Esri News
for Petroleum

Spring 2012

Portal Delivers Maps and Lightweight Apps

By Barbara Shields, Esri Writer

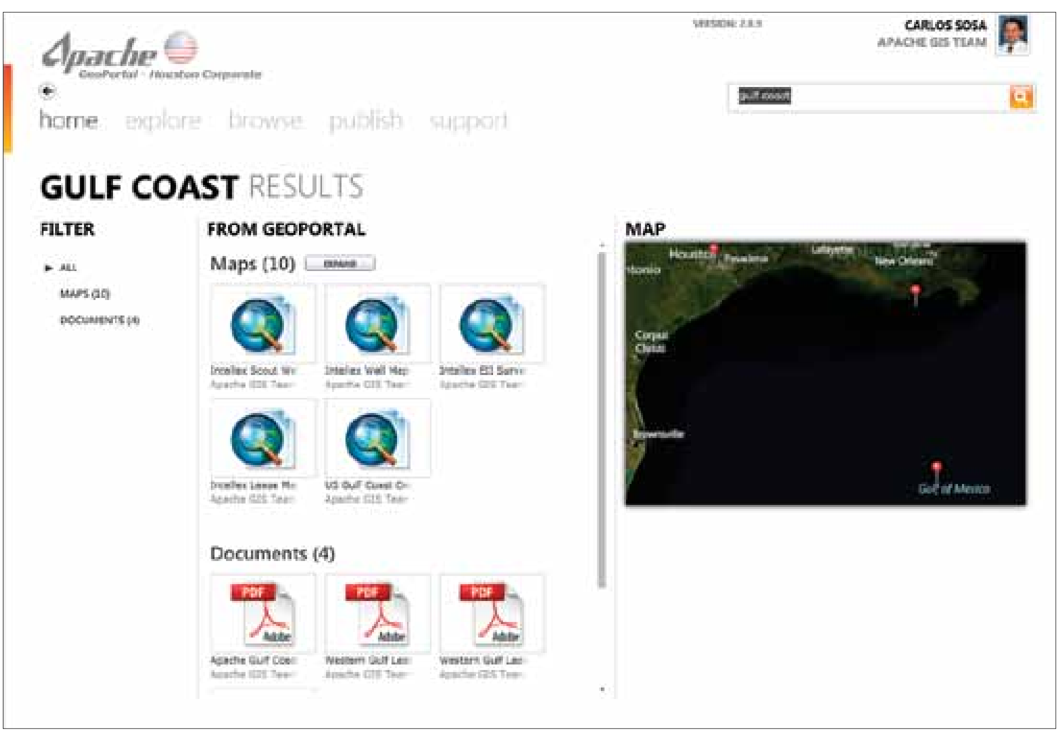
Apache Corporation uses ArcGIS as a core technology for its oil and gas exploration and production (E&P) and business operations. In 2011, the team launched Apache GeoPortal, a framework that allows staff to access and share GIS resources on a variety of computing platforms and mobile devices.

The portal's architecture is Apache's technical approach to disseminating GIS resources to all its regions worldwide. This architecture uses Esri's ArcGIS; Silverlight-based web maps; and an internally developed Silverlight-based website that serves Apache users looking for maps, spatial data, satellite imagery, and other GIS resources. Apache GeoPortal is an intranet solution that is only accessible by employees and contractors.

Apache GeoPortal is a distributed architecture. It has been implemented in Apache's Houston, Texas, office and is accessed by offices around the world. The company is now setting up portal frameworks in its Argentina and Australia offices. As individual regional offices come on board, they will have the same architecture along with their locally generated data and services from spatial data engines and ArcGIS. These self-contained systems link back to the central data server in Houston. Currently, the tie is through spatial data management scripts that keep the databases in sync. In the near future, many of the spatial layers will be synchronized through replication.

The GIS team is using ArcGIS API for Silverlight to build workflow apps for the company. This platform is a powerful tool for creating and delivering rich Internet and intranet map applications, all hosted via a browser. No installation is required, since Silverlight includes a lightweight version of the .NET Framework CLR (CoreCLR) and the runtime. "This combination provides more opportunity for our users to easily share and access content," explained Carlos Sosa, Apache GIS architect. "Lightweight APIs form a large part of the services we deploy on GeoPortal. Our people really like them because they are fast and easy to use."

