

GIS Best Practices

# Environmental Management



October 2010



# Table of Contents

<b>What Is GIS?</b>	<b>1</b>
<b>GIS for Environmental Management</b>	<b>3</b>
<b>Panama Environmental Authority Uses GIS for Planning and Public Outreach</b>	<b>5</b>
<b>Woods Hole Research Center Measures Carbon Footprints in U.S. Forests with GIS</b>	<b>7</b>
<b>Emerald Isle's Coastal Contingency Plan</b>	<b>13</b>
<b>Water Resource Community Streamlines Environmental Decision Making</b>	<b>19</b>
<b>Climate Wizard Delivers Climate Change Data and Models for Trend Analysis</b>	<b>23</b>
<b>Keeping Nature and Man in Balance</b>	<b>27</b>

# What Is GIS?

Making decisions based on geography is basic to human thinking. Where shall we go, what will it be like, and what shall we do when we get there are applied to the simple event of going to the store or to the major event of launching a bathysphere into the ocean's depths. By understanding geography and people's relationship to location, we can make informed decisions about the way we live on our planet. A geographic information system (GIS) is a technological tool for comprehending geography and making intelligent decisions.

GIS organizes geographic data so that a person reading a map can select data necessary for a specific project or task. A thematic map has a table of contents that allows the reader to add layers of information to a basemap of real-world locations. For example, a social analyst might use the basemap of Eugene, Oregon, and select datasets from the U.S. Census Bureau to add data layers to a map that shows residents' education levels, ages, and employment status. With an ability to combine a variety of datasets in an infinite number of ways, GIS is a useful tool for nearly every field of knowledge from archaeology to zoology.

A good GIS program is able to process geographic data from a variety of sources and integrate it into a map project. Many countries have an abundance of geographic data for analysis, and governments often make GIS datasets publicly available. Map file databases often come included with GIS packages; others can be obtained from both commercial vendors and government agencies. Some data is gathered in the field by global positioning units that attach a location coordinate (latitude and longitude) to a feature such as a pump station.

GIS maps are interactive. On the computer screen, map users can scan a GIS map in any direction, zoom in or out, and change the nature of the information contained in the map. They can choose whether to see the roads, how many roads to see, and how roads should be depicted. Then they can select what other items they wish to view alongside these roads such as storm drains, gas lines, rare plants, or hospitals. Some GIS programs are designed to perform sophisticated calculations for tracking storms or predicting erosion patterns. GIS applications can be embedded into common activities such as verifying an address.

From routinely performing work-related tasks to scientifically exploring the complexities of our world, GIS gives people the geographic advantage to become more productive, more aware, and more responsive citizens of planet Earth.

# GIS for Environmental Management

GIS technology is an effective tool for studying the environment, reporting on environmental phenomena, and modeling how the environment is responding to natural and man-made factors. Environmental managers, scientists, regulators, planners, and many others use GIS to visualize data about

- Natural resources
- Hazard control
- Pollution emissions
- Ecosystem health
- Climate change

Understanding relationships within the environment is essential for creating environmental impact reports, designing sustainable management plans, prioritizing project areas and funding, and informing government and the public about environmental concerns. In the following case studies, you will learn how environmental management professionals around the world have successfully implemented GIS to analyze ecological footprints; improve watershed resource management; and respond to climate change, pollution, and more.

# Panama Environmental Authority Uses GIS for Planning and Public Outreach

By Susan Harp, Esri Writer

Panama's National Environmental Authority (ANAM is the Spanish acronym), uses Esri's ArcGIS software to keep track of the country's natural resources and environmental programs. GIS projects for the environment are administered by ANAM's Directorate for Environmental Information Systems Administration. The directorate works with ANAM's GIS, remote-sensing data, and digital cartography and performs spatial analysis of environmental information.

GIS is the underpinning technology for generating and organizing ANAM's natural resources and environmental programs. Approximately 35 percent of Panama's territory has been protected in 60 ecological areas. Environmental data on these areas is georeferenced and housed in the geodatabase. The database also includes geological, geomorphological, and soils maps along with a national map, which is at a scale of 1:25,000, and scanned and georeferenced topographic maps at a scale of 1:50,000. Areas needing higher resolution, such as major cities, are mapped at a scale of 1:12,500. Ecology map data consists of forest and vegetation coverage and ecosystem areas. Watershed georeferenced data, which includes Panama's 52 watersheds, are generated using a 30-meter-interval digital elevation model.

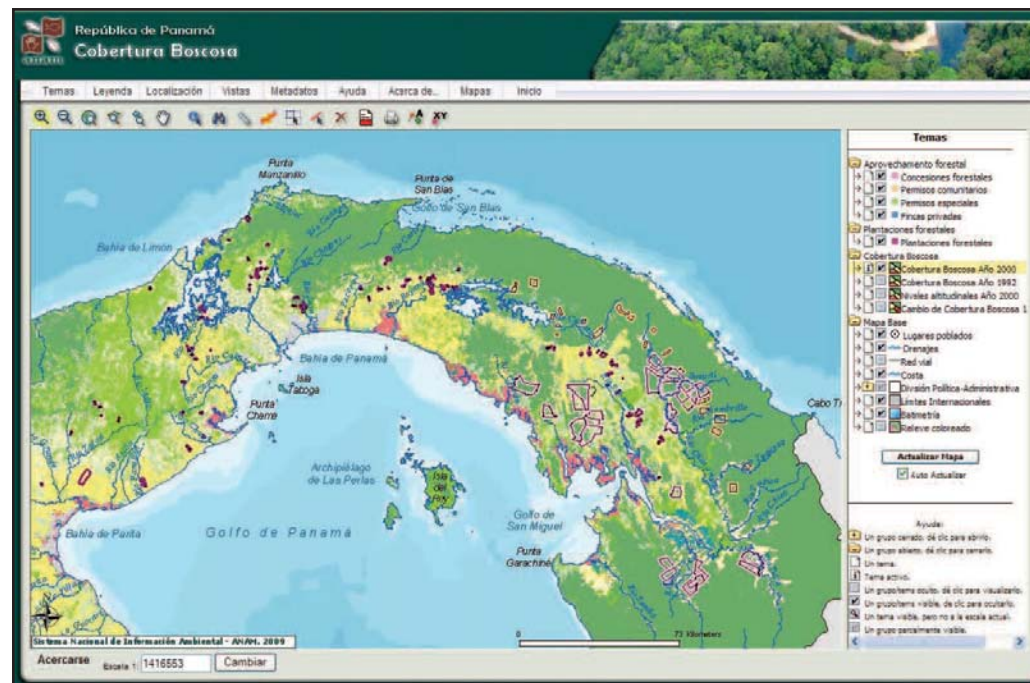
"Having GIS maps accessible over the Internet saves our organization time," says Diana Laguna Caicedo, information systems director for ANAM. "ArcGIS delivers well-designed maps that provide a valuable resource for anyone who needs fast access to information."

Decision makers use environmental analysis as a factor for planning. For example, ANAM's approach to planning a hydroelectric project begins at the watershed level wherein it uses GIS to consider a list of ecosystem-level variables.

