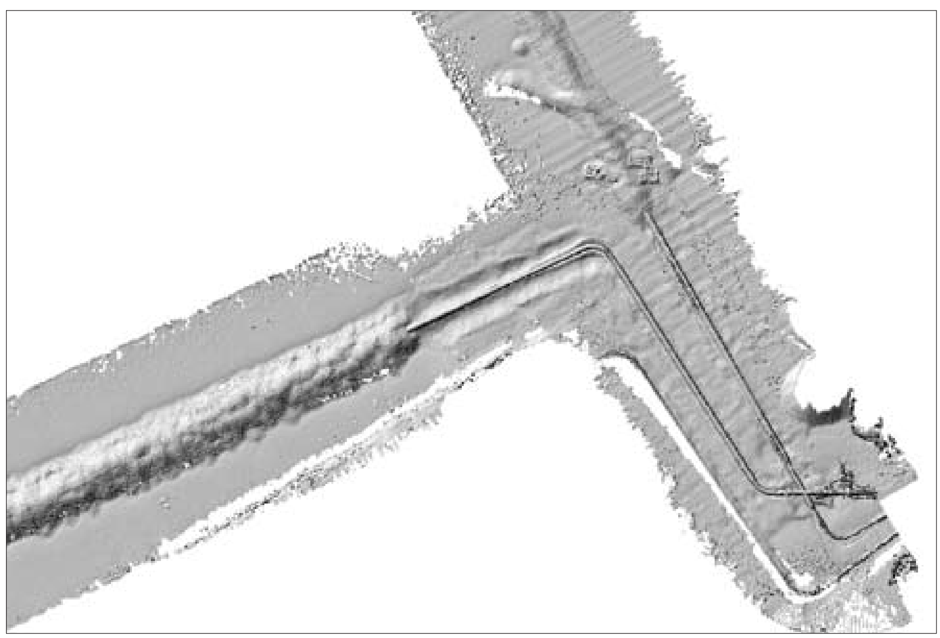


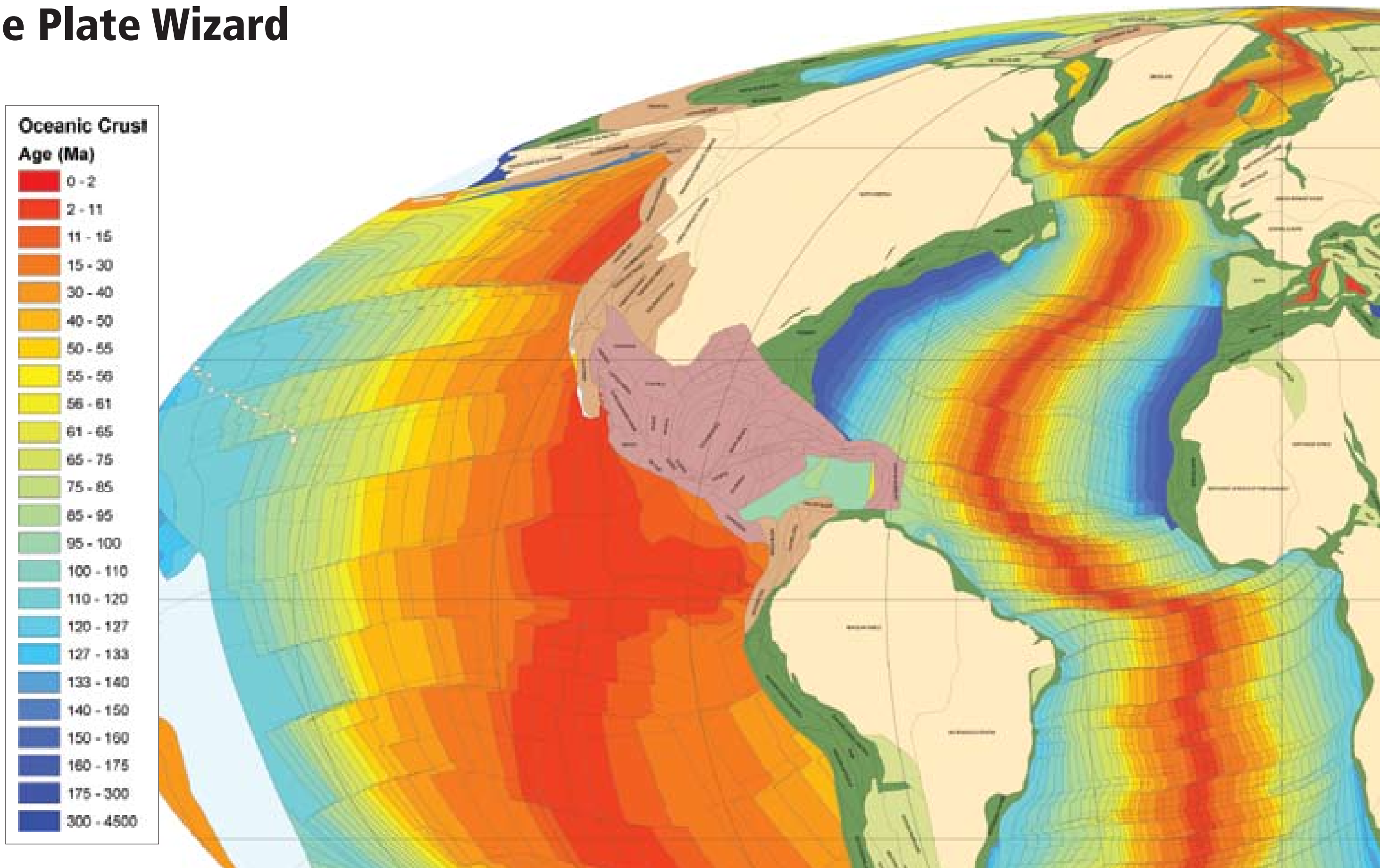
Figure 4. Detailed high-resolution bathymetry and hillshades are stored in a raster catalog.

