Forestry GIS Journal

GIS for Forestry and Timberland Management

Forestry Tasmania Combines GIS and Lidar to Model Canopy Height

By Allyson Lawson, ESRI Writer

Forestry Tasmania employees input lidar data into a geographic information system (GIS) to model and map forests located on Australia's southern island state of Tasmania. While they were analyzing tree health, canopy density, and standing timber volumes, they discovered the world's tallest standing hardwood tree.

Foresters measured the Goliath eucalyptus, nicknamed Centurion, at 99.6 meters in height and 405 centimeters in diameter. California coast redwood trees still maintain the record as the world's highest trees, the tallest of which reaches 115 meters.
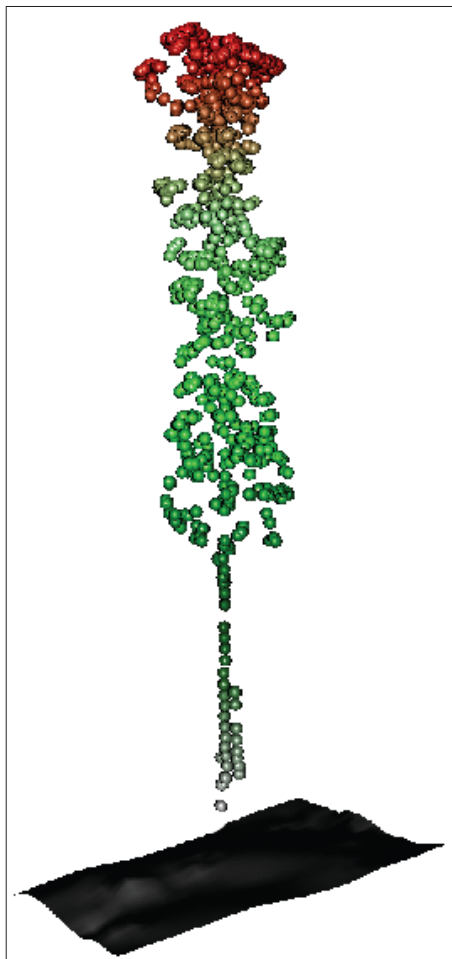
Lidar, short for light detection and ranging, is an optical remote-sensing technology that uses laser pulses (strikes) to measure the properties of scattered light to find range or other information about its target. Like radar technology, which uses radio waves instead of light, lidar determines the range to an object by measuring the time delay between transmission of a pulse and detection of the reflected signal.

When a plane equipped with lidar sensors flies over forests and other vegetation, some laser strikes penetrate the canopy and reflect off the ground, while other strikes reflect off vegetation such as trees and shrubs. Engineers separate vegetation strikes and use GIS to process the remaining strike data to create digital elevation models (DEMs) of floor and canopy heights. These models provide them with three-dimensional visualizations of the terrain and the forest.

"Lidar promises to revolutionize forest mapping and inventory," says Martin Stone, resources manager, Forestry Tasmania. "With traditional aerial photography, accurate pho-

Lidar and GIS technologies are used to create this three-dimensional model of the enormous eucalyptus tree.

togrammetry is impossible when the ground is obscured, so we were reliant on skilled but subjective manual interpretation. Lidar provides more accuracy to data for creating visualizations of our forest."

Passive satellite imagery relies on statistical inference that has relatively low reliability at operational scales. This method leaves foresters guessing about the terrain lying under dense vegetation. Conversely, lidar is an active sensor. It directly measures forest and terrain variations accurately and repeatedly. The lidar-based ground DEMs precisely reveal streams and contours in great detail.

The forestry staff uses lidar data and ESRI's ArcGIS to model and map forest features such as tree height, canopy density, and standing timber volumes. It is effective even if the forest cover is highly variable. Forestry Tasmania managers claim that the system enables them to plan access roads, cable harvesting, and silvicultural activities. ArcGIS helps them easily delineate harvest boundaries, improve planning methods, better estimate environmental

ESRI News

Domtar to Enhance Forest Operations Management with ESRI Technology

By Joy Chan, ESRI Canada Limited

Domtar's Forest Products Group in Toronto, Ontario, Canada, has signed an enterprise license agreement (ELA) with ESRI Canada Limited. The ELA allows Domtar to expand its usage of ESRI's GIS solutions, gain better operational visibility, and enhance forest operations management.

The system will help Domtar manage its harvesting activity to protect forest values such as fish and wildlife, flora, water resources, tourism, and natural heritage and manage assets such as bridges, culverts, and roads. Domtar also uses GIS to support third-party forest certification, regulatory reporting, and public consultation with external stakeholders for forest management planning.