ANAM is a member of the Panama National Environmental Information System, a group made up of government institutions, such as the ministries of agricultural development, public works, and health, that generate environmental information. The directorate maintains a server that stores this environmental information and provides interinstitutional access to the data. ANAM serves the information to others in the form of interactive maps that are available on its Web site.

Within the first year of launching its GIS-enabled Web site built on Esri technology, ANAM was able to double the number of environmental maps available to staff and other agencies. Web site users access interactive maps of protected areas, forest coverage, and green development projects such as clean energy generation. They can see maps about watersheds, geology, and geomorphology and add them to their projects. For example, a decision maker can link to the environmental Web site, open a GIS map of a protected area, draw a polygon around an area of interest, and make a query about the forest types within that area. Maps can be served online or printed.

Read more about ANAM at its Spanish-language site [www.anam.gov.pa](http://www.anam.gov.pa). Learn more about GIS for the environment at [www.esri.com/environment](http://www.esri.com/environment).



A forest coverage map of the Republic of Panama is published on Panama's National Environmental Authority Web site using ArcGIS technology. Map layers include forest usage types as well as forest coverage by year.

(Reprinted from the Fall 2009 issue of *Environmental Observer* newsletter)



# Woods Hole Research Center Measures Carbon Footprints in U.S. Forests with GIS

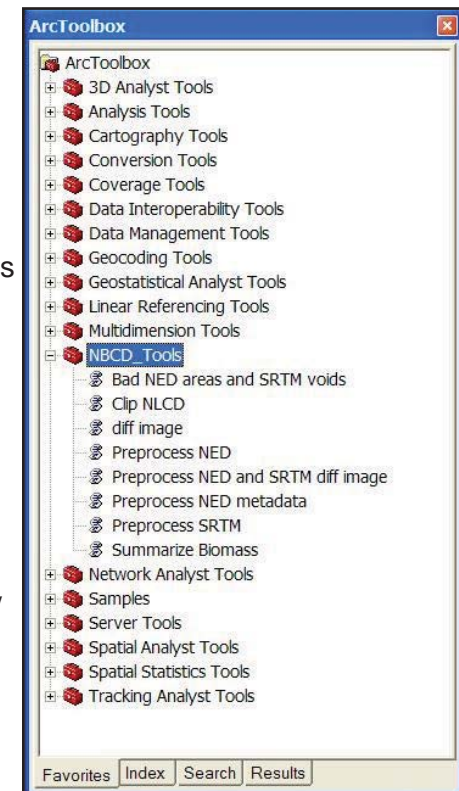
## Highlights

- Study uses GIS to measure the carbon-rich biomass in heavily wooded areas.
- ArcGIS Desktop and ArcGIS Server are used to manage data and create maps.
- Researchers can analyze and illustrate changes, manage findings, and model through maps with GIS.

How do we retrace our ecological footprints? Where will the footprints lead? Scientists at the Woods Hole Research Center (WHRC), Falmouth, Massachusetts, are tracking carbon footprints across the globe starting with U.S. forests. One ongoing study, using GIS technology, is measuring the carbon-rich biomass in heavily wooded areas to indicate the effect deforestation and land use have on rising carbon levels in our atmosphere.

The National Biomass and Carbon Dataset for the year 2000 (NBCD2000) will serve as a baseline for quantifying carbon stock in U.S. forests. The information can then be used to improve current methods of assessing carbon flux between forests and the atmosphere. To establish the baseline, researchers fed many layers of data into the GIS, including National Aeronautics and Space Administration (NASA) satellite imagery, topographic survey data, land-use/land-cover information, and extensive forest inventory data collected by the U.S. Department of Agriculture (USDA) Forest Service Forest Inventory and Analysis (FIA) program.

"The datasets that are now available should be of interest to natural resource managers across the country," says Josef Kellndorfer, an associate scientist at WHRC and leader of



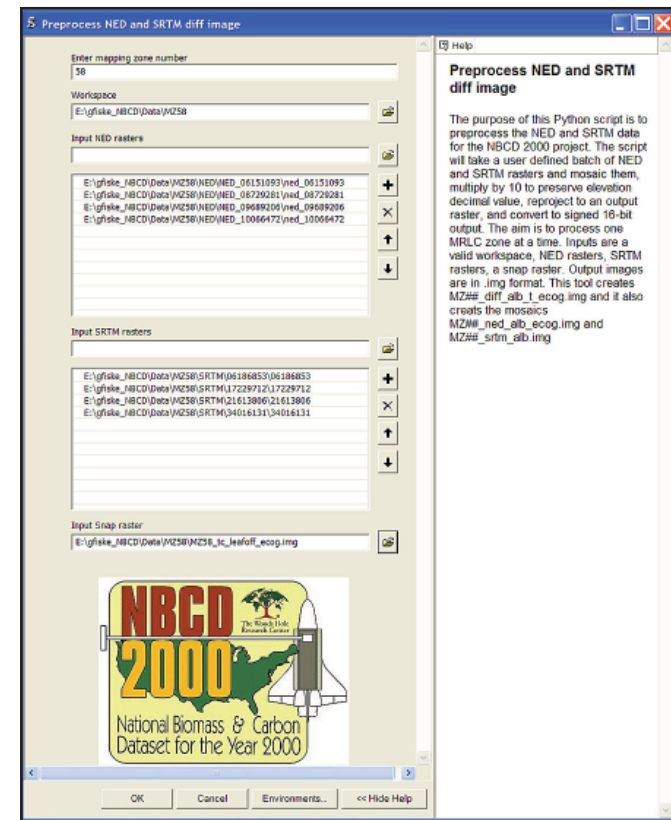
A screen shot showing the NBCD2000 Toolbox created for GIS-data processing.

the NBCD2000 project. "The availability of high-resolution estimates of forest biomass and associated carbon stock is an important step forward in understanding the North American carbon balance."

Mapping projects target 67 ecologically diverse regions—mapping zones that span the conterminous United States. Of the nine completed zones, five were finished during a two-year pilot phase. Work on the remaining zones will be completed at a rate of roughly one zone every seven days. The project is scheduled for completion in early 2009. The NBCD2000 initiative started in 2005 and is funded by NASA's earth science program with additional support from U.S. Geological Survey (USGS)/LANDFIRE.

ArcGIS Desktop and ArcGIS Server are being used to manage the data and create the maps. "The work of our GIS users depends on the symbiosis of digital image processing software and GIS software," says John P. Holdren, WHRC director. Many of the center's GIS users have completed Esri's online courses and classroom training, and ArcGIS is ubiquitous among WHRC's spatial analysts.

Within each mapping zone, data from the 2000 Shuttle Radar Topography Mission is combined with topographic survey data from the National Elevation Database (NED) to produce a radar-based map of vegetation canopy height. Subsequently, the map illustrates estimates of actual vegetation height, biomass, and carbon stock using survey data from the FIA program and ancillary datasets from the National Land Cover Database 2001 (NLCD2001) project. The NLCD2001 data layers are crucial inputs to the NBCD2000



A screen shot of the "Preprocess NED and SRTM diff image" tool, a key component of the NBCD Toolbox.



project as they provide land-cover and canopy density information used in the stratification/ calibration process.