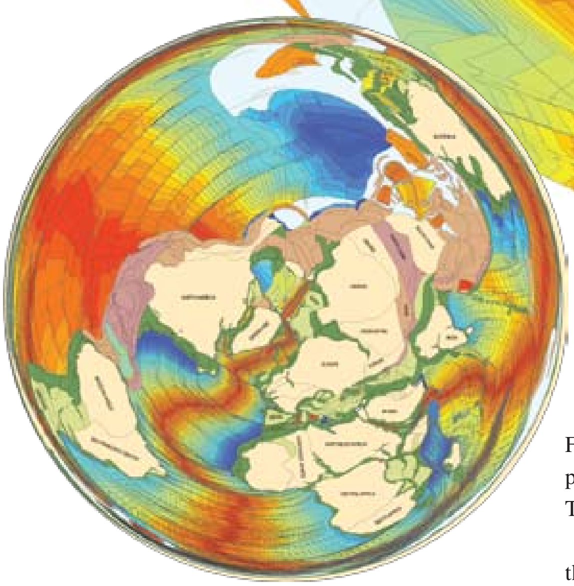
Future GIS Plans

The GIS vision for the future at Statoil includes a GIS portal where all subsurface data is stored in one structured database or indexed from other corporate datasets. GIS users will have easy access to the data within this enterprise GIS data management system that is powered by ArcGIS Server and distributes the data over standard Web services and feature image services.

Contact Leslie Austdal, Statoil leading advisor, Mapping and Geographic Information, at leau@statoil.com. Also, visit www.statoil.com.