"Businesses with complex operations need solutions that can help them gain better visibility and control over their activities and reduce their environmental impact," said James Wickson, vice president of ESRI Canada's sales and professional services. "ESRI's leading GIS technology provides the capability to produce a comprehensive picture of Domtar's operations in real time, enabling staff to make critical decisions quickly and effectively."

The ELA provides customers with affordable, unlimited access to ESRI software, maintenance, services, and training. It also allows them to leverage the latest version of ESRI's ArcGIS software suite, which provides comprehensive functionality for authoring, managing, and sharing geographic information on servers, desktops, and mobile devices as well as over the Web. ArcGIS helps organizations increase operational efficiency, improve communication, and enhance decision making.

For more information on ESRI ArcGIS, visit www.esricanada.com/products/arcgis. For more information about ESRI Canada's ELA program, contact your nearest ESRI Canada regional office.

ESRI Career Opportunity

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Use your consulting and project management experience in the natural resources and environmental markets to help clients transform real-world needs into state-of-the-art, GIS technology-driven solutions. This is a challenging opportunity to lead project teams and manage the entire GIS implementation process. Learn more and apply at www.esri.com/careers/consulting.

Forestry Tasmania Combines GIS and Lidar to Model Canopy Height

outcomes, efficiently maintain timber inventories, and accurately map the forest's spatial variation.

Lidar forest inventory datasets are quite large. An average of two lidar strikes per square meter of forested land is captured. This is a lot of data to store and process. Forestry Tasmania's data management system includes an Oracle Spatial relational database. The data in Oracle is efficiently replicated to a separate geodatabase, where ESRI's ArcGIS Desktop is used to perform advanced geoprocessing and analysis on it. The output is a range of derived products that can be published as GIS layers such as DEMs, timber volume surfaces, contours, and drainage lines.

"Our organization has become spatially aware, and everyone uses GIS in some form, especially in the field offices," says Luke Ellis, GIS manager for Forestry Tasmania. "Our employees regularly use ArcGIS to browse and query data and publish maps. We use it to per-

form everyday work tasks such as processing lidar data, modeling and analyzing the state of the forest, computing statistics for spatial analysis, monitoring sustainability indicators for annual reporting, and visualizing our forest's attributes."

GIS gives foresters a better picture of what resides in the forest, such as the very special Centurion tree. The tree has lived in the forest for 400 years and survived recent threats such as logging operations in the 1950s and two massive wildfires, one in 1934 that passed just to the west of the tree and another in 1966 on its east side.

"No one was looking out for the tree in those days," Stone remarks. "We didn't know it was there. But thanks to lidar and GIS, it now has a name and is, literally, on the map." Centurion has been formally classified as a giant tree, and the area surrounding it has been designated as a protected reserve.

Imagery: A Core Component of GIS

By Lawrie Jordan, ESRI Director of Imagery Solutions

Several years ago, ESRI launched a major program to enhance support for the use, exploitation, and analysis of imagery across its product line. This began with the introduction of ArcGIS Image Server, a product that allows users to manage and disseminate vast quantities of imagery quickly and easily. This technology has continued to mature, and last year it became an extension to ArcGIS Server. At the same time, image services, which optimize the delivery of imagery over the Web, were built into the core ArcGIS Server product.

In the next version, ArcGIS 10, ESRI will continue to integrate image services and, at the same time, improve the performance and capabilities of all its products with regard to imagery. Its desktop product will include basic image analysis with focused imagery tools and

fast image display capabilities. This will allow intuitive and high-performance capabilities for navigating imagery integrated with map displays. ESRI is improving its image data modeling, management, and visualization and adding dynamic analytic tools in a way that supports the typical workflows associated with geospatial imagery.

With the additional imagery capabilities in ArcGIS 10, ESRI is making imagery a fundamental component of ArcGIS. ESRI's strategy for providing increased imagery support includes highly scalable image data management, new desktop image display and analysis tools, and the ability to leverage the strengths of key technology partners.

Learn about ESRI products at www.esri.com/products.

GIS Tree Inventory Project Aids Park Improvement Plan

In the heart of Houston, Texas, is Hermann Park. The 445-acre park is home to a zoo, outdoor theater, outdoor railroad, garden center, and golf course that provide Houston's citizens and visitors with a beautiful place to enjoy the day. To improve park grounds, the Hermann Park Conservancy (HPC), a nonprofit citizens' organization, is using GIS to enhance and maintain the park.

HPC has used ArcGIS software as part of its ongoing tree inventory project. The goal of the project is to record information on the species, diameter, and location of every tree in the park. The user can visualize this digitized

A summer intern captures data to include in a city park GIS tree inventory project.

geographic data on maps and use it for planning park maintenance and improvement.

With a notebook, pen, handheld Garmin 60CSx GPS unit, and measuring tape, summer interns have surveyed nearly the entire park and are continually updating the inventory when old trees are removed or new trees are planted.