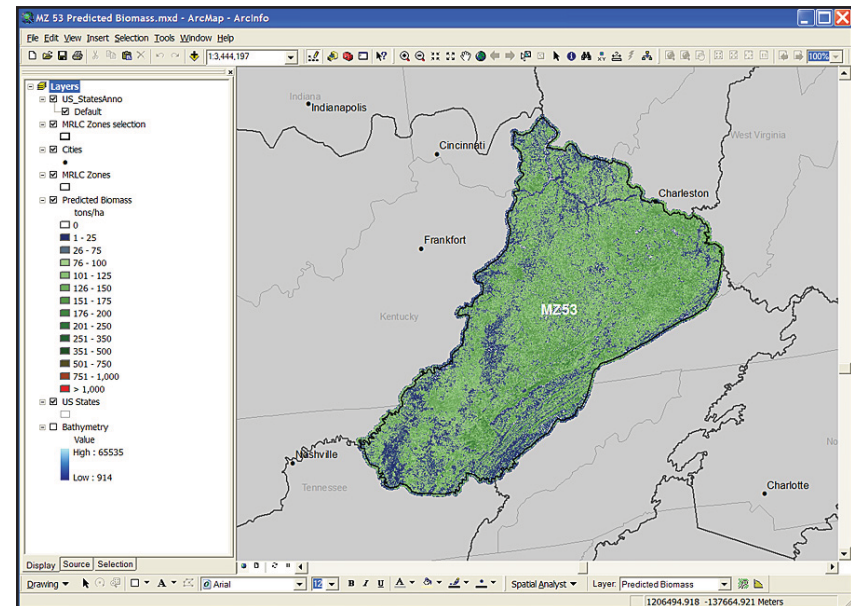
Says Diane Wickland, program manager for NASA's Terrestrial Ecology program, "Because this is the first systematic, regional-scale study that uses radar data to quantify carbon storage in vegetation, the end result will not only provide valuable information on how well we can do with existing data but will allow us to see how we might improve and refine requirements for future, more capable missions."

## The Case for Measuring Carbon

Ecologists have been interested in carbon for a long time, according to WHRC scientist Richard Houghton, primarily because all plants and animals are made of carbon. More recently, carbon has become interesting to scientists—and many other people—because carbon dioxide is the major greenhouse gas produced by human activity.

"The continued release of greenhouse gases is raising the temperature of the earth, disrupting the climate we and our agricultural systems depend on, and raising the sea level," Houghton states. "The concentration of CO<sub>2</sub> in the atmosphere has already increased by about 30 percent since the start of the Industrial Revolution sometime around the middle of the 19th century. It will continue to increase unless societies choose to change their ways."

*A screen shot showing a map of predicted aboveground live dry biomass for mapping zone 53, which covers a portion of the central Appalachians including parts of Kentucky, Ohio, Tennessee, Virginia, and West Virginia.*



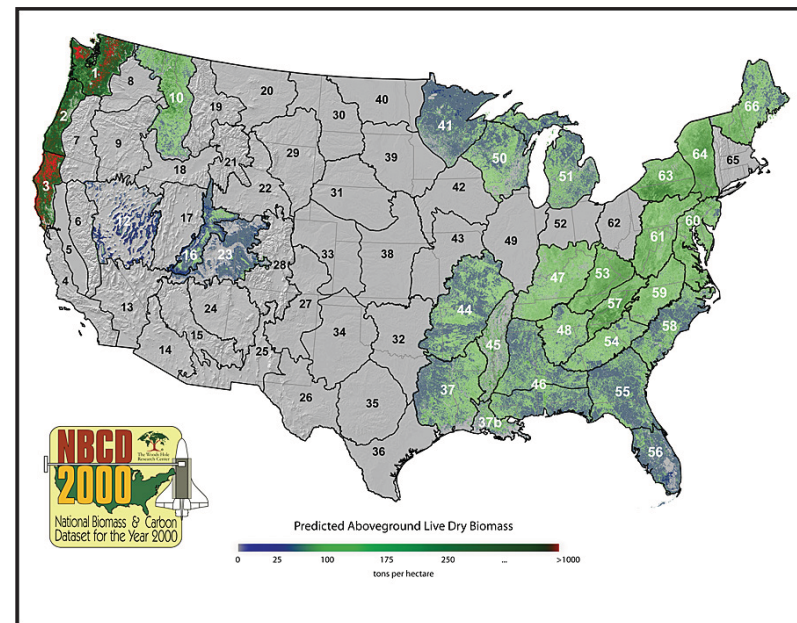
Most of the increase in atmospheric CO<sub>2</sub> concentrations has been and will continue to be from the use of fossil fuel for energy. About 25 percent of the increase over the last 150 years has come from changes in land use—the clearing of forests and cultivation of soils for food production. Much of the carbon stored in trees and soils is released into the atmosphere when forests are cleared and cultivated. Some of the release occurs rapidly with burning. Some of it occurs slowly as dead plant material decomposes. When forests regrow on cleared land, they withdraw carbon from the atmosphere and store it again in trees and soils. The difference between the total amount of carbon released into the atmosphere and the total amount withdrawn from the atmosphere determines whether the land is a net source or sink for atmospheric carbon. WHRC scientists therefore study the rates of land-use change or deforestation and the sources and sinks of carbon that follow.

## The Use of GIS in Conservation

With ArcGIS, researchers are able to analyze and illustrate changes on the earth, manage findings in an easily accessible database, and model through maps the effects of various future land-use and carbon-related decisions.

"Almost all ecological research is inherently spatial and needs to be put into a local or regional context," states Holdren. "Among a text-weary public, maps are perhaps the most direct route to understanding research results and the status of the earth's natural resources."

WHRC has initiatives in the Amazon, the Arctic, Africa, Russia, Asia, and North America. Center programs focus on the global carbon cycle, forest function, land cover and land use, water cycles, chemicals in the environment, science in public affairs, and education,



*A screen shot showing the NBCD Progress ArcGIS Server Web map service. This Web interface will be updated regularly as data becomes available for distribution.*

providing primary data and enabling better appraisals of the trends in forests (see sidebar below).

WHRC scientists recently released initial data from NBCD2000. All data products are available for download on a zone-by-zone basis at [www.whrc.org/nbcd](http://www.whrc.org/nbcd).

### **Woods Hole Research Center GIS Projects**

Woods Hole Research Center is currently using Esri technology to obtain global GIS data for the following projects:

- Research climate change by studying current and historic releases of carbon and exploring how forests might be used to withdraw carbon from the atmosphere.
- Define the agricultural aptitude of lands in Amazonia and look at farmlands now in conservation reserve status in the United States.
- Map land cover of the Chesapeake Bay watershed to examine water quality, urban expansion trends, and habitat connectivity.
- Derive from laser remote sensing the forest canopy structure in Maryland as it correlates with bird species richness.
- Evaluate habitat connectivity between the Adirondacks and New England to help define optimal wildlife corridors and outline roadless areas.
- Examine the pan-Arctic rivers that supply the Arctic Ocean with freshwater and could determine the future of the region with respect to global warming.
- Quantify the amount of biomass and carbon in the forests of Russia and the contiguous United States.
- Monitor and map the great ape population of Africa.

