

Environmental OBSERVER

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GIS for Environmental Management Solutions

GIS Aids Dry Cleaner Water Resources Risk Analysis

EPA Department of Toxic Substance Control Uses Geospatial Analysis to Target Site Remediation

By Barbara Shields, ESRI Writer

Need to get that stain out of your favorite business suit? Surely the local dry cleaner shop can remove it. For years, dry cleaners have used perchloroethylene (perc) to efficiently remove spots from garments. But what is good for your clothes is not good for your health, because perc is a carcinogen. The residue produced in dry cleaning processes is classified as hazardous waste that contaminates soil and gets into the drinking wa-

ter. In California, the Environmental Protection Agency's (EPA) Department of Toxic Substance Control (DTSC) has been using ESRI's geographic information system (GIS) technology to locate and prioritize community sites that have been contaminated by dry cleaning chemicals and need remediation.

In 2007, California legislators banned the use of Perc because it endangers the environment and

public health. Because perc is a volatile compound, it can migrate from the groundwater through the soil and into the air, where it may be trapped within homes and businesses. Perc vapors may also contribute to toxic

smog. Federal environmental protection and state health officials warn that either inhaling perc vapors or ingesting perc in drinking water causes esophageal, cervical, and bladder cancer and lymphoma and may affect the central nervous system. Now, many dry cleaners have adopted different practices, such as using silicone or carbon-based cleaning sub-

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stances. But the dry cleaning industry has left its legacy of perc in the soil, threatening water and air resources.

With a grant from the EPA, in 2005, DTSC staff developed a dry cleaner discovery process that uses data from the California Department of Public Health's drinking water well database and ArcGIS technology from ESRI to spatially analyze at-risk sites in California's Central Valley. Two years later, DTSC launched its initial discovery project, focused on a community of 123,000 people located in the San Joaquin Valley at the base of the Sierra Nevada Mountains.

In the initial phase of the project, DTSC sampled the soil and shallow groundwater and analyzed the results. "GIS is an incredible tool to use for analysis of sampling data," notes Rick Fears, DTSC project manager and engineering geologist. "We used the Department of Public Health's database to generate a map of perc-impacted public supply wells and their proximity to current and former dry cleaning operations. We then examined existing land-use and landownership data to determine potential areas of concern.



Inset: A water sampler uses GPS to attach coordinates for mapping attributes in GIS. Above: DTSC uses ESRI ArcGIS to produce the map of perc detections in public water supply wells. (Data is from the California Department of Public Health Water Quality Database.)

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ESRI on the Road

GEOHAB 2010

May 4–7, 2010
Wellington, New Zealand
<http://geohab2010.com>

2010 World Environmental & Water Resources Congress

May 16–20, 2010
Providence, Rhode Island, USA
<http://content.asce.org/conferences/ewri2010>

A&WMA's 103rd Annual Conference & Exhibition

June 22–25, 2010
Calgary, Alberta, Canada
www.awma.org/ACE2010/

24th Annual Meeting of the Society for Conservation Biology

July 3–7, 2010
Edmonton, Alberta, Canada
www.conbio.org/2010

ESRI International User Conference

July 12–16, 2010
San Diego, California, USA
www.esri.com/events

COP 16 United Nations Climate Change Conference

November 29–December 10, 2010
Mexico City, Mexico
www.cop16.mx

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DOI Previews Climate Change Solution

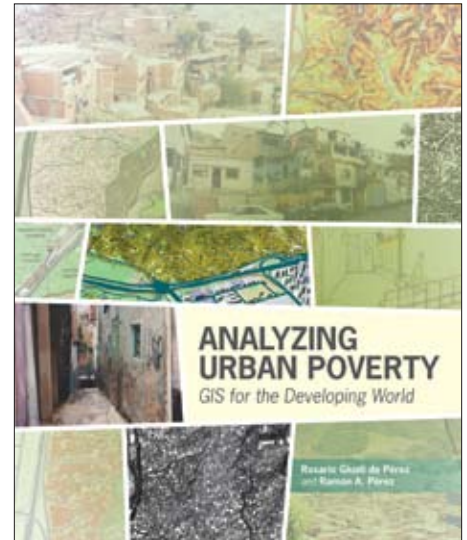
Secretary of the Interior Ken Salazar recently signed an order to establish a coordinated strategy within the United States Department of the Interior (DOI) to improve response to climate change. During the press conference announcing the order, DOI staff used ESRI GIS technology to demonstrate the current and future impacts of global climate change.