After uploading the inventory information as a layer in ArcGIS, the interns created maps that aid in tree maintenance. Map outputs include the distribution of different species, the sites of the park's most valuable trees, the spread of invasive species, and the locations of dead trees that need to be removed. This information is used to make informed decisions on the best locations for planting sites

that will enhance the park's biodiversity and preserve its canopy cover. HPC has also produced GIS maps that show the species and diameter distribution in each of the park's pruning divisions and zones to aid pruning contractors in estimating the cost of a project.

With ArcGIS, HPC has been able to expand its inventory project to include information on all park structures, including buildings, sculptures, parking lots, paths, the tracks of the miniature train, and user amenities such as trash cans and picnic tables. HPC hopes to eventually use this information in conjunction with the tree inventory data to create a complete picture of the park and its offerings to the public. HPC has used these additional layers to create maps of newly completed construction projects showing trees, buildings, planting structures, and every new amenity installed for public use.

ArcGIS provides an invaluable tool for assessing the results of completed park improvement projects and planning new ones.
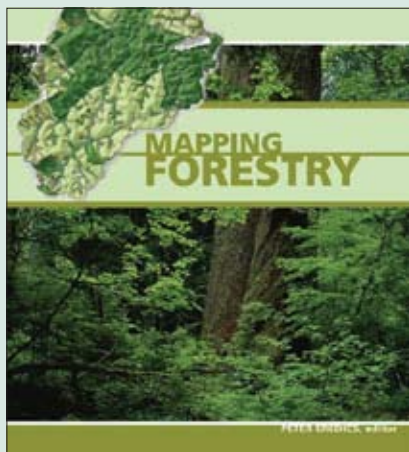
Thanks to Barbara Jo Harwell, conservation director, Hermann Park Conservancy, for sharing this story.

Learn more about ArcGIS at www.esri.com/arcgis.

Mapping Forestry

A beautiful set of maps and descriptions created by people working in the forestry industry from around the world is presented in the ESRI Press book *Mapping Forestry.* From logging feasibility to operations management to sustainability planning applications, GIS increases productivity and efficiencies. *Mapping Forestry* highlights GIS-produced forestry maps developed for a full range of research, planning, and operational forestry activities. In addition to maps and descriptions, contributors offer recipes for map-building success for you to follow in creating similar GIS projects.

Editor: Peter Eredics
ESRI Press, 2010
80 pages, $39.95
ISBN: 978-1-58948-209-8

GIS for Forest Carbon Management— Free Booklet Download

Foresters, policy makers, and businesses are using GIS to measure and support the forest's natural ability to clean carbon dioxide (CO_2) emissions from earth's atmosphere and reduce the greenhouse effect on climate change. Download this free ESRI Best Practices PDF to read GIS case studies about GIS for forest carbon management at www.esri.com/library/bestpractices/forest-carbon-management.pdf.

GIS Featured at Australasian Forestry Conference

GIS was a featured technology at the ForestTECH 2009 conference in New Zealand. Peter Eredics, ESRI's forestry solutions manager, showcased groundbreaking GIS applications for the forest industry. In recent years, the role of GIS has evolved from merely a stand inventory tool to a full enterprise solution. Eredics, a world-renowned forestry geographic technologies authority, showcased real-world forestry applications such as forest management systems, field data collection solutions, and image management tools.

The Forest Industry Engineering Association (FIEA), which hosts ForestTECH, uses the venue to further its goal of transferring new technology to wood product and forest management companies in the Australasian region. More than 200 forestry managers, forest owners, technical foresters, forestry consultants, plantation forestry researchers, and key suppliers to Australian and New Zealand forestry companies attended the New Zealand and Australian event in November 2009. Attendees of Eredics' presentation gained a wider understanding of the technologies that will assist them in making key operational, planning, and strategic decisions.

Eagle Technology Group, Ltd. (www.eagle.co.nz/gis), ESRI's distributor in New Zealand, supports ForestTECH alongside a number of New Zealand ESRI business partners including Explorer Graphics Ltd, Geographic Business Solutions Ltd., and ATLAS Technology.

Learn more about ForestTECH at www.foresttechevents.com.

Peter Eredics, ESRI's Forest Solutions Manager

Use GIS for a Science-Based Approach to Carbon Sequestration Assessment

Allowing the earth's forests to thrive and do their job of carbon sequestration is essential to reducing the threat of climate change. Technology offers hope to the greenhouse phenomenon caused by industrial society. One such technology is ESRI's ArcGIS, which offers scientists, decision makers, and policy implementers a critical tool for obtaining and using information they need for healing our planet. GIS allows temporal climate data to be visualized, contrasted, and forecasted. Use it to study current land use, land-use change, and what-if scenarios for responsible planning. Turn to ArcGIS for

- **Robust imagery management**—Handle hundreds or thousands of files. Publish image services that you get directly from your source imagery. Fast access functionality quickens imagery data retrieval and lowers bandwidth requirements.