- Research, model, and plan for ecological concerns in Brazil with a large outreach effort among Brazilian professionals, government officials, farmers, and the agriculture industry.

**More Information** For more information, visit [www.whrc.org](http://www.whrc.org).

(Reprinted from the Winter 2008/2009 issue of *ArcNews* magazine)

# **Emerald Isle's Coastal Contingency Plan**

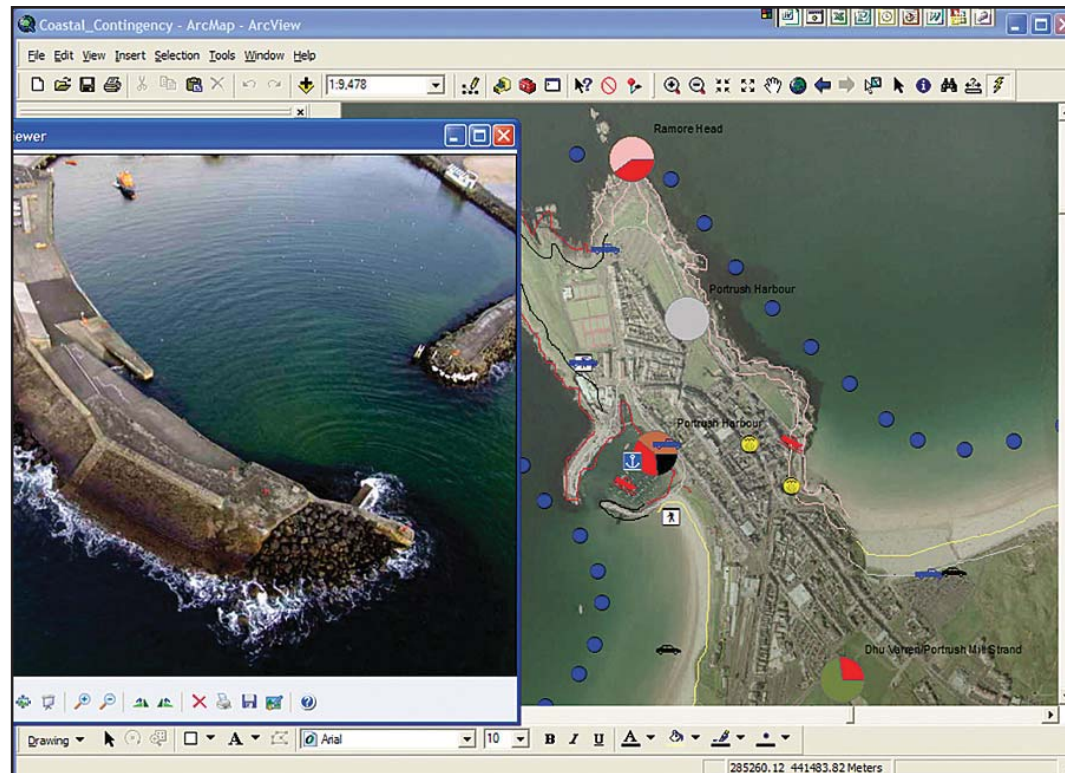
## ***Northern Ireland Environment Agency Quickly Responds to Pollution and Shipping Incidents with GIS***

### Highlights

- ArcGIS is used to create charts and graphs showing characteristics of the Northern Ireland coastline.
- Voluminous information is accessible via an online spatial data catalog served from ArcGIS Server.
- Enterprise GIS enables the NIEA Coastal Survey Team to represent more than 40 layers of data spatially.

Northern Ireland Environment Agency (NIEA) is the largest agency within the Department of the Environment in Northern Ireland, with approximately 700 staff. NIEA takes the lead in advising on and implementing the government's environmental policy and strategy in Northern Ireland. The agency carries out a range of activities that promotes the government's key themes of sustainable development, biodiversity, and climate change. Its overall aims are to protect and conserve Northern Ireland's natural heritage and built environment, control pollution, and promote the wider appreciation of the environment and best environmental practices.

NIEA is the body responsible for coordinating the response to any pollution incident that may affect the coastline of Northern Ireland and is a partner in the Emergency Response to Coastal Oil, Chemical and Inert Pollution from Shipping (EROCIPS) project jointly funded by Interreg IIIb (a European Union-funded program that helps Europe's regions form partnerships to work together on common projects), the United Kingdom's Department of Communities and Local Government, and NIEA.



*Ortho maps and aerial photographs are used in coastal contingency planning.*

The EROCIPS project aims to develop "a transferable methodology that communicates relevant information to responders and decision-makers involved in shoreline counter pollution operations following a shipping incident." In the context of EROCIPS, a shipping incident is considered to be the large-scale accidental discharge of hydrocarbons, chemicals, or inert material (timber, plastics, etc.), carried as cargo, into the coastal marine environment. The incident may result in contamination of coastal habitats and/or pollution damage to the natural, human, and built resources they support.

### **Migrating the Information**

NIEA is the repository for a diverse range of coastline information concerning, for example, vehicle access points, pedestrian access points, equipment lay-down areas, wastewater treatment discharge points, coastal assets, booming sites, and National Trust areas—in total,



more than 40 distinct types of data. This information is held in both hard- and soft-copy formats, sitting in disparate locations throughout the agency. On examination, all this information was found to have a spatial component, and as a result, a GIS was determined to be the ideal platform on which to integrate and communicate this information.

The challenge was to migrate all this information to a GIS platform that would enable the NIEA Coastal Survey Team to integrate all the information NIEA held on coastal assets and communicate this information to external stakeholders, such as local councils, port authorities, other government bodies, cleanup contractors, and waste management companies, which also play their part in the response to a large incident.

Conor Symington, EROCIPS and coastal contingency planning officer at NIEA, comments, "In 2002, I was tasked with compiling the data required to populate the data directory component of a coastal contingency plan for Northern Ireland. I spent the next 18 months or so out on the coastline carrying out surveys of all aspects of the physical coastal environment and liaising with a large variety of external and departmental agencies in order to draw together all the requisite datasets. My thinking at all times was toward producing a GIS-enabled set of layers and maps of all the data so that responders during a major coastal pollution incident (e.g., from a shipping casualty) would have at their fingertips all the necessary data and tools to mount a timely, effective, and appropriate response to the incident facing them."