Apache has taken this one step farther by bundling the workflow with spatial layers in the Silverlight map viewer in a new concept that the company's developers call Map Apps. It allows users to quickly execute a business process that requires a map. Workflows are tailored to the map layer and can include custom thematics, search, and dynamic links to external data. Among the company's many apps is one that generates a bubble map of wells indicating petroleum or gas production. One can easily see wells that are producing and those that are not. Another Map App, which is updated daily, →



↑ Apache GeoPortal brings maps and data together.

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

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→ shows permits to drill held by Apache and its competitors, the target formation, and whether the well is horizontal or vertical. A Map App designed for Apache's land lease group extracts data from a tabular database and converts it into a map of Apache's leased areas. Lease analysts can use a search tool to find a specific lease, compare its information with other geographic data, and verify its accuracy.

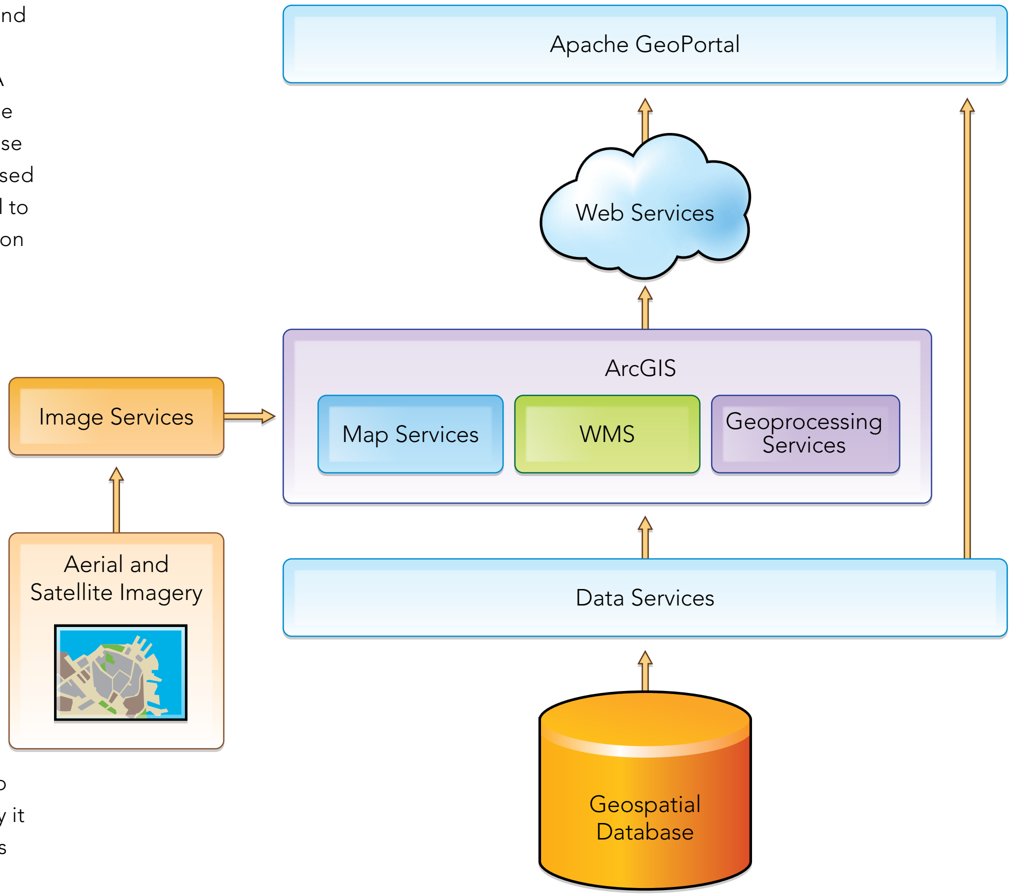
Users find the Map Apps they need by using the robust search capability that is built into the portal. They can search for map applications using a keyword or geographic search or simply browsing through the various categories such as featured maps, types, and departments. They must have connectivity to the internal-facing website but do not need software installed on the device. The experience of accessing Apache Map Apps is similar to that of popular app stores. Users open a browser from a desktop or mobile device, log in to the system, go to the Map App store, find the app needed, and apply it to the mapping concept. In addition, users can rate content and add comments.