The Plate Wizard





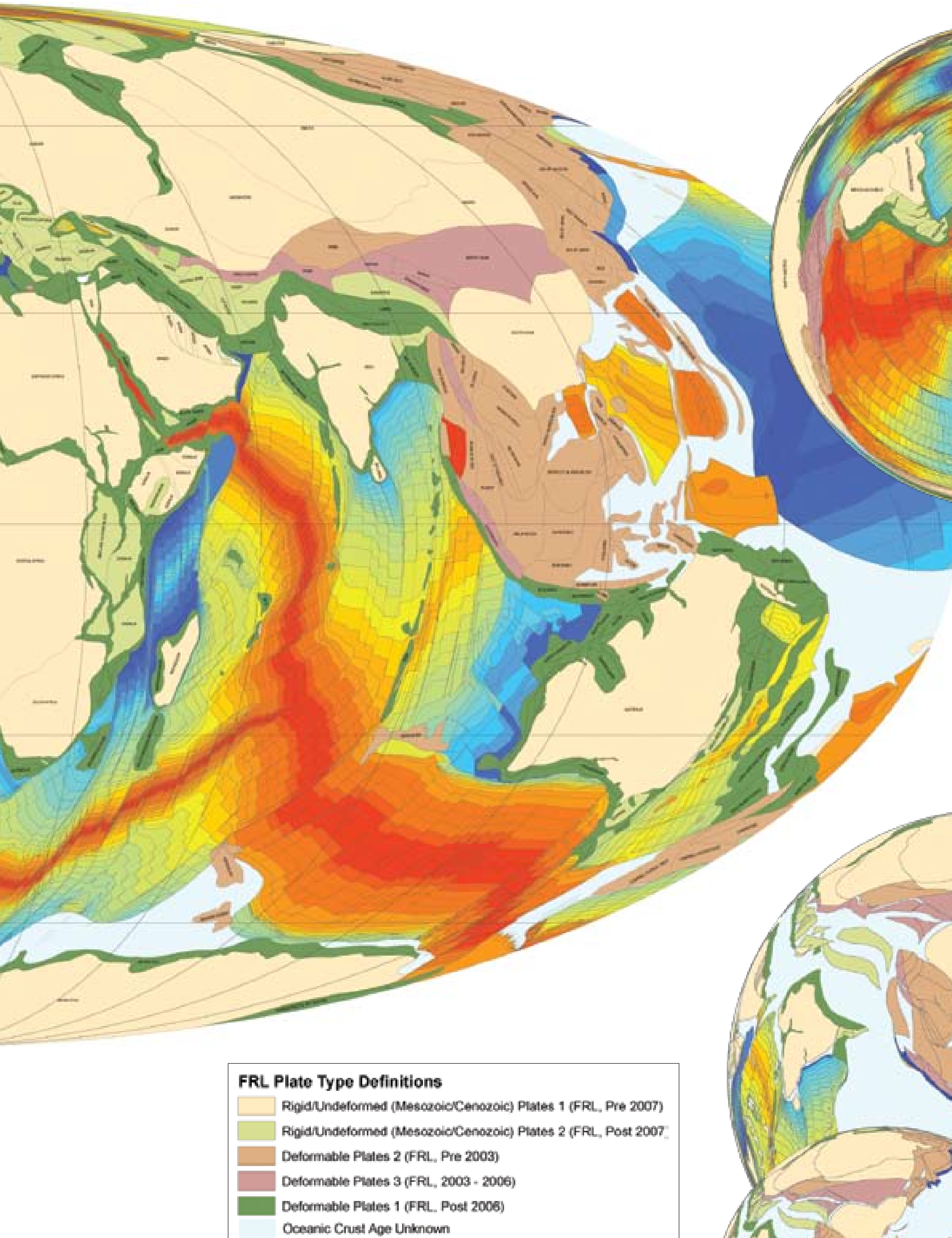
North Polar Projection

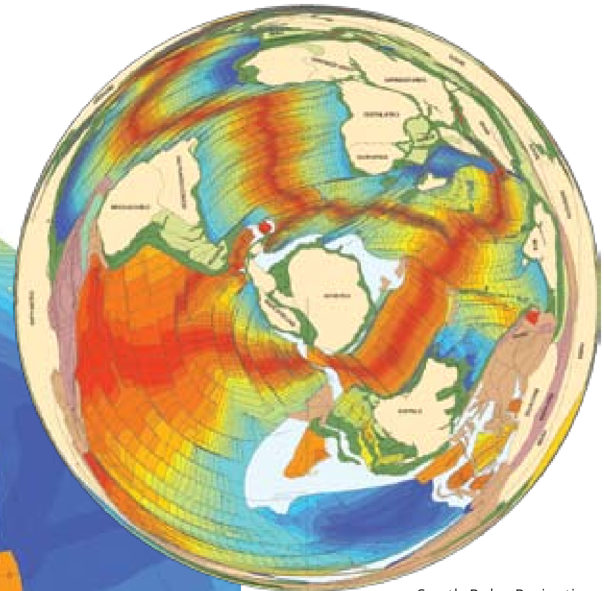
Fugro Robertson Limited's (FRL) Plate Wizard is an ongoing, subscription-based project that provides a global dynamic plate model for the entire Phanerozoic eon in a GIS environment. These maps represent an overview of the project.

The plate model is derived from the detailed regional plate models developed at FRL during the last 10 years, together with a comprehensive analysis of the near-global passive margins and oceans gravity and magnetics dataset compiled by FRL. This has been used in conjunction with FRL's global geologic database to define a consistent global set of continent-ocean boundary definitions.

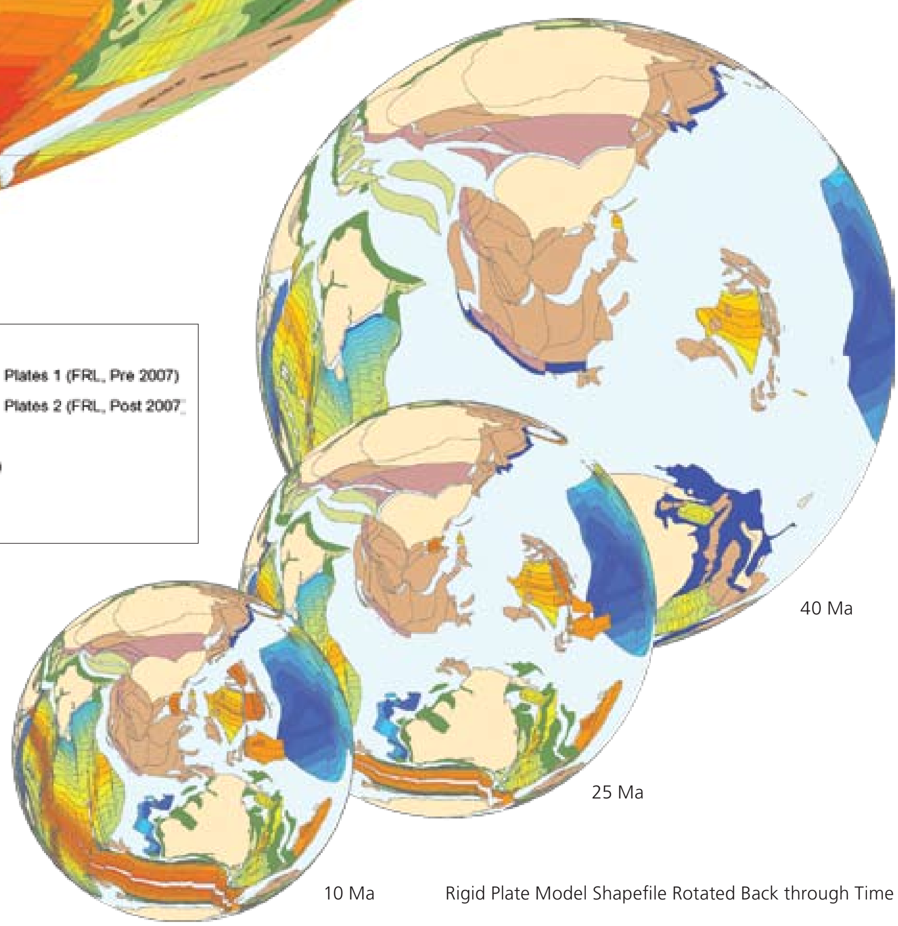
The project has as its starting point detailed global plate definitions, including defined rigid cores and deformable margins. A key aspect of Plate Wizard is the development of a deformable plates methodology for both convergent and divergent environments. Plate Wizard represents a major advance over the rigid plate models (with all their inherent problems) that have been available so far. The geologic control information aspect of the project is feature linked in GIS to supporting databases, including geologic information and references. Finally, the GIS front end enables full access to the plate polygons and rotation files, detailed browsing, and reconstruction and deformation of both Plate Wizard and third-party data.

Contact Mike Goodrich at mjg@fugro-robertson.com.





South Polar Projection



Rigid Plate Model Shapefile Rotated Back through Time

Well Planning Made Easy

Shell's Rocky Mountain Team Streamlines the Process with Dramatic Savings

Shell Exploration and Production's Rocky Mountain team in Denver, Colorado, supports the Pinedale field in the Green River Basin in Wyoming. Currently the second-largest gas resource in the United States, the 30-mile by 5-mile strip is located in the southwest part of the state on mostly federal land.

Shell's Denver GIS team supports the well planning and execution team including drilling engineers, surveyors, production geologists, and rig planners. When Shell bought the field in 2002, there were eight wells in the system. The number of wells planned and drilled per year has grown exponentially since then, and currently, the team plans approximately 600 wells per year and drills approximately 100 wells per year. The current utilization is 10-acre spacing—16 wells per quarter section.