## **Building on the Enterprise Environment**

After examining the technology options, ESRI Ireland, Esri's distributor in Ireland, was engaged to advise and assist NIEA in building a GIS platform to meet its needs under the EROCIPS project. To meet the objectives of the agency, ESRI Ireland carried out a requirements analysis that considered

- The nature of existing datasets and their readiness for inclusion in GIS
- How to collect new information and collate it for ultimate use within GIS
- How to synchronize and share information of common interest to multiple business units within the agency
- The technical specification of a GIS hardware and software platform that could store, integrate, analyze, and communicate this data

Following the requirements analysis, a decision was made to build on the enterprise GIS environment already implemented within NIEA. This solution is based on the ArcGIS 9 technology suite and utilized ArcGIS Server for the management, visualization, and dissemination of spatial data. ArcGIS Desktop (ArcEditor) clients are used for desktop visualization, analysis, and data capture.

### **Accessing and Visualizing Mapping**

The solution was delivered through the development of an online spatial data catalog served from ArcGIS Server. Using ArcGIS Desktop, agency users can now access and visualize all basemapping from Ordnance Survey Northern Ireland—including all large-scale mapping and aerial photography—in conjunction with the NIEA Coastal Survey Team's own business layers that include hyperlinks to additional nonspatial data.



*Aerial photography taken from an oblique angle.*

Rapid response is key to the effective management of any pollution incident. With the simple click of a mouse on a digital map, the agency's incident managers can now access all relevant information such as the harbor booming plans for Belfast Lough, where booms would be erected in the event of a disaster; ground-level photographs; additional aerial perspective photography (taken at oblique angles by coastal marine helicopters); and various vector datasets. Access to

hyperlinked photographs of harbor piers, beach entrances, slipways, and other coastal assets will allow the Coastal Survey Team to ascertain the likely specifics of deploying beach cleaning equipment at the best possible vantage points.

Although pollution incidents cannot be readily predicted, contingency planning is undertaken by the agency. This is where the analytic capability of ArcGIS has been particularly valuable. The system has been used to create charts and graphs showing the characteristics of the Northern Ireland coastline section by section. Users are able to view shoreline substrate types and, as a result, determine the type of cleanup response required for that particular substrate type. This allows the agency to predetermine likely appropriate responses to various incident types, thereby feeding into the rapid response at the time of an incident.

### **A Model of Data Management**

The enterprise GIS environment has enabled the Coastal Survey Team to represent more than 40 layers of data spatially; see spatial patterns emerge; make informed decisions in planning response to minor and major shipping incidents, such as ship spillages; and visualize ship accident "black spots" and ship traffic density of the Northern Ireland coastline.

"The outcome has been extremely useful," remarks Symington. "The user-friendly desktop data management and planning tool has been as good as, if not better than, we had originally hoped for prior to the project completion. One of the most pleasing aspects of the finished tool is that it has an in-built versatility, because not only is it loaded onto the enterprise server within NIEA and therefore can be shared across the agency, but it also has offline capabilities, meaning that the datasets and tools can be utilized in the field using a notebook PC and an external hard disk drive, without being connected to the NIEA network. Other teams have expressed an interest in following our model."

(Reprinted from the Summer 2009 issue of *ArcNews* magazine)

# Water Resource Community Streamlines Environmental Decision Making

## *Kentucky Improves Watershed Modeling Across the State with GIS*

### Highlights

- State portal provides easy, one-stop access to ready-to-use data.
- Service increases use of modeling for better management of water resources.
- A centralized data source allows decision makers to focus on modeling, not data gathering.

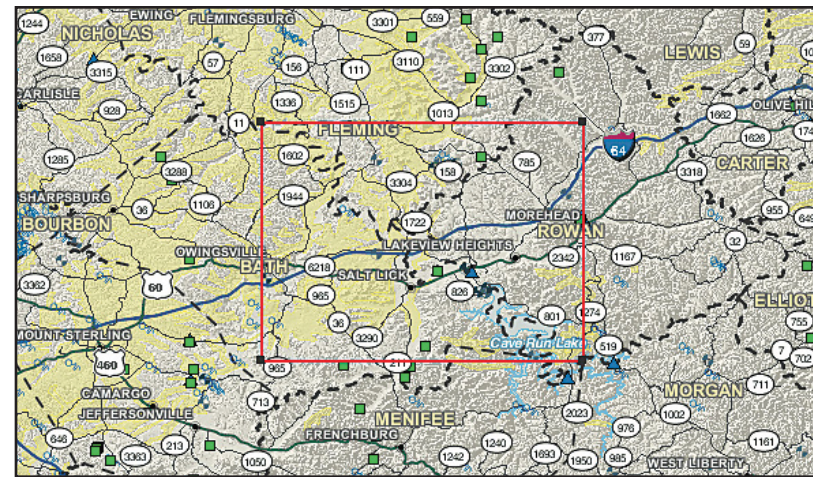
The Commonwealth of Kentucky is often associated with thoroughbred horses and horse racing, calling to mind lush green pastures crisscrossed by narrow country roads and bounded by stone and wood plank fences. Known as the Bluegrass State for the distinctive color of its native grass, it is a land with diverse environments and abundant resources, including the world's longest cave system, the nation's most productive coalfield, and more navigable miles of water than any state in the union other than Alaska.

Kentucky's 90,000 miles (140,000 km) of streams comprise one of the most expansive and complex stream systems in the nation. Kentucky is the only U.S. state to be bordered on three sides by rivers—the Mississippi River to the west, the Ohio River to the north, and the Big Sandy River and Tug Fork to the east. Its major internal rivers include the Kentucky, Tennessee, Cumberland, Green, and Licking rivers. The state is home to three major natural lakes and many artificial ones, including the largest artificial lake east of the Mississippi in water volume (Lake Cumberland) and surface area (Kentucky Lake).

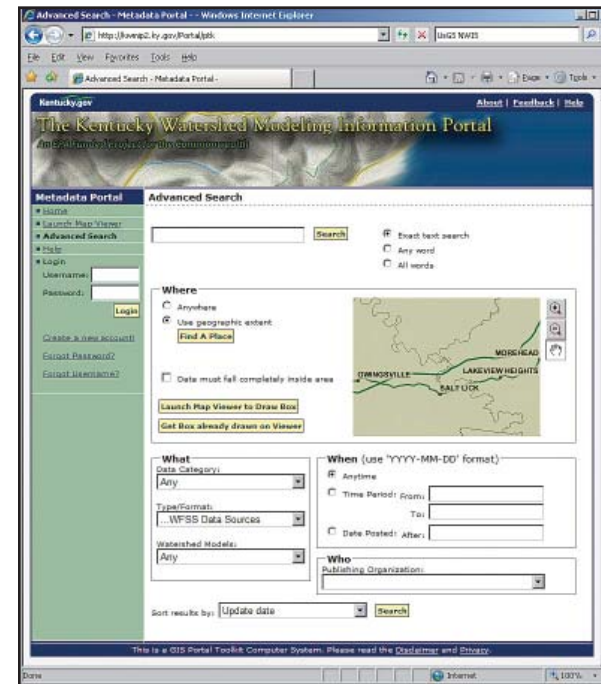
To better manage these extensive and fragile resources, Kentucky's Commonwealth Office of Technology (COT) wanted to improve the reliability of the water resource data provisioning process and increase the use of watershed modeling by water resource managers.