"We could not have done this project five years ago—maybe not even two years ago," explained Bruce Sanderson, Apache GIS team manager. "We tried ArcIMS five years ago and found it just didn't have the horsepower or scalability for what we wanted to do. Our next attempt was ArcGIS for Server using Web ADFs [Application Developer Frameworks], and still it was too slow and clunky. Esri technology began incorporating popular web concepts into its services and pumped up its product performance in ArcGIS 10. Because Apache is committed to being on the edge of technology, we kept our system up-to-date with these technology changes, and now our enterprise GIS works the way we initially envisioned it. The system is scalable and can be used in the field on thin clients such as mobile workstations and ultrathin smartphones. When the lightweight ArcGIS APIs came out, we first went with Flex and then quickly changed to Silverlight."

Users also go to the portal to find content including ArcGIS map projects and spatial layers, satellite imagery, geotagged photos and documents, and resources such as information about training and upcoming events. Users can publish content either individually or as part of a team and can restrict access as needed.

Through the content socialization tools, users rate the published items and help promote the quality of the content being disseminated. Similar to social media sites, users can establish communities around this content, thus encouraging its use. Apache GeoPortal and data are secured because the entire system is behind the company's firewall, and the server platform is accessible only through granted privileges and credentials. Nothing is accessible outside the firewall.

"It is an interesting and exciting time for us, because we are reaping the benefit of all this investment that Esri has made in this technology," said Sanderson.



Apache's Enterprise GIS Architecture

> "When the lightweight ArcGIS APIs came out, we first went with Flex and then quickly changed to Silverlight."
>
> Bruce Sanderson,
> Apache GIS Team Manager

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ArcGIS for SharePoint provides a robust set of configurable mapping components that allow you to visualize and analyze your business data on a map in Microsoft SharePoint. No programming is required to quickly design and deliver a compelling visual representation of your information assets.

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June 4–7, 2012
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www.eage.org

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Petroleum User Group Meeting
July 24, 2012
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November 7–9, 2012
London, United Kingdom
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November 13–15, 2012
New Orleans, Louisiana, USA
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Evaluating Disturbance of E&P Access Roads

By Chris W. Baynard, University of North Florida; James M. Ellis, Ellis GeoSpatial; and Hattie Davis, Artistic Earth

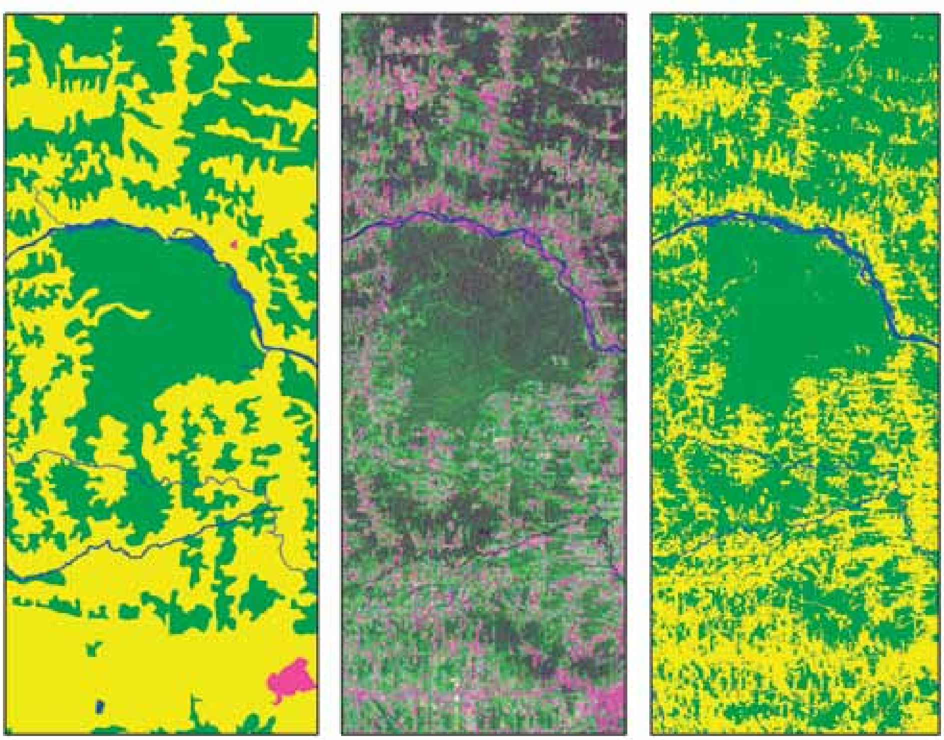
GIS impact study shows how E&P development and peripheral activities alter landscapes inside oil concessions.