ESRI News

Analyzing Urban Poverty: GIS for the Developing World

By Rosario Giusti de Pérez and Ramón Pérez

In developing countries, squatter developments are without infrastructure, dense with dwellings without ownership, and built from materials at hand. Yet they house more than one-third of the urban population in developing countries and are valued by residents. The scope and depth of urban poverty in squatter developments requires immediate action. *Analyzing Urban Poverty: GIS for the Developing World* shows how GIS can be used in developing countries to improve quality of life in poor urban areas. With 30 years of experience using GIS technology to manage urban problems in Venezuelan barrios, Rosario Giusti de Pérez and Ramón Pérez describe how they developed sustainable solutions that go beyond conventional planning programs. Chapters cover site analyses of the natural and built environments, visualization of poverty maps, development of appropriate improvement proposals, management of projects, or-



ganization of communities, and methods for encouraging participation of barrio residents.

ESRI Press, 2008, 125 pages
ISBN: 978-1-58948-151-0

ESRI International User Conference Sets Sights on Environment

ESRI invites environmental managers, analysts, policy makers, educators, and practitioners to the ESRI International User Conference. At this conference, you will see how GIS is being applied to develop climate change policy and carbon accounting. Learn about the latest innovations to ArcGIS 10, which combines imagery and GIS for land-use and trend analysis, and how fast performance and on-the-fly processing can change the way your agency does its work. Hone your skills at the GIS technology tracks; meet with the largest gathering of GIS consultants in the world; and find the solution you need, from a desktop habitat analysis project to an enterprise-wide GIS implementation to cloud computing and shared data. Build your professional network



by attending Special Interest Group meetings such as regional GIS groups and the EPA group. Come join us and be inspired.

When: July 12–16, 2010

Where: San Diego Convention Center, San Diego, California, USA

Learn more and register: www.esri.com/events/user-conference

GIS Aids Dry Cleaner Water Resources Risk Analysis

With GIS, we were able to use this information to guide our sampling program, record the data, and analyze the results.”

To detect the impact of dry cleaning contamination, the team first samples wells and tests them for halogenated hydrocarbons—most predominantly, perc. Field-workers, such as licensed land surveyors, use GPS to attach latitude and longitude coordinates to the samples at the site. This location data makes it possible for the GIS team to create a well sample data layer of GIS shapefiles and generate a map that shows the proximity of dry cleaners to public supply wells.

This map is used to direct the next phase, wherein field-workers perform soil borings to collect passive soil gas samples in shallow soil. Once again, they use GPS to attach coordinates, capturing sample record data at submeter levels. Because the sample data layer includes laboratory results, health risk assessors can query the geodatabase, requesting to see all the wells containing a certain level of perc. They can also see specific sample data about the perc concentration of trichloroethylene (TCE) in soil gas. Moreover, they can run screening models on this data and determine potential health risks for people occupying buildings around those areas, prioritize remedial action, and determine areas where additional analysis is needed.

The strength of GIS is its ability to show geospatial relationships between different information sources. To create a comprehensive view of the project, toxic sample data can be correlated with other brownfield cleanup project data, such as underground storage tank or other environmental project information. The data is useful for identifying potential contamination sources and potential risks to public health. In addition to the Department of Public Health’s public water supply data, DTSC also accesses U.S. Geological Survey (USGS) maps and data from the California Air Resources Board, which is responsible for licensing dry cleaners. Another valuable data resource is DTSC’s Hazardous Waste Tracking System.

Generators of hazardous wastes that dispose of solvents off-site are required to complete a manifest for shipping to a disposal facility. This

information enables the government to attach a business name to a hazardous waste generator or contractor removing wastes from a contaminated site. This data makes it possible for analysts to identify a time frame for when the pollutant was generated or may have been released into the ground. All this data is used to coax a picture of an area’s potential threats to groundwater and public health. Combining this data with their own expertise, DTSC staff members assigned prioritization to site cleanup projects.

“We initiated this dry cleaner discovery in consultation with the Regional Water Quality Control Board for the Sacramento and San Joaquin valleys,” explains Steve Becker, DTSC supervisor. “Performing a statewide investigation of perc detections in public water supply wells, the team noted clusters of impacted public supply wells.”