- **Geospatial metadata**—Document how, when, where, and by whom the data was collected; information on its availability and distribution; its projection, scale, resolution, and accuracy; and its reliability.

- **Multiple imagery management**—Use robust imagery capability formats; projections; and resolution from multiple sources, such as ground truthing data, for assessment that goes beyond satellite imagery.

- **Integration**—Use many management systems to broaden analysis solutions.

- **Spatial modeling and analysis**—Analyze cell-based raster data, perform integrated raster/vector analysis, derive new information from existing data, query information across multiple data layers, and fully integrate raster data with traditional vector data sources.

- **Spatial data exploration using sophisticated statistical methods**—Create a surface from limited data measurements in situations in which extensive data collection is impractical or impossible.

- **Infrastructure that supports sharing**—Share data across disciplinary boundaries that span the environmental and social science fields. Better analyze the cross-sector studies of a symbiotic relationship between climate change, sustainable development, and the conservation of natural resources.

The robust functionalities provided by ArcGIS help scientists gain a better understanding of the structure and content of geographic information and ensure proper model specification and validation. ArcGIS also provides governments with methodologies to make decisions and employ solutions for a better world.

ESRI International User Conference Supports Foresters

ESRI invites foresters and timberland managers to the ESRI International User Conference. See how GIS improves the efficiency of your forest service operations, from tree inventory to roads development to contract management and sustainable forest compliance.

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 and Data Layers Support Sustainable Forest Management in North Rhine-Westphalia

By Frank Franken and Dr. Stefan Franz

To sustainably manage Germany's North Rhine-Westphalia (NRW), forest owners and administrators use ArcGIS to study forest conditions and surrounding infrastructure. GIS helps them identify areas that are most suitable for industrial timber production and make informed decisions for sustainable forest management.

NRW has approximately 900,000 hectares of private and municipal forestland next to a high-density population (18 million people). To support the region's forestland owners, Landesbetrieb Wald und Holz NRW (LWH) provides comprehensive maps about the conditions and infrastructure related to forestry property. The staff uses GIS to describe its forest management recommendations.

LWH analysts designed a model for visualizing the resource utilization potential of forests. The model gives forest owners an overview of four important aspects of their forest lands: operating limitations for harvesting and transportation equipment, physical soil stability, resource development, and biomass productivity. LWH maintains a forestry database from which it creates different types of maps available for the whole federal state of NRW. Here are descriptions of these maps using the example of National Park Eifel:

Forest Resource Development map—GIS reveals forest areas that are accessible to logging trucks and harvesting equipment throughout the year. The ArcGIS Spatial Analyst extension was used to calculate cost distance and optimum travel corridors. Moreover, it factored in travel obstacles within the road network to generate a true cost evaluation. This map is a combination of two data layers: a wooded area timber inventory and forestland locations that are accessible for hauling logs in all seasons.

Class	Attributes
1	Accessible
3	Not Accessible

Slope Classes for Trafficability map—Forestry machines such as feller bunchers, harvesters, skidders, forwarders, and loaders can operate only on specific terrains. The steeper the forest, the less likely that machines can operate safely. Analysts used GIS to examine a gridded digital elevation model (DEM) of the area and create the map. Three classes were differentiated as follows:

Class	Slope	Attributes
1	0–10%	Accessible
2	11–35%	Limited Access
3	>35%	Not Accessible

Physical Stability map—Bulk density is a measure of the weight of soil per unit volume, which is used to describe the porosity and moisture retention of the soil. Analysts created a soil stability map that shows the values of bulk density and soil types. GIS makes it easy to see on this map areas that have similar soil makeup characteristics. For the purposes of this analysis, soil types are classified as the following:

Class	Attributes
1	Accessible
2	Limited Access
3	Not Accessible
9	Anthropogenic

Potential Biomass Productivity map—This map contains hydrologic requirements of forest vegetation from climatologic data and water datasets derived from the soil map. This is essential for high timber yields.

Class	mm	Attributes
1	≥ 36	High-Productive Area
2	-90–<36	Productive Area
3	<-90	Low-Productive Area

forest resource development
- accessible (green)
- not accessible (red)
- border of national park
- not wooded
- rivers
- lakes

physical stability of soil for forest machines
- accessible (green)
- limited accessible (yellow)
- not accessible (red)
- anthropogenic (black)
- border of national park
- not wooded
- rivers
- lakes

0   3.100

slope classes for trafficability

- accessible
- limited accessible
- not accessible
- border of national park
- not wooded
- rivers
- lakes

potential biomass productivity

- high-productive area
- productive area
- low-productive area
- area with pseudogley
- border of national park
- not wooded
- rivers
- lakes