E&P development in remote regions is often considered a catalyst for landscape change through the direct alterations created by infrastructure features, as well as the accessibility provided by roads. The construction, expansion, and improvement of transportation routes in isolated areas can attract newcomers and resource users who engage in illegal logging, poaching, commercial agriculture, and colonization. These actions can lead to larger-scale surface disturbances that may also affect indigenous territories and natural preserves. However, do these peripheral activities and outcomes always accompany E&P development, or can controlled access minimize landscape change? Secondly, when peripheral activities do occur alongside E&P development, how do they contribute to landscape alterations inside oil concessions?

To answer these questions, remote-sensing and GIS techniques were used to calculate landscape infrastructure footprint (LIF) metrics, which link visible infrastructure features to surface disturbance. This "accounting-from-above" approach helped determine the spatial relationship between infrastructure pattern and land use/land cover (LULC), soils, protected areas, and colonization zones for the year 2000. The study area included four neighboring oil blocks in eastern Ecuador's tropical forest, displaying three types of E&P development: public access, controlled access, and roadless.

Processed and enhanced Landsat imagery was used to create subset images of the concession blocks with different band combinations and to produce an LULC map, which was compared to a map by the Ecuadorian remote-sensing agency CLIRSEN. Roads were selected to represent infrastructure features and were updated using ArcGIS and expert knowledge. Google Earth (high-resolution) imagery was used to clarify questionable roads. GIS tools (such as clip, merge, buffer, dissolve, union, and intersect) proved invaluable in calculating various metrics associated with landscape disturbance including length of roads, types of access (public access, controlled, and none), road density, direct effects, and edge effects (core areas and number of rivers crossed). (See figure 1.)

↓ Figure 1. This is a comparison of land-use/land-cover methodologies in Block O. The Ecuadorian remote-sensing agency CLIRSEN is on the left; the authors' LULC is on the right; and a Landsat ETM+2000 image with a 7,4,3 band combination (as RGB) is in the center.



Access Type and Oil Block

- Public access: Block O had the longest network of E&P roads (all designated as public access by the government), fertile soils, and some developed areas (located inside a government-designated colonization zone). Development unrelated to E&P activities occurred over several decades, and the road network became 3.5 times more dense.
- Controlled access: Blocks 14 and 16 were developed in the 1990s with one central E&P road, where access was controlled at the entrance to Block 14. Indigenous groups and energy company workers were the only people allowed to enter the area. Since other roads were few in Block 14 and not present in Block 16, the E&P network was the dominant one. The amount of agricultural conversion in these two blocks was quite small, less than 2 percent.
- Roadless: Block 10 was developed with the use of helicopters. No roads were detected with Landsat imagery. This block retained

98 percent of its forests. Interestingly, agricultural land was found in all concessions, but some of this was linked to areas adjacent to rivers whose banks have historically provided fertile soils for farming.

Disturbance Metrics

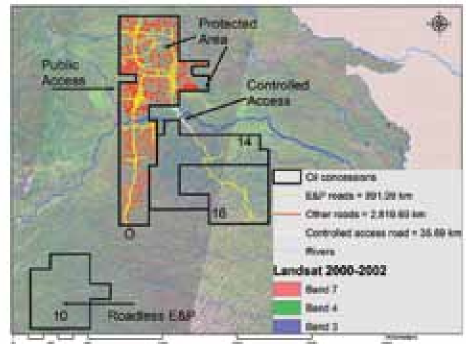
- Road density: A factor in landscape fragmentation, which was rated on a scale, ranges from 0.1 in remote regions to 40.0 in urban locations. In Block O, the E&P road density rating was 0.17, and the density rating of other roads was 0.63, totaling 0.80, which is the upper density limit on the ability for some areas to support large mammals. In Block 14, the E&P road density was 0.02, and for other roads 0.01, totaling 0.03. Block 16's E&P road density rating was 0.04. Block 10, with no roads detected, had no road density measures. (See figure 2.)
- Direct effects: The amount of land directly disturbed by the presence of road and related infrastructure features. All roads were assigned a width of 15 meters for direct disturbance. E&P roads that included additional alterations associated with rights-of-way and pipelines, well pads, and central production facilities were assigned a width of 50 meters for disturbance, three times the area assigned to other roads.
- Edge effects: Transition zones of open land to forest where potential ecological disturbance may extend outward from infrastructure features. E&P roads were assigned a 100-meter edge effect width, and other roads were assigned a 65-meter edge width. Once determined, these edge effects were masked. Doing so revealed the remaining patches of land. These core areas were measured. (See figure 3.)
- Rivers crossed: Roads that cross over rivers indicate potential disturbance to aquatic ecosystems. Block O, with its dense road network, was most affected; however, the E&P road network river-crossing points in this block were less extensive than those of other roads. In Block 14 and Block 16, river crossings were linked to one E&P road, and Block 10 had no detectable river crossings.