The initial step of the dry cleaner discovery project was to develop a process to locate potential problems associated with dry cleaner operations, and the second was to apply the process in consultation with the local community and government. Through this process, 35 cleaners in one city were identified as potential perc sources. Of these, 20 sites were designated as candidates for possible remediation.

A subsequent 2008 study of active soil gas and water samples in the community revealed contamination in shallow soil and groundwater at 80 to 90 feet below ground surface. In general, DTSC determined that the overall level of contamination would not present a short-term risk of health effects. But DTSC did decide to evaluate potential vapors that may have moved into nearby buildings. It determined that additional sampling needs to be performed in seven other areas in the vicinity where elevated levels of perc have been discovered.

“We have a two-tiered technique of putting GIS to work,” explains Mike Vivas, hazardous substances engineer and project manager for DTSC’s site cleanup program. “One is to use ESRI’s ArcGIS to build our project-specific shapefile library and generate composite maps of relevant features that can be combined with municipal and county data, such as shapefiles

for the local sewer system and local parcel maps. The maps display relevant features that we can click on and off for a clear view of the spatial relationships that can guide site remediation activities. The second is to use a server for general record keeping and publishing information via our online tool EnviroStor.”

With EnviroStor, citizens can type in their own addresses and see if cleanup sites and hazardous waste permitted facilities are near where they work or live. Site visitors type in the city or county, and the tool offers them a list of cleanup projects, a report and map, the cleanup status (active, inactive, complete), facility type, and site address. Users can click data layers such as Federal Superfund, Voluntary Cleanup, Corrective Action, and Hazardous Waste Permit. The GIS-generated dynamic data files are laid over a static Google basemap.

This information provides transparency to the community. “School districts are particularly interested in this data,” notes Bud Duke, a DTSC project manager and senior engineering geologist in its schools program. “In California, any school district that is going to use state funds to either build a new school or expand an existing school is required to go through DTSC to ensure that the site is safe for students and staff.” Duke and Fears used GIS to create maps that helped project managers screen school sites for environmental health risks.

Different types of data can be input into a GIS to better understand a site’s geographic context. DTSC uses GIS to run a predictive model that shows where naturally occurring asbestos and other contaminants may be. Researchers identified ultramafic formations, which are rock formations that potentially contain asbestos, throughout the state. They also obtained data about radon gas locations from the California Geological Survey and USGS along with the locations of soil samples collected for arsenic. Comparing these data layers with the location of schools provides insight needed about contamination that may endanger schoolchildren.

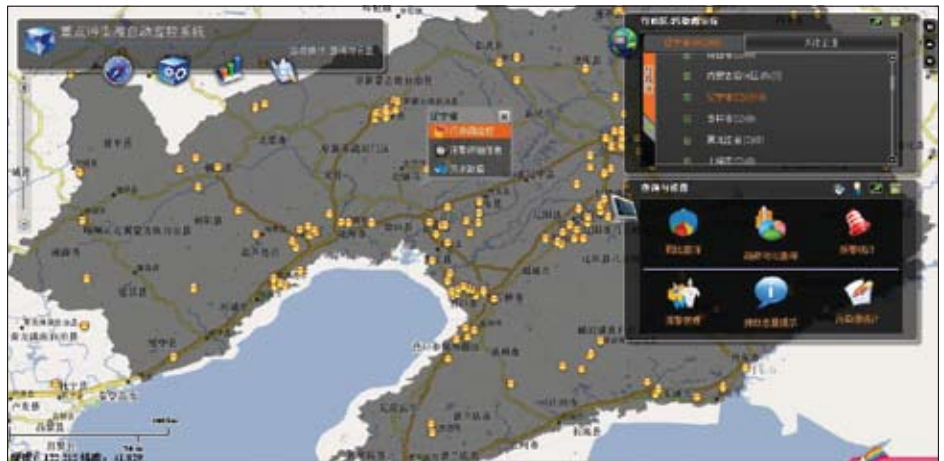
Learn more about GIS for site remediation at www.esri.com/brownfieldsGIS.

China's Ministry of Environmental Protection Deploys GIS for Pollution Source Monitoring

The Ministry of Environmental Protection of the People's Republic of China is using GIS to reduce pollutant discharge. China's manufacturing boom has put its environmental practices in the spotlight of national and international attention.