Scale: 1: 230.000

Publisher:
© Landesbetrieb Wald und Holz Nordrhein-Westfalen

© Geobasisdaten: Land NRW, Bonn
© Geologische Daten: GD NRW, Krefeld
© Forstliche Geodaten: LWH NRW, Münster

S. Franz, F. Franken   Date: 07.04.2008

Landesbetrieb Wald und Holz
Nordrhein-Westfalen

6.200   9.300   12.400
                                   meters

Four Forest Functions to Determine the Utilization Potential of Forests

Each of these GIS-generated maps helps LWH convey forest information in an easy-to-understand way, thereby improving forest managers' decisions. Data layers for individual forest maps were combined to create a comprehensive map (page 8). LWH added analysis to the map classes by assigning priority ratings according to importance and significance levels. GIS then incorporated these priorities into the maps.

The map output from this model is the resource utilization potential of forests, which shows area-to-timber priority levels along with jurisdictional boundaries and rivers.

Class	Range	Utilization
1	1–1,4	Timber Production: High Priority
2	1,41–1,8	Timber Production: Priority
3	1,81–2,2	Timber Production: Potential Priority
4	2,21–2,6	Timber Production: No Priority
5	2,61–3,0	Other: Nature Conservation or Landscape Protection
X	> 3,0 or < 1,0	Anthropogenic Influenced Soil: No Conclusion Possible

Learn more about ArcGIS and the ArcGIS Spatial Analyst extension at www.esri.com/arcgis.

Contact the authors: Frank Franken, Hessen-Forst FENA, Gießen, Germany (e-mail: frank.franken@forst.hessen.de), or Dr. Stefan Franz, Landesbetrieb Wald und Holz NRW, Münster, Germany (e-mail: stefan.franz@wald-und-holz.nrw.de.

Forest Service's GIS Web Server Speeds Enterprise-wide Map Access and Production

Used by the U.S Department of Agriculture Forest Service (USFS), FSTopo enables fast production and maintenance of basemap products covering the lands managed by USFS. Built on ArcGIS Server and ArcIMS, FSTopo provides the enterprise with GIS Web services and portal functionality that let users access basemaps anytime from any USFS computer.

To create FSTopo, ESRI's Professional Services deployed ArcGIS Server and ArcIMS. The database-driven system enables on-the-fly generation and downloading of large-scale topographic maps. The Web-based interface allows users to browse and select data, then produce the desired map.

The USFS Geospatial Service and Technology Center (GSTC) is responsible for producing and disseminating geospatial data and manages the FSTopo system. GSTC reports that FSTopo is able to quickly meet production requirements. Staff can make minor changes and respond to customers much faster. In contrast to previous work with a film-based workflow, the turnaround time for minor revisions has been reduced from more than 10 years to approximately 3–6 months. Moreover, the costs and overhead associated with film-based printing have been eliminated. The FSTopo site provides 365/24/7 access to USFS users.

For more information, contact Byron Taylor, GSTC project manager, USFS (e-mail: btaylor01@fs.fed.us), or Shree Rajagopalan, ESRI (e-mail: srajagopalan@esri.com).

GIS and Data Layers Support Sustainable Forest Management in North Rhine-Westphalia