Conclusion

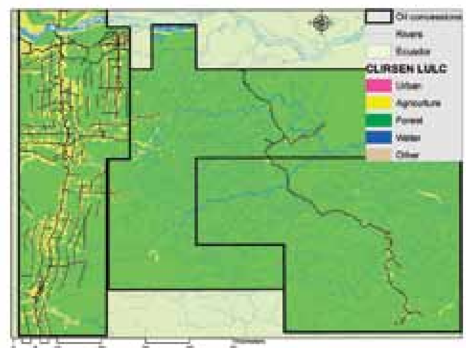
Block O, the oldest concession, showed the greatest land surface disturbances. These were primarily linked to the additional and denser infrastructure network resulting from activities peripheral to E&P such as agricultural conversion and colonization. The remaining blocks, with controlled access and roadless E&P development, did not exhibit these surface disturbances. These findings highlight the importance of controlling road access if land conservation is a priority. (See figure 4.)

The accounting-from-above approach used in this study advances E&P environmental performance standards through the adoption of geospatial technologies with metrics and standardization. It also underscores that understanding, planning, modeling, monitoring, and mapping the E&P physical footprint, as well as peripheral economic activities, are very important tasks for E&P companies to pursue in remote regions and developed landscapes.

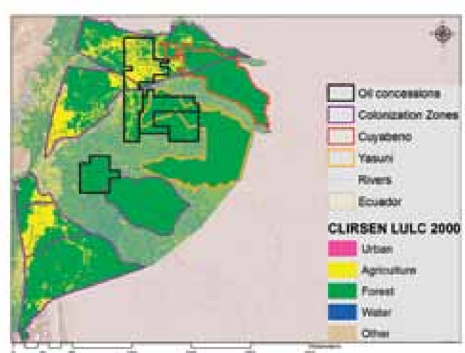
For more information, contact Chris W. Baynard at cbaynard@unf.edu or baynardspatial@gmail.com, James M. Ellis at jellis@ellis-geospatial.com, or Hattie Davis at artisticearth@comcast.net.



↑ Figure 2. This map shows the pattern of E&P and other roads in the four study area concessions. All roads in Block O were designated public access, a single E&P controlled-access road ran through Blocks 14 and 16, and some development occurred in Block 10 without using roads. Also, protected areas in Block O remained largely without roads.



↑ Figure 3. This map shows the core areas, or patches, that remained after all infrastructure features were discounted from the concessions. Parts of Blocks O, 14, and 16 are shown here. The dark lines represent edge effects for both E&P and other roads, measured at 100-meter width and 65-meter width, respectively.



↑ Figure 4. The CLIRSEN LULC map shows that agricultural expansion occurred primarily in the designated colonization zones (purple polygons) in Blocks O, 14, and 16. More than 95 percent of land cover remained forested within controlled access areas. Block 10 also maintained the majority of its natural state in areas of controlled access or not accessible by roads.

Lightning Strike Analysis Shocks Oil Field Engineers

↑ A lightning strike grid shows at-risk electric lines in oil fields.

At the La Circa Infantas petrol field in El Centro, Santander, Colombia, lightning is a major problem. Colombia ranks second to the Democratic Republic of the Congo in annual lightning strikes, according to NASA's Global Hydrology and Climate Center. In the past two years, La Circa Infantas alone attracted 30,000 lightning strikes.

"Lightning affects our electrical distribution network, which feeds the engines that operate the wells, causing the terrible effects of production loss, equipment damage, and uncertainty in the network design," said Luis Alejandro Zorrilla, an electrical engineer with Occidental Oil & Gas.

