Utilities Spark Remote Sensing Demand

by Harold J. Hough

Harold Hough has a degree in economics from Anderson University. He writes on technical issues, including satellites and remote sensing. His book, Satellite Surveillance, was named an "Outstanding Book of 1993" by the American Library Association's Choice magazine. Prior to becoming a full time writer, Hough was a U.S. Naval officer, and worked for several defense companies.

It was a battle royal between the electric power company, local conservationists, and the utility commission, with the consumers the ultimate loser. A five-year study backed by the utility concluded construction must begin on a 115kv transmission line. The utility commission, under prodding of conservationists, however, denied the request and asked for a new study showing how the 115kv line could be saved through active conservation measures. Unfortunately, the company didn't have that much time to waste. The study showed that if construction didn't begin within a year, residents would face brownouts.

The utility had two problems: developing a study quickly and making their arguments persuasive to the commission. The solution was a Geographic Information System (GIS) built around high-resolution SPOT satellite imagery. Unlike the previous study which took five years to complete, this one took only two months to develop, and although it showed some savings from conservation, the evidence was so conclusive that four months later the commission approved construction of a transmission line.

Utilities aren't only facing the uncertainties of cost and long-term planning, they are also finding every business decision reviewed by often unfriendly utility commissions. Anxious to please conservationists and environmentalists, commissions are questioning new construction, disagreeing with projections, and encouraging conservation. Unfortunately, these new demands take time to study and utilities are often forced to delay projects, cope with customer dissatisfaction, or find a new way to gather information quickly.

There is a tool that hundreds of utilities are using that's fast, inexpensive and capable of convincing critics. Satellite imagery combined with GIS is giving the electric power industry the tool to project future electrical demand, choose power corridors, develop land and monitor the environment. In the communications industry, satellites and GIS are helping a new utility, cellular communications, establish itself. And, unlike traditional methods such as aerial photography, it's considerably cheaper. According to Lee Willis of ABB, "Satellite imagery gives us an order of magnitude less costly than other methods."

Predicting the Future

One of the most exciting applications, according to Willis, is predicting electrical power demand in a region using satellite imagery. He estimates that 70 percent of electrical power costs come from transmission and distribution, and having the equipment in the right place is just as important as having the equipment. In addition to giving the utility the information it needs, satellite-based

This 500-mile high satellite view of San Francisco was used to generate a land use map for cellular system planning. ©1993 CNES, provided by SPOT Image Corporation.

GIS also provides the concrete evidence that the companies need to persuade the public and utility commissions. "Most utilities are as nervous as a long-tailed cat in a room of rocking chairs when it comes to proving their business plans to commissions, courts and the public," Willis notes with a touch of Carolina charm.

One example of a utility using satellite imagery to project future demand is Central Power and Light in southern Texas. According to Chris Greenwell, manager of marketing, most of their power generating equipment is in the northern part of their region while the greatest growth is near the border of Mexico. They are using satellite imagery to predict future growth, identify end uses (air conditioners, motors, appliances, etc.), and determine if additional equipment is needed in the southern part of their area. The study will also allow them to identify effective conservation measures.

Predicting future demand depends on identifying land use through computer models. "We know a petrochemical plant has certain end uses," notes Greenwell. Other factors considered are rail lines which engender industrial growth, major road intersections which are ideal for shopping malls, and super dense highway intersections which lead to high-rise buildings. This type of analysis is "consistently the most accurate planning tool," says Willis.

Much of the analysis is based on the pioneering work of Americo Lazzari of Arizona Public Service Co. in the late 1950s. At that time, forecasting was based on costly, time-consuming aerial photographs and massive computers. However, the satellite and computer revolutions have made these predictions faster and more accurate. First, satellite imagery is digital and therefore can be entered into a computer to act as a base for a GIS. Second, satellites can acquire an image of a whole utility territory in one overhead pass instead of taking months as with traditional aerial photography. Finally, the satellite revisits the site every couple of weeks, allowing frequent updates. Since each satellite scene covers as much territory as thousands of aerial photographs, the high-resolution SPOT imagery is ideal for these type of studies and persuading difficult utility commissions. "We had to wait until SPOT came along with its higher resolution before we could use satellite imagery for utility studies," notes Willis.