The vision was to provide easy, one-stop access to ready-to-use data for water resource managers and modelers in Kentucky. Surveys indicate that as much as 70 percent of the time expended to produce a watershed model is used to assemble the data and prepare it for use. Against this backdrop, COT partnered with the Kentucky Environmental and Public Protection Cabinet; Open Geospatial Consortium, Inc. (OGC); U.S. Environmental Protection Agency (EPA); and U.S. Geological Survey (USGS) to develop the Kentucky Watershed Modeling Information Portal (KWMIP).

The primary goal was to design the KWMIP to significantly reduce the time spent collecting watershed modeling data by providing a single point of access to both geospatial data and time-series (i.e., tabular) data already maintained in active and legacy database systems.



*KWMIP users can define an area of interest from a Web map interface or by specifying the desired hydrologic unit.*





When the project was conceived, water resource managers in Kentucky utilized numerous Web sites to obtain spatial and time-series data for watershed analyses and models. Managers had to learn different user interfaces for formulating queries for data, and the data came in many different formats.

Even though a rich and diverse set of statewide geospatial data holdings in Kentucky could be accessed through the Kentucky Geography Network (KYGEONET)—the geospatial data clearinghouse for the Commonwealth of Kentucky—or obtained at the county level, the datasets were typically downloaded and processed and updated locally. There was no provision for sharing those changes back with the water resource community.

"We realized that there would be many data sources and many systems using the data, and interoperability became a key aspect of the target solution," says Demetrio Zourarakis, remote sensing/GIS analyst and project manager with the Kentucky Commonwealth Office of Technology, Division of Geographic Information.

The KWMIP Initiative Management team (consisting of OGC and COT) contracted with Esri Business Partner Stantec (Louisville, Kentucky) and Esri Professional Services to develop a portal that was *interoperable* such that it could provide uniform interfaces to existing data sources without requiring changes to those data sources; *extensible* such that more data sources could be integrated, following a well-documented interface; and *flexible* to account for the fact that different watershed models use different data types in various combinations and formats.

The solution for providing uniform access to tabular data held in active and legacy database systems was found in defining and implementing a new OGC specification, OGC Web Feature Service—Simple (WFS-Simple), which is designed to access heterogeneous tabular datasets through a standard interface.

OGC and Stantec developed interfaces to EPA's Water Quality Exchange, STORET database, Permit Compliance System (PCS), and Facility Registry System (FRS) and USGS' National Water Information System (NWIS). To improve watershed model reliability, USGS' Kentucky Water Science Center developed a statewide temperature and precipitation model, called the Kentucky Climate Data Generator, which users can access through the portal. Kentucky's vector data is accessible through SpatialDirect from Esri Business Partner (Surrey, Canada) Safe Software.



Esri Professional Services provided the solution for extensibility and flexibility by applying a service-oriented architecture, combined with a registry of these services and models built using Esri's GIS Portal Toolkit. In this registry, both the data services noted above and the watershed models are described using Federal Geographic Data Committee (FGDC) metadata.

"Using this approach, instead of custom designing every data access component, reduced our software development costs exponentially," comments Zourarakis. The Esri team also developed a data broker component that interacts with the vector data, as well as the tabular data sources, using the OGC WFS-Simple interface.

While receiving data in the proper format provides an enhanced user experience for water resource managers, getting data only for the target study area is equally important. Since study areas typically take the shape of watershed boundaries, the team chose to integrate this aspect of the solution with the USGS StreamStats Watershed Boundary Delineation service. Users can generate watershed boundaries and clip spatial data to them in an online user interface integrated with GIS Portal Toolkit.

The KWMIP provides a one-stop geospatial data portal that enhances the quality and quantity of watershed modeling in Kentucky's environmental decision making by freeing up time previously spent on data procurement and provisioning activities.

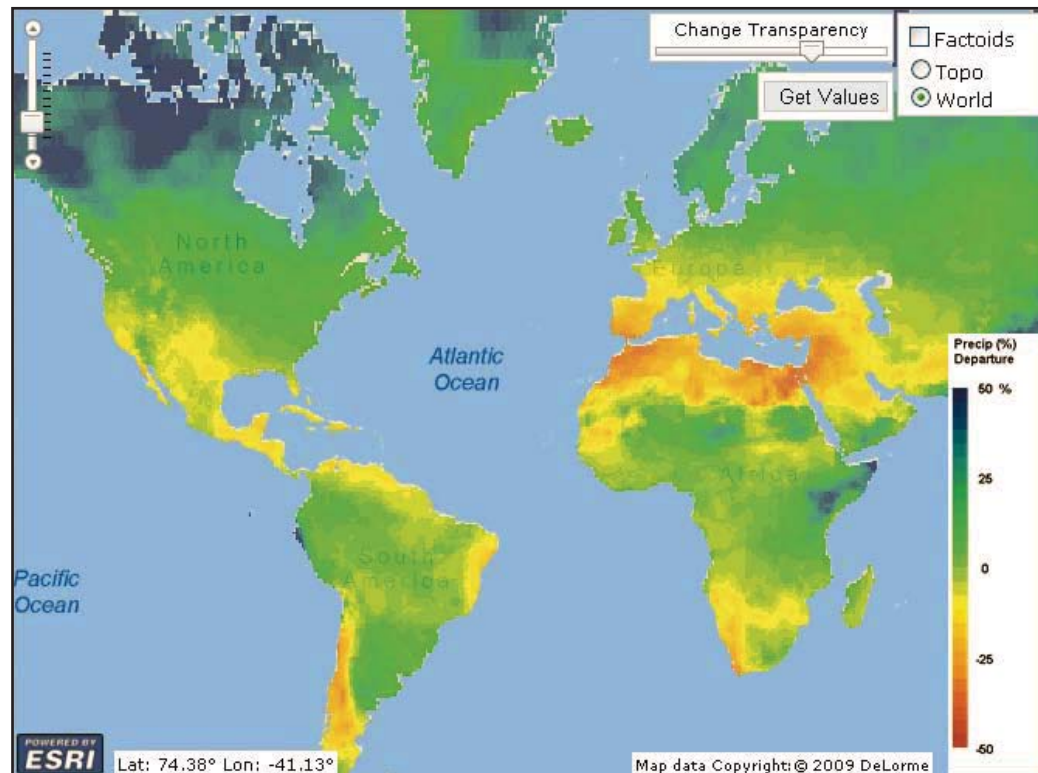
"KWMIP represents an unprecedented opportunity for the Kentucky community of watershed modelers," says Gary R. Harp, former director of the Kentucky Division of Geographic Information. "The portal ensures that appropriate and usable data and tools are available for the programmatic needs of government and citizens of the commonwealth."

The portal increases the use of models and improves modeling efficiency by compiling and formatting input data for the user. This allows water resource managers to focus on performing modeling rather than collecting data. By providing a central location for data and models, the portal also improves model consistency across the state. The result is better management of Kentucky's extensive water resources to ensure their continued existence and viability into the future.