The North Rhine-Westphalia utilization map prioritizes areas for timber productivity. This map makes it easy for responsible forest owners to quickly understand land-use options for a range of timber production priorities.
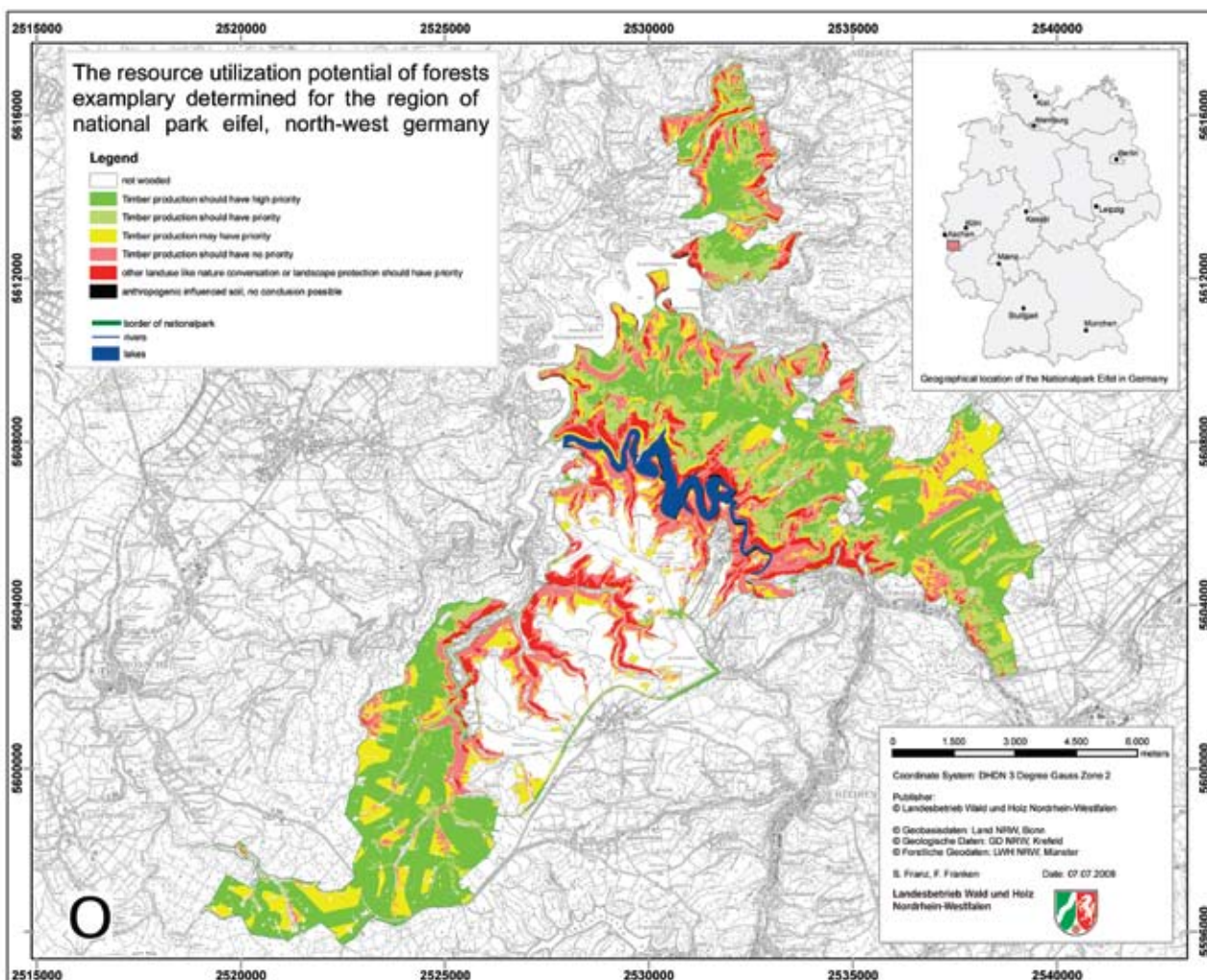
Urban Ecologist Uses GIS to Study Urban Forestry, Natural Systems, and Human Networks

By Barbara Shields, ESRI Writer

Gary Moll studies natural systems.

An advocate of using technology to integrate human and natural systems, Gary Moll has been a force in bringing the value of urban ecology to the attention of federal and local leaders. Moll is the senior vice president of the Urban Ecosystem Center at American Forests and is one of the nation's foremost authorities on urban forestry and urban ecosystems.

Along his life path as a conservationist, Moll has successfully worked with Congress to increase funding for urban forestry and with the U.S. Forest Service (USFS) to expand urban forestry programs to 50 states. His work in the development of GIS software program CITYGreen helps local governments measure urban forests and harness their benefits.

"The human network needs to be built with the natural system in mind," posits Moll. "Urban forests and green infrastructure are part of the city ecosystem. GIS shows the relationships between social and ecological systems and offers a means for us to weave the city structure into the natural system."

Moll and his team developed the ArcGIS extension CITYGreen. This program makes it possible for local communities to calculate the functions of their natural system, attach dollar values to storm water and air quality, and use this information to make better decisions about managing their communities.

Here is how it works. CITYGreen users classify remotely sensed data (satellite or aerial imagery) along with climate data from the National Oceanic and Atmospheric Administration (NOAA) and soils data from the Natural Resources Conservation Service (NRCS). This data drives the scientific and engineering models that produce accurate measurements of how land cover affects the movement of air and water in a particular place. Once these volumes or quantities are

	1986	2001	2008	Percent Change		
				1986–2008	1986–2001	2001–2008
Open Space	187.20	210.89	181.92	-2.90	11.23	-15.92
Trees	212.49	161.67	142.74	-48.86	-31.43	-13.26
Urban	126.90	155.18	202.69	37.39	18.22	23.44
Water	23.10	21.94	22.34	-3.40	-5.25	1.76

This table indicates that Mecklenburg's urban growth occurred at the expense of trees, as opposed to open space conversion in the more distant suburbs.

known, they are converted to dollar estimates that decision makers can use. The software includes models for storm water, air pollution, carbon storage and sequestration, land-cover breakdown, and alternate scenarios. Based on a current land-cover map, the Alternate Scenario model calculates the effects of future land-cover change before those changes are made.