Satellite imagery is also ideal for creating GISs of undeveloped areas. According to Willis, most utilities use their customer base to develop information systems. If the database doesn't cover an area because of sparse demand, any projections based on that information could be wrong. With satellite information, a utility has an information source for any area, no matter how uninhabited, that gives accurate information on roads, buildings and population. Consequently, the utility's information base will be better equipped to forecast demand in outlying areas.

In addition to satellite information and their own databases, some utilities use other sources for expanding their information systems. For instance, Baltimore Gas and Electric merged state employment records

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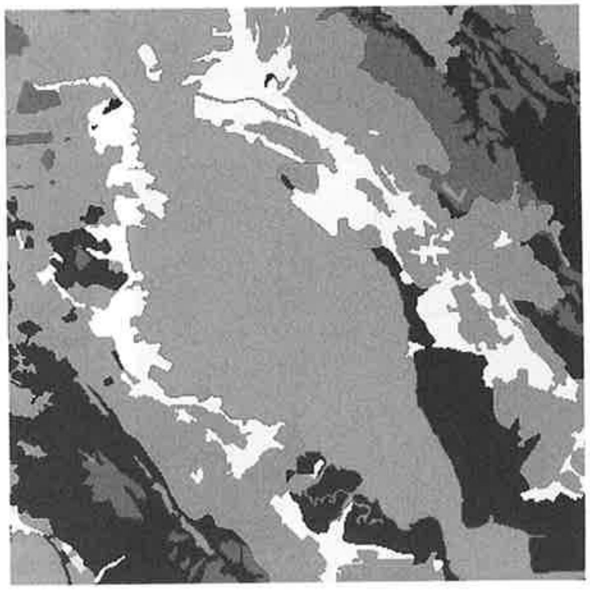
with their GIS to give a better idea of area population and income. This is part of an ongoing effort to predict demand in the crowded Baltimore Washington utility corridor.

Crowded areas like Baltimore also give utility builders more trouble as they try to identify power transmission corridors which avoid urban areas but remain inexpensive. According to Gayle Houston of EDAW Atlanta, Georgia, several power companies use satellite imagery to route power lines. By using stereoscopic views, engineers develop three-dimensional models which allow them to consider elevation in addition to vegetation and population centers. According to Axel Hoffmann of Hammon, Jensen, Wallen & Associates Inc., this method takes one tenth the time of aerial photography.

Duke Power faced this problem as they developed plans to build a 500kv transmission line to their southern region in order to prevent anticipated power shortages in 1996. Since elevation changes, detours and populated areas can drastically increase construction costs, they asked EDAW to propose power line routes taking public concerns and cost into account. Since aerial photography and interpretation was too expensive and time-consuming, they relied on up-to-date SPOT imagery to identify the hydrology, land cover and population centers. One result of this effort was an award for EDAW from the American Society of Landscape Architects for the methodology.

This isn't the only time Duke Power used satellite imagery. They had 7,000 acres of land surrounding Bellows Lake in North Carolina that required a land management plan. In order to develop the plan, they created a GIS using satellite imagery, elevations, land usage and parcel identification. Thanks to this information, the utility executives will be able to decide if the land should be used for industrial, residential, recreational or forestry applications.



Land use map of San Francisco Bay area with classes relevant to cellular system design. This was generated entirely from SPOT satellite imagery using standard image processing techniques. ©1993 CNES, provided by SPOT Image Corporation.

Land management is an important consideration for utilities with reservoirs. According to Houston, federal law states that utilities must establish and maintain recreational facilities like campgrounds, horse trails and picnic grounds around reservoirs. With satellite imagery, analysts can identify the shoreline, obtain digital elevation, identify vegetation, and locate thoroughfares. "USGS maps are too out of date to rely on," says Houston.

Partner in a New Utility

Obsolete maps are also hindering another utility: cellular phone systems. Many parts of the world like the former eastern bloc nations are building cellular phone systems, and are finding that their maps are obsolete or deliberately misleading. Often maps were printed with errors in order to hinder an enemy invasion. However, all they are hindering today is the modernization of their antiquated communications systems. Since cellular phone transmissions travel in a straight line and don't bend around large objects, inaccurate elevations or urban growth can interfere with reception. A company which relies on maps will spend millions of unnecessary dollars covering these blind spots. The same holds true for conventional communications systems which build microwave towers on high ground. A false elevation designed to ruin an enemy air attack may ruin a project and a company's reputation.