(Reprinted from the Fall 2008 issue of *ArcNews* magazine)

# 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.

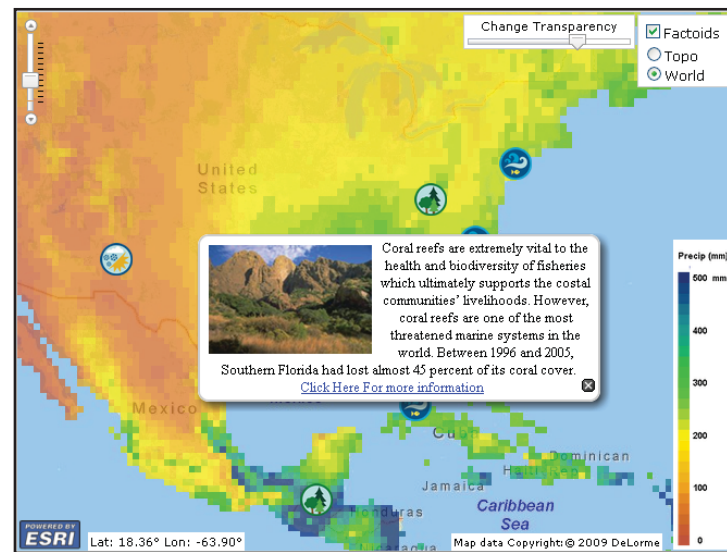


*Use Climate Wizard powered by Esri to analyze climate trends globally and locally.*

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](http://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.



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

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

(Reprinted from the Spring 2010 issue of *Environmental Observer* newsletter)

# Keeping Nature and Man in Balance

## *GIS data portal enables ecosystem-based management*

By Katie Budreski, Stone Environmental, and Karen Richardson, ESRI

An online atlas and geoportal makes more than 400 datasets available for managing the shoreline of the North Atlantic Ocean, estuaries, and portions of two of the five Great Lakes that are within the State of New York.



*Visitors seine for fish and crabs in the shallows of the Hudson River, part of the Esopus Meadows, which has abundant aquatic wildlife and forest ecology.*

Developed by the New York Ocean and Great Lakes Ecosystem Conservation Council, the atlas and geoportal are used for ecosystem-based management (EBM). EBM is the study of activities within specific geographies with the goal of finding ways for humans and nature to

coexist in a sustainable manner. Used mainly to study terrestrial environments, EBM has gained recent popularity in marine studies as communities search for solutions to ailing fisheries and ocean ecologies. Spatial data plays a key role in assisting communities practicing EBM because this management approach is place based and studies are focused on activities in specific geographies.

New York State uses EBM for managing the shoreline of the Northern Atlantic Ocean and its estuaries as well as portions of two of the five Great Lakes. To do this effectively, the state created The New York Ocean & Great Lakes Atlas ([nyoglatlas.org](http://nyoglatlas.org)) and geoportal ([portalnyoglecc.nyoglatlas.org](http://portalnyoglecc.nyoglatlas.org)). The atlas is used by the general public as well as local, regional, and state decision makers to view and explore more than 400 datasets about the region. The GIS Portal Toolkit [now known as the ArcGIS Server Geoportal extension] helps visitors easily navigate the vast catalog of data accessed via the geoportal. The Geoportal extension includes a catalog service and a Web application.

### **An Innovative Way to Manage the Marine Environment**

The New York Ocean and Great Lakes Ecosystem Council, created in 2006, is charged with protecting, restoring, and enhancing New York's ocean and Great Lakes ecosystems while taking into account sustainable economic development and job creation. The council is chaired by the commissioner of Environmental Conservation and composed of commissioners from Agriculture and Markets, Economic Development, and Transportation, as well as the secretary of state, the president of the New York State Energy Research and Development Authority, and the interim chancellor of the State University of New York.

Stone Environmental, an Esri business partner based in Montpelier, Vermont, helped create the atlas. When launched in July 2008, the atlas was composed of a Web-based mapping application and more than 200 datasets. Users could view the datasets, download metadata and spatial data in multiple formats, and view attributes of the data. While the council had technically met its mandate, it was clear that an online catalog would be necessary to help navigate the available datasets.

### **Portal Makes Data Searchable**

After reviewing several technologies, the council implemented the GIS Portal Toolkit because it had—out of the box—the functionality that the council required. Sophisticated searching capabilities, the ability to establish user accounts and data provider access, and flexible metadata authoring tools were very important and readily available in the software. In addition, Esri's open software environment aligned with the council's vision for future enhancements outlined in its five-year strategy document.



The portal provides a robust way for users to search all the data holdings at the atlas. Users of the portal can perform metadata searches by keyword, data type, data category, date modified, and geographic location. Information for specific areas of interest can be easily found and compared in this manner. Once found, the search results can be saved in several ways: to a user profile, to a GeoRSS feed, or as an HTML page or HTML fragment that allows users to embed a defined block of HTML inside documents at key locations. Data can also be downloaded in various GIS formats, including Esri shapefile format, via an FTP link.



*The deep-water harbor of Greenport has been a working seaport since the 18th century and continues to be a vital hub both environmentally and economically for the area.*

## One-Stop Shop for Data

When Stone first began looking for relevant data, it discovered this was a huge task. To find the data included in the atlas, the company employed Web searches, phone calls, e-mails, and face-to-face conversations with staff from more than 300 organizations. Since the first launch, more data has been added for a total of nearly 400 searchable datasets.

Data includes administrative boundaries; elevations; cadastre; environment and geoscientific information, such as geology, groundwater, and soils; marine data, such as fish distribution and habitat, and invasive species; as well as cultural information including historic sites and settlement information.

Many datasets are from organizations that had never before distributed geospatial data widely. For example, the Facility Limit Measurement Violation data from the New York Department of Environmental Conservation (NYDEC)—Water Division provides information necessary for the Clean Water Act National Pollutant Discharge Elimination System Program that had been identified as a priority through a data needs workshop. The agency had resource and technical constraints with sharing the data internally. Providing the data via the atlas—without having to host the data—allowed this important dataset to be shared.

## Publishers Control Data

When the Atlas Data Portal was first launched, the council published the data and metadata provided by the data providers. Moving forward, the council will encourage data providers to publish metadata records directly to the portal and, when possible, host their own data through subportals. Providing direct access will ensure that data is as current as possible for EBM planners and communities.

To make it easier, data providers have several avenues for easily publishing data using the portal. Records can be published by uploading metadata that has been created by a metadata editor based on Federal Geographic Data Committee (FGDC) and International Organization for Standardization (ISO) standards, like the metadata included within the Geoportal extension. Metadata can also be created using a Web form. Data providers can establish a data harvesting relationship with the portal through a subportal or Web-accessible folder. This allows the data portal to collect desired Web pages and extract necessary data.

The Tug Hill Commission GIS Data Portal (24.39.214.21/GPT9/catalog/main/home.page) is an example of a subportal. Tug Hill is a 2,100-square-mile area in a remote rural region of New York located between Lake Ontario and the Adirondacks mountain range. Several geospatial datasets were developed as part of an EBM demonstration project in the Sandy Creeks watersheds on the eastern shore of Lake Ontario. A separate data portal, the subportal, was developed so the Tug Hill Commission could manage its own geospatial data holdings but still make the data available to New York Ocean & Great Lakes Atlas users.