To keep pace with this rapid growth, in early 2008, Shell evaluated the well planning process and launched a GIS implementation that helped increase efficiency, reduce planning cycle time, and realize a dramatic cost benefit.

Streamlining the Process

Well planning was taking too much time; the team was spending as long as five months per quarter section. They needed to develop a standard process for well planning that transitioned out of the traditional tools they were using such as Excel and an engineering tool called Canvas. The goals were to provide timely access to decision support information, accomplish more work with fewer resources, provide automated tools to save time, and give users an intuitive interface.

Well planning was not integrated with other data or processes, and accuracy was another problem. The team wanted to provide high-quality deliverables by generating accurate and reliable data through the implementation of a spatial component.

While a GIS was in place, it had not been implemented in many of the work processes. The first step for Janyce Jaramillo, the GIS manager, was to start collecting data, synchronize it, and verify its accuracy. Next, she conducted a needs assessment to determine how each department was involved in the process, which hardware and software were needed, and where training was indicated.

Data Collection

Data for the GIS came from a variety of sources, including text files, spreadsheets, AutoCAD, GIS Web sites, and digitized hard copies, in a variety of coordinate systems. The team began by organizing everything into an Oracle/SDE database, and because the database was located in Houston, Texas, the displays were optimized for faster response times. "We didn't want to rely on on-the-fly conversions," says Jaramillo, so a standard coordinate system was implemented.

A six-inch resolution aerial image simplifies quality control.

Because a lot of editing occurs within the system, the team uses a versioned database for multiuser capabilities. To eliminate translation inconsistencies, there is a direct connection to the source of records for timely record access.

The base data consists of the well locations in OpenWorks, well pads digitized from aerial photos and converted from AutoCAD, owner/operator leasehold data, legal information, wildlife stipulations, estimated ultimate recovery (EUR) contours, and anticollision information. All of this data is critical in well planning efforts.

The well location information includes surface and bottom hole locations, survey paths, picks, and any available competitor data. The public land survey data is focused on quarter sections. The Wyoming Oil and Gas Conservation Commission requires land survey data to be GPS surveyed, and an ongoing project is to align the commercial sections with the GPS coordinates to achieve an accurate bottom hole location. The legal data in the system tracks negotiations for drilling and includes legally defined areas and setbacks.

Minimizing the environmental impact of drilling is a huge objective. Much of the wildlife data in the system comes from the Bureau of Land Management, the Fish and Wildlife Service, and environmental impact studies, which help ensure that wildlife habitats and migration patterns are understood. The EUR contours provide high versus low production area information, and anticollision planning begins with accurate surveys of the subject well and a complete set of plans for existing wells.

A Toolset to Streamline the Process

There are many steps in the well planning process. It begins with the rig planner and production geologist, who determine where to place the wells. They generate the bottom hole locations and drainage ellipses. Next, the permitting group performs quality control for the proposed location and prepares the legal documentation for the surveyors, who generate the plats. The well loggers define an optimal well path, then the drilling engineers begin to reconcile all this data. Finally, the production geologists monitor the plan.

ESRI business partner New Century Software, Inc., a provider of pipeline GIS solutions, worked with the Shell team to develop a toolset that focused on streamlining the well planning process and ensuring that the large amounts of required data were continuously updated. The toolset, an extension of ArcGIS, streamlines existing workflows and makes them much more repeatable. Along with the toolset implementation, they also migrated data for enterprise data storage.

The deployment strategy was to minimize disruption, develop incrementally with clearly defined specifications, leverage the GIS experts at Shell to align with existing enterprise architectures, train team members on tool specifics, and be able to distribute a map to the entire team after each planning cycle.

Three-Part Dataset

The data generated from the toolset comes in three parts: the well planning dataset, the execution dataset, and the maintenance and synchronization dataset.

Included in the well planning dataset are the proposed drainage ellipses, which are based on induced hydrologic fractures; the 80-foot-radius target areas; the proposed wells; and the callouts that are sent to the permitting