For example, Mecklenburg County, North Carolina, was the subject of a land-cover assessment that used CITYGreen. The county has undergone enormous growth in population. From 1984 to 2001, the county saw a 127 percent increase in areas covered by impervious surfaces (streets, parking lots, etc.). Moll's research team used Landsat imagery, high-resolution aerial imagery, and GIS to assess the region. They then calculated storm water runoff and air quality benefits of the tree cover in the city of Charlotte and the county as a whole.

Recently, Moll and his team studied the Piedmont Crescent, which lies north of Birmingham, Alabama; extends up into southern Virginia; and includes areas within North and South Carolina, the Appalachian Mountains, Tennessee, and Kentucky. The task to collect the data and maps about the region's many different systems was long and, at times, tedious. Using GIS to analyze data from the USGS, NOAA, USFS, the Census Bureau, and the Army Corps of Engineers, the team found the area to be much different than expected. Ninety-nine percent of the southern forest of the Piedmont area is gone, and 93 percent of the forest of the Smoky Mountains is gone. The system is in total disarray. These findings

have been published in the map book *Piedmont Crescent.* One of the study's biggest surprises was that all of the thousands of rivers in the Piedmont Crescent area had been altered—every single one. In reality, the area is not a natural system but actually an unnatural one.

A complex question is, If expansion of the human network is inevitable, how do we manage its impact? It is important to determine ways in which the human network can move through these places without destroying them. Questions need to be asked: What economic and social patterns are driving the development of a region? Where are the transportation corridors? Where are the economic corridors? What metro areas are nearby? How are they linked? How is expansion and change happening? How do air and water move through these ecosystems?

"The solution to building better communities in the future lies in learning how to interact the natural system with the human network," advises Moll. "The first step is to understand how the natural system functions, and the second is to understand the human network's real needs. GIS technology can help people understand how the two will interact and help guide them to better decision making."

Read more about American Forests at www.americanforest.org. Download a free PDF version of the booklet 2009 Co-Evolution at www.americanforest.org/Co-Evolution. Contact Gary Moll by e-mail at gmoll@amfor.org.

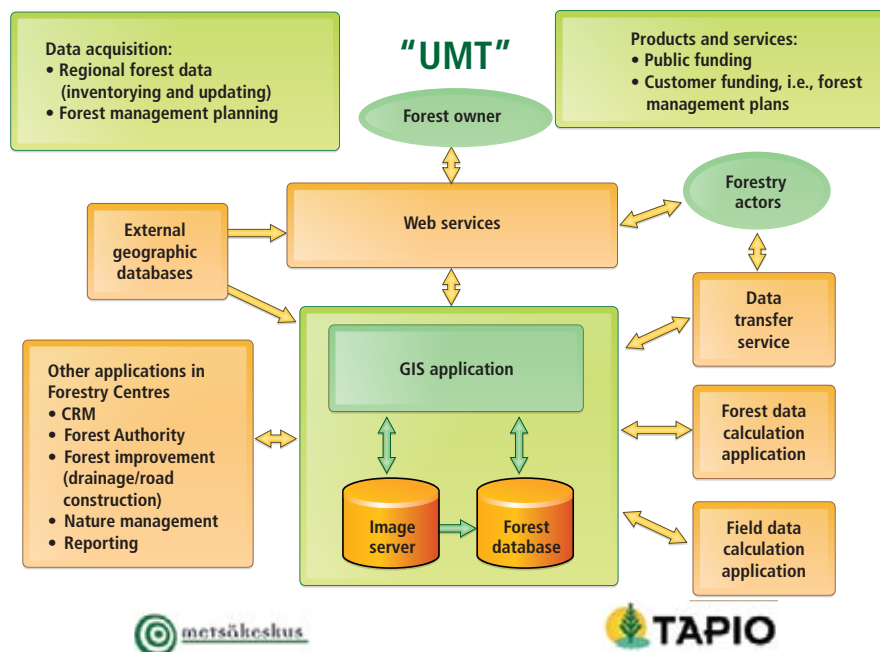# GIS Forestry Tool Lowers Costs of Finnish Forest Management

Forestry Development Centre Tapio of Finland is using ESRI's ArcGIS software and a solution designed by Tieto, an ESRI business partner, to meet Forestry Centres' goal to decrease forest inventory costs by 40 percent. The solution is designed to improve productivity, cost efficiency, and cooperation between organizations, including data procurement and two-way dataflow. It will also increase customer use of Forestry Centre services and advice.

Working with Finland's Ministry of Agriculture and Forestry, Tapio supports forest management planning for the country's 13 regional Forestry Centres by providing them with information systems. To make operative planning more effective, Tapio deployed Tieto's solution, which is built on ArcGIS, ESRI's GIS software. ArcGIS has been used to support forest management solutions for decades. The system enables Forestry Centres to maintain an up-to-date, high-quality forest resource database for the entire country.