Nor are things any better in the rest of the world. Emerging nations' maps are often relics of their colonial periods and frequently a half of a century old. Even the USGS maps are often 20 or 30 years old. Not only have urban areas grown since these maps were made, many of the topographical features are simply wrong.

John Meyer, director of engineering for Mobile Systems International, notes that as cellular phones become more popular and the number of calls grow, the need for more accurate elevation information grows. "Six months ago I didn't even know what SPOT was," Meyer says. "Now we need that fine data for finer engineering."

Communications companies can avoid map errors and gather up to date information by using stereoscopic satellite imagery to develop Digital Elevation Models (DEMs). With it, the communications company can produce a GIS that shows road networks, population centers and areas which may hamper transmissions, including recently built skyscrapers. Then, using the GIS as a database, a computer can calculate the wave propagation and develop the ideal location for the transmission facilities. This was the method used by engineers to plan the cellular phone system for Bombay, India. Using SPOT imagery, Fairchild Defense produced the DEM used to determine how phone transmissions would be hindered by higher elevations. The result will be a more efficient system for less money.

Force for Conservation

Satellite imagery-based GISs are more than just tools to increase profits and accommodate conservationists. They can merge utility needs and environmental concerns by moving building and industrialization away from congested or sensitive areas. In Kansas, Midwest Energy is using satellite imagery to identify underutilized regions in its territory. This data is used to attract industries that require more electrical power while bringing more economic growth to the area. According to Mike Engel, manager of systems planning and engineering, "Small area load forecasting is a lot more accurate with satellite imagery."

One of the biggest applications is in Demand Side Management (DSM). These are utility-sponsored programs that lower consumer demand in order to decrease generating plant and transmission line construction. These studies look at the type of land usage–industrial, business or residential–and the end use of the power. The result of the study is that the utility may help its customers buy more efficient equipment.

DSM is part of Central Power and Light's program in southern Texas. According to Greenwell, the goal of the study is to determine if it is cheaper to build more equipment or conserve energy. "The final cost will be important in determining future plans," he notes.

Even if construction is inevitable, satellite imagery can mitigate the visual pollution. By using three-dimensional models, a utility can see if ugly construction will be visible to neighbors and what modifications will keep it hidden.

Satellite imagery information systems will also be critical in keeping pollution under control in the future.

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translate the realtime navigational position-fix values into the precise record latitude and longitude values. Using a method known as "differential positioning," vector measurements between GPS observation points are applied to an anchored "point of beginning," rendering precise position fixes for all observation points of a GPS survey.

A land surveyor can transform three-dimensional vector measurements into two-dimensional distance measurements based on a common statewide reference system, known as a state plane coordinate system. By definition, this "plane" is a perfectly flat, horizontal surface that does not take into account the curvature of the earth. A state plane coordinate system may be thought of as a large sheet of graph paper superimposed over a state at some constant elevation. This standardized reference system allows land surveyors to share mapping information.

Land surveyors are able to apply specific multipliers for project latitude (scale factor) and elevation (elevation factor) in order to adjust any state plane coordinate map to fit specific local conditions. On a map or report, these two factors are often shown together as a local project combination factor. Land surveyors can use this combination factor to transform state plane grid coordinates into local ground coordinates, and vice-versa, in order to integrate smaller plane surveying projects with larger geodetic surveying projects involving measurement techniques such as GPS.

One utility is studying the growth of electrical demand as electric vehicles become available. This GIS combines imagery with demographics and will predict which areas will use electric cars first.

The program looks at the income of the residents and driving habits. Since electric vehicles will be major electricity users, the utilities must develop plans to provide the additional power when electric cars become available to the public.

Although satellite imagery has been used by utilities for 15 years, most companies aren't aware of the high-resolution imagery available and still don't appreciate all of its applications. According to Willis, developing a GIS based on satellite imagery only costs about $250,000, which is paid back in about a year. Not only does it allow utility executives to develop plans quicker and for a tenth of the cost of traditional methods, the visual information convinces critics and commissions. As the industry moves into an era of increased regulation and oversight, persuasive tools will become more valuable. In this case, an image will be worth a thousand arguments.

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