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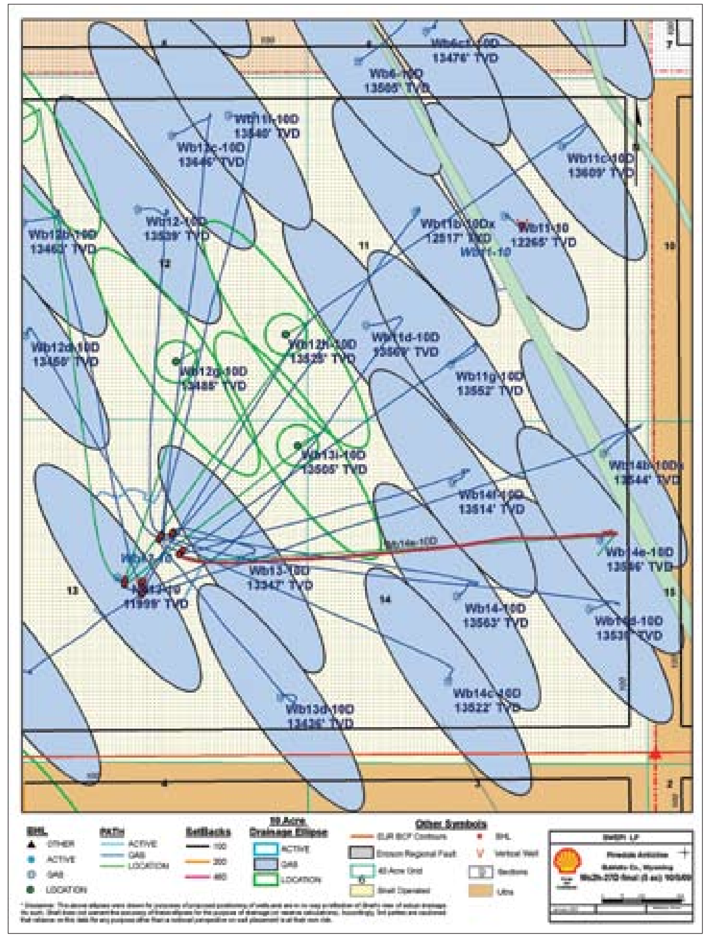
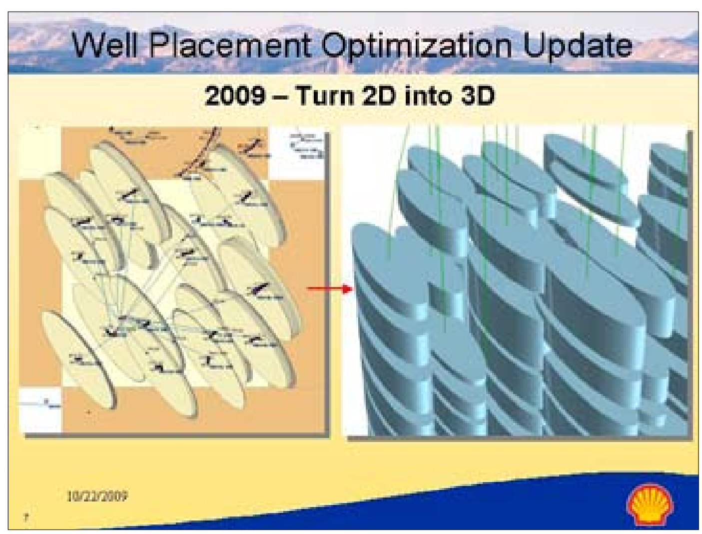


The standard ArcGIS template is used in daily drilling meetings for multidiscipline collaboration.



Comparing well path drainage overlap between two-dimensional and three-dimensional surfaces provides further insight when optimizing well placement and drill path.

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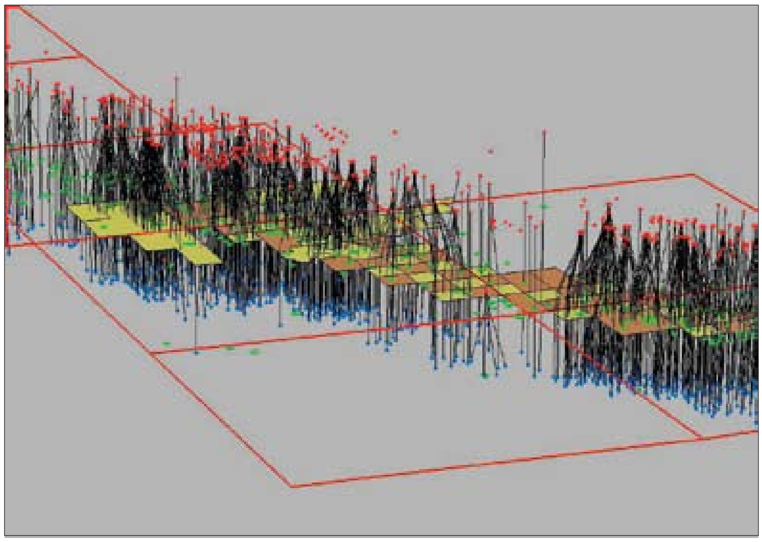
Well Planning Made Easy

group. A key element of this dataset is the drag-and-drop feature. Users can simply click a well or ellipse and drag it anywhere on the map and assign attributes. The callout application calculates accurate bottom hole locations in the required format for the Wyoming Oil and Gas Conservation Commission.

The second part of the dataset is the execution dataset, which is derived from the actual fieldwork. OpenWells software collects operations data for a well including the actual drilling well path and points, the planned well path and points, and graphs of the drill path vertical cross section. This information is sent directly to the Denver office in spreadsheet format, where it is loaded into the GIS and stored in ArcGIS—a huge benefit from a data management standpoint. The z-attribute for the points is also set so that the data can be easily integrated with ArcScene. The planned versus actual well paths and points are important for evaluating time spent, accuracy, and expenditures.



Data is easily integrated to produce an overview of the well planning area.

Maintenance and synchronization compose the third part of the dataset that involves direct import of field data from OpenWorks software, creating on-the-fly drainage ellipses around existing wells, and developing a map template. The direct connection from the OpenWorks database to the GIS enables easy data updates.

The map template is used to display areas of interest along with the daily drilling status. It has proved to be a valuable communication tool for the planning, drilling, and completion teams and is used in the daily drilling meetings. "The map template has become a useful tool around the office," says Jaramillo. "It's become a daily activity to print the maps and use them to collaborate with other teams."

Some other tools developed by New Century have been useful to the team including a tool to calculate drainage overlap for further analysis, the symbology toggle that enables users to turn on and off parts of a layer, and the section navigation tool that easily locates an area of interest.