Ministry staff members are using ESRI's ArcGIS software to manage, inventory, and analyze nearly 10,000 pollutant discharge points within the country. Data collection for such a large scope was a challenge faced by GIS project managers when planning the project. With ArcGIS in place, they can integrate GIS and the department's automated monitoring system as a method for quickly accessing environmental data. GIS supports comparative spatial analysis for conducting side-by-side comparisons of different provinces and different cities.

The implementation of ESRI's ArcGIS Desktop software, using the SQL 2005/2008 database system, makes it possible for the ministry's system users to create data layers of pol-



Ministry of Environmental Protection of the People's Republic of China uses ArcGIS to reveal manufacturing sites that have high levels of air pollution discharge.

lution sources, real-time data, pollutant amount counts, and other relevant data. They can easily integrate projects and run trend analyses. The ministry has also deployed ArcGIS Server so that the data can be accessed enterprise-wide. Based on the GIS, the ministry reformed its entire work process flow to make for a more efficient service.

GIS now provides staff with a scientific approach for environmental law enforcement by locating illegal discharges of pollution and providing solid evidence for litigation. Moreover, GIS speeds response of environmental regulation enforcement.

Learn more about ESRI China (Beijing) Limited at www.esrichina-bj.cn.

ESRI Supports Guyana's GIS Technology for Carbon Accounting and Tropical Forest Management

In an effort to mitigate the effects of climate change, the South American nation of Guyana is developing the world's first national Low-Carbon Development Strategy (LCDS) using enterprise GIS technology and expertise from ESRI. The environmental technology company will provide Guyana with software for use in national carbon accounting and sustainable management of forests.

ESRI president Jack Dangermond met with Guyana's president, Bharrat Jagdeo, at the Office of Guyana's Permanent Mission to the United Nations and committed ESRI to support the country's LCDS initiative.

The government of Norway, the World Bank, the Clinton Climate Initiative, and McKinsey and Company are working with Guyana to implement the LCDS. Norway



President of Guyana Bharrat Jagdeo and ESRI president Jack Dangermond meet to discuss GIS for a carbon accounting program.

is one of the key countries backing Guyana's move to use its forests for carbon financing and payment for forest conservation now. This arrangement allows future innovations, including an eventual forest carbon credit system as such a market evolves. This strategy aligns with the United Nations Collaborative Programme on Reducing Emissions from Deforestation and

Forest Degradation in Developing Countries (UN-REDD), a climate change mitigation scheme created to pay developing countries for conserving their tropical forests.

GIS is the core technology of Guyana's monitoring, reporting, and verification (MRV) system. Building on work done in-country, the MRV will integrate field observations with satellite imagery and other geographic data using methodologies consistent with the Intergovernmental Panel on Climate Change (IPCC) guidelines for measuring, reporting, and verification. Guyana's MRV will be a system for data sharing and the cross-sector analysis that is essential for effective climate change research, mitigation, and adaptation planning.

Climate Wizard Delivers Climate Change Data and Models for Trend Analysis

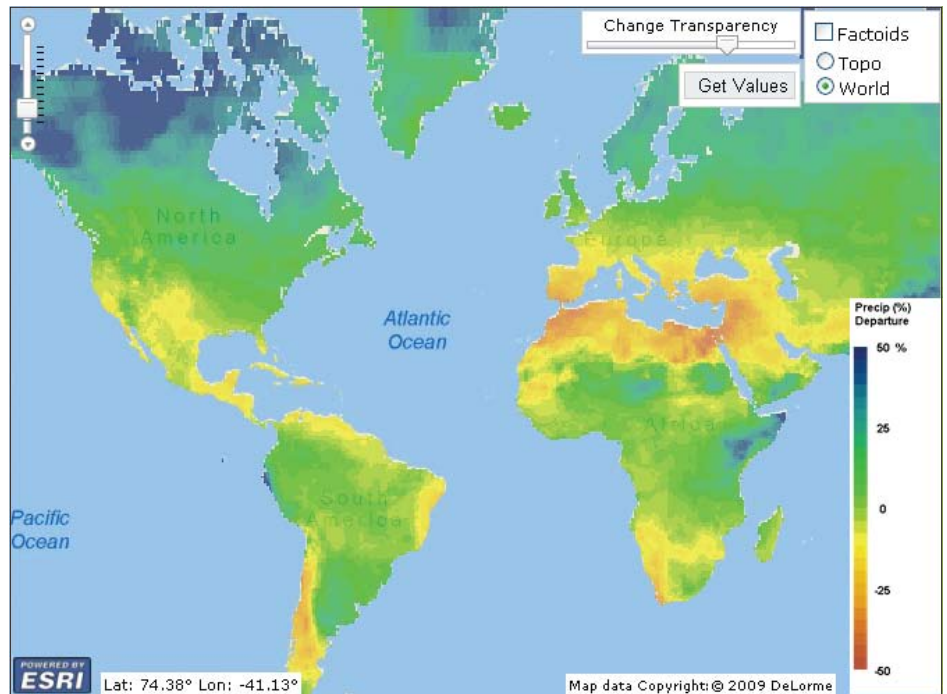
The Nature Conservancy Climate Wizard, powered by ESRI, displays free maps of historic climate change and projected change. Climate Wizard offers scientists, planners, environmentalists, and public users an intuitive means to understand and compare climate change models useful to decision making.