Occidental operates La Circa Infantas through a joint venture contract with Ecopetrol S.A. La Circa Infantas was the first petrol field in Colombia, with its first well, Infantas 2, completed in April 1918.

"This historic field has all the great challenges of a field built by many companies," Zorrilla added.

The oil field's electric distribution network is made up of 3,000 poles, about 300 miles of electric line, and 1,000 engines. After more than 90 years in operation and many changes in management, the electric network was suffering huge inefficiencies. Data was duplicated, incomplete, old, or inaccurate.

Complicating matters was the fact that the electric infrastructure undergoes daily changes, with new lines and poles and new electric and communication equipment due to new wells. The whole process demands planning, design, connection, and reporting—a set of tasks highly dependent on accurate data.

By contrast, the information about the wells—their geographic location, maintenance history, construction date, and more—was concentrated in a GIS.

"The well GIS helps our team develop all our engineering activities. We saw a need to build a GIS for the electric network as well," Zorrilla said. "Our first step in developing an electric network GIS was to spatially enable the information related to the load on our electric network."

Next, the team created a data model that reflected the entire workflow, from work force to energy management. The data required in the workflow was described in the data model.

Once the data model was constructed, the distribution network inspection project began. The goal was to update and unify all geodata available. With a geodataset in hand, workers modeled the electrical GIS geodatabase and developed the system in ArcGIS.

"The well GIS helps our team develop all our engineering activities. We saw a need to build a GIS for the electric network as well."

Luis Alejandro Zorrilla,
Electrical Engineer with Occidental Oil & Gas

Improving the Design

Electric network pole designs were fashioned based on average annual lightning density and current amplitude data. The designs were researched and studied. Nevertheless, every lightning storm managed to identify faults in the design. Zorrilla reported approximately 600 faults in the distribution network circuits that feed the field in one year.

"The questions were obvious," Zorrilla said. "Why are the designs failing? How can we improve the designs?"

When the engineers took a closer look at the annual fault data, a clue emerged. About 90 percent of the failures were caused by lightning discharges and flashovers. The shielding angle did not protect the lines.

They would need a more specific and accurate measurement of the lightning density and current amplitude.

Colombia's national lightning data system has 50 sensors to determine the location and electric characteristics of lightning. La Circa Infantas' energy management department requested this data. The electrical studies department developed a grid within the GIS to record the lightning's extent, count, and average amplitude per square mile.

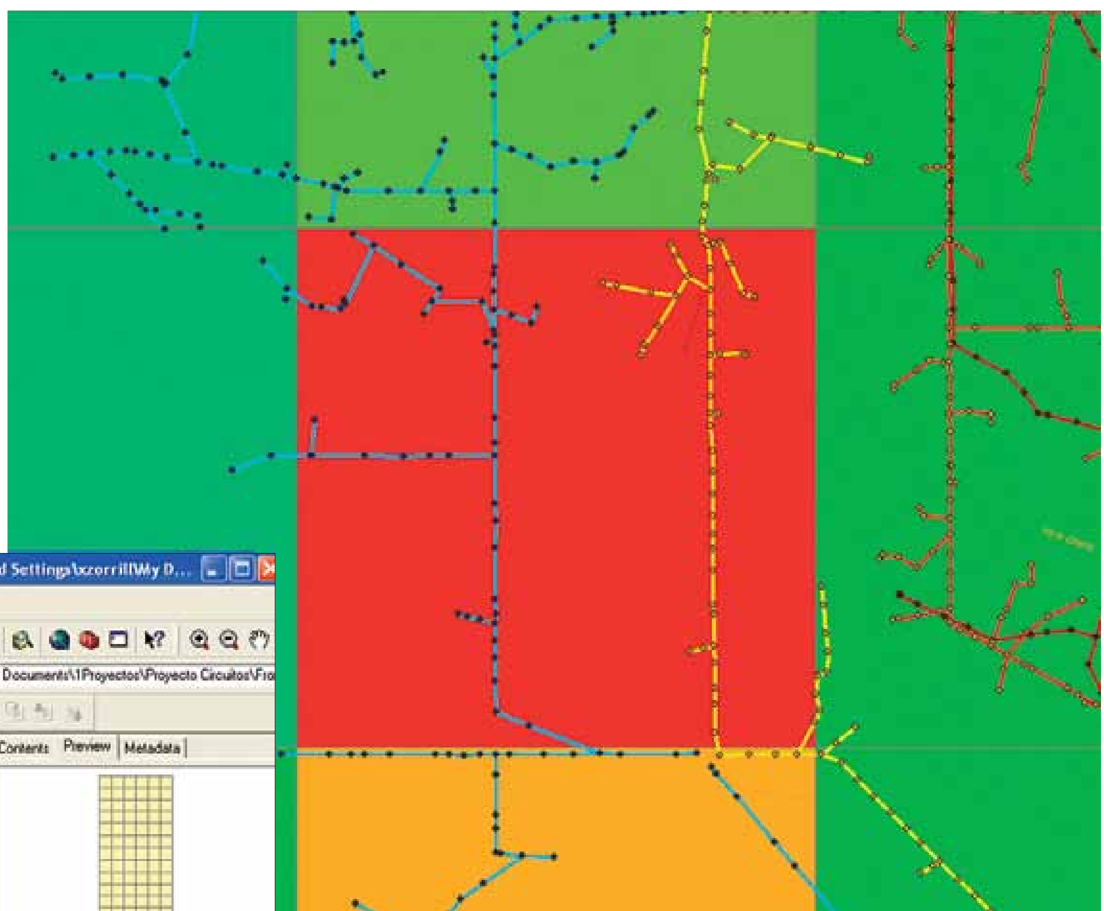
"When we overlapped the electrical GIS with the lightning density and current amplitude grid, we saw an amazing relationship between the failures and the critical areas," Zorrilla explained. "The lightning data visualized as a grid, with the correlation of the two variables—density and current amplitude per square mile—helps us understand locally why the pole designs failed."