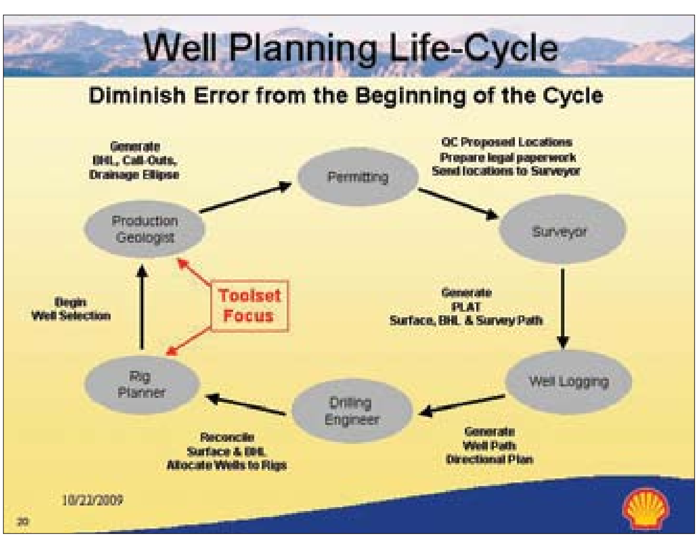
New Process Produced Many Benefits

Being able to visualize the complex process was an immediate benefit of the new streamlined system. Other advantages of the new process were the easy access to information from the centralized database, a clearly defined workflow, stronger decision support, increased collaboration across disciplines, support for a multiuser environment, better quality control, increased accuracy, and the ability to get work done faster. Because it isn't necessary to do a lot of manual inputting with the new system, human errors have decreased.

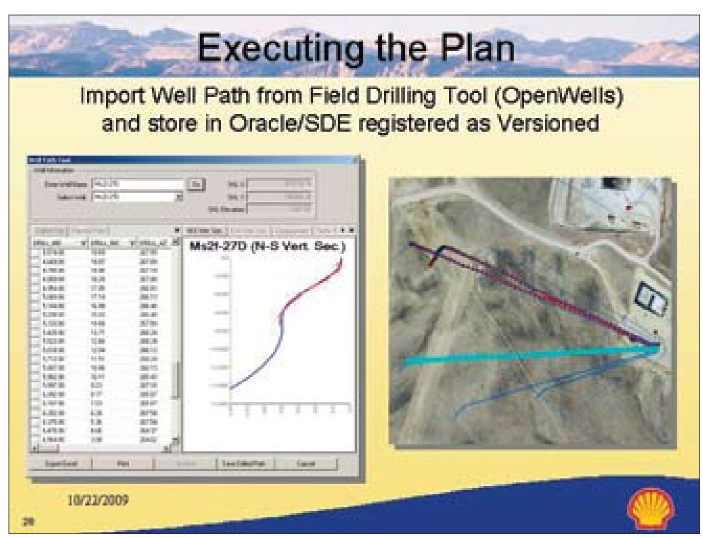
The cost savings from the new system have been an important benefit. Previously, the time to complete a well planning cycle was three to five months per quarter section. "Now we have multiple cycles going on at the same time and can complete a plan in about two weeks," says Jaramillo. "We plan approximately 35 quarter sections a year, with a savings of at least $2 million a year."

Finally, survey rework has decreased, as well as exception reporting fees for going beyond the setbacks in the legal data, because now team members know exactly where they are drilling. New aerial imagery that the team acquired is at six-inch resolution, which has made quality control extremely tight. "Surface holes need to be seven feet apart, and now we can see if something is off almost immediately," reports Jaramillo.

Contact Janyce Jaramillo, GIS manager, at janyce.jaramillo@shell.com.



The well planning life cycle begins with the rig planner and production geologist.

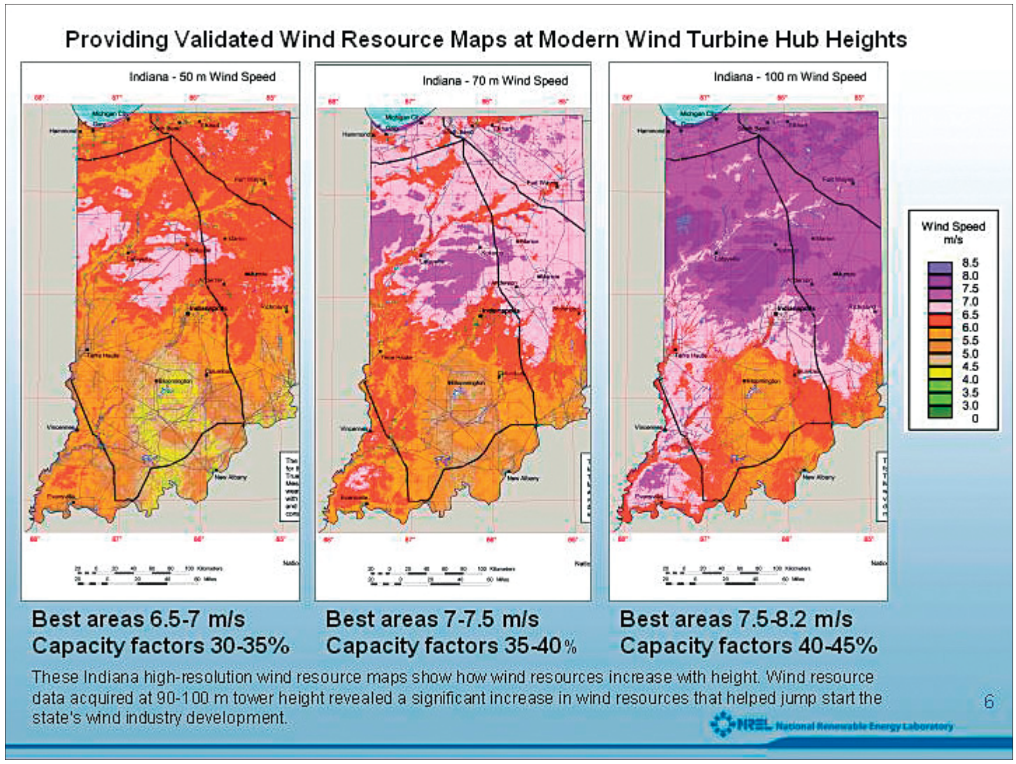


The OpenWells tool collects operations data for a well.