*Wetlands are among the most productive ecosystems in the world, comparable to rain forests and coral reefs. These wetlands located in Wilson, New York, on Lake Ontario are an example of one of the "biological supermarkets" that can be managed using The New York Ocean & Great Lakes Atlas.*

## Next Steps

This year, the New York Ocean and Great Lakes Ecosystem Conservation Council will work with Stone Environmental to integrate the Data Portal and Data Viewer, currently two separate applications, by upgrading to ArcGIS Server. Additional enhancements will include the

incorporation of thesauruses for enhanced searching and the use of Web Map Services (WMS) and Web Feature Services (WFS) for data dissemination.

(Reprinted from the Summer 2010 issue of *ArcUser* magazine)

Copyright © 2010 Esri  
All rights reserved.  
Printed in the United States of America.

The information contained in this document is the exclusive property of Esri. This work is protected under United States copyright law and other international copyright treaties and conventions. No part of this work may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or by any information storage or retrieval system, except as expressly permitted in writing by Esri. All requests should be sent to Attention: Contracts and Legal Services Manager, Esri, 380 New York Street, Redlands, CA 92373-8100, USA.

The information contained in this document is subject to change without notice.

#### U.S. GOVERNMENT RESTRICTED/LIMITED RIGHTS

Any software, documentation, and/or data delivered hereunder is subject to the terms of the License Agreement. In no event shall the U.S. Government acquire greater than RESTRICTED/LIMITED RIGHTS. At a minimum, use, duplication, or disclosure by the U.S. Government is subject to restrictions as set forth in FAR §52.227-14 Alternates I, II, and III (JUN 1987); FAR §52.227-19 (JUN 1987) and/or FAR §12.211/12.212 (Commercial Technical Data/Computer Software); and DFARS §252.227-7015 (NOV 1995) (Technical Data) and/or DFARS §227.7202 (Computer Software), as applicable. Contractor/Manufacturer is Esri, 380 New York Street, Redlands, CA 92373-8100, USA.

©Esri.com, 3D Analyst, ACORN, ADF, AML, ArcAtlas, ArcCAD, ArcCatalog, ArcCOGO, ArcData, ArcDoc, ArcEdit, ArcEditor, ArcEurope, ArcExplorer, ArcExpress, ArcGIS, ArcGlobe, ArcGrid, ArcIMS, ARC/INFO, ArcInfo, ArcInfo Librarian, ArcInfo—Professional GIS, ArcInfo—The World's GIS, ArcLocation, ArcLogistics, ArcMap, ArcNetwork, ArcNews, ArcObjects, ArcOpen, ArcPad, ArcPlot, ArcPress, ArcQuest, ArcReader, ArcScan, ArcScene, ArcSchool, ArcSDE, ArcSdi, ArcSketch, ArcStorm, ArcSurvey, ArcTIN, ArcToolbox, ArcTools, ArcUSA, ArcUser, ArcView, ArcVoyager, ArcWatch, ArcWeb, ArcWorld, ArcXML, Atlas GIS, AtlasWare, Avenue, Business Analyst Online, BusinessMAP, Community, CommunityInfo, Data Automation Kit, Database Integrator, DBI Kit, EDN, Esri, Esri—Team GIS, Esri—The GIS Company, Esri—The GIS People, Esri—The GIS Software Leader, FormEdit, Geographic Design System, Esri BIS, Geography Matters, Geography Network, GIS by Esri, GIS Day, GIS for Everyone, GISData Server, JTX, MapBeans, MapCafé, MapData, MapObjects, Maplex, MapStudio, ModelBuilder, MOLE, NetEngine, PC ARC/INFO, PC ARCPLOT, PC ARCSHELL, PC DATA CONVERSION, PC STARTER KIT, PC TABLES, PC ARCEdit, PC NETWORK, PC OVERLAY, PLTS, Rent-a-Tech, RouteMAP, SDE, Site-Reporter, SML, SourcebookAmerica, Spatial Database Engine, StreetEditor, StreetMap, Tapestry, the ArcAtlas logo, the ArcCAD logo, the ArcCAD WorkBench logo, the ArcCOGO logo, the ArcData logo, the ArcData Online logo, the ArcEdit logo, the ArcEurope logo, the ArcExplorer logo, the ArcExpress logo, the ArcGIS logo, the ArcGIS Explorer logo, the ArcGrid logo, the ArcIMS logo, the ArcInfo logo, the ArcLogistics Route logo, the ArcNetwork logo, the ArcPad logo, the ArcPlot logo, the ArcPress for ArcView logo, the ArcPress logo, the ArcScan logo, the ArcScene logo, the ArcSDE CAD Client logo, the ArcSDE logo, the ArcStorm logo, the ArcTIN logo, the ArcTools logo, the ArcUSA logo, the ArcView 3D Analyst logo, the ArcView Business Analyst logo, the ArcView Data Publisher logo, the ArcView GIS logo, the ArcView Image Analysis logo, the ArcView Internet Map Server logo, the ArcView logo, the ArcView Network Analyst logo, the ArcView Spatial Analyst logo, the ArcView StreetMap 2000 logo, the ArcView StreetMap logo, the ArcView Tracking Analyst logo, the ArcWorld logo, the Atlas GIS logo, the Avenue logo, the BusinessMAP logo, the Community logo, the Data Automation Kit logo, the Digital Chart of the World logo, the Esri Data logo, the Esri globe logo, the Esri Press logo, the Geography Network logo, the MapCafé logo, the MapObjects Internet Map Server logo, the MapObjects logo, the MOLE logo, the NetEngine logo, the PC ARC/INFO logo, the Production Line Tool Set logo, the RouteMAP IMS logo, the RouteMAP logo, the SDE logo, The World's Leading Desktop GIS, Water Writes, www.Esri.com, www.Esribis.com, www.geographynetwork.com, www.gis.com, www.gisday.com, and Your Personal Geographic Information System are trademarks, registered trademarks, or service marks of Esri in the United States, the European Community, or certain other jurisdictions.

Other companies and products mentioned herein may be trademarks or registered trademarks of their respective trademark owners.

**Since 1969**, Esri has been giving customers around the world the power to think and plan geographically. The market leader in geographic information system (GIS) solutions, Esri software is used in more than 300,000 organizations worldwide including each of the 200 largest cities in the United States, most national governments, more than two-thirds of Fortune 500 companies, and more than 5,000 colleges and universities.

Esri applications, running on more than one million desktops and thousands of Web and enterprise servers, provide the backbone for the world's mapping and spatial analysis. Esri is the only vendor that provides complete technical solutions for desktop, mobile, server, and Internet platforms. Visit us at [www.esri.com](http://www.esri.com).

### Contact Esri

1-800-GIS-XPRT (1-800-447-9778)

Phone: 909-793-2853

Fax: 909-793-5953

[info@esri.com](mailto:info@esri.com)

[www.esri.com](http://www.esri.com)



380 New York Street  
Redlands, CA 92373-8100 USA