ESRI has had a longtime commitment to environmental sciences and is working with many organizations dedicated to meeting the challenges of climate change (www.esri.com/climate). For many years, ESRI has supported Nature Conservancy efforts to protect our planet by providing environmental expertise and GIS technology.

The new ESRI-powered version of Climate Wizard was first demonstrated at the 2009 United Nations Climate Change Conference (COP 15) in Copenhagen, Denmark. It allows anyone to click a map location and get up-to-date data on climate change trends. A user can also choose between different climate change models to predict impacts on that location.

Climate Wizard uses 16 models from the Coupled Model Intercomparison Program (CMIP3) published for the United Nations Environment Programme and the World Meteorological Organization Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. The user selects a model or ensemble of models from a menu and displays them on a GIS map interface.

These new displays replace previous static climate map images with live Web mapping services. An important new capability available due



Use Climate Wizard powered by ESRI to analyze climate trends globally and locally.

to this improvement enables users to query the 16 different climate change projections for three carbon emissions scenarios at specific locations. They can see the range of future climate projections in graph and tabular formats and view and analyze dynamic data using GIS functionality to see highly specific details relevant to their unique projects. They can also download the climate change data in GIS format.

An extension of Climate Wizard—a future climate model comparison application—allows users to directly compare different model outputs for a chosen area.

The Nature Conservancy launched Climate Wizard in January 2009 with the intent of making climate change a place-based issue so that people would consider how changes in the earth's climate affect them. The original objective was to build a state-of-the-art framework that could easily accept new data as it comes from modeling agencies and put this information into the hands of researchers quickly and easily. The addition of ArcGIS Server technology to the tool in December 2009 made a big step toward achieving this objective by providing live Web mapping services and maps that can be queried on the fly, as well as improved Web application mashup

capabilities. The Climate Wizard project is a collaborative effort of The Nature Conservancy, University of Southern Mississippi, University of Washington, and ESRI.

“ArcGIS Server has made it possible for our vision of Climate Wizard to come to fruition,” says Evan Girvetz, senior scientist with the Global Climate Change Program. “We feel this tool is now on the cutting edge of GIS technology. The framework is there, and users can get the maps and information they need to better plan for future climate in specific places.”

Chris Zganjar, information specialist for the Global Climate Change Program, has been dedicated to the project since its inception. “GIS brings sophistication to the Climate Wizard. We can now serve vital climate change data to the practitioner with an easy-to-use tool,” notes Zganjar. “Real data that virtually scales down to a person's backyard brings the issue into personal space.”

In its development of the GIS framework for Climate Wizard, ESRI Applications Prototype Lab used the beta version of the next release of ArcGIS Server.



A factoid tool provides information about climate-relevant information for the selected site.

GIS Priority Map Set to Focus WetlandCare Australia's Resource Management Projects

By Ian Foreman, GHD

WetlandCare Australia is improving New South Wales (NSW), Australia's wetland environments and biodiversity through natural resource management projects. It commissioned the Central West Catchment Management Authority (CWCMA) to develop an access database that would enable staff members to prioritize and rank 113 wetland complexes. This information would help them in their rehabilitation and protection efforts. CWCMA created a tabular database that contained more than 32,000 individual polygons and 32 attributes. This data was used in calculating a weighted assessment. Rankings were then included in a wetland site priority index.