U.S. DOE's Renewable Energy Lab Maps Wind Resources with GIS

During the 1970s, the United States experienced a significant energy crisis as oil consumption grew and supply fell. Soon after President Jimmy Carter came into office in 1977, he addressed the nation and said, "We must balance our demand for energy with our rapidly shrinking resources. By acting now, we can control our future instead of the future controlling us." His energy policy included maintaining healthy economic growth; protecting the environment; and developing the new, unconventional energy sources that the nation would rely on in the following century.

Several months later, Carter established the U.S. Department of Energy (DOE), and the Solar Energy Research Institute (SERI) was opened in Golden, Colorado. In September 1991, SERI was designated a DOE national laboratory, and its name was changed to the National Renewable Energy Laboratory (NREL). NREL is the primary laboratory for renewable energy and energy efficiency research and development in the United States.



These Indiana high-resolution wind resource maps show how wind resources increase with height.

NREL works to advance many renewable resources, including solar, hydrogen and fuel cells, biomass, and geothermal, but wind is currently the most developed renewable energy market. Windmills appeared on the American landscape in the early 20th century and evolved into wind turbines that increasingly capture more energy and become more cost-effective. In 2006, President George W. Bush spoke about the nation's need for a more diversified energy portfolio and how wind energy might provide 20 percent of the nation's energy by 2030.

In May 2008, DOE released a groundbreaking report, 20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply. The report provides a road map to reaching this important goal, including identifying steps and challenges.

As part of the research behind having 20 percent wind energy by 2030, NREL team members were tasked with updating wind resource maps. The updated maps were a critical component of the wind deployment model used to develop the 20 percent scenario. Using ArcGIS Desktop software (through a U.S. government license agreement), the NREL team can determine the most favorable locations for wind farms based on the cost of transmission, locations of load centers and wind resources, and the layout of the electrical grid. GIS-based modeling enables analysis of terrain, which significantly impacts the quality of wind at a particular site.

The NREL team also examines economic development potential based on strong manufacturing centers and filters the data to exclude sites such as national parks and wilderness areas. "We use GIS for policy analysis and implementation analysis," says Marguerite Kelly, senior project manager at NREL. "We use it to help decision makers at all levels understand what their resource is."

For utility developers, NREL creates forecasting models. "A utility wants to know not only what the average wind speed is at a location," Kelly adds, "but also what's going to happen in 10 minutes, and then in an hour—that's how they buy and sell electricity."

The collaborative that produced the road map report includes the American Wind Energy Association, engineering consultants from Black and Veatch Corporation, DOE, Lawrence Berkeley National Laboratory, NREL, Sandia National Laboratories, and more than 50 energy organizations and corporations.

Maps include details such as voltage of transmission lines and classes of wind speed and wind power. Forecasts include projected wind capacity by state in 2030 and the expansion of transmission lines that would be required.

"The wind maps consistently amaze people," Kelly notes. "Often, the wind resource is much bigger than people expect, since a wind farm requires a strong steady breeze, not gusts." The primary audience for these maps is government decision makers who are thinking about how renewable energy can be used in their counties and states. The secondary audience is developers looking for renewable energy installations.

As of September 2008, 35 states were generating wind power. Texas, California, Iowa, Minnesota, and Washington (respectively) made the Top 5 list of total wind power capacities. According to the American Wind Energy Association, as of December 3, 2008, U.S. wind capacity was just over 21 gigawatts (GW) (awea.org/projects). The United States must reach 305 GW by 2030 to meet the 20 percent goal.

More Information

For more information, contact Marguerite Kelly, senior project manager, NREL (e-mail: marguerite_kelly@nrel.gov).

Mark Your Calendars for These Upcoming Events

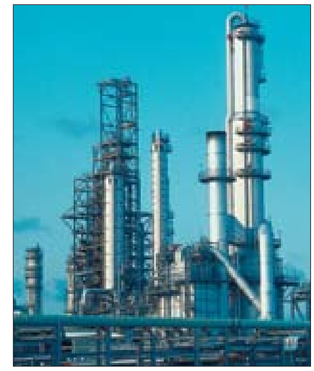
2010 Petroleum User Group (PUG) Conference
February 22–24, 2010
Houston, TX USA
www.esri.com/pug

2010 AAPG Annual Convention & Exhibition
April 11–14, 2010
New Orleans, LA USA
www.aapg.org/neworleans

72nd EAGE Conference and Exhibition (incorporating SPE EUROPEC 2010)
June 14–17, 2010
Barcelona, Spain
www.eage.org

ESRI International User Conference
July 12–16, 2010
San Diego, CA USA
www.esri.com/uc

Career Opportunities at ESRI in the Petroleum/Pipeline Industry



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Proceedings from the 5th Annual European Petroleum User Group in Stavanger, Norway, are now available at www.esri.com/epug2009.