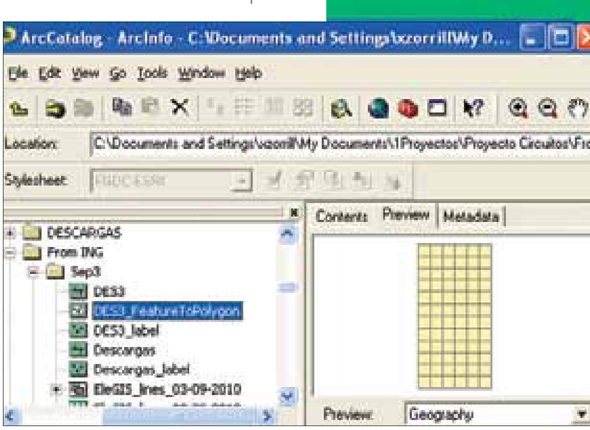
With the help of the grid and the electrical GIS that was built on ArcGIS, engineers can approach every pole design according to the pole's location and its consistency with the geodataset. The grid is colored on a blue-to-red scale, with red signifying critical. An additional benefit is that engineers can prioritize the correction of the designs and plan maintenance based on the critical areas.

"A deep understanding of the lightning situation is now available," Zorrilla said. "Better decisions are being made. Design can now be standardized, depending on pole location and similar features, in lieu of a unique design for each pole."

Now that the electrical GIS is established and integrated with other corporate systems, La Circa Infantas is enjoying the benefits. New geoapplications, such as the grid, are under way. And there is a boost in overall performance of the energy management department's daily work.

For more information, contact Luis Alejandro Zorrilla, electrical engineer, Occidental Oil & Gas, at Alejandro_zorrilla@oxy.com.





→ Users can zoom in for details about georeferenced distribution lines and poles.

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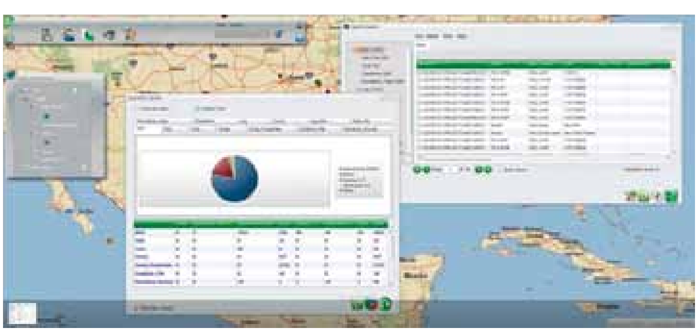

↑ Access and manage information in one place.

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