To say the least, the tabular database was unwieldy, so the authority teamed with technical consulting group GHD to convert the existing tabular database to an ESRI ArcGIS geodatabase. This data conversion enabled CWCMA to use ArcGIS to manipulate the data and perform spatial queries and analysis.

A user-friendly interface to the wetland data enabled users to point to a wetland complex on a map and, via the use of a drop-down inputs box, easily update attributes that could immediately be visualized on a thematic map. Data for map overlays includes local government area, catchments, subcatchments, and localities. The single

geodatabase and the associated GIS project file is in a standard format, so that it can be easily ported to WetlandCare's corporate server.

Of the 32,184 polygons, 1,176 have been identified with a wetland name—most having more than one polygon. Each polygon record has 52 fields of information, some relating to the spatial location of the polygon and attributes that are scored and, in turn, used to calculate the polygon's priority rank. In each field, a domain has been created to assign valid attribute choices for that field. This ensures data integrity and speeds up the data entry process. It is also possible to select a series of polygons within a wetland complex to execute a bulk upgrade using the Field Calculator tool in ArcGIS.

Feature classes from the geodatabase were set up and symbolized in the ArcGIS project CWCMA Priority Wetlands 2009. These feature classes are wetland boundaries, localities, roads, rivers, catchments, subcatchments, Interim Biogeographic Regionalisation for Australia (IBRA) regions, and wetland data.

These feature classes assist in locating wetland polygons and provide spatial boundaries for reporting. More feature classes can easily be added to the project as new information becomes available.

Priority scoring calculations were derived from three indexes: (1) The statutory index contains attributes on national parks, state forests, crown lands, and so forth. (2) The landscape index contains attributes on type rarity, ecological contribution, regulatory structure, and edge sensitivity. (3) The conservation index contains attributes on heritage, threatened species, habitat, habitat corridor, and so forth. Scores and weightings were defined and assigned. The priority score equation is $\text{Priority Score} = \text{Average (Conservation Total)} + \text{Max (Conservation Total)}$.

In addition, a threat score was calculated for the wetland. The threat score is the sum ratings assigned from land-use, development, infrastructure, and environmental impact indexes.

Among the various maps that ArcGIS generated is the Wetland Priority map, which is a 1:250,000 scale wetland map that is a composite of the best existing priority data and is useful for conservation, protections, and conditions improvement.

Many people will benefit from this map, including environmentalists, who will gain knowledge about the area of wetland habitat in the Central West Catchment that is to be protected, conserved, or rehabilitated. The community will gain information about wetland areas and be able to use it for education. In addition, wetland managers will use the map to make informed decisions about the management of wetlands. Finally, the CWCMA will use this resource to justify and focus investment in wetland protection and condition improvement of identified priority wetlands in line with the catchment action plan.

Data: Wetland data resources came from various Australian government departments, with most available data at the large scale of 1:250,000.

For more information about GIS for conservation management, visit www.esri.com/environment.

For more information about GHD, visit www.ghd.com.



Wetland Priority map indicates catchments that are to be protected, conserved, or rehabilitated.

GIS Offers Insight on Wind Power Resource's Feasibility

By Jessica Wyland, ESRI Writer

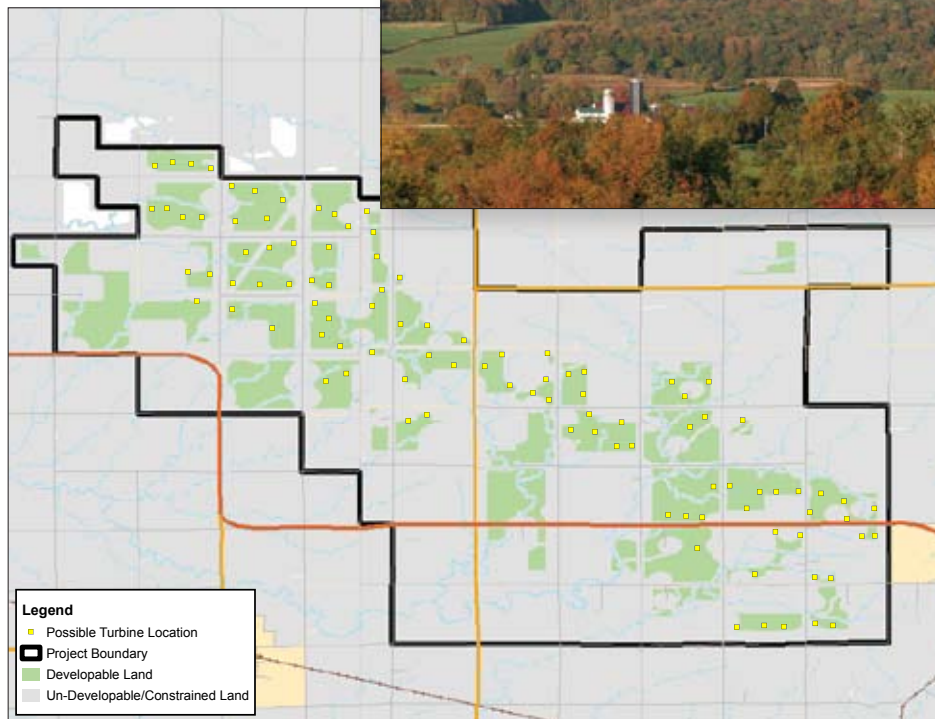
Iberdrola Renewables is the largest developer of wind power in the world. To model the feasibility of wind farm sites, analysts use ArcGIS to consider location, wind speed, property limitations, environmental concerns, and other variables.

There was a time not long ago when the company's development teams of meteorologists, engineers, environmental permitting staff, and land agents only had paper maps to work from. These paper maps didn't show property ownership, wetlands, county- or state-required safety setbacks, rights-of-way, or environmental and cultural resource sites.

ArcGIS helps Iberdrola Renewables staff answer questions about the feasibility of wind farm sites.

What regions are not suitable for wind farm locations? GIS helps analysts rule out areas that would not qualify. It shows state and county land-use data, identifying areas that are under development restrictions from the U.S. Bureau of Land Management and those requiring right-of-way grants. It shows privately owned lands. It also shows land that is environmentally protected for migratory flight paths or other animal activity as well as military bases and airports where wind farm developers must consider radar interference and U.S. Federal Aviation Administration regulations. These lands do not qualify.

Areas that do qualify should obviously be windy enough to effectively turn turbines. Researchers add a resource layer to ArcGIS that details wind speed and reliability. They also add meteorological data collected from tower-based anemometers and vanes mounted at heights up to 60 meters above the ground. Wind power can be classified into wind power density classes ranging from one (poor) to seven (excellent). For example, a wind power class of four has an average wind speed of 15.7 to 16.8 mph at a height of 50 meters aboveground. This can be shown on a map. Meteorologists use wind data, which is stored in Iberdrola Renewables'



This example of siting wind turbines with GIS shows six layers of data.

ArcGIS Server platform, to help design the layout of a wind farm by identifying wind direction, strength, and location. This information is compared for a period of one to five years to determine consistency.

Another important factor is the proximity of existing power lines that tie the wind-generated energy to the power grid. By loading utility data into the GIS, researchers can quickly see existing transmission routes and estimate the benefits of accessing existing electric lines. If the wind is strong and steady, developers may decide to build their own transmission line.

When development teams visit a proposed location, they collect site-based data to compare with digital information and maps within the GIS. Using a mobile device equipped with GPS and GIS, the team is able to update data from the site and make any necessary adjustments to the facility layout.

"Almost all the wind power facility layouts can be visualized in GIS, with maybe one or two visits to the field," says Tyler Hoffbuhr, GIS analyst and manager with Iberdrola Renewables.

"We combine our GIS with U.S. Geological Survey maps, property lines, aerial photography, and detailed topography data to see how the buildable area matches up with the wind data.

"GIS enables us to reach our goal of finding the best wind areas while causing as little impact as possible to wildlife and the environment," he continues. "Locating the right site can be done quickly and accurately with publicly available data and GIS technology."

Once a wind farm is up and running, operators continue to use GIS to help gather inspection and operational data. Since wind energy is variable, utility companies have to figure out what to do when the wind does not blow. With ArcGIS technology, operators can model and predict how well the wind will perform in the next few hours or days and accurately match energy production with demand.

Learn more about Iberdrola Renewables at www.iberdrolarenewables.us. Learn more about GIS applications for renewable energy by visiting www.esri.com/electric and clicking Electric Generation.



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