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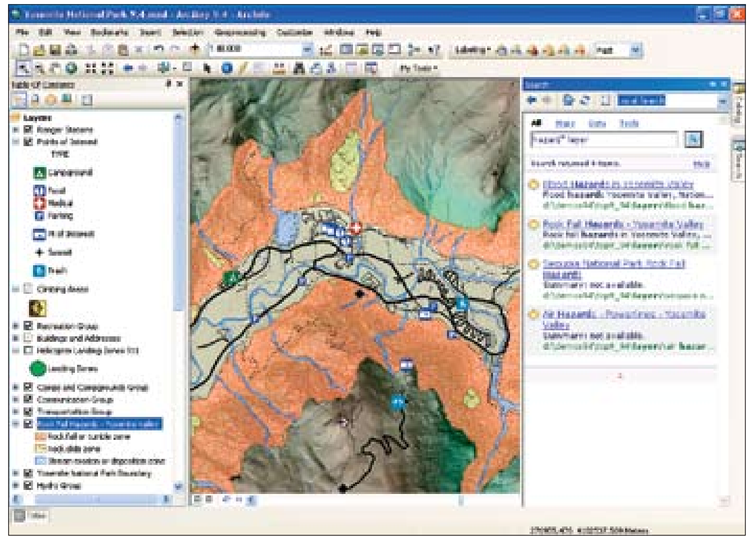
ArcGIS 10 Top Nine Innovations

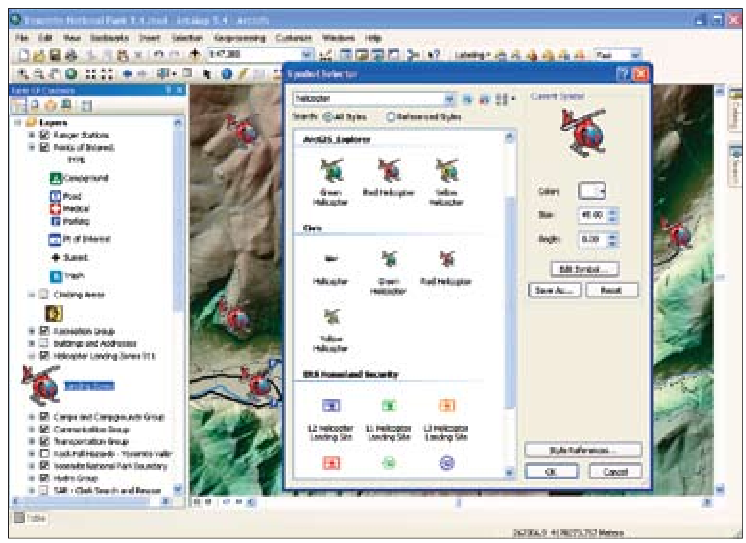
Each year, the ESRI International User Conference features John Calkins, ESRI's technical evangelist, who gives a brief overview of his favorite innovations. Here are Calkins' top nine favorite innovations in ArcGIS 10, excerpted from his presentation at the July 2009 conference in San Diego, California.

9. *User Interface:* ArcGIS 10 features a new user experience. The upgraded look includes dockable windows that can automatically hide. Also, ArcMap has a new embedded catalog window. These and other underlying framework changes will greatly improve your productivity.
8. *Attribute Tables:* At 10, attribute tables are displayed in a dockable window. You'll see a new toolbar across the top that gives you easier access to the tools you need. Also, you will be able to open multiple tables using the tabbed interface at the bottom.
7. *Search:* A new search capability complements the Add Data dialog box. The new search tool enables you to type in search criteria and, with subsecond response time, locate the data you specify. You will be able to use special keywords like *points, lines, polygons,* or *layer* to further refine your search.
6. *Reporting:* ArcGIS 10 includes a new reporting capability. A series of predefined templates makes it easier to make appealing, formatted reports. Once you've created a report, you will be able to save the report and later reexecute it with a different selected set.
5. *Geoprocessing Tools:* The customization capability in ArcGIS 10 is enhanced to give you access to all analysis tools. You'll be able to drag and drop the Buffer tool or a geoprocessing model onto a toolbar. There's also a new geoprocessing option that will enable background processing.
4. *Table of Contents Views:* The table of contents supports multiple views. In addition to listing the layers by drawing order you can now list by source, list by visibility, and list by selection.
3. *Symbol Search:* You no longer have to browse through 20,000 different symbols to change symbols. You will simply do a search, which is far more efficient than browsing through the multitude of symbols included with ArcGIS.
2. *Temporal Mapping:* ArcGIS 10 is becoming time aware, making it easier to make temporal maps with ArcGIS. There's a new Time tab on the Layer Properties dialog box as well as a new clock tool that will allow you to set the display's date and time.
1. *Fast Basemaps:* In versions prior to 10, when ArcMap updates the display, it redraws each layer sequentially. A new basemap layer in 10 enables continuous, fast redraw.

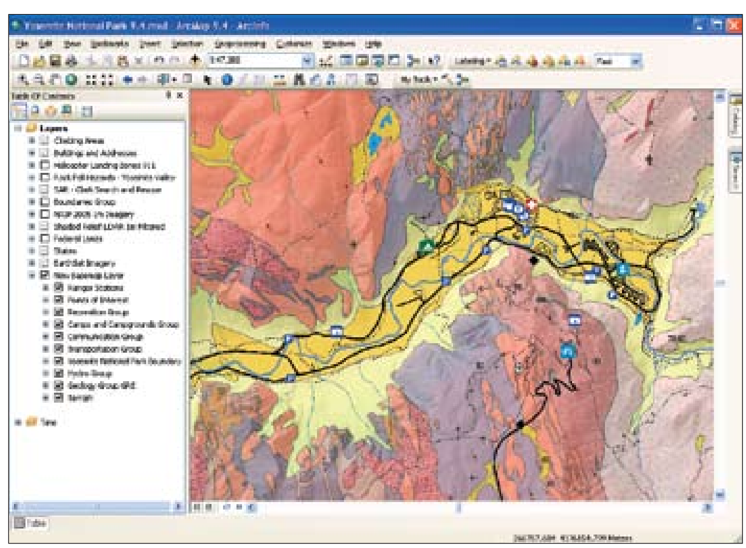
ArcGIS 10 is expected to be available in the second quarter of 2010.



Locate the data needed using the new search tool.



Use the symbol selector in ArcGIS 10 to find the symbol you need.



Redraw basemap layers quickly in ArcGIS 10.

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