"GIS makes geographic information easier to use and increases the value of the data produced by Forestry Centres and other organizations," says Kirsi Valanne, geographic information specialist at Tapio. "Eventually, we will expand the system to support other operations performed by Forestry Centres."

Built on ArcGIS, Tapio's project facilitates data procurement and delivers two-way dataflow between Finland's forestry centers.

ESRI and Eagle's Forestry ELA Reduces Software Costs

ESRI and its New Zealand software distributor Eagle Technology Group, Ltd., have launched the New Zealand Small Forestry Enterprise License Agreement (ELA) program. The agreement offers forestry companies access to ESRI software, maintenance, and training for a set annual fee based on hectares of land under management/ownership. An ELA strengthens program delivery by extending the functionality of the ArcGIS platform throughout the entire organization. This means that foresters can build a standard service infrastructure within existing budget constraints while saving time on procurement and applications development, release, and deployment. Contact a forestry representative at www.esri.com/forestry/contacts.html or www.eagle.co.nz/gis.

Finland is a significant contributor to the world's commercial production of sawn goods and pulp production. With 66 percent of Finland's land use dedicated to productive forests, Forestry Centres have a lot of data to manage. Tapio project manager Henry Schneider notes, "With this new system, Forestry Centres can increase the amount of annually collected forest resource data and, at the same time, reduce the costs of data collection per hectare." The new GIS is designed to support a new concept for field data procurement based on laser scanning and aerial photographs. This dramatically reduces the need for fieldwork.

Each Forestry Centre provides information that plays a key role in promoting regional development projects, building cooperation between forest organizations, and counseling forest owners. Tapio's GIS will enhance this ability via a centralized database that contains forest resource and management planning data. This includes proposed cuttings and silvicultural work; key biotopes required by the Forest Act; cadastral data; aerial photographs; laser scanning data; and external geographic data such as topographic maps, groundwater areas, protected areas, and prehistoric monuments.

Tapio anticipates that 400 users will interact with the data. Eventually, Tapio hopes to expand the user group to 850 people, who will access GIS for forestry law supervision, forest extension service (through public funding), forest management planning, and forest improvement projects.

The client application is built on ArcGIS Desktop tools. An Oracle database is connected by ArcGIS Server using SQL*Net (or Net8) protocol. GIS interfaces with Tapio's PDA field data collection program, forest data calculation application, customer relationship management (CRM) system, financial management applications, and data transfer service. Users will be able to connect to map servers via the Internet.

Tieto has full responsibility for the delivery of the project. Its strong experience in implementing large geographic information solutions and its in-depth knowledge about the wood-processing value chain will aid the development and implementation of this project. ESRI's distributor ESRI Finland Oy is providing the GIS software for the project via an enterprise license software purchasing agreement as well as maintenance, support services, and training.

Find out more by visiting www.tapio.fi/home and www.Tieto.com.

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). It uses 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.

In a national announcement, Guyana's president, Bharrat Jagdeo, described the goal of LCDS: "Our low-carbon strategy combats deforestation, a factor contributing to climate change, without slowing down national development or compromising our people's sovereignty over the forest. The emerging carbon market provides us with a unique opportunity to use the global economy to save the world's rain forests by putting a value on them."

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

"ESRI's commitment brings vital technology for studying the effects of the forest on the planet," said Jagdeo. "The combination of GIS software, training, and other capacity-building efforts will provide Guyana with the tools it needs to scientifically measure and analyze our natural resources effectively. With GIS, we can support responsible resource management decisions that benefit generations to follow."

"ESRI's support stems from a longtime goal to advance sustainable environments and economies," noted Dangermond. "GIS has become an integral component in the development of new carbon accounting methodologies. It adds the rigor of science to a decision support system that validates a credible carbon exchange mechanism."

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

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

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 system 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 will have an MRV system for data sharing and the cross-sector analysis that is essential for effective climate change research, mitigation, and adaptation planning. This enterprise approach enables the transparent disclosure of land-use dynamics and the status of natural resources for Guyana's citizens, indigenous communities,

investors, partners, and the international carbon science community.

ESRI continues to work with countries around the world, such as New Zealand, Australia, Canada, and the United States, to design solution models that offer a credible scientific approach to measuring, reporting, and verifying carbon emissions and sequestration. These systems incorporate ESRI's robust imagery management, integrated workflows, spatial modeling, and analysis capabilities to help countries use reliable data and consider scientific evidence in their decision-making processes.

Jagdeo presented Guyana's LCDS at the 2009 United Nations Climate Change Conference in Copenhagen, Denmark. Representatives of participating nations also discussed establishing emissions targets for industrialized countries and a method for financing mitigation and adaptation actions by developing countries.

Forestry GIS Journal is a